



P-604
ELECTRICAL - SAFE ACTS FOR
EMPLOYEES (E-SAFE)

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VERSION HISTORY

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FORWARD

This Electrical – Safe Acts for Employees (E-SAFE), P-604, is the electrical safety program and procedures for NAVFAC employees and was developed to comply with the National Fire Protection Association (NFPA) 70E, “Standard for Electrical Safety in the Workplace” and UFC 3-560-01, “Operations and Maintenance: Electrical Safety.” As Technical Authority for the Navy on electrical systems, this E-SAFE was developed to provide safe procedures for electrical work. This document presents the principles to minimize and/or eliminate hazards when working on exposed energized electrical circuits, to utilize PPE and other equipment to mitigate potential electrical hazards, to provide written guidance and training in support of a safe working environment, and to promote safe Standard Operating Procedures. This E-SAFE codifies processes for electrical safety throughout NAVFAC in order to ensure the safety of our workers and the effective operations of the Navy’s shore electrical systems, which directly support readiness and play a vital role in increasing lethality.

Compliance with this publication is mandatory across the Navy, both inside and outside the US, and is applicable to all in-house employees. Although contract employees follow company policies for Lock-Out/Tag-Out, compliance with Ship-To-Shore procedures in this document are mandatory for all personnel working on ship-to-shore power. This E-SAFE is intended to be both a resource and a training tool used in conjunction with local SOPs.

The E-SAFE, P-604, has been published as Version 1.0. It will be updated as necessary to reflect technology improvements, policy & accounting system changes, and other drivers. The point of contact for all questions is Patrick Connor at NAVFAC HQ, PWBL UM (Patrick.t.connor@navy.mil, 202-685-9245).



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Assistant Commander for
Public Works

NEW DOCUMENT SUMMARY SHEET

Document: ELECTRICAL SAFE ACTS FOR EMPLOYEES, P-604

Superseding:

- Electrical SAFE PWBL SAFE 01 dated March 2010
- Naval Engineering Training and Operating Procedure and Standard (NETOPS) #29, "Shore-To-Ship Power Connect and Disconnect Procedures" dated 06 Jan 2015.

Description: The NAVFAC Electrical Safe Acts For Employees (E-SAFE) program standardizes procedures across NAVFAC for all in-house personnel, regardless of location, to ensure our personnel are using the best possible methods to accomplish all covered electrical work.

Reasons for Document:

- Provide guidance for all aspects of electrical safety.
- Conform to UFC 3-560-01 "Operations and Maintenance: Electrical Safety".
- Standardize operating procedures

Impact: There are cost impacts associated with these requirements associated with working on exposed and enclosed energized circuits, and providing shore power that involve additional safety precautions and inspections.

However, the following benefits will be realized.

- Personnel working on electrical systems have improved guidance to ensure a safer working environment.
- Electrical systems will have improved reliability and operate more safely.

Unification Issues:

In several places in the E-SAFE, National Fire Protection Association (NFPA) 70E "Standard for Electrical Safety in the Workplace" and UFC 3-560-01 "Operations and Maintenance: Electrical Safety" are referenced.

CHAPTER 1 - ELECTRICAL SAFE ACT FOR EMPLOYEES

1.1. PURPOSE

The NAVFAC Electrical Safe Acts for Employees (E-SAFE) program standardizes Safety Standard Operating Procedures for the entire NAVFAC workforce, so that all locations are using the same methods to protect employees and conduct procedures in a defined manner, including the use of Personal Protective Equipment (PPE) and safety tags and locks. The Electrical SAFE is designed to utilize Navy's Operational Risk Management (ORM) principles and encourage a safety culture and focus on prevention and elimination of hazards. The basic principles of the Electrical SAFE program are:

- Minimize and/or eliminate working on exposed energized electrical circuits.
- Utilize PPE and other equipment to mitigate potential electrical hazards.
- Provide written guidance and training to support a safe working environment.
- Each FEC shall craft Standard Operating Procedures based on the comprehensive requirements of this E-SAFE and additional requirements necessary to satisfy local conditions.

1.2. BACKGROUND

The NAVFAC Electrical SAFE Program was developed to comply with the National Fire Protection Association (NFPA) 70E "Standard for Electrical Safety in the Workplace" and UFC 3-560-01 "Operations and Maintenance: Electrical Safety". The program is managed by the Public Works Business Line (PWBL) at the Business Line Director (BLD) level. The program is coordinated closely with the Safety Department. The E-SAFE program components do not stand alone and are designed to be implemented as a whole and in conjunction with national standards and code. The required PPE and equipment must be provided and in place in order for personnel to safely perform the processes and procedures. The training requirements outlined for personnel are updated to ensure that employees meet industry standards for electrical safety. Lockout/tagout procedures outlined in the E-SAFE are to be implemented in conjunction with the lockout/tagout procedures for non-electrical energy sources addressed by other trades.

1.3. PROCESSES

Chapters 2 through 15 are the Standard Operating Procedures (SOP's) for the Electrical SAFE Program. The documentation is primarily based on UFC 3-560-01 "Operations and Maintenance: Electrical Safety".

1.4. ABBREVIATIONS, ACRONYMS, AND DEFINITIONS

The Electrical SAFE (Chapter 1) and Standard Operating Procedures (Chapters 2 through Chapter 15) use the following acronyms and definitions.

Affected employee: An employee whose job requires him/her to operate or use a machine or equipment on which servicing or maintenance is being performed under lockout or tagout, or whose job requires him/her to work in an area in which such servicing or maintenance is being performed. ESAMS stipulates an affected employee must receive annual on the job training from their supervisor.

Arc Rated (AR) Clothing: Arc Rated clothing is designed and tested to protect against the thermal output of arc flash as expressed in a rating of cal/cm². AR clothing will only withstand arc levels to the rating that it is listed at. In addition, all AR clothing is also fire resistant.

Authorized Employee (AE): An employee who locks out or tags out machines, equipment or electrical systems in order to perform servicing, maintenance, repairs or installation on that machine, equipment or electrical system and has received Electrical SAFE training on the LOTO procedure and hazards involved. A list of Authorized Employees shall be maintained on the SOC personnel list. AEs must meet all qualifications for AEs as listed in Section 1.5.

Authorized Official (AO): An Authorized Employee, low voltage or high voltage, who has been designated by their supervisor to write switching orders. A list of Authorized Officials shall be maintained on the SOC personnel list. AOs must meet all qualifications for AOs as listed in Section 1.5.

Authorized Switch Operator (ASO): The only persons authorized to operate high voltage energy-isolating devices as designated by their supervisor. A list of Authorized Switch Operators shall be maintained on the SOC personnel list. ASOs must meet all qualifications for ASOs as listed in Section 1.5.

BLD: Business Line Director.

Business or Production Reasons: Equipment and systems to be de-energized and tagged and locked out due to inoperative/needing repair, poor efficiency, to be recycled, to be sold, waiting to be removed, waiting for parts or materials, re-scoping and re-estimating the work, waiting funds, waiting scheduling of crews or other trades and any other reasons to de-energize equipment or systems that occurs solely for the protection of the equipment or system. Business reasons for a worker stopping work include any type of leave from work.

Electrically Safe Work Condition: A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection.

Energized: Electrically connected to, or is, a source of voltage.

Energized Work: Work on or near (e.g., part of tools being used or worker's body less than restricted approach boundary) energized or potentially energized lines (i.e. grounding, live-tool work, hot stick work, gloving, and bare hand work).

Energy-Isolating Device: A mechanical device that physically prevents the transmission or release of energy, including but not limited to a manually operated circuit breaker or a disconnect switch, used to isolate electrical energy. Push buttons, selector switches and other control circuit type devices are not energy-isolating devices.

Equipotential Grounding: A method of temporary personal protective grounding at the work site that causes a zone of equal potential of all conductors within reach of the worker.

ESAMS: Enterprise Safety Applications Management System.

[ESAMS web link](https://www.hgwllc.com/ESAMS_GEN_2/LoginEsams.aspx) (https://www.hgwllc.com/ESAMS_GEN_2/LoginEsams.aspx)

FEAD: Facilities Engineering & Acquisitions Division.

FEC: NAVFAC Engineering Command, echelon IV.

FR: Flame Resistant

Group Lockout/Tagout: A procedure that assigns primary responsibility is vested in a Qualified Person-in-Charge (QP-in-charge) for a red "Danger-Worker On" control LOTO for multiple employees.

High Voltage (HV): For the purposes of this Electrical SAFE, high voltage is defined as above 600 volts. IEEE 100 defines a high voltage system with an RMS voltage above 72,500 volts.

Individual Lockout/Tagout: A procedure for each AE and QP (LV or HV) to be responsible for his/her LOTO action.

Job Safety Analysis: Documented analysis of the work steps for a given activity/task, the associated hazards and the actions implemented to mitigate those hazards to an acceptable level. The analysis is intended to be performed by the workers involved with the activity/task.

LOTO: Lockout/tagout.

Lockout Device: A device that uses a positive means, such as a lock and key (no combination locks), to hold an energy-isolating device in a safe position, preventing operation or energizing of the equipment controlled. Lockout devices include blank flanges that require tools for installation or removal. (An electrical panel containing more than one circuit breaker with a door that locks is not a lockout means. A locked cage preventing access to several devices is not a lockout means).

Lockout: The placement of a lock, red or yellow, on an energy-isolating device to ensure the equipment being controlled cannot be energized or operated until the lock is removed.

Low Voltage (LV): For the purposes of this Electrical SAFE, low voltage is defined as a nominal voltage 50-600 volts. IEEE 100 defines a low voltage system with an RMS voltage less than 1,000 volts.

OC (Operations Center): A location that typically operates 24 hours a day, 7 days a week and provides a variety of services that may include some or all of the following: Trouble Call Center, Utility and/or Facility Operation Control Center, Control System Management, Engineering Support, and Safety Operation Control.

ORM: Operational Risk Management.

PPE: Personal Protective Equipment.

PWBL: Public Works Business Line.

Qualified Person (QP): An Authorized Employee qualified as High Voltage and/or Low Voltage as defined in the qualifications Sections 1.4 and 1.5. A list of Qualified Persons shall be maintained on the SOC personnel list.

Qualified Person-in-Charge (QP-in-charge): Meets the training and qualifications for QP, LV or HV, and is assigned as the person in charge of a group LOTO. In situations where there are more than one work crew working on a circuit performing different tasks, assignment of overall job-associated LOTO control responsibility shall be given to a QP-in-charge designated to coordinate affected work forces and ensure continuity of protection. The QP-in-charge shall also verify that all mechanical potentially hazardous stored or residual energy devices (i.e. charged springs, pneumatic or hydraulic operators) shall be relieved, disconnected, restrained, or otherwise rendered safe. A list of Qualified Persons-in-Charge shall be maintained on the SOC personnel list.

Red Danger Lockout: A red danger lock placed on an energy-isolation device in a safe position and prevents the energizing of a circuit or equipment and cannot be energized or operated until the red danger lock is removed by the employee who can be injured if the energy-isolating device is operated. Red danger locks shall be serialized to indicate the identity of the Authorized Employee applying the lock.

Red "Danger-Worker On" Tag: A red serialized tag and a means of attachment which can be securely fastened to an energy-isolating device to indicate the circuit/equipment being controlled is actively undergoing servicing, maintenance, repair or installation by an employee who can be injured if the energy-isolating device is operated.

SAFE: Safe Acts for Employees.

SOC Personnel List: A list that is maintained and updated by SOC personnel that contains a list of all AEs, QP-LVs, QP-HVs, AOs, ASOs, and SOC personnel within their area of responsibility. It is ultimately the responsibility of the ESAFE coordinator to verify accuracy of all SOC Personnel Lists in their AOR if they do not have a regional SOC list.

SOC (Safety Operations Control): A system by which a person or persons following the safety processes established within the ESAFE assure work performed at exposure to

50 volts or more is performed by trained, qualified and authorized personnel. A list of all authorized personnel is maintained by SOC personnel on the SOC Personnel List. SOC personnel also maintain the function of providing a point-of-contact for utility drawings, SOP's, tags and locks, tag logs. SOC personnel shall direct the implementation of switching orders. SOC personnel may also be assigned additional duties such as managing SCADA operations and outage requests. A SOC person must be available 24 hours/day, 7 days a week from either the local installation or a regional center.

NOTE: It is strongly recommended that SOC functions not presently included in a Local or Regional Operations Center become integrated in a Local or Regional Operations Center.

SOP: Standard Operating Procedure.

Supervisory Control and Data Acquisition System (SCADA): A computer system used to monitor and control the electrical distribution system.

Tag Log: A database maintained by SOC personnel utilized to record red danger tag information and yellow caution tag information.

Tagout Device: A tag and a means of attachment, which can be securely fastened, to an energy-isolating device to indicate that the energy-isolating device and the equipment being controlled may not be operated until the tag is removed.

Tagout: The placement of a tagout device on an energy-isolating device to indicate that the energy-isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Temporary Personal Protective Grounds: Assemblies consisting of clamps, ferrules, and cable capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault and limiting currents through the worker due to exposure voltage at the worksite to acceptable levels.

Worker On System: A worker shall be considered worker on system for the continuous performance of a work order or job to perform servicing or maintenance, including during breaks to eat or rest while on site.

Working On (Energized Electrical Conductors or Circuit Parts): Intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment (PPE) a person is wearing. There are two categories of "working on": Diagnostic (testing) is taking readings or measurements of electrical equipment with approved test equipment that does not require making any physical change to the equipment; repair is any physical alteration of electrical equipment (such as making or tightening connections, removing or replacing components, etc.).

Yellow Caution Lock: A yellow caution lock placed on an energy-isolation device to ensure the equipment being controlled cannot be energized or operated until the yellow caution lock is removed.

Yellow Caution Tag: A yellow serialized tag and a means of attachment which can be securely fastened to an energy-isolating device to indicate the circuit/equipment being controlled is defective and shall not be energized or operated until the yellow caution tag is removed.

1.5. EMPLOYEE QUALIFICATIONS – HIGH VOLTAGE (HV)

1.5.1. AUTHORIZED EMPLOYEE (AE) QUALIFICATIONS

- One who has received annual ESAFE training.
- One who is trained in understanding the purpose and function of the energy control program (LOTO) and the knowledge and skills required for the safe application, usage, and removal of energy controls.
- One who is trained in the recognition of applicable hazardous energy sources, the type and magnitude of energy available, and in the methods and means necessary for energy isolation and control.
- One who is on the centralized list of Authorized Employees maintained on the SOC personnel list.

1.5.2. QUALIFIED PERSON FOR HIGH VOLTAGE (QP-HV) QUALIFICATIONS

An Authorized Employee (AE) who has skills and knowledge related to the construction, maintenance, and operation of the electric power generation, transmission, and distribution equipment involved and has received safety training on the hazards involved. One who has completed CPR training within two years, completed the annual electrical SAFE training, is designated by their supervisor, is on the SOC personnel list, and has the skills and techniques:

- To distinguish exposed live parts from other parts of electrical equipment.
- To determine the nominal voltage of exposed live parts.
- To determine the restricted approach boundary and the minimum working distance specified in table 4.1 of Chapter 4 for the corresponding voltages to which the person will be exposed.
- To determine the proper use of the special precautionary techniques, PPE, insulating and shielding materials and insulated tools for working on or near exposed energized parts.
- To read and interpret distribution maps and one line diagrams.

- QP-HV can additionally be designated by supervisor to have authority to waive a temporary grounding requirement for LOTO on a case-by-case basis. This must be noted on their QP-HV designation on the SOC personnel list.

1.5.3. AUTHORIZED SWITCH OPERATOR (ASO) QUALIFICATIONS

The only personnel authorized to operate high voltage energy isolating devices are those with the following qualifications:

- Be a Qualified Person-High Voltage as defined above.
- Has demonstrated an ability to do all the high voltage switching techniques without a mistake and without instructions.
- Be designated by supervisor as an Authorized Switch Operator.
- Be on the SOC personnel list.

1.5.4. AUTHORIZED OFFICIAL (AO) QUALIFICATIONS

- One who is an AE and has received annual ESAFE training.
- Only Authorized Officials can write and approve switching orders.
- Authorized Officials may include SOC personnel, electrical engineering technicians, electrical engineers, first line supervisors and work leaders who meet the qualifications of an Authorized Employee.
- Be designated by supervisor as an Authorized Official.
- Be on the SOC personnel list.

1.5.5. SAFETY OPERATIONS CONTROL (SOC) PERSONNEL QUALIFICATIONS

- One who is an AE and has received annual ESAFE training.
- Be designated by supervisor as SOC personnel.
- Be on the SOC personnel list.
- SOC Personnel must be capable of the following
 - Understanding the ESAFE document and local SOP's.
 - Maintaining the list of designated QP's (LV or HV), AE's, AO's, and ASO's.
 - Understanding the development of switching order packages and how to develop and review switching order packages.
 - Understanding the local distribution systems and one line diagrams in their area of responsibility.

- Identify energy isolation device locations and how to isolate sections of the electrical distribution system for their areas of responsibility.
- Be aware of the nominal voltage of circuits and/or equipment in their areas of responsibility and understand the hazards of each.
- Understand where to place temporary personal protective grounds and ensure they can be placed at that location.
- Identify alternative generation sources such as PV systems and facility generators to ensure power is not derived from another source during switching.

1.6. EMPLOYEE QUALIFICATIONS – LOW VOLTAGE (LV)

1.6.1. AUTHORIZED EMPLOYEE (AE) QUALIFICATIONS

- One who is trained in understanding the purpose and function of the energy control program (LOTO) and the knowledge and skills required for the safe application, usage, and removal of energy controls.
- One who is trained in the recognition of applicable hazardous energy sources, the type and magnitude of energy available, and in the methods and means necessary for energy isolation and control.
- Be designated by their supervisor and be on the centralized list of Authorized Employees maintained on the SOC personnel list.

1.6.2. QUALIFIED PERSON FOR LOW VOLTAGE (QP-LV) QUALIFICATIONS:

An Authorized Employee (AE) who has skills and knowledge related to the construction, maintenance, and operation of the electrical equipment and installations and has received safety training on the hazards involved. One who has completed CPR training within two years, completed the annual electrical SAFE training, is on the SOC personnel list, and has the skills and techniques:

- To distinguish exposed energized parts from other parts of electric equipment.
- To understand that the operation of any electrical isolation device rated above 600 volts requires a switching order.
- To determine the nominal voltage of exposed energized parts.
- To determine the restricted approach boundary and the minimum working distance specified in table 1 of Chapter 4 for the corresponding voltages to which the person will be exposed.
- To determine the proper special precautionary techniques, PPE, and other temporary protective equipment, insulating and shielding materials, and insulated tools for working on or near exposed energized parts.

1.7. REFERENCES

The Electrical SAFE program and SOP's use the following references:

1. Unified Facilities Criteria 3-560-01 - "Operations and Maintenance: Electrical Safety"
2. EM 385-1-1, Health and Safety Requirements, Sections 11 & 12
3. OPNAVINST 11310.3C Operation and Maintenance Policy for Shore To Ship Power
4. S9086-RJ-STM-010: NSTM 504 Section 17, Infrared Thermal Imaging Systems
5. IEEE 516 - IEEE Guide for Maintenance Methods on Energized Power Lines
6. ASTM F18
7. ANSI/IEEE 978-1984 - IEEE Guide for In-Service Maintenance and Electrical Testing of Live-Line Tools
8. NFPA 70 - National Electrical Code
9. NFPA 70E - Standard for Electrical Safety in the Workplace
10. IEEE C2-2004 - National Electrical Safety Code
11. 29 CFR 1910 – Occupational Safety and Health Standards
12. 29 CFR 1915 - Occupational Safety and Health Standards for Shipyard Employment, Section 1915.89 Control of hazardous energy (lockout/tags-plus)
13. Unified Facilities Criteria 4-150-02 - Dockside Utilities for Ship Service
14. ASTM F 696 - Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens
15. BMS F 12.12.2 - In-House Mishap Reporting, Investigation, and Recording
16. BMS F 12.12.6 - Reporting, Investigation, and Recording of In-House Near Misses

1.8. POLICIES

The following policies are to be included in all training for conducting any electrical work task.

1.8.1. ENERGIZED WORK POLICY

DO NOT work on energized electrical circuits operating at 50 volts or more except when required to support a critical mission, prevent human injury, or protect property. Work on energized circuits requires Commanding Officer's approval. Routine (unavoidable) energized work tasks, such as testing and establishing a safe work condition, are approved by following Chapter 5 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems. Chapter 4 Working On or Near Exposed and Enclosed Energized Electrical Systems provides an energized work permit process to obtain NAVFAC FEC Commanding Officer's approval for unique situations.

1.8.2. SAFE WORKING POLICY

The basic safety rule governing safe clearance and lockout/tagout procedures are that all conductors and equipment are considered energized until placed in an electrically safe working condition.

1.8.3. MAINTENANCE OF ELECTRICAL SPACES POLICY

All electrical spaces are to be kept free of storage items and clutter, secure from unauthorized access, and clearances and working space maintained in accordance with the National Electrical Code and the National Electric Safety Code.

1.8.4. HIGH VOLTAGE POLICY

Switching orders shall be developed for operations on all equipment rated above 600V except for emergency switching. Switching orders are required to place or remove red danger and yellow caution locks and tags on circuits or equipment rated over 600 volts. Switching orders are required to install and remove temporary personal protective grounds. Only Authorized Switch Operators (ASO) shall operate high voltage energy-isolating devices (see ASO definition). Only Authorized Officials shall write switching orders (see AO definition). SOC personnel shall direct the implementation of switching orders.

1.8.5. EMERGENCY SWITCHING POLICY

An emergency outage occurs when a circuit for equipment rated above 600V has to be immediately de-energized because there is a clear and present danger to life and property. The person who is the first Authorized Utilities Switch Operator to respond to the problem is responsible for rendering the condition safe. Since prepared switching orders are not available, they will be developed during switch out or after the switch out has occurred. Power restoration is not considered an emergency. During an emergency outage all conductors and equipment shall be treated as if they are energized.

1.8.6. CONTRACTOR INTERFACE POLICY

When a contractor is working on NAVFAC systems a means of communicating and coordinating the hazardous energy control program to clearly outline the scope, purpose, authorization, responsibilities, rules, and techniques to be used for the control of hazardous energy shall be established.

Contractors are required to establish an electrically safe work condition for their protection by applying their Danger tags and locks, perform testing to verify the absence of voltage, and, if necessary, temporarily ground for personnel protection.

For the purposes of this document, all non-NAVFAC entities (to include other Federal Agencies and Military personnel) must adhere to the contractor interface policy..

1.8.7. VOLTAGE TESTING POLICY

Voltage testing for LOTO shall always be performed per Chapter 2 Control of Hazardous Electrical Energy Lockout/Tagout and Chapter 5 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems. Only QP-HVs or QP-LVs shall test for no voltage and install and remove temporary personal protective grounds.

1.8.8. TEMPORARY PERSONAL PROTECTIVE GROUNDS POLICY

Temporary personal protective grounds shall be used where:

- The possibility of induced voltages or stored electrical energy exists.
- It could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts.

Temporary personal protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in electrical potential. The temporary personal protective grounds should be installed in a manner that establishes a zone of equipotential where each employee is working.

Temporary personal protective grounds shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.

Equipotential grounding shall be used when feasible to establish a zone of equipotential. When not feasible, grounds shall be placed as close to the work site as practical.

The location of installed temporary personal protective grounds shall be written on red "Danger-Worker On" tags.

Only a QP can test for no voltage and install or remove temporary personal protective grounds.

1.8.8.1. TEMPORARY PERSONAL PROTECTIVE GROUNDS POLICY FOR HV

Temporary personal protective grounding requirements for high voltage work may be waived by an Electrical Utility Supervisor or QP-HV, who has the designated authority to waive grounds on the SOC personnel list, if it can be demonstrated that the installation of grounds is not practical or that the installation of grounds would present a greater hazard than working without grounds. In this case, conductors and equipment may be treated as de-energized provided the following conditions are met:

- The conductors and equipment have been de-energized, red danger locked, red danger tagged and tested for no voltage per Chapter 2.
- There is no possibility of contact with another energized source.
- The hazard of induced voltage is not present

When a temporary personal protective ground is attached to a line/conductor or equipment, the temporary personal protective ground end connection shall be attached first. Live line tools and the proper voltage rated gloves shall be used to install personal protective grounds to a line/conductor or equipment.

When a temporary personal protective ground is to be removed, the temporary personal protective grounding assembly shall be removed from the line/conductor or equipment first using voltage rated gloves with a live line tool before the temporary personal protective ground-end connection is removed.

1.8.8.2. TEMPORARY PERSONAL PROTECTIVE GROUNDS POLICY FOR LV

Temporary personal protective grounding requirement may be waived by the QP-in-charge or a QP-HV or LV if it is not practical or that the conditions resulting from the installation of a ground would present greater hazards than working without grounds. Only QP-HV may waive temporary personal protective grounding requirements for work on 600 volt class (480) motor control centers, 600 volt switchgear (with power circuit breakers or fused switches), 600 volt class switchboards (with molded case or insulated case circuit breakers) and 480 volt transformers.

Temporary personal protective grounding shall be used where:

- The possibility of induced voltages or stored electrical energy exists.
- It could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts

When a temporary personal protective ground is attached to a line/conductor or equipment, the temporary personal protective ground end connection shall be attached first and then the other end shall be attached by means of voltage rated gloves or voltage rated gloves with a hot stick.

When a temporary personal protective ground is to be removed, the temporary personal protective grounding assembly shall be removed from the line/conductor or equipment using voltage rated gloves or voltage rated gloves with a hot stick before the temporary personal protective ground-end connection is removed.

1.8.9. MULTIPLE CREW POLICY

In situations where there are more than one work crew working on a circuit performing different tasks, assignment of overall job-associated LOTO control responsibility shall be given to a QP-in-charge to coordinate affected work forces and ensure continuity of protection. The QP-in-charge shall also verify that all mechanical potentially hazardous stored or residual energy devices (i.e. charged springs, pneumatic or hydraulic operators) shall be relieved, disconnected, restrained, or otherwise rendered safe.

1.8.10. RED “DANGER-WORKER ON” CONTROL TAGS AND LOCKS POLICIES

The use of DANGER tags and locks shall be used solely for the purpose of personnel safety in compliance with OSHA policy. Lockout and tagout devices for DANGER while a worker is ON the system shall be red. Red “Danger-Worker On” control tags are required to show the words “DANGER-WORKER ON SYSTEM: DO NOT OPERATE” on the front and back. An example red “Danger-Worker On” control tag and additional information is shown in Chapter 2.

Authorized employees shall remove their red “Danger-Worker On” control devices and control tags when they are not physically on the system performing the work order or servicing and maintenance as defined. The policy of NAVFAC is that the red “Danger-Worker On” control tags and locks shall retain the specific meaning of a worker ON the system.

A worker shall be considered working on the system for the continuous performance of a work order or job to perform servicing or maintenance, including during breaks to eat or rest while on site. If a worker stops and fails to return for business or production reasons or the work order is closed the worker is no longer on the system and shall replace the red “Danger-Worker On” control tags and locks with caution devices and tags, if needed, as prescribed by each FEC to ensure the system remains de-energized for the protection of the system until the worker returns to the system.

SOC personnel and supervisors shall maintain control of red “Danger-Worker On” control tags and locks issued to workers and shall ensure workers remove these control tags and locks when a worker stops for business reasons such as sick or annual leave or emergencies. SOC personnel and supervisors shall continuously monitor that workers remove their red “Danger-Worker On” control tags and locks when stopping work for business or production reasons.

SOC personnel shall serialize all red danger locks numbers to indicate the identity of the Authorized Employee applying the lock. SOC personnel shall maintain these serialization records. SOC personnel shall issue all red “Danger-Worker On” control locks with one key to QPs, LV or HV and AE’s. Control locks shall be available from SOC personnel 24 hours/day, 7 days/week.

Red “Danger-Worker On” control tags shall be placed directly on the energy isolating device. If that is not possible, the tags shall be placed as close as possible to the device in a manner that will make it immediately obvious.

Red “Danger-Worker On” control locks shall be used to render a device or circuit inoperable (open, safe or off) when personnel are working on a circuit or equipment fed by that device. All energy isolating devices capable of being locked shall be locked. Red “Danger-Worker On” control locks and tags always take priority over any other lock or tag.

Red “Danger-Worker On” control locks shall only be used to accompany red “Danger-Worker On” control tags.

When authorized employees are ready to return to working on the equipment or system from a normal work delay they must re-establish an electrically safe working condition, including assuring the proper placement of red “Danger-Worker On” control locks and tags. Switching orders are required if the circuit/equipment involved operates at greater than 600 volts.

Automatic and remote control switches, which could cause an electrical device to operate, introducing hazardous energy, shall also be red “Danger-Worker On” locked out/tagged out at the point of control. The automatic or remote control feature shall be rendered inoperable.

Following the application of red “Danger-Worker On” control lockout/tagout devices, all potentially hazardous stored or residual energy shall be relieved, disconnected, restrained, blocked or otherwise rendered safe. For red “Danger-Worker On” control situations if there is a possibility of re-accumulation of stored energy to a hazardous level, the isolation shall be continually verified until the task is finished, or the possibility of accumulation no longer exists.

For individual red “Danger-Worker On” control lockout/tagout, all QP’s, HV and LV, and AE’s are responsible to affix their control locks and tags to the energy isolation devices when he/she begins work and shall remove their control tags/locks when he/she stops working on the machine or equipment being serviced or maintained as described above. When work is complete, the red “Danger-Worker On” control tags shall be returned to SOC personnel or supervisor.

For group red “Danger-Worker On” control lockout/tagout, primary responsibility shall be vested in a QP-in-charge for a set number of employees working under the protection of group LOTO. The QP-in-charge shall ascertain the exposure status of all individual group members with the regard to the LOTO of the machine or equipment and verify that LOTO has been performed properly. All QP’s, HV and LV and AE’s shall review the LOTO for adequacy and are responsible to affix their control locks to the energy isolation devices when he/she begins work and shall remove their control locks when he/she stops working on the machine or equipment being serviced or maintained on a work order as described above. When work is complete, the QP-in-charge shall return the red “Danger-Worker On” control tags to SOC personnel.

The use of DANGER tags and locks shall be used solely for the purpose of personnel safety in accordance with OSHA Policy 1910 and 1915. The use of a separate color scheme is required for use when equipment is secured for any business and production reasons.

1.8.11. CAUTION TAGS AND LOCKS POLICIES

Caution tags are required to show the words “CAUTION DEFECTIVE EQUIPMENT DO NOT OPERATE” on the front and back. An example caution tag and additional information is shown in Chapter 2.

Caution tags and locks shall NOT be used as a substitute for red “Danger-Worker On” control tags and locks and shall not be red.

Caution locks and tags shall be used when electrical circuits and equipment need to be secured or controlled in a particular manner to prevent energizing/operation for business or production reasons. (see definitions).

SOC personnel shall serialize all caution locks numbers to indicate the identity of the Authorized Employee applying the lock. SOC personnel shall maintain these serialization records. SOC personnel shall issue all caution control locks with one key to QPs, LV or HV and AE’s. Control locks shall be available from SOC personnel 24 hours/day, 7 days/week.

It is permissible to have caution locks and tags and red “Danger-Worker On” control locks and tags on the same device. Therefore, if during job planning workers are aware of job delays, but want the system to remain secure they may place the caution tags and locks at the beginning of the job for the duration of the job and remove and replace the worker red “Danger-Worker On” control tags and locks as necessary when a worker is on the system. Note that red “Danger-Worker On” control tags and locks take priority over any other lock and tag.

Automatic and remote control switches, which could cause an electrical device to operate, introducing hazardous energy, shall be caution locked out/tagged out at the point of control. The automatic or remote control feature shall be rendered inoperable. Following the application of caution lockout/tagout devices, all potentially hazardous stored or residual energy shall be relieved, disconnected, restrained, blocked, or otherwise rendered safe.

1.9. PERSONAL PROTECTIVE EQUIPMENT AND REQUIREMENTS

This section outlines Personal Protective Equipment (PPE) to be purchased for the program. Chapter 4 describes PPE requirements for working on or near exposed and enclosed energized electrical systems. The PPE listed here and described in Chapter 3 and Chapter 4, shall be purchased and issued to personnel. It is recommended to measure for arc-rated clothing sizes during training. Costs vary with trade and function. Personnel typically exposed to 50V or more, depending on the location of the work, are to be considered for arc flash protection:

- Boiler plant operator or mechanic.
- Construction inspector.
- Electrical engineer.
- Electrical engineering technician.
- Electronic industrial controls mechanic.
- Electrical Power Controller (EPC).
- Elevator technician.
- Emergency/standby generator technician.

- Heating, ventilation, and air conditioning technician.
- High-voltage electrician.
- Industrial equipment mechanic.
- Liquid oxygen maintenance personnel.
- Low-voltage electrician.
- Maintenance mechanics.
- Mechanical engineer.
- Project manager.
- Ship-to-shore electrician
- Utility system worker

Additional guidance for personnel clothing:

- QP's shall be trained and advised to wear all cotton undergarments when wearing AR clothing.
- SAFE and PPE Coordinators shall also consider purchase of additional Arc Rated clothing for Thermal Stress environments.

The information in the following tables are examples provided for planning and guidance purposes only, catalogues and part numbers frequently change and items may no longer be available as shown below or procurement methodology may not be best approach for all FEC's.

1.9.1. EXAMPLE-PPE PURCHASED PER EMPLOYEE

- NAVFAC Hard Hat (Class E – Rated for 20,000V)
- Arc Flash Shield
- Arc Flash Face Shield Brackets
- Arc Flash Shield Carry Bag
- Rubber Gloves Class 0
- Rubber Gloves Class 2
- Leather cowhide Protector (for Class 2)
- Leather cowhide Protector (for Class 0)
- Canvas Glove Bag (for Class 2)
- Canvas Glove Bag (for Class 0)
- Glove Dust -12 pack
- Arc Rated Hoods
- Safety Eyewear 1.5 Magnifier

- Hearing Protection, ear canal inserts
- Arc Flash Jackets
- Rubber Gloves Class 4
- Canvas Glove Bag (for Class 4)
- Leather cowhide protector (for Class 4)
- FR Cementex belts or Oberon belts

1.9.2. EXAMPLE-PPE SUPPLIED BY LAUNDERING CONTRACT

- Arc Rated Shirts 8 cal (1 year rental/laundry contract)
- Arc Rated Pants 8 cal (1 year rental/laundry contract)
- Arc Rated Coveralls 8 cal (1 year rental/laundry contract)
- Category 4 Arc Hoods
- Category 4 Jackets
- Category 4 Bib Coveralls

1.9.3. ELECTRICAL PROTECTIVE RUBBER GOODS AND LEATHER PROTECTORS

ASTM 496-02A applies. This section outlines PPE Coordinators/management's duties to purchase, issue, manage, and store inventory, and the periodic evaluation and testing of Electrical Protective Rubber Goods.

Manage and Store Inventory: Inventory of gloves and leather protector PPE shall be sufficient to keep QP supplied at all times and for issuance to new personnel as they report on-board. If you do not have a rubber goods testing program, contact your FEC core PWBL or NAVFAC LANT/ PAC PWBL for assistance. Inventory of goods requires:

- Maintaining records of issuance and testing
- Arranging the in-service inspection & testing by a certified testing facility. Base the interval between date of issue and retest on work practices and test experience. It shall not exceed 6 months for gloves, and 12 months for sleeves
- Coordinating orderly exchange when rubber goods maximum in use period expires
- Storing to assure no damage to gloves

1.9.4. LIVE-LINE TOOLS

IEEE 516, ASTM F18 and IEEE 978 apply. This section outlines PPE Coordinators/management's duties to purchase, issue, manage and store inventory, and the periodic evaluation and testing of Live-Line tools.

Manage and Store Inventory: Inventory of live-line tools PPE shall be sufficient to keep QP supplied at all times and for issuance to new personnel as they report on-board. Inventory of live-line tools requires:

- Maintaining Records of issuance and testing
- Coordinating orderly exchange when live-line tools are removed from service for testing
- Storing to assure no damage to the live-line tools

1.10. TRAINING REQUIREMENTS

A consistent team of trainers with a strong electrical trade background is recommended to provide quality training to applicable mechanics and electricians. A trade background brings credibility as well as years of applicable experiences to the training event. A dedicated team ensures the program is delivered consistently throughout the entire workforce. The length of the training varies with the trade and experience of the mechanics as well as the understanding of current regulations.

Training Responsibilities:

- Echelon II will approve and promulgate Electrical SAFE and its inclusive training requirements NAVFAC wide and place the training outline and aids in ESAMS.
- Echelon III will arrange and provide safety and operation training resources.
- Echelon IV will designate trainers, arrange for their attendance at required training, and conduct the annual training within their area of responsibility.
- Echelon IV may write task order statements of work for contracted trainers and schedule and coordinate contracted training sessions for FECs with no or limited in-house trainers.
- All NAVFAC components will schedule and assure all applicable employees receive ESAFE training annually as stated herein and will track employee ESAFE training in ESAMS.

Training aids: The training session outline and instructional power point presentations along with links to video aids may be found in ESAMS.

Applicability: Any NAVFAC employee exposed at or above 50 volts. Applies to all NAVFAC employees at all Echelons. All employees whose jobs require the use of Electrical SAFE SOP's shall be trained to understand the purpose and function of the hazardous energy control and the hazards they face. AE's shall receive refresher Electrical SAFE training annually. A list of names and job titles of trained AE's, AO's, ASO's, QP-LV's, QP-HV's and Designated QP's (LV and or HV) shall be kept by SOC personnel.

Frequency: The training shall be conducted annually. New employees shall be trained prior to working on or near exposed energized electrical systems requiring the use of Electrical SAFE SOP's.

1.11. IMPLEMENTATION REQUIREMENTS

1.11.1. PROGRAM MANAGEMENT

Development and Implementation of the Electrical SAFE Program is intensive and requires dedicated resources. The PW BLD shall:

Designate an Electrical SAFE Coordinator: This position's duties are time intensive at startup of acquiring the right PPE and performing training. Once the new processes are in place, most duties may be turned over as collateral duty to supervisors.

Designate the Electrical PPE Coordinator: This position may be full time or a continuing collateral duty for FEC staff.

Establish SOC functions: The Safety Operation Control personnel are responsible for providing the necessary checks and balances to ensure that electrical procedures are performed safely. SOC personnel maintain the SOC Personnel List, which comprises the current lists of QP's High voltage, QP's Low Voltage, Authorized Employees, Authorized Officials, Authorized Switch Operators and SOC Personnel. The SOC personnel also act as POC for all LOTO operations with Contractors. A member of the SOC personnel must be available 24 hours/day, 7 days/week for access to utility drawings, E-SAFE Chapters 1 thru 15, maintaining records of tag logs, outage requests and may manage SCADA operations. SOC personnel shall also direct the implementation of switching orders.

Appoint Shipyard LOTO Coordinator: FEC's with a Shipyard installation shall appoint a LOTO coordinator at the Shipyard site to keep track of shipyard LOTO actions and assure coordination with contractors and NAVSEA coordinators where the work situation affects multiple employers' personnel in conducting an outage or LOTO.

1.11.2. ELECTRICAL SAFE PROGRAM RESPONSIBILITIES

The Electrical SAFE Coordinator:

Shall be appointed to oversee, purchase and maintain inventory of all tags/locks and other general equipment required to implement and maintain the Electrical SAFE program to meet requirements of electrical workers within the Public Works Business Line. Inventory must include the in-service requirements as well as the number required to facilitate an orderly exchange when products are to be taken out of service due to defects, breakage or loss. The Electrical SAFE Coordinator shall also oversee certification and record keeping functions and coordinate training on an annual basis. The Electrical SAFE Coordinator shall be able to routinely communicate with all levels of management and union representatives. Duties may include:

- Assist BLD with SOC function establishment
- Coordinate and schedule training
- Identify personnel requiring training
- Identify Trainers to conduct training
- Define PPE and equipment requirements for procurement.
- Make union notification and issue resolution

- Confirm for the command that records are maintained and accessible for audits of energy control program, training of personnel and mishap and near miss incidents, assuring processes in BMS F-12.12.2 and F-12.12.6 for mishap and near miss reporting of electrical incidents are in place.
- Coordinate periodic review of energy control procedures: At least once per year, execution of procedures in Chapters 2 through 15 shall be reviewed to ensure the procedures are being followed. The review of both red danger and yellow caution lockout and tagout processes can occur at shorter intervals as directed by management. The Electrical SAFE Coordinator will select the individuals to perform the review. The only restriction is that the reviewer cannot review his own procedure. A review will involve one or more specific hazardous electrical energy control lockout and tagout procedures from start to finish, and be accomplished at the PWD level. All deficiencies will be noted. Upon completion of the review, the reviewer shall report findings to the Electrical SAFE Coordinator who is responsible for coordinating all (LV and HV) report findings to FEC PWBL Director and Safety management and oversee procedural corrections and improvements. Section 1.11.5 “Electrical SAFE Program Checklist” contains the form to be used.
- Annually review mishaps and near miss reports in ESAMS in order to direct improvements to safety processes from lessons learned.

The Electrical PPE Coordinator:

- Define PPE, rubber goods, and live line tool requirements for procurement and may include developing contracts
- Distribute and manage PPE and Equipment
- Perform all functions of procurement, inventory and maintenance of PPE and equipment as defined in Chapter 3, Use and Care of Electrical Protective Rubber Goods and Live Line Tools above.

Supervisors: The supervisor shall be trained on all aspects of ESAFE and enforce the requirements of Chapters 2 through 15 by visiting job sites to:

- Take corrective actions to correct deficiencies discovered.
- Train employees in the proper use of live line tools.
- Train employees in the proper care and inspection of live line tools.
- Comply with mishap and near miss reporting of BMS F-12.12.2 and F-12.12.6
- Designate qualifications for the employees in their group.

Employee Responsibilities:

Employees whose duties require performing work on or near exposed and enclosed energized electrical systems are responsible to use the PPE required by this SAFE, plan the work to minimize time exposed to shock and arc flash hazards, and keep unqualified people from entering the limited approach and arc flash protection boundaries who are not wearing the required PPE and are not knowledgeable of the work.

- The user of electrical protective rubber goods and live line tools shall inspect, and care for them as specified in Chapter 3, Use and Care of Electrical Protective Rubber Goods and Live Line Tools.
- Rubber goods found to be defective or have questionable electrical integrity must not be used. Report defective goods to the supervisor to arrange replacement.
- Use only certified, tested and approved live line tools.
- Be knowledgeable in the use, care of and inspection of live line tools.
- Turn in any damaged live line tools for evaluation, repair and testing.
- Be knowledgeable in the use, care of and inspection of personal protective grounds.

1.11.3. THE IMPLEMENTATION PLAN

The following steps outline a process for implementing the Electrical SAFE Program. These steps are based on implementing a program in an organization with some form of existing electrical safety program. The actual steps, order, and effort will vary based on the organization and experience of the workforce.

1. Identify and assign resources for the training and program management functions.
 - 1.1. The trainer(s) should have a strong trade background in a variety of electrical work.
 - 1.2. The training team should be used to conduct the training to the entire FEC so that a consistent training program is provided.
2. Determine a list of personnel whose duties will routinely be exposed to energized electrical circuits. Use first line supervision to assist in the development of this list.
3. Develop a budget framework addressing the elements included in this document.
4. Determine a plan for procuring the PPE and equipment. A combination of open purchases and contracts to obtain the PPE and equipment may be required.
5. Procure the PPE and equipment for the identified personnel. Note that all people that are trained will not necessarily receive all the equipment and/or PPE. For instance, an electrical engineering technician will receive the training, but may not require a LOTO kit.
6. Stand-up or modify a rubber goods program based on the written documentation and assign an Electrical PPE Coordinator.
7. Conduct training on all SOPs.
8. Issue PPE/Equipment
9. Stand-up SOC and support activities related to LOTO (log books, etc.).
10. Identify an on-site source for follow-on training and new-employee training.
11. Continuously update training and reviews of the Electrical SAFE program.
12. Follow up on the planned reviews.

1.11.4. APPLICATION OF ESAFE TO NON-NAVFAC EMPLOYEES

1. CHAPTERS 1-6 ESAFE PROGRAM AND PRACTICES

Chapters 1-6 of the ESAFE only apply to government civilian employees in the employ of NAVFAC. These chapters do not apply to any other governmental organizations, military personnel, or contractors that are performing work as a part of a contract to provide electrical services to NAVFAC (including but not limited to new construction, repair, maintenance, ongoing BOSC service, etc.) ESAFE can be applied to contractors if explicitly stated in their contracts.

2. CHAPTERS 7-15 SHIP TO SHORE CONNECTIONS

Chapters 7-15 of the ESAFE applies to all military, civilian, and contractor personnel assigned to activities that provide shore power services regardless of their organization or affiliation. In the case of military personnel, non-NAVFAC civilians or contracted forces providing Ship to Shore connections, the electrical work and testing procedures outlined in Chapters 7-15 must be followed completely but the safety program requirements and administrative requirements are to be defined by their contract or organizational requirements documentation (e.g. training documentation does not need to be recorded in ESAMS for non-NAVFAC personnel).

These procedural requirements must be included in any contract documents that involve Ship to Shore connections completed by contractor personnel. Failure to include these requirements in contract documents will result in the need for contract modifications and delay any support from NAVFAC facility/utility personnel until a time that the contractor can meet the requirements of these procedures.

In cases where NAVFAC personnel are not the primary Ship to Shore personnel, the NAVFAC QP in Charge and NAVFAC QPs in the procedures outlined in Chapters 7-15 will be substituted as follows.

NAVFAC Personnel	Military	Non-NAVFAC Agency / Contractors
NAVFAC QP in Charge	Electrical Officer/ Senior Electrician	Qualified Electrician in Charge
NAVFAC QP	Qualified Electricians	Qualified Electricians

1.11.5. ELECTRICAL SAFE PROGRAM CHECKLIST

This checklist is a holistic review of the Electrical SAFE requirements and can be used to review implementation compliance.

ELECTRICAL SAFE PROGRAM INSPECTION CHECKLIST

Audits/Inspections

- 1) Each PWD performs at least one audit a year. The audits will be led or assigned by the ESAFE Coordinator within the PWDs. The audit involves a complete program inspection of Chapter 1-6 and all applicable Ship to Shore Chapters 7-15. Perform audits in accordance with the Electrical SAFE Program Inspection Checklist. Maintain checklists for three years.
- 2) The PWD will use the audit results to generate a report and develops a Plan of Actions and Milestones (POAM) to correct the deviations and/or inadequacies.

Electrical SAFE Program Inspection Checklist

NAME OF INSPECTOR: _____

FEC: _____

INSTALLATION: _____

ITEM			
PROGRAM & PERSONNEL	YES	NO	REMARKS
Electrical SAFE Coordinator identified			
Electrical PPE Coordinator identified			
Establish SOC function and personnel			
All AE, QP-HV, QP-LV, ASO, AO designated			
All AE, QP-HV, QP-LV, ASO, AO on SOC personnel list			
Shipyards LOTO coordinator designated where required			
ESAFE trainers identified or the use of contracted trainers obtained			
All applicable employees & supervisors receive ESAFE training annually and tracked in ESAMS			
Employees are knowledgeable of minimum approach boundaries and can determine the restricted approach boundary and minimum approach distance.			
All QP-HV and QP-LV have required CPR training			
PPE available and provided to affected employees			

PERSONNEL PROTECTIVE EQUIPMENT	YES	NO	REMARKS
Employees wearing appropriate PPE as required			
Long sleeves must be rolled down and buttoned.			
The top button of shirts, coveralls, and jackets must be fastened.			
Shirts tucked into the trousers.			
Shorts are prohibited and trousers must extend the full length of the leg.			
Employees knowledgeable of arc flash rated PPE categories and can determine which category is appropriate for level of work.			
Garments with exposed metallic fasteners must not be worn, unless the garments are properly arc rated.			
Garments, including safety harnesses, worn over arc flash rated protective clothing must be arc flash rated.			
Arc Flash PPE rated for the work to be performed per Chapter 4			
Electrical Protective Rubber Goods:	YES	NO	REMARKS
Issuance and testing records maintained			
Certified testing facility used.			
Rubber goods tested and not exceed 6 months for gloves, and 12 months for sleeves			
Orderly exchange when rubber goods maximum in use period expires			
Storing to assure no damage to gloves			
Rubber goods visually inspected by employees prior to use and rubber gloves air tested prior to use.			
Temporary personal protective ground clusters available and in good condition			
LIVE LINE TOOLS	YES	NO	REMARKS
Issuance and testing records maintained			
Certified testing facility used or in house capability used.			
Live-Line Tools tested at not more than 2 year intervals.			
Orderly exchange when live-line tools are removed from service for testing			
Storing to assure no damage to tools			

Live-line tools visually inspected and wiped clean with a manufacturer approved silicone impregnated cloth prior to use			
LOCK OUT / TAG OUT (LOTO)	YES	NO	REMARKS
Red danger and yellow caution tags available and consistent with examples in CH 2			
Red danger and yellow caution locks available and serialized to indicate the identity of the Authorized Employee applying the lock			
Annual LOTO audit inspections using the checklist(s) in Chapter 2. Deficiencies identified and POAM to correct developed.			
POLICY & PROCEDURES	YES	NO	REMARKS
Compliance with NAVFAC ESAFE Policies			
Energized Work Policy (Section 1.8.1)			
Safe Working Policy (Section 1.8.2)			
Electrical Space Policy (Section 1.8.3)			
High Voltage Policy (Section 1.8.4)			
Emergency Switching Policy (Section 1.8.5)			
Contractor Interface Policy (Section 1.8.6)			
Voltage Testing Policy (Section 1.8.7)			
Temporary Personal Protective Grounds Policy (Section 1.8.8)			
Multiple Crew Policy (Section 1.8.9)			
Red Control Tags and Locks Policy (Section 1.8.10)			
Caution Tags and Locks Policy (Section 1.8.11)			
Compliance with Table 4-5 and Table 4-6 for jobs requiring more than a single worker.			
Inspection, Entry and Work in Confined Spaces			
Specific JSA developed for the work to be performed and approved.			
Follow procedures as outlined in 6.4.			
480V Surface Ships (If applicable)	YES	NO	REMARKS
Annual Connect audit inspections using the checklist in Chapter 8.			
Annual Disconnect audit inspections using the checklist in Chapter 9.			
Deficiencies identified in Connect/Disconnect inspections and POAM to correct developed.			
480V Submarines (If applicable)	YES	NO	REMARKS
Annual Connect audit inspections using the checklist in Chapter 10.			

Annual Disconnect audit inspections using the checklist in Chapter 11.			
Deficiencies identified in Connect/Disconnect inspections and POAM to correct developed.			
4160V Ships (If applicable)	YES	NO	REMARKS
Annual Connect audit inspections using the checklist in Chapter 12.			
Annual Disconnect audit inspections using the checklist in Chapter 13.			
Deficiencies identified in Connect/Disconnect inspections and POAM to correct developed.			
13.8V Ships (If applicable)	YES	NO	REMARKS
Annual Connect audit inspections using the checklist in Chapter 14.			
Annual Disconnect audit inspections using the checklist in Chapter 15.			
Deficiencies identified in Connect/Disconnect inspections and POAM to correct developed.			

CHAPTER 2 - CONTROL OF HAZARDOUS ELECTRICAL ENERGY LOCKOUT/TAGOUT

2.1. PURPOSE

To provide policy and guidance for obtaining, placing, and removing electrical lockout/tagout devices, testing for no voltage and installing and removing temporary personal protective grounds. Circuits and/or equipment shall be considered energized unless the following steps have been taken to establish an electrically safe work condition:

- All energy sources have been identified and isolated.
- All energy-isolating devices have been red danger locked and tagged.
- Conductors and/or equipment have been tested for no voltage.
- Conductors and/or equipment have been grounded unless waived by QPIC.

This procedure establishes the minimum requirements to establish an electrically safe work condition while performing service, maintenance, repairs or installation on electrical systems operating at voltages of 50 volts or greater.

This chapter does not apply to contractors but when a contractor is working on a NAVFAC system coordination is required. When a contractor is working on NAVFAC systems, a means of communicating and coordinating the hazardous energy control program shall be established to clearly outline the scope, purpose, authorization, responsibilities, rules, and techniques to be used for the control of hazardous energy.

Contractors are required to establish an electrically safe work condition for their protection by applying their Danger tags and locks, perform testing to verify the absence of voltage, and, if necessary, temporarily ground for personnel protection.

This procedure also establishes the minimum requirements for yellow caution lockout/tagout of defective electrical equipment that could create a safety hazard if energized. Yellow caution lockout/tagout is not to be used to control hazardous energy and establish an electrically safe work condition while someone is performing service, maintenance, repair or installation on electrical circuits or equipment.

2.2. BACKGROUND

This procedure considers all possible sources of electrical energy and ensures the electrical energy does not unexpectedly reappear. Non-electrical energy isolating devices that need to be secured as a part of creating a safe working condition for work on electrical equipment are included in the scope of this SOP. If work is required on or near energized equipment, see Chapter 4 of this Electrical SAFE. Red danger locks and tags shall only be used when a worker is working on the equipment/circuit/system. Yellow caution locks and tags shall be used when electrical circuits and equipment occasionally need to be secured or controlled in a particular manner to prevent energizing/operation when conditions exist that could create safety hazards. These conditions could be circuits or equipment in need of repair, adjustments, or testing. Yellow caution locks and tags shall not be used as a substitute for red danger locks and

tags to establish a safe working condition. If work needs to be performed on an electrical system, an electrically safe work condition, including the use of red danger locks and tags, shall be established in accordance with this SOP or the system shall be considered energized and requiring an Energized Electrical SOP or a Special Permission Energized Electrical Work Permit in accordance with Chapter 4, Working On Or Near Exposed and Enclosed Energized Electrical Systems. Hazards avoided by use of this SOP: electrical shock, arc flash, arc blast, electrical burns, body injury or loss of life due to unexpected mechanical motion and/or sudden fluid pressure release. A centralized list of references and definitions are located in Chapter 1.

2.3. RED DANGER LOCKOUT/TAGOUT PROCEDURES

2.3.1. HIGH VOLTAGE PROCEDURE STEPS

2.3.1.1. HV STEP 1. REQUEST OUTAGE

SOC personnel and/or Authorized Official shall be contacted to request a circuit, facility or equipment outage. The minimum information provided to SOC personnel shall be:

1. Requestor and requestor's organization.
2. Date of the request.
3. Contract number or work order number the outage is requested under.
4. Contract title or work order description.
5. Point of contact if further information is required.
6. Requested outage's start date and time.
7. Projected outage's completion date and time (duration of outage).
8. Circuit, facility or equipment to be de-energized.
9. Reason for outage request. A written description of the work to be performed shall be included in the outage request.
10. The name of the QP-In-Charge and QP-HV authorized to place red danger locks and tags and/or grounds.

In addition to the above minimum information the outage request should include as much information as possible to clearly define the outage requested. SOC personnel and/or AO will contact the requestor for all questions concerning the request.

2.3.1.2. HV STEP 2. DEVELOP SWITCHING ORDER

1. Upon being contacted, SOC personnel and/or AO will assign a unique number to the outage and create an outage folder. This folder will contain the following:
 - 1.1. The outage request received.
 - 1.2. All notes concerning the outage.
 - 1.3. Switching order package.

2. The AO is responsible to develop the switching orders for all outages. The switching orders shall be complete, accurate and achievable. See Section 2.7 Switching Order Package for a blank sample switching order package.
3. The AO developing the switching orders will study the pertinent one line diagrams, review previous switching orders, verify current status of all devices affecting the switching orders and consult with the outage requestor and site utility personnel in order to collect the following information to place in the switching orders package:
 - 3.1. Completed switching orders, sheets 1 through 5.
 - 3.2. Devices to be opened or closed.
 - 3.3. Placement of red danger locks and tags.
 - 3.4. Pertinent one-line diagrams.
 - 3.5. Nominal voltage of circuits and/or equipment to be de-energized.
 - 3.6. Circuits and/or equipment at work site which will remain energized.
 - 3.7. Where to place temporary personal protective grounds and ensure they can be placed at that location or a determination if protective grounds can be waived.
 - 3.8. Any special hazardous conditions at work site.
 - 3.9. Current status of all devices to be operated as per switching orders.
 - 3.10. Location of facility emergency generators (non-portable).
 - 3.11. Where temporarily placed generators (installed to provide power to selected facilities during the outage during the outage) will be located.
 - 3.12. Be sure to note alternative generation sources such as PV systems.
4. The switching orders, prepared by the AO per Section 2.7, shall contain the following:
 - 4.1. The cover sheet, sheet 1 of 5.
 - 4.2. The job briefing sheet, sheet 2 of 5.
 - 4.3. The switch out and installation of temporary personal protective grounds sheet, sheet 3 of 5.
 - 4.4. Acceptance and release sheet, sheet 4 of 5.
 - 4.4.1. Acceptance: A signoff statement for the ASO to document that the switch out and installation of temporary personal protective grounds section has been completed as described in switching orders and the QP-in-charge accepts the switch out and installation of temporary personal protective grounds section as complete.
 - 4.4.2. Release: A signoff statement for the QP-in-charge performing the actual work that all work is complete, all personnel are in the clear, all tools and equipment are in the clear, all affected employees have been notified. The ASO accepts the release of the system.
 - 4.5. The switch back and removal of temporary personal protective grounds sheet, sheet 5 of 5, is a detailed step by step procedure, followed in listed order to

energize a circuit, facility, or equipment and shall be completed as shown and include pertinent one-line drawings.

5. The AO shall send the completed switching orders to SOC personnel and other outage participants. The switching orders may be E-Mailed, faxed, or hand delivered to the appropriate person.
6. If necessary due to short notice, the switching orders may be communicated via phone or radio to an ASO in the field. SOC personnel will read the switching orders to the ASO and that employee will fill out a blank switching orders sheet as the information is communicated. Once all the data has been transmitted, the ASO will read their copy of the switching orders to SOC personnel. SOC personnel will verify the accuracy of the ASO's switching orders. All discrepancies shall be resolved. The field version and the SOC version shall be exact duplicates.
7. The outage participants will review the final switching orders to determine that it meets the need of the outage requested. If there are any problems SOC personnel or AO will be contacted to resolve the issue prior to the start of outage switching.
8. Once the extent of the outage is finalized, AO notifies affected personnel.

2.3.1.3. HV STEP 3. SWITCH OUT

1. Changes in field conditions: If the ASO and/or the QP-HV encounters any discrepancies between the written switching orders (specifically sheet 3 of 5 of Section 2.7), and the actual field conditions, the switch out and installation of temporary personal protective grounds process shall stop. The outage shall be canceled or postponed until the discrepancies are resolved. All changes to switching orders shall be documented and approved by the ASO Supervisor, ASO and SOC personnel.
2. Pre Switch Out: Prior to executing the written switching orders (specifically sheet 3 of 5 of Section 2.7), the ASO shall:
 - 2.1. Conduct a job brief with all personnel involved and complete Section 2.7, sheet 2 of 5.
 - 2.2. Review applicable SOP for the circuit/equipment to be operated.
 - 2.3. Wear required PPE per Chapter 4.
 - 2.4. Notify SOC personnel that he/she is ready to execute the switching orders.
 - 2.5. The QP-In-Charge shall obtain red danger tag serial numbers from SOC personnel and write serial numbers on red danger tags. Provide the following information to SOC personnel:
 - 2.5.1. Name and work center of QP placing red danger tags.
 - 2.5.2. Reason red danger tags placed.
 - 2.5.3. Equipment description.
 - 2.5.4. Position/description of red danger tagged components.
 - 2.5.5. Location of grounds to be installed.

- 2.5.6. Red danger lock identification numbers.
- 2.5.7. Location of red danger tags.
- 2.6. SOC personnel and the QP-In-Charge shall record the red danger tag serial numbers and red danger lock identification numbers on sheet 3 of 5 of Section 2.7 (specifically “Switch Out and Temporary Personnel Protective Grounds” sheet).
- 3. Switch Out Execution – completing sheet 3 of 5 of Section 2.7 (specifically the “Switch Out and Temporary Personnel Protective Grounds” sheet):
 - 3.1. SOC personnel shall direct all switching operations.
 - 3.2. SOC personnel and ASO shall verify requirements and shall operate each energy-isolating device as specified in the switching orders.
 - 3.3. SOC personnel and ASO shall initial off on the written switching orders the operation of each energy-isolating device.
 - 3.4. Fill in all required information on the red danger tag except the serial number and release/remove items. If a group red danger tagout is being used only the QP-In-Charge with the overall responsibility of the LOTO shall place red danger tags. When using an individual red danger tagout, each involved QP-HV shall perform the tagout on each energy-isolating device and verify that the LOTO has been completed in accordance with the related switching orders.
 - 3.5. The QP-HV performing the work shall place a red danger lock on each energy-isolating device and write red danger lock serial numbers on of the written switching orders.
 - 3.6. If an energy-isolating device is not capable of being locked, additional safety measures shall be taken to provide full employee protection. The additional safety measure(s) adopted shall be documented in the switching order package. Possible additional actions include:
 - 3.6.1. Removal of an isolating circuit breaker.
 - 3.6.2. Block a controlling switch.
 - 3.6.3. Open an extra disconnecting device.
 - 3.6.4. Open an extra energy isolating device.
 - 3.6.5. Installation of temporary personal protective grounds.
 - 3.6.6. Lift conductor at termination between the worksite and the source.

2.3.1.4. HV STEP 4. TEST FOR NO VOLTAGE & INSTALL TEMPORARY PERSONAL PROTECTIVE GROUNDS

- 1. Voltage testing is considered “working on” an exposed energized electrical system. QP-HV’s performing voltage testing shall wear the PPE specified in Chapter 4.
- 2. QP-HV shall test for no voltage as per below:
 - 2.1.1. Voltage tester is to be rated for the voltage as if the circuit tested is actually energized.

- 2.1.2. Test the voltage tester on a known energized source at approximately the same potential, using the same setting on the voltage tester.
 - 2.1.3. Test all phases of the circuit/equipment for no voltage.
 - 2.1.4. Test the tester again on a known energized source at the same potential, using the same setting on the voltage tester.
 - 2.1.5. If voltage is indicated, contact the SOC personnel and inform supervisor.
3. Temporary personal protective grounds shall be installed by QP-HVs in accordance with below:
 - 3.1. Temporary personal protective grounds shall be placed in accordance with the switching order package. Record location(s) of installed grounds on the associated serialized red danger tag(s) for all ground placements under LOTO.
 - 3.2. Equipotential grounding shall be utilized when feasible. When not feasible, grounds shall be placed as close to the work site as practical.
 - 3.3. Any circuit not grounded shall be considered energized except when grounding has been waived.
 - 3.4. A designated QP-HV or AO can waive the grounding requirement if it can be demonstrated that installation of grounds is impractical or that the installation of grounds would present a greater hazard than working without grounds. Waiving of grounds shall be documented on sheet 3 of 5 of Section 2.7 "Switch Out and Temporary Personnel Protective Grounds" of the switching orders. In this case, the conductors and equipment may be treated as de-energized provided the following conditions are met:
 - 3.4.1. The conductors and equipment have been de-energized, red danger locked, red danger tagged and tested for no voltage.
 - 3.4.2. There is no possibility of contact with another energized source.
 - 3.4.3. The hazard of induced voltage is not present.
 - 3.5. Temporary personal protective grounds shall have an impedance low enough to cause immediate operation of protective devices in case of unexpected energizing of the lines or equipment.
 - 3.6. Conductors to be grounded shall be cleaned of oxidation or other conditions that would reduce conductivity at the point the clamp is to be installed.
 - 3.7. When a temporary personal protective ground is attached to a line/conductor or equipment, the ground-end connection shall be attached first and then the other end shall be attached by means of voltage rated gloves with a live line tool.
 - 3.8. When a temporary personal protective ground is to be removed, the grounding device shall be removed from the line/conductor or equipment using voltage rated gloves with a live line tool before the ground-end connection is removed.

2.3.1.5. HV STEP 5. SIGNATURES AND JOB BRIEF

1. Upon completion of the written steps documented on sheet 3 of 5 of Section 2.7 "Switch Out and Temporary Personal Protective Grounds" of the switching orders,

The ASO shall sign and date sheet 3 and also the “Released By” signature block of sheet 4 of 5 of Section 2.7 (Acceptance Sheet), of the switching orders.

2. QP-HV shall acknowledge completion by signing “Accepted By” signature block of sheet 4 of 5 of Section 2.7 (Acceptance Sheet) of the switching orders.
3. Prior to performing work on a circuit or equipment that has been de-energized, red danger locked, red danger tagged, tested for no voltage, temporary personal protective grounded, and meets the requirements of this SOP to establish an electrically safe work condition, QP-in-charge shall:
 - 3.1. Conduct a job brief to discuss the job plan and site conditions.
 - 3.2. Discuss what was switched and grounded.
 - 3.3. Discuss what is still energized and other hazards.
4. QP-HV’s who leave the site and return shall be briefed on current site work conditions.

2.3.1.6. HV STEP 6. VERIFICATION OF NO VOLTAGE

Before starting work on a circuit or equipment that has already been de-energized, red danger locked, red danger tagged, tested for no voltage, and temporary personal protective grounded, a QP-HV shall verify no-voltage by re-testing the equipment or circuit.

2.3.1.7. HV STEP 7. PERFORM THE WORK

1. QP-HV may leave danger locks and tags in place during the current shift.
2. If work is stopped at the end of the current work shift and all of the work crew leaves the job site, red danger locks and tags shall be removed.
3. If it is desired to keep the circuit/equipment out of service for reasons other than establishing an electrically safe work condition, yellow caution locks and tags shall be placed.
4. Switching orders are required to place/remove red danger locks and tags/yellow caution locks and tags, and temporary personal protective grounds.
5. When personnel are ready to work on the circuit/equipment again, switching orders shall be written to start from the beginning and establish an electrically safe work condition with red danger locks and tags.
6. If it becomes necessary to temporarily energize a circuit/equipment for testing or re-positioning the following steps shall be followed under the direction of SOC personnel.
 - 6.1. Ensure that all guards and covers have been reinstalled and adjusted to their proper position.
 - 6.2. Temporarily remove red danger locks and tags and temporary personal protective grounds for testing.
 - 6.3. Clear the work area of all tools and equipment.

- 6.4. Notify affected personnel.
- 6.5. Inform SOC personnel that the red danger locks and tags and temporary protective grounds have been temporarily removed for testing.
- 6.6. The ASO shall re-energize the circuit or equipment.
- 6.7. Perform the required test.
- 6.8. Execute the switch out and installation of temporary personal protective grounds sheet of the switching orders.
- 6.9. Test for no voltage.
- 6.10. Notify SOC personnel when the red danger locks and tags and temporary personal protective grounds have been re-applied.

2.3.1.8. HV STEP 8. REMOVAL OF TEMPORARY PERSONAL PROTECTIVE GROUNDS AND SWITCH BACK

1. Changes in field conditions: If the ASO and/or the QP-HV encounters any discrepancies between what is documented on Section 2.7, sheet 5 of 5, of the switching orders and the actual field conditions the switch out and removal of temporary personal protective grounds process shall stop. The removal of temporary personal protective grounds and switch back shall be canceled or a solution to proceed shall be arranged and all changes to switching orders shall be documented and approved by the ASO Supervisor, ASO and SOC personnel.
2. Upon work completion, the QP-in-charge shall verify:
 - 2.1. Work completion.
 - 2.2. All employees are clear from circuits and equipment.
 - 2.3. Equipment is clear of all tools, etc.
 - 2.4. All covers, panels, etc. have been replaced.
 - 2.5. No hazardous conditions have been created as a result of work performed.
3. Prior to executing Section 2.7 sheet 5 of 5, (Switch Back and Removal of Temporary Personal Protective Grounds) of the switching orders, the ASO shall:
 - 3.1. Review the documented switching orders.
 - 3.2. Conduct a job brief/review with all personnel involved.
 - 3.3. Review applicable SOP for the circuit/equipment to be operated.
 - 3.4. Wear required PPE per Chapter 4, Working On or Near Exposed and Enclosed Energized Electrical Systems.
 - 3.5. Require QP-in-charge sign in the "release by" signature block of the documented Section 2.7, sheet 4 of 5.
 - 3.6. Sign the switching orders "Accepted by" signature block, Section 2.7, sheet 4 of 5.
 - 3.7. Notify SOC personnel that he/she is ready to remove temporary personal protective grounds and execute switch back according to the switching orders.

4. Execution:
 - 4.1. SOC personnel direct all switching operations.
 - 4.2. SOC personnel and QP shall remove temporary personal protective grounds as documented in the switching orders.
 - 4.3. SOC personnel and QP shall initial off, on sheet 5 of 5 of the switching orders, the removal of each temporary personal protective ground.
 - 4.4. SOC personnel, the QP-In-Charge and the QP-HV shall remove red danger locks and tags as specified in switching orders. If QP that placed the red danger locks and tags is unavailable, follow the procedure in Section 2.3.1.9 to remove.
 - 4.5. SOC personnel and QP-In-Charge shall record on sheet 5 of 5 of the switching orders, the serial numbers of the red danger tags removed, and the identification numbers of the red danger locks removed.
 - 4.6. SOC personnel and ASO shall operate each energy-isolating device as specified and documented on sheet 5 of 5 of the switching orders.
 - 4.7. SOC personnel and ASO shall initial off, on sheet 5 of 5 of the switching orders, the operation of each energy-isolating device and upon completion, sign and date the sheet where provided.
 - 4.8. The field copy of completed switching orders and red danger tags shall be forwarded to SOC personnel to be maintained for one year.

**2.3.1.9. PROCEDURE FOR REMOVAL OF RED DANGER LOCKS AND
RED DANGER TAGS IF QP-HV WHO PLACED THE TAG IS ABSENT**

1. QP-HV's shall remove only the red danger locks and tags that they personally placed on equipment or circuits.
2. If the QP-HV who placed the red danger locks and tags is absent, then the following procedure shall be followed for removal by someone else:
 - 2.1. The person who finds the red danger locks and tags will contact their supervisor. If their supervisor is absent, they will contact their next level of supervision.
 - 2.2. Their supervisor will contact the supervisor responsible for the employee who placed the red danger locks and tags. If their supervisor is absent, then another supervisor in their organization will be contacted.
 - 2.3. The supervisor of the QP-HV who placed the red danger locks and tags will have the equipment or circuit carefully inspected by a QP-HV to ensure no one is working on that circuit or equipment. In addition, the supervisor will verify that the employee who placed the red danger locks and tags is absent and contact SOC personnel for approval.
 - 2.4. If no one is working on the circuit or equipment and all relevant information has been acquired, then the supervisor responsible for the red danger locks and tags may direct the red danger locks and tags be removed.

- 2.5. The supervisor of the QP-HV who placed the red danger locks and tags shall notify the QP-HV before he/she returns to the job site that their red danger locks and tags have been removed.

2.3.2. HV EMERGENCY OUTAGE PROCEDURE

An emergency outage occurs when a circuit has to be immediately de-energized because there is a clear and present danger to life and property. The person who is the first ASO to respond to the problem is responsible for rendering the condition safe. Since prepared switching orders are not available, they will be developed during switch out or after the switch out has occurred. Power restoration is not considered an emergency. During an emergency outage, all conductors and equipment shall be treated as if they are energized.

1. Switching Orders:
 - 1.1. The ASO responding to an emergency situation shall notify SOC personnel that an emergency switch out is in progress.
 - 1.2. The ASO shall perform switching based on field conditions. SOC personnel shall monitor switching and assist as required.
 - 1.3. SOC personnel will fill out the switch out section as each device is operated.
 - 1.4. Upon switching completion, SOC personnel shall create an outage file with completed switching orders. The completed switching orders will be transmitted to the QP-HV and ASO prior to switch back.
2. Switch Out/switch Back: The execution of the switching orders for an emergency outage is the same as for the planned outages, except on the switch out there will not be any prepared switching orders to follow.
3. Work: The execution of work procedures is same as for a planned outage.

2.3.3. LOW VOLTAGE PROCEDURE STEPS

(Switching orders are not required)

2.3.3.1. LV STEP 1. PREPARATION

QP-In-Charge shall:

1. Determine all possible sources of energy to the specific circuit/equipment.
2. Identify the method of isolating the energy.
3. Obtain red danger lockout and tagout devices.
4. Complete the red danger tags as required.
5. Ensure area is clear.
6. Notify affected personnel.

2.3.3.2. LV STEP 2. DE-ENERGIZE CIRCUIT/EQUIPMENT

Prior to opening the switches/breakers, the QP-LV shall:

1. Conduct a job brief/review with all personnel involved.
2. Review Chapter 4 and all other applicable SOP's for the correct safe work practices and required PPE.
3. Wear appropriate PPE.
4. Verify that sufficient clearance will exist between the energized parts from the de-energized parts to allow work to be performed safely.
5. Open switch/circuit breaker(s):
 - 5.1. Open the switch/circuit breakers.
 - 5.2. As each switch/breaker is opened, place a red danger lock and enter the red danger lock number on the red danger tag. Red danger locks are required for each QP-LV on each energy-isolating device before he/she may begin work in either an individual or group lockout/tagout. If an energy-isolating device is not capable of being locked, additional safety measures shall be taken to provide full employee protection. Possible additional actions include:
 - Removal of an isolating circuit element/circuit breaker.
 - Block a controlling switch.
 - Open an extra disconnecting device.
 - 5.3. Fill in all required information on the red danger tag except the release/remove items. If a group lockout/tagout is being used, only the designated QP-In-Charge with the overall responsibility of the red danger tagout shall place red danger tags. Place red danger tags on each energy-isolating device.

2.3.3.3. LV STEP 3. TEST FOR NO VOLTAGE & APPLY TEMPORARY PERSONAL PROTECTIVE GROUNDS

1. Voltage testing is considered "working on" an exposed energized electrical system. QP-LV's performing voltage testing shall wear the PPE specified in Chapter 4.
2. QP-LV's shall test for no voltage per Chapter 5 and in this manner:
 - 2.1. Voltage tester is to be rated for the voltage to be encountered as if the circuit tested is actually energized.
 - 2.2. Test the voltage tester on a known energized source of approximately same potential, using the same setting on the voltage tester.
 - 2.3. Test all phases of the circuit/equipment to be under LOTO for no voltage phase to phase and phase to ground.
 - 2.4. Test the tester again on a known energized source of approximately same potential, using the same setting on the voltage tester.
3. If voltage is present review all available information to find energy source. Investigate until resolved using work methods and PPE as required by Chapter 4.

4. If temporary personal protective grounding equipment is to be used, select and wear the PPE as required by Chapter 4. QP-LV's shall install temporary personal protective grounds as required below:
 - 4.1. Temporary personal protective grounds are to be used when working on de-energized electrical conductors or equipment to minimize the hazards of accidental re-energizing from unexpected sources.
 - 4.2. Temporary personal protective grounding requirements may be waived by the QP-in-charge or the Designated QP-HV or QP-LV if it is not practical or that the conditions resulting from the installation of a ground would present greater hazards than working without grounds. **Only** the designated QP-HV may waive temporary personal protective grounding requirements for work on 600 volt class motor control centers, 600 volt class switchgear (with power circuit breakers or fused switches), 600 volt class switchboards (with molded case or insulated case circuit breakers) and 480 volt secondary transformers.
 - 4.3. Temporary personal protective grounding shall be used where:
 - The possibility of induced voltages or stored electrical energy exists.
 - It could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts.
 - 4.4. Equipotential grounding shall be used when feasible to establish a zone of equipotential. When not feasible, grounds shall be placed as close to the work site as practical.
 - 4.5. Temporary personal protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in electrical potential. The temporary personal protective grounds should be installed in a manner that establishes a zone of equipotential where each employee is working.
 - 4.6. Temporary personal protective grounds shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
 - 4.7. The location of installed temporary personal protective grounds shall be written on red danger tags.
 - 4.8. When a temporary personal protective ground is attached to a line/conductor or equipment, the temporary personal protective ground end connection shall be attached first and then the other end shall be attached by means of voltage rated gloves or voltage rated gloves with a live line tool. Wear the PPE required by Chapter 4.
 - 4.9. When a temporary personal protective ground is to be removed, the temporary personal protective grounding assembly shall be removed from the line/conductor or equipment using voltage rated gloves or voltage rated gloves with a live line tool before the temporary personal protective ground-end connection is removed. Wear the PPE required by Chapter 4.

- 4.10. One has to be a QP to test for no voltage and install and remove temporary personal protective grounds.

2.3.3.4. LV STEP 4. JOB BRIEF

1. Prior to performing work on a circuit or equipment that has been de-energized, red danger locked, red danger tagged, tested for no voltage, temporary personal protective grounded, and meets the requirements of this chapter to establish an electrical safe work condition, the supervisor or QP-In-Charge shall:
 - 1.1. Conduct a job brief to discuss the job plan and site conditions.
 - 1.2. Discuss what was de-energized and temporary personal protective grounded.
 - 1.3. Discuss what is still energized and other hazards.
2. Workers who leave the site and return shall be briefed on current site work conditions.

2.3.3.5. LV STEP 5. VERIFICATION OF NO VOLTAGE

Before starting work on a circuit or equipment that has already been de-energized, red danger locked, red danger tagged, tested for no voltage and temporary personal protective grounded, the QP that locked and tagged the equipment shall verify no voltage by re-testing the equipment or circuit per Low Voltage Step 3.

2.3.3.6. LV STEP 6. PERFORM THE WORK THAT REQUIRED THE LOTO

1. A QP-LV may leave red danger locks and tags in place during the current work shift.
2. If work is stopped at the end of the current work shift and all of the work crew leaves the job site, then red locks and tags shall be removed.
3. If it is desired to keep the circuit/equipment out of service for reasons other than establishing an electrically safe work condition for the safety of someone working on it, yellow caution locks and tags shall be placed.
4. When personnel are ready to work on the circuit/equipment again, start from the beginning and establish an electrically safe work condition and place red danger locks and tags.
5. If it becomes necessary to temporarily energize a circuit/equipment for testing or re-positioning, the following steps shall be followed:
 - 5.1. Ensure that all required guards, covers have been reinstalled and adjusted to their proper position.
 - 5.2. Remove red danger tags, red danger locks and temporary personal protective grounds if used. If QP that placed the red danger locks and tags is unavailable, follow the procedure in Section 2.3.3.8 to remove.
 - 5.3. Clear the work area of all tools and equipment.

- 5.4. Notify affected personnel.
- 5.5. Re-energize the circuit/equipment as needed to perform required test.
- 5.6. Repeat steps 2 through 5 of the Low Voltage LOTO procedure to re-establish a safe work condition.
6. Upon work completion, the QP-In-Charge shall verify:
 - 6.1. Work completion.
 - 6.2. All employees are clear from circuits and equipment.
 - 6.3. Equipment is clear of all material, tools, etc.
 - 6.4. All covers have been replaced.
 - 6.5. No hazardous conditions have been created as a result of work performed.

2.3.3.7. LV STEP 7. REMOVAL OF DANGER TAGS AND LOCKS AND RE-ENERGIZE CIRCUIT/EQUIPMENT

1. Prior to re-energizing, the QP-LV shall:
 - 1.1. Wear correct PPE per Chapter 4.
 - 1.2. Review applicable SOP for the circuit/equipment to be operated.
 - 1.3. Conduct a job brief/review with all personnel involved.
 - 1.4. Remove grounds (if installed).
 - 1.5. Remove red danger tags and red danger locks. If QP that placed the red danger locks and tags is unavailable, follow the procedure in Section 2.3.3.8 to remove.
2. The QP-LV shall operate the energy isolating devices necessary to restore the circuit/equipment to service.
3. QP-In-Charge shall contact SOC personnel and provide the following information to be entered into the Tag Log:
 - 3.1. Location.
 - 3.2. Red danger tag numbers.
 - 3.3. Red danger tags removal date and time.
 - 3.4. QP-LV's removing tags.
4. Removed red danger tags shall be maintained for one year.

2.3.3.8. PROCEDURE FOR REMOVAL OF RED DANGER LOCKS AND RED DANGER TAGS IF QP-LV WHO PLACED THE TAG IS ABSENT

1. QP-LV's shall remove only the red danger locks and tags that they personally placed on equipment or circuits.
2. If the QP-LV who placed the red danger locks and tags is absent, then the following procedure shall be followed for removal by someone else:

- 2.1. The person who finds the red danger locks and tags will contact their supervisor. If their supervisor is absent, they will contact their next level of supervision.
- 2.2. Their supervisor will contact the supervisor responsible for the employee who placed the red danger locks and tags. If their supervisor is absent, then another supervisor in their organization will be contacted.
- 2.3. The supervisor of the QP-LV who placed the red danger locks and tags will have the equipment or circuit carefully inspected by a QP-LV to ensure no one is working on that circuit or equipment. In addition, the supervisor will verify that the employee who placed the red danger locks and tags is absent and contact SOC personnel for approval.
- 2.4. If no one is working on the circuit or equipment all relevant information has been acquired, then the supervisor responsible for the red danger locks and tags may direct the red danger locks and tags be removed.
- 2.5. The supervisor of the QP-LV who placed the red danger locks and tags shall notify the QP before he/she returns to the job site that their red danger locks and tags have been removed.

2.4. YELLOW CAUTION LOCKOUT/TAGOUT PROCEDURES

2.4.1. YELLOW CAUTION PROCEDURE STEPS HIGH VOLTAGE

Follow red danger procedure steps for high voltage: Steps 1, 2, 3, 4, 5, 6 and 8. No work will be performed on the equipment. Use Section 2.8 as guidance for yellow tag format and instructions.

2.4.2. YELLOW CAUTION PROCEDURE STEPS LOW VOLTAGE

Follow red danger procedure steps for low voltage: Steps 1, 2, 3, 4, 5, and 7. No work will be performed on the equipment. Use Section 2.8 as guidance for yellow tag format and instructions.

2.5. TRAINING, CERTIFICATION, AND RECORD KEEPING

All employees whose job requires the use of the lockout/tagout SOP shall be trained to understand the purpose and function of the hazardous energy control and the hazards they face. Training procedures are specified in Chapter 1.

2.6. RED DANGER TAG INSTRUCTIONS

NAVFAC102/13 (rev 08/02)

SERIAL NO. _____ (1)

DANGER

WORKER ON SYSTEM
DO NOT OPERATE

LOCATION _____ (2) LOCK NO _____ (3)

CIRCUIT/EQUIPMENT _____ (4)

ISOLATION DEVICE _____ (5)

POSITION OF VALVE/EQUIPMENT _____ (6)

TIME _____ (7) DATE _____ (8)

TYPE OF TAG (9) GROUP _____ INDIVIDUAL _____

QUALIFIED PERSON (PRINT) _____ (10)

QUALIFIED (SIGN) _____ (11)

WC/CODE/PHONE# _____ (12)

AUTHORIZED OFFICIAL (PRINT) _____ (13)

GROUND'S INSTALLED _____ (14) YES ___ NO ___ NA ___

REMARKS _____ (15)

LOCATION OF GROUND'S INSTALLED

1 _____ (16)

2 _____

3 _____

4 _____

Red Danger Tag Instructions

Note: All information recorded on red danger tags shall be legible and understandable.

- (1) Serial Number – A unique number provided by SOC personnel. This number shall identify the year the red danger tag was issued as well as the site and a sequential number that started on 1 January of the year or when the logbook was established.
- (2) Location – *The location of the red danger tag. The building number, floor, panel number or any other information that would enable someone to identify where the red danger tag was placed.*
- (3) Lock Number – A serialized number on the red danger lock provided by SOC personnel. This number will enable the supervisor to identify to whom it was issued.
- (4) Circuit/Equipment – The circuit or the identification of the equipment that is being tagged out.
- (5) Isolation Device – Use any name or identification number that identifies where the red danger tag will be placed.
- (6) Position of Switch/Equipment – Enter the position of the isolating device; breaker/switch is open.
- (7) Time – The time the serial number is obtained from the red danger tag logbook.

(8) Date – The date the serial number is obtained from the red danger tag logbook.

(9) Type of Tag – Check as applicable: Individual or Group

(10) Qualified Person (print) – Clearly print the name of the QP performing Tagout/Lockout and will be working on the equipment identified on line (4) above.

(11) Qualified Person (sign) – Enter the signature of the person identified on line (10) above.


(12) WC/Code/Phone Number – Enter the work center or code of the person identified on line (10) and a phone number that could be used to contact him/her.

(13) Authorized Official – Print the name of the AO who wrote the switching orders

(14) Grounds Installed – Check yes or no.

(15) Remarks – Enter any additional information that would be helpful to someone not familiar with the Lockout/Tagout.

(16) Location Grounds Installed – Enter location grounds actually installed.



(REVERSE SIDE)

DANGER

WORKER ON SYSTEM

DO NOT OPERATE

THIS TAG SHALL BE USED AND
RELEASED IN COMPLIANCE WITH
NAVFAC SOP# _____ (17) _____

CLEARANCE SERIAL NO. _____ (18) _____

GROUNDS CLEARED (19) YES NO N/A _____

TAG CLEARED BY (PRINT) _____ (20) _____

TAG CLEARED BY (SIGN) _____ (21) _____

WC/CODE/PHONE _____ (22) _____

TIME _____ (23) _____ DATE _____ (24) _____

LOCATION OF GROUNDS REMOVED

1 _____ (25) _____

2 _____

3 _____

4 _____

Red Danger Tag Instructions (Reverse Side)

- (17) Enter: Local SOP Number.
- (18) Clearance Serial No. - Enter tag clearance number from SOC personnel.
- (19) Grounds Cleared – Enter yes, no or N/A.
- (20) Tag Cleared By (print) – Enter Qualified Person’s name.
- (21) Tag Cleared By (sign) – Enter Qualified Person’s signature.
- (22) WC/Code/Phone Number – Enter the work center or code of the person identified on line 10.
- (23) Time – The time the clearance serial number is obtained from the red danger tag logbook.
- (24) Date – The date the clearance serial number is obtained from the red danger tag logbook.
- (25) Location Grounds Removed – Enter location of grounds removed.

2.7. SWITCHING ORDER PACKAGE

Switching Order Package (Sheet 1 of 5)

Cover Sheet

Outage Number: _____

Purpose of Outage: _____

Work Order or Contract Number: _____

Work Order or Contract title: _____

Outage Duration: _____

Start Date: _____ Start Time: _____

Completion Date: _____ Completion Time: _____

Areas affected by switching: _____

Authorized Official: _____ Date: _____
(Print name) (Date developed)

SOC Reviewer: _____
(Print name) (Signature)

ASO(s): _____
(Print name)

Qualified Person(s) High Voltage: _____
(Print name)

Supervisor of ASO: _____
(Print name)

Qualified Person-In-Charge: _____
(Print name)

Work Execution Supervisor: _____
(Supervisor of employees performing the work.) (Print name)

Work Center: _____
(Print name)

Sheet 2 of 5
 Switching Order Package
Job Briefing Sheet

Date: _____ Topics Of Brief: _____

Switch Order Number: _____

Authorized Official: _____ Date: _____

Outage Description:

By my signature below, I acknowledge that I understand all briefing topics discussed, including the outage description above and that my questions have been satisfactorily answered:

Supervisor: _____
 (Print & sign name) (Phone number)

ASO: _____
 (Print & sign name)

Qualified Person, High Voltage: _____
 (Print & sign name)

Qualified Person-In-Charge: _____
 (Print & sign name)

Additional Attendees: (All workers involved with outage are required to attend & understand briefing)

Printed Name	Work Center	Phone Number

Acceptance Sheet

ASO: _____ Date and Time: _____

The _____

is out of service. The switch out and installation of temporary personal protective grounds sheet procedure described by switching order _____ has been completed as written.

<p>Release by ASO/ASO Supervisor</p> <p>Name _____ (print name)</p> <p>Signature _____</p> <p>FEC Code: _____</p> <p>Date and Time _____</p>	<p>Accepted by QP or QP-in-charge</p> <p>Name _____ (print name)</p> <p>Signature _____</p> <p>Company _____</p> <p>Date and Time _____</p>
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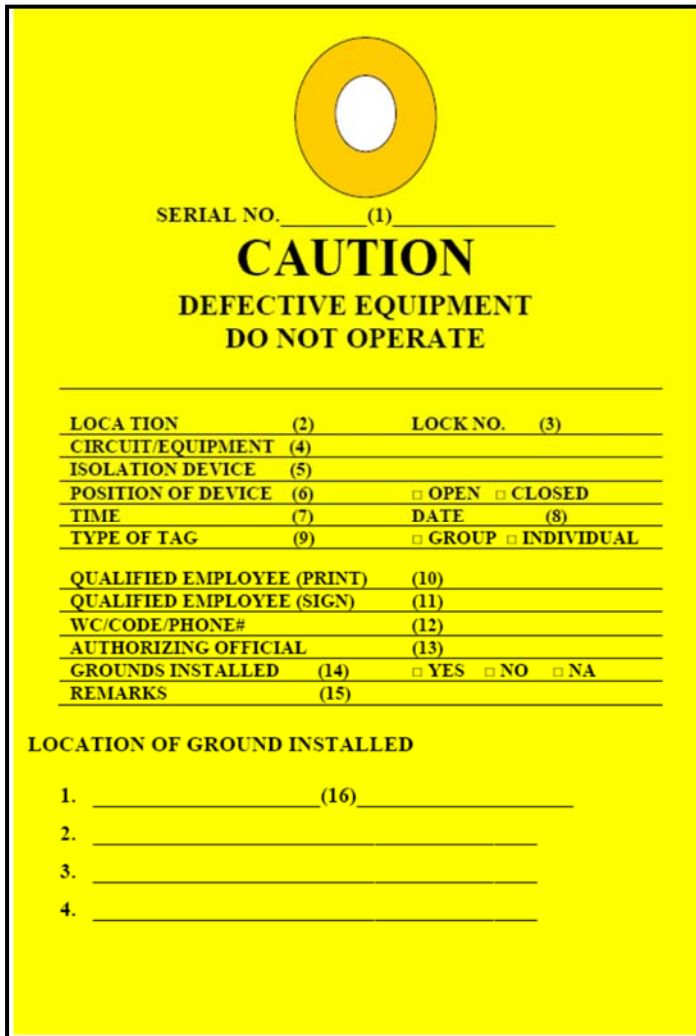
Release Sheet


Post Work Acceptance by ASO:

All work has been completed, all tools and equipment are in the clear, all personnel are in the clear and all affected employees have been notified.

<p>Release by QP or QP-in-charge</p> <p>Name _____ (print name)</p> <p>Signature _____</p> <p>Company _____</p> <p>Date and Time _____</p>	<p>Accepted by ASO/ASO Supervisor</p> <p>Name _____ (print name)</p> <p>Signature _____</p> <p>FEC Code _____</p> <p>Date and Time _____</p>
---	--

2.8. YELLOW CAUTION TAG INSTRUCTIONS




 SERIAL NO. _____ (1)
CAUTION
DEFECTIVE EQUIPMENT
DO NOT OPERATE

LOCATION	(2)	LOCK NO.	(3)
CIRCUIT/EQUIPMENT	(4)		
ISOLATION DEVICE	(5)		
POSITION OF DEVICE	(6)	<input type="checkbox"/> OPEN	<input type="checkbox"/> CLOSED
TIME	(7)	DATE	(8)
TYPE OF TAG	(9)	<input type="checkbox"/> GROUP	<input type="checkbox"/> INDIVIDUAL

QUALIFIED EMPLOYEE (PRINT)	(10)
QUALIFIED EMPLOYEE (SIGN)	(11)
WC/CODE/PHONE#	(12)
AUTHORIZING OFFICIAL	(13)
GROUNDS INSTALLED	(14) <input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
REMARKS	(15)

LOCATION OF GROUND INSTALLED

1. _____ (16) _____
2. _____
3. _____
4. _____

Yellow Caution Tag Instructions

Note: All information recorded on yellow caution tags shall be legible and understandable.

(1) Serial Number – A unique number provided by SOC personnel. This number shall identify the year the yellow caution tag was issued as well as the site and a sequential number that started on 1 January of the year or when the logbook was established.

(2) Location – The location of the yellow caution tag. The building number, floor, panel number or any other information that would enable someone to identify where the yellow caution tag was installed.

(3) Lock Number – A serialized number on the yellow caution tag provided by SOC personnel. This number will enable the supervisor to identify to whom it was issued.

(4) Circuit/Equipment – The circuit or the identification of the equipment that is being tagged out.

(5) Isolation Device – Use any identification number or name that identifies where the yellow danger tag will be installed.

(6) Position of Device – Enter the position of the isolating device, open or closed.

(7) Time – The time the serial number is obtained from the yellow caution logbook.

(8) Date – The date the serial number is obtained from the yellow caution tag logbook.

(9) Type of Tag – Not used

(10) Qualified Employee (print) – Clearly print the name of the QP performing the Yellow caution tagout.

(11) Qualified Employee (sign) – Enter the signature of the person identified on line (10) above.

(12) WC/Code/Phone Number – Enter the work center or code of the person identified on line (10) above and a phone number that could be used to contact him/her.

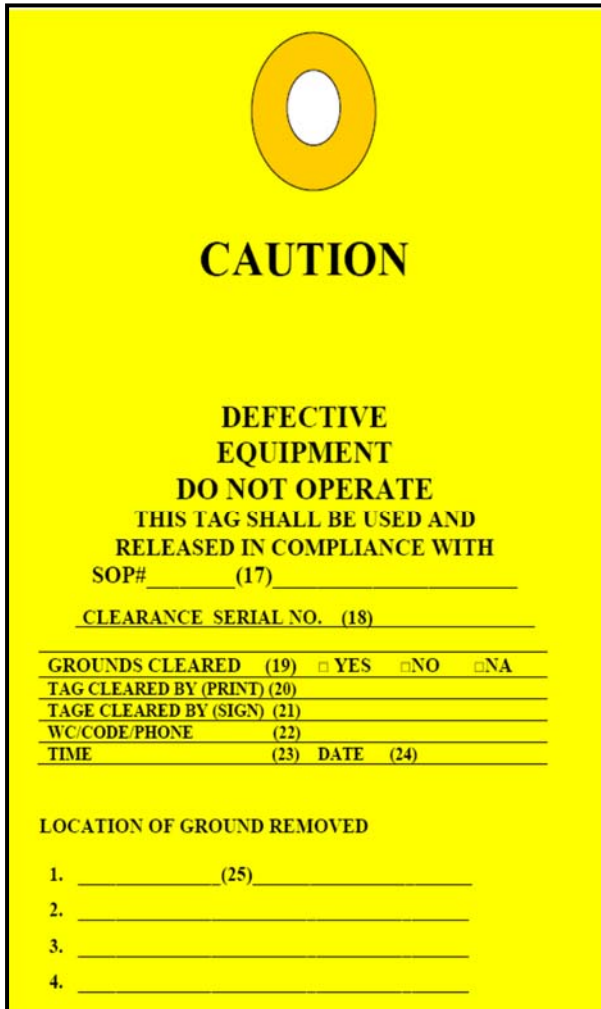
(13) Authorized Official (print) – Name of the Authorized Official who wrote the switching orders.


(14) Grounds Installed – Check yes or no.

(15) Remarks – Enter and additional information that would be helpful to someone not familiar with the Lockout/tagout.

(16) Location Grounds Installed – Enter location of grounds actually installed.

Yellow Caution Tag/Yellow Lock/ Grounds




CAUTION

**DEFECTIVE
EQUIPMENT
DO NOT OPERATE**
 THIS TAG SHALL BE USED AND
 RELEASED IN COMPLIANCE WITH
 SOP# _____ (17)
 CLEARANCE SERIAL NO. (18) _____

 GROUNDS CLEARED (19) YES NO NA
 TAG CLEARED BY (PRINT) (20) _____
 TAG CLEARED BY (SIGN) (21) _____
 WC/CODE/PHONE (22) _____
 TIME (23) DATE (24) _____

LOCATION OF GROUND REMOVED
 1. _____ (25) _____
 2. _____
 3. _____
 4. _____

(17) Enter Local SOP Number

(18) Clearance Serial Number – Enter tag clearance number provided by OC.

(19) Grounds Cleared – Check Yes, No, or NA.
Employee's name.

(20) Tag Cleared By (print) – Enter Qualified Employee's name.

(21) Tag Cleared by (sign) - Enter signature of Qualified Employee.

(22) WC/Code/Phone Number – Enter the work center or code and the phone number of the person identified on line (10).

(23) Time – The time the clearance serial number is obtained from the yellow caution tag logbook.

(24) Date – The date the clearance serial number is obtained from the yellow caution tag logbook.

(25) Location of Grounds Removed – Enter the location of grounds removed.

2.9. LOCKOUT / TAGOUT INSPECTION CHECKLIST – HIGH VOLTAGE

Audits/Inspections

- 1) Each PWD performs at least one audit a year for each work center performing high voltage work. The audits will be led by Supervisors within the PWDs. The audit of this lockout/tagout (LOTO) procedure involves a visual inspection/observation of an actual job, from start to finish. Perform audits in accordance with the Lockout/Tagout Inspection Checklist. Maintain checklists for three years.
- 2) The PWD will use the audit results to generate a report and develops a Plan of Actions and Milestones (POAM) to correct the deviations and/or inadequacies.
- 3) The audits shall be performed by an authorized employee(s) who is not using the energy control (lockout/tagout (LOTO) procedure being inspected.

Lockout / Tagout Inspection Checklist – High Voltage

TITLE OF JOB: _____

SYSTEM VOLTAGE: _____

SWITCHING ORDER NUMBER: _____

LOCATION OF WORK: _____

LIST EMPLOYEES ON JOB SITE, CIRCLE AUTHORIZED SWITCH OPERATOR AND QUALIFIED PERSON IN-CHARGE NAMES: _____

GENERAL

ITEM	YES	NO	REMARKS
Check employees qualifications			
Work site appears safe			
Employees wearing appropriate PPE			
If a group red danger lockout/tagout, is there a designated Qualified Person In-Charge			

ITEM	YES	NO	REMARKS
If multiple crews are working at site, overall job-associated LOTO control responsibility has been assigned to a Qualified Person In-Charge to coordinate affected work forces and ensure continuity of protection.			
Red danger locks are approved and serialized to identify person who installed the locks			
Each Authorized Employee has reviewed the adequacy of the LOTO before starting work on the circuit/equipment			
Red danger Locks affixed by (Name)_____			
Red danger Locks hold device in proper position			
Personal red danger locks attached by each Authorized Employee working job			
Red danger tag appropriately attached			
Red danger tag has correct and adequate information recorded on the tag			
Red danger tags registered in the SOC tag log			
Protective grounds are properly placed			
Adequate testing performed prior to placing grounds			
Adequate testing performed after placing grounds			
Grounding waiver specified by QP-in charge, Utilities Supervisor or Designated QP-HV			
Location of grounds recorded by SOC			
Authorized Employee that attached red danger tags removes same			
Red danger tag information entered in SOC tag log			
Switching orders present on job site			
Switching orders contains information specified in Section 2.3.1			
Switching orders developed using criteria outlined in Section 2.3.1			
Switching orders transmitted by phone or radio. If yes compare job site copy with SOC copy			

ITEM	YES	NO	REMARKS
Accuracy of switching orders (phone or radio) verified by SOC personnel. Method used:			
The Cover Sheet is completed as specified in Section 2.3.1			
The Job Briefing Sheet is completed as specified in Section 2.3.1			
The Switch Out and Installation of Temporary Protective Grounds Sheet is completed as specified in Section 2.3.1			
The Acceptance and Release Sheets are completed as specified in Section 2.3.1			
The Switch Back and Removal of Temporary Protective Grounds Sheet is completed as specified in Section 2.3.1			
Pertinent one-line-diagrams are provided			

SWITCH OUT EXECUTION

ITEM	YES	NO	REMARKS
Switching orders developed by Authorized Official			
All involved AEs, QPs, ASOs, SOC personnel and Contractors reviewed the switching orders for safety and operational requirements			
Authorized Switch Operator performs the following:			
Job Brief/review with all personnel involved			
Review appropriate SOPs			
Review required PPE			
Notify SOC personnel prior to beginning			
SOC personnel directs all switching operations			
Devices operated per switching orders and Field Switching Orders and SOC Switching Orders initialed off per Section 2.3.1			
Proper PPE worn			

ITEM	YES	NO	REMARKS
Red danger locks and tags placed per Section 2.3.1 and serialized numbers recorded on field switching orders and SOC switching orders			
Requirements of switching orders followed			
Red danger tag attached per Section 2.3.1 and information on red danger tag is correct and adequate			
SOC personnel contacted and provided information specified in Section 2.3.1 and SOC records this information in tag log			
Test for no voltage per Section 2.3.1			
Grounds installed per Section 2.3.1			
Ground information on Red Danger tags is correct and adequate			
Location of grounds recorded on field Switching Orders and communicated to SOC personnel and recorded on SOC Switching Orders			
SOC and field copy of switching orders have red danger lock identification numbers and Red danger tag serial numbers			
All red danger tag information entered in SOC tag log			
Upon completion of switch out, Authorized Switch Operator shall sign and date the completed switch out sheet and the "Released By" signature block on the acceptance sheet			
Authorized Employee (QP-HV in SOP) or Contractor shall sign "Accepted By" signature block on the acceptance sheet			
If discrepancies noted, process stopped and outage canceled or procedure in Section 2.3.1 is followed			

WORK

ITEM	YES	NO	REMARKS
Prior to performing work, on a circuit/equipment that is LOTO, the Qualified Person-in-charge shall:			
Conduct a job brief			
Discuss what was switched and grounded			
Discuss what is still energized and other hazards			
Authorized Employees who leave the site and return are briefed on current conditions			
Before starting work, Qualified Employee shall test for no voltage per Section 2.3.1			
If work is stopped at the end of the current work shift and all of the work crew leaves the job site, red danger tags and red dangers locks shall be removed. If it is desired to keep the circuit out of service for reasons other than establishing an electrical safe work condition, install yellow caution tags and yellow caution locks			
Temporarily removed red danger tags, red danger locks and grounds to temporarily energize a circuit/equipment (Section 2.3.1) of procedure followed (list steps used)			
Upon work completion, Qualified Person In-Charge shall verify:			
Work is complete			
All employees are clear from circuits and equipment			
Equipment is clear of all tools, etc.			
All covers, panels, etc. have been replaced			
No hazardous conditions have been created as a result of work performed			

SWITCH BACK EXECUTION

ITEM	YES	NO	REMARKS
Prior to executing switch back, Authorized Utility Switch Operator performs the following:			
Review Switching Orders			
Job Brief/review with all personnel involved			
Review appropriate SOPs			
Review required PPE			
Contractors remove grounds he/she installed per Chapter 1			
QP-in-charge or Contractor shall sign "Released By" signature block of release sheet			
Authorized Switch Operator shall sign "Accepted By" signature block of release sheet			
Notify SOC personnel prior to switch back			
SOC personnel directs all switching operations			
Grounds removed per switching orders			
Grounds removed recorded on red danger tags, Field Switching Orders and communicated to SOC personnel and recorded on SOC Switching Orders			
Red danger locks removed per switching orders and identification numbers recorded on field switching orders and SOC Switching Orders			
Red danger tags removed per and serial numbers on red danger tags entered on field Switching Orders and SOC Switching Orders			
Devices operated per switching orders and field Switching Orders and SOC Switching Orders initialed off			
Requirements of switching orders followed			
If discrepancies noted, process stopped and outage canceled or procedure in Section 2.3.1 is followed			

ITEM	YES	NO	REMARKS
Upon completion of switch back switching orders, Authorized Switch Operator sign and date switch back switching orders			
All switching orders and removed red danger tags forwarded to SOC personnel			
SOC personnel maintains the SOC and field copy of completed switching order packages and removed red danger tags for one year			

ADMINISTRATIVE

ITEM	YES	NO	REMARKS
Pull all switching order packages for the previous four months and verify tags are filled out properly and compare/analyze switching order packages, tags and Maximo work orders			
Review tag log for previous four months and compare and analyze with switching order packages, tags and Maximo work orders			
Pull Employee qualifications centralized list and review			
Observe that there is an up to date system one line for each area of responsibility			

2.10. LOCKOUT / TAGOUT INSPECTION CHECKLIST – LOW VOLTAGE

Audits/Inspections

- 1) Each PWD performs at least two audits a year for low voltage work. The audits will be led by Supervisors within the PWDs. The audit of this lockout/tagout (LOTO) procedure involves a visual inspection/observation of an actual job, from start to finish. Perform audits in accordance with the Lockout/Tagout Inspection Checklist. Maintain checklists for three years.
- 2) The PWD will use the audit results to generate a report and develops a Plan of Actions and Milestones (POAM) to correct the deviations and/or inadequacies.
- 3) The audits shall be performed by an authorized employee(s) who is not using the energy control (lockout/tagout (LOTO) procedure being inspected.

Lockout / Tagout Inspection Checklist – Low Voltage

TITLE OF JOB: _____

SYSTEM VOLTAGE: _____

LOCATION OF WORK: _____

LIST EMPLOYEES ON JOB SITE, CIRCLE QUALIFIED PERSON IN-CHARGE NAMES (SHALL BE A QUALIFIED PERSON) AND QUALIFIED PERSON NAMES:

GENERAL

ITEM	YES	NO	REMARKS
Check employees qualifications			
Work site appears safe			
Employees wearing appropriate PPE			
If a group red danger lockout/tagout, is there a designated Qualified Person In-Charge			

ITEM	YES	NO	REMARKS
If multiple crews are working at site, overall job-associated LOTO control responsibility has been assigned to a Qualified Person In-Charge to coordinate affected work forces and ensure continuity of protection.			
Red danger locks are approved and serialized to identify person who installed the locks			
Each Authorized Employee has reviewed the adequacy of the LOTO before starting work on the circuit/equipment			
Red danger Locks affixed by (Name)_____			
Red danger Locks hold device in proper position			
Personal red danger locks attached by each Authorized Employee working job			
Red danger tag appropriately attached			
Red danger tag has correct and adequate information recorded on the tag			
Protective grounds are properly placed			
Adequate testing performed prior to placing grounds			
Adequate testing performed after placing grounds			
Grounding waiver specified by QP-in charge, Designated QP-LV or Designated QP-HV			
Qualified Person that attached red danger tags removes same			

PROCEDURE

ITEM	YES	NO	REMARKS
Qualified Person-in-Charge Shall:			
Determine all possible sources of energy			
Identify method of isolating the energy			
Obtain red danger lockout and tagout devices			
Complete the red danger tags as required			

ITEM	YES	NO	REMARKS
Ensure area is clear			
Notify affected personnel			
Prior to opening Devices, Qualified Person shall:			
Conduct a job brief /review with all personnel involved			
Review applicable SOPs			
Ensure proper PPE worn			
Verify that sufficient clearance will exist between the energized parts from the de-energized parts to allow work to be performed safely			
Red danger locks placed per Section 2.3.3			
Red danger tag attached per Section 2.3.3 and information on red danger tag is correct and adequate			
Each Authorized Employee installs a red danger lock on each energy isolating device			
Test for no voltage per Section 2.3.3			
Grounds installed per Section 2.3.3			
Ground information on Red Danger tags is correct and adequate			
If discrepancies noted, process stopped and outage canceled or procedure in Section 2.3.3 followed			

ITEM	YES	NO	REMARKS
Prior to performing work, on a circuit/equipment that is LOTO, the Qualified Person-in-charge shall:			
Conduct a job brief			
Discuss what was switched and grounded			
Discuss what is still energized and other hazards			
Authorized Employees who leave the site and return are briefed on current conditions			

ITEM	YES	NO	REMARKS
Before starting work, Qualified Employee shall test for no voltage per Section 2.3.3			
If work is stopped at the end of the current work shift and all of the work crew leaves the job site, red danger tags and red dangers locks shall be removed. If it is desired to keep the circuit out of service for reasons other than establishing an electrical safe work condition, install yellow caution tags and yellow caution locks			
Temporarily removed red danger tags, red danger locks and grounds to temporarily energize a circuit/equipment (Section 2.3.3) of procedure followed (list steps used)			
Upon work completion, Qualified Person In-Charge shall verify:			
Work complete			
All employees are clear from circuits and equipment			
Equipment is clear of all tools, etc.			
All covers, panels, etc. have been replaced			
No hazardous conditions have been created as a result of work performed			

ITEM	YES	NO	REMARKS
Prior to backer-energizing, Qualified Person performs the following:			
Job Brief/review with all personnel involved			
Review appropriate SOPs			
Review required PPE			
Remove grounds he/she installed			
Remove red danger locks they personally installed			
Remove red danger tag they personally installed			
Removed red danger tags shall be maintained for one year			

ITEM	YES	NO	REMARKS
Devices operated to restore the circuit/equipment to service			
QP-In-Charge shall contact SOC personnel and provides the following information to be entered into the Tag Log:			
Location			
Red danger tag numbers			
Red danger tags removal date and time			
QP-LV removing tags			

ADMINISTRATIVE

ITEM	YES	NO	REMARKS
Review tag log for previous four months and compare and analyze with Maximo work orders			
Pull Employee qualifications centralized list and review			
Review backlog of open red danger tags			

2.11. JOB SAFETY ANALYSIS

JOB SAFETY ANALYSIS	JOB TITLE: Hazardous Electrical Energy Control		DATE:	<input type="checkbox"/> NEW
	JSA no: ESAFE Chapter 2			<input type="checkbox"/> REVISED
	TITLE OF PERSON WHO DOES JOB: Qualified Employees	SUPERVISOR:	ANALYSIS BY:	
	PLANT LOCATION: NAVFAC	DEPARTMENT: Public Works Business Line	REVIEWED BY:	
Required Personal Protective Equipment :	Arc rated (AR) long sleeve shirt and pants (or coveralls) Electrical hazard (EH) rated Safety Shoes, Non-metallic safety glasses with side shields, Class E hard hat, Voltage rater gloves with leather protectors, hearing protection (ear canal inserts), 12 cal/cm ² Arc flash hood (sock/balaclava) in combination with a 10 cal/cm ² face shield attached to hard hat, multilayer minimum 40 cal/cm ² arc flash suit and temporary personal protective grounds.			APPROVED BY:
SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	RECOMMENDED ACTION OR PROCEDURE		
Planned Outage and LOTO Event:				
1. De-energize circuit/equipment	Electric shock, arc flash, arc flash burns, arc blast	Wear PPE as required by Chapter 4		
2. Install red or yellow locks and red or yellow tags	Electric shock, arc flash burn, arc blast	Wear PPE as required by Chapter 4		
3. Test and apply grounds	Electric shock, arc flash, arc flash burns, arc blast	Wear PPE as required by Chapter 4, test voltage tester as instructed in this Chapter		
4. Remove Locks, tags, and grounds	Electric shock, arc flash, arc flash burns, arc blast	Wear PPE as required by Chapter 4, apply grounds as instructed in this Chapter		
5. Re-energize circuit/equipment	Electric shock, arc flash, arc flash burns, arc blast	Wear PPE as required by Chapter 4, remove grounds as instructed in this Chapter		

CHAPTER 3 - USE AND CARE OF ELECTRICAL PROTECTIVE RUBBER GOODS AND LIVE LINE TOOLS

3.1. PURPOSE

Many task-related and hazard-related SOP's in the electrical trade require rubber goods. While this SOP does not establish when the rubber goods are required, it does establish methods for the care and use of electrical protective rubber products as required by the Electrical SAFE. This procedure also provides acceptance criteria by which electrical protective rubber goods can be evaluated by the user as to its readiness for continued service.

Several task-related SOP's in the electrical trade require the use of live-line tools. While this SOP does not establish when the live-line tools are required, or how to use them, it does establish methods for the care, inspection and testing of such tools. This procedure also provides acceptance criteria by which live-line tools can be evaluated by the user as to their readiness for continued service.

3.2. BACKGROUND

Electrical protective rubber goods designed to protect the worker from shock hazards and are available in six basic voltage classes from class 00 to class 4 and two types Type I, non-ozone resistant and Type II, resistant to ozone and UV rays. The table below provides the OSHA 29 CFR 1910.137 voltage and proof test requirements for rubber insulating equipment.

Type I gloves are typically utilized because of increased flexibility. Leather protectors provide the necessary resistance to ozone and UV rays over the normal usage period of gloves.

Class of Equipment	Color Label	Maximum Use (AC Volts)	Proof Test (AC Volts)	Retest Voltage (DC or AC – Average)	Minimum Distance ¹ in Inches (Millimeters)
00	Beige	500	2,500	10,000	1 (25)
0	Red	1,000	5,000	20,000	1 (25)
1	White	7,500	10,000	40,000	1 (25)
2	Yellow	17,000	20,000	50,000	2 (50)
3	Green	26,500	30,000	60,000	3 (75)
4	Orange	36,000	40,000	70,000	4 (100)

1 – Wear leather protectors over rubber gloves. Minimum distance is the minimum length that the exposed rubber glove must extend beyond the leather protector.

Live-Line Tools are designed to enable qualified personnel to perform operations and maintenance on electrical distribution systems while energized. Live-Line Tools includes hot sticks, insulated cable cutters, insulated compression tools and many other tools designed for work on energized systems. While live-line maintenance is an

accepted practice within the industry, NAVFAC policy limits the use of live-line tools to voltage testing, phase testing, the operation of high voltage switches, fuses, cut-outs and the installation/removal of temporary personal protective grounds. All live line tools (hot sticks) shall be fiberglass-reinforced plastic (FRP).

3.3. EQUIPMENT/SERVICES FOR MAINTAINING ELECTRICAL PROTECTIVE RUBBER GOODS AND LIVE LINE TOOLS

The required equipment and services are:

- An electronic live-line tool tester
- Manufacturer approved silicone impregnated cloth
- An approved electrical testing facility in compliance with reference (a) and OSHA 1910.137
- Vinyl storage bags
- A mechanical inflator
- Leather protectors for rubber insulating gloves

3.4. PERIODIC EVALUATION AND TESTING

3.4.1. RUBBER GOODS

In-service inspection and testing at the electrical testing facility must conform to reference (a), Unified Facilities Criteria (UFC) 3-560-01 “Operations and Maintenance: Electrical Safety”.

Purchase of new rubber goods must be in compliance with reference (a). Damaged or otherwise obviously defective products will be destroyed and disposed. The maximum period between date of issue and removal from service for re-inspection/testing will be as follows:

Type of Equipment	Test Frequency
Rubber insulating covers	Upon indication that insulating value is suspect
Rubber insulating blankets	Before first issue and every 12 months thereafter
Rubber insulating gloves	Before first issue and every 6 months thereafter
Rubber insulating sleeves	Before first issue and every 12 months thereafter

Note: Gloves, sleeves and blankets that have been inspected and electrically tested at an approved electrical testing facility but not issued for service shall not be placed into service unless they have been electrically tested within the previous twelve months.

Line hoses and covers are not subject to scheduled periodic re-testing but must be removed from service and re-inspected and tested at the electrical testing facility if a visual inspection gives reason to suspect their electrical integrity.

3.4.2. LIVE LINE TOOLS

Periodic evaluation, wet electrical testing and post-repair wet electrical testing are required for live line tools.

Live line tools must be submitted to a wet electrical test at not more than 2-year intervals, and after any repair or refinishing. This test must be performed over the entire working length of the tool. All live-line tool repairs and/or refinishing will be performed in accordance with the manufacturer's recommendations. Use of either laboratory or shop/field testing is acceptable to complete these tests:

- Laboratory testing in accordance with ASTM F3121/F3121M-16. FRP tools require an application of 75,000 V (ac) per ft (305 mm) for one minute.
- Shop or field testing using calibrated test equipment, such as the Hubbell Chance Wet/Dry Hot Stick Tester.

Precautions for Shop or Field Testing. - Follow the manufacturer's instructions and comply with the following precautions:

- Use demineralized water (such as sold in local grocery stores), if available. Otherwise use clean water of conductivity of 3.0 micromho-centimeters or less at room temperature.
- Support the tool in a horizontal position during the test.
- Avoid over-wetting. Use a mist applicator (such as a laundry-type spray bottle) and spray the test section until drops just start to run down the surface. If too much water is sprayed on the tool, water can collect in a line of drops at the undersurface, producing a false rejection because of flashover or high leakage current.
- Take overlapping readings from one end of the tool to the other but do not slide the tester on the tool. Lift up the tester before moving it. This can prevent streaks that can cause a false rejection.
- Rotate the tool 90 degrees and again test the tool from end to end. Continue in this manner until four different positions around the tool circumference have been tested.

Two sets of test records are to be kept. One record shall be stored in a database to be maintained by the PPE Coordinator and will contain the testing records of all live-line tools. The second record is attached to the live-line tool itself, in accordance with manufacturer's instructions. Both records will state at a minimum the serial number, date tested, next testing due date, and the initials of the person who performed the test. Live-line tools with test dates greater than two years shall be removed from service.

3.5. STORAGE

3.5.1. RUBBER GOODS

Electrical protective rubber goods shall be stored in a clean, cool, dark, and dry location free from ozone, chemicals, oils, solvents, damaging vapors and fumes, electrical

discharges and sunlight. Rubber goods shall not have any identifying adhesive tapes or labels applied to them.

Gloves, sleeves and blankets shall not be folded, creased, turned inside out, compressed, or stored in any manner that will cause stretching or compression. Gloves shall be stored in their natural shape and must be kept inside of protectors or in a bag, box, or suitable container. Sleeves may be loosely rolled lengthwise inside a sleeve rollup. Tape shall not be used on gloves, sleeves or blankets for shipment or storage. Line hoses and covers shall be stored without distortion and mechanical stress. They shall be stored or packaged in a suitable compartment or in containers such as boxes or bags.

3.5.2. LIVE LINE TOOLS

Live-line tools shall be stored in a clean and dry location. Live-line tools stored in substations and work center's storage areas shall be protected from physical damage as well as moisture, dust, dirt or other contaminants. Live-line tools carried on vehicles shall be stored in storage bins or canisters. Live-line tools on vehicles shall not be stored in storage space with loose metal objects. The use of vinyl storage bags is recommended for optimal protection.

3.6. INSPECTION

3.6.1. RUBBER GOODS

The field care and inspection of electrical protective rubber products performed by the individual user is an important requirement in providing protection from shock hazards. Prior to each use electrical protective rubber products shall be given a visual inspection over the entire surface. Items found to have texture changes, swelling, softening, hardening, sticky surface, loss of elasticity, holes other than factory produced openings, punctures, cuts, corona or ozone cutting, contamination from injurious materials, or any other obvious condition that would adversely affect performance shall not be used. Where a visual inspection indicates that there may be reason to suspect the electrical integrity of an item, it shall not be used before it has been inspected and re-tested at an electrical test facility.

Glove and Sleeve Inspection:

Gloves shall be inspected over the entire surface and shall be rolled gently between the hands to expose defects and imbedded materials. They shall be air-tested before each day's use and at other times if there is cause to suspect any damage. The air test can be accomplished by rolling the cuff tightly toward the palm in such a manner that air is entrapped inside the glove, or by using a mechanical inflator. When using the latter, care should be taken to avoid over-inflation. The inflation limit for a Type I glove is two times its normal size. The inflation limit for a Type II glove is 125% of its normal size. The glove shall be examined for punctures and other defects. Puncture detection may be enhanced by listening for escaping air or holding the gloves against the worker's cheek to feel for escaping air.

Blanket Inspection:

Blankets shall be inspected visually by the user for defects before being installed, and at other times if there is cause to suspect any damage. They shall be inspected on both sides over the entire surface for defects and imbedded materials.

Line Hose and Cover Inspection:

Line hoses and covers shall be inspected visually by the user for defects before being installed, and at other times if there is cause to suspect any damage. They shall be inspected over the entire surface for defects and imbedded materials.

3.6.2. LIVE LINE TOOLS

Prior to use live-line tools shall be visually inspected and wiped clean with a manufacturer approved silicone impregnated cloth. The glossy finish on the surface of the live-line tools is key to maximizing the electrical integrity of the tool. When contaminates such as dirt, creosote, grease, soaps and unknown substances that could adversely affect the insulating qualities are present after wiping, the tool shall be removed from service.

Caution: Do not use soap detergents, liquid or powdered form, such as 409, Fantastic, Comet, Spray 9, or Ajax to clean fiberglass tools. These can leave a conductive residue and abrasives could damage the surface gloss of the tool (thus permitting water to “wet-out” or “sheet” on the surface of the tool if later exposed to rain or heavy fog).

Live-line tools having loss of glossy surface, electrical tracking, burn marks, blisters caused from heat, deep cuts, scratches, nicks, gouges, dents, looseness, excessive wear, bent pins/bolts or any obvious condition that would adversely affect insulating qualities or mechanical integrity shall not be used until repaired and re-tested. Severely damaged live-line tools will be destroyed.

Other conditions for removal from service are if one or more of the following conditions are detected:

- It fails to pass an electrical wet test during laboratory, shop, or field testing.
- If a tingling or fuzzy sensation is felt when the tool is in contact with energized conductors or hardware.
- If a tool has been dropped from a significant height (such as from an overhead line or a structure) or subjected to impact such that internal structural damage is suspected.

3.7. FIELD CARE

3.7.1. RUBBER GOODS

Rubber goods should be wiped clean of any oil, grease, or other damaging substances as soon as practicable. Gloves and sleeves should be rinsed as necessary to remove perspiration. Store rubber gloves with the fingers up to allow moisture to drain/dry from the gloves. Care should be exercised to keep protector gloves as free as possible from oils, greases, chemicals, and other materials that may injure the insulating gloves. Line

hoses and covers should be left in service on energized lines for minimum necessary periods of time as exposure may result in ozone checking, corona cutting, or excessive weathering.

3.7.2. LIVE LINE TOOLS

The field care of live-line tools is an important element in providing protection from shock and flash hazards. If the tool is not in use, return it to the truck, lay it on a tarpaulin, or prop it up on an improvised rack. Never lay live-line tools on the ground or expose them to moisture. Do not use a hot stick in inclement weather if it is not beading water. Live-line tools that become wet must be wiped dry as soon as practicable. When raising or lowering from an elevated work location, live-line tools should be securely attached to hand lines. Live-line tools are to be used only to accomplish the job for which they were designed. Live-line tools shall not have any identifying adhesive tapes or labels applied to them except as required in Section 3.4.

3.7.2.1. LEATHER PROTECTORS FOR RUBBER INSULATING GLOVES AND MITTENS

The purpose of the leather protectors is to provide mechanical protection for the rubber gloves and rubber mittens. ASTM F 696 standard applies. The leather protectors alone shall not be used for electrical protection. Protector gloves that have been used for any other purpose shall not be used to protect insulating gloves. Leather protectors are not subject to scheduled periodic re-testing but must be visually inspected by the user prior to each use. They must be free of cuts, tears or any obvious condition that would adversely affect performance. Leather protectors must be sized and shaped so that the insulating glove is not deformed from its natural shape. The minimum distance between the top of the cuff of the protector and the rolled top of the cuff of the insulating glove shall not be less than that specified in Section 3.2.

3.8. TRAINING, CERTIFICATIONS, AND RECORD KEEPING

The correct use of electrical protective rubber goods is vital to the safety of each employee whose job involves working on or near exposed energized electrical conductors. Employees who are required to perform such work must be trained and thoroughly knowledgeable of the rubber goods program before being exposed to work conditions that involve electrical shock hazards. Training procedures and program responsibilities are specified in Chapter 1.

3.9. JOB SAFETY ANALYSIS

	JOB TITLE: Use and Care of Electrical Protective Rubber Products and Live Line Tools		DATE:	<input type="checkbox"/> NEW
	JSA no: ESAFE Chapter 3			<input type="checkbox"/> REVISED
JOB SAFETY ANALYSIS	TITLE OF PERSON WHO DOES JOB: All employees who work on or near exposed energized electrical systems	SUPERVISOR:	ANALYSIS BY:	
	PLANT LOCATION: NAVFAC	DEPARTMENT: Public Works Business Line	REVIEWED BY:	
Required Personal Protective Equipment :	Voltage rated electrical protective rubber products and live line tools.		APPROVED BY:	
SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	RECOMMENDED ACTION OR PROCEDURE		
Periodic testing of rubber goods	Electrical shock/electrocution	Perform periodic testing of rubber goods as specified		
Periodic and post repair inspection and testing of live line tools	Dielectric failure causing electrical shock, flash, burns	Inspect and test live line tools as specified		
Storage of rubber goods	Electrical shock/electrocution	Store rubber goods as specified		
Storage of live line tools	Dielectric failure causing electrical shock, flash, burns	Store live line tools as specified		
Leather protectors	Electrical shock/electrocution	Visually inspect prior to each use,		
Pre-use inspection of live line tools	Dielectric failure causing electrical shock, flash, burns	Inspect live line tools as described before each use		
Field care of rubber goods	Electrical shock/electrocution	Use rubber goods as described		
Field care of live line tools	Dielectric failure causing electrical shock, flash, burns	Use live line tools as described		

CHAPTER 4 - WORKING ON OR NEAR EXPOSED AND ENCLOSED ENERGIZED ELECTRICAL SYSTEMS

4.1. PURPOSE

To establish safety related work practices and personal protective equipment (PPE) required to work on or near exposed and enclosed energized electrical systems.

4.2. BACKGROUND

When a person is exposed to a bare (exposed), energized conductor he or she is at risk of injury not only to themselves, but also to others nearby. The hazards of working on or near exposed and enclosed energized electrical conductors can result in electrical shock, electrocution, arc flash burns, arc blast, thermal burns, respiratory contamination and other physical trauma injuries related to falling or being struck by objects due to an arc blast. The definition of energized work is "Work on or near energized or potentially energized lines (e.g. part of tools being used or worker's body less than the restricted approach boundary such as removing and attaching grounds, live line tool work, gloving and bare hand work).

4.3. TOOLS AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

The required Tools and PPE are:

- Live line tools (Hot Sticks)
- Voltage rated hand tools
- Approved high and low voltage testers
- Red danger locks
- Red danger tags
- Temporary personal protective grounds
- Arc rated (AR) long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm²
- Leather electrical hazard (EH) - rated work shoes/boots
- Non-metallic safety glasses with side shields
- Class E hard hat
- Voltage rated gloves with leather protectors
- Hearing protection (ear canal inserts)
- 12 cal/cm² Arc flash suit hood or 12 cal/cm² balaclava in combination with 10 cal/cm² face shield attached to hard hat.
- Multilayer arc flash suit, minimum 40 cal/cm²

4.4. PROCEDURES

Electrical equipment/conductors to which an employee could be exposed shall be put in a safe work condition before the employee works on or near them.

Defined below are the exceptional circumstances when work on exposed energized electrical systems is allowed.

1. Measuring/testing electrical parameters per Chapter 5, Measuring/Testing Parameters of Energized Electrical Systems (Low and High Voltage).
2. Performing a task energized is necessary to support a critical mission, prevent human injury, or protect property.

Also identified are the required safe work practices and PPE necessary to protect employees from the hazards associated with energized electrical work. Established below are the parameters to develop project safety plans for specific energized tasks.

4.4.1. ENERGIZED ELECTRICAL WORK

All energized work requires written task specific procedures approved by the NAVFAC FEC Commanding Officer specifying all appropriate safe work practices and PPE as required by this Electrical SAFE. Procedures shall be in SOP/JSA format or as a special permission energized electrical work permit (Section 4.11), with a Job Safety Analysis.

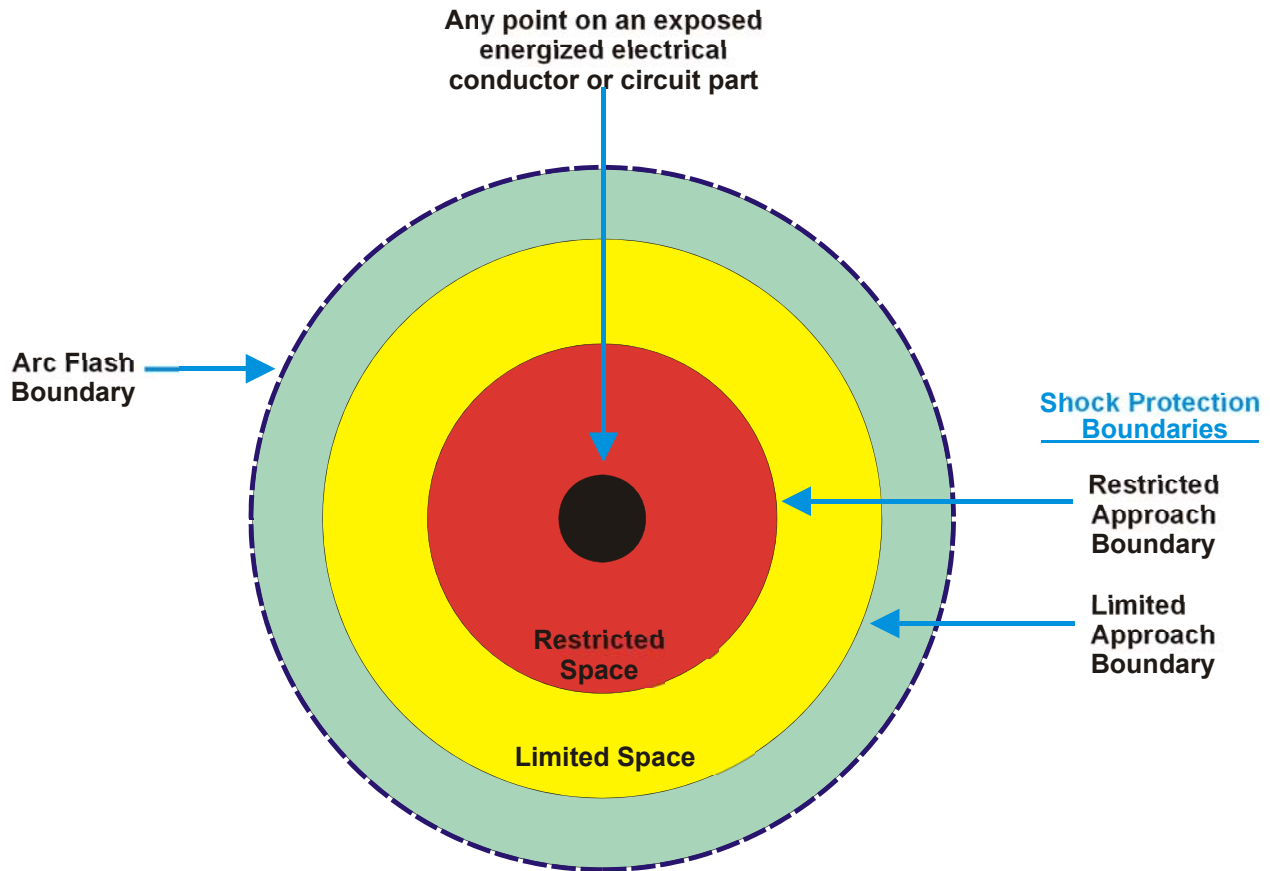
4.4.2. WORKING NEAR ENERGIZED CIRCUITS

Perform electrical maintenance near energized circuits with rubber blankets or other suitable guards as a safety measure. Minor work (such as cutting weeds, taking oil samples, or securing nameplate data) when done near energized apparatus or conductors located on or near the ground may be performed by unqualified workers outside the arc flash and limited approach boundaries, as appropriate.

4.4.2.1. APPROACH LIMITS

Figure 4-1 shows a general layout of the various approach limits. Each boundary is defined following Figure 4-1.

Figure 4-1. Approach Limits



4.4.2.2. ARC FLASH BOUNDARY

The distance from an arc source (energized exposed equipment) at which the potential incident heat energy from an arcing fault on the surface of the skin is 1.2 cal/cm^2 (5 J/cm^2). Within this boundary, workers are required to wear appropriate personal protective equipment (PPE) clothing. Only qualified workers wearing appropriate PPE are permitted to be within this boundary. Note that the arc flash boundary is not always outside the limited approach boundary, as shown in Figure 4-1.

4.4.2.3. LIMITED APPROACH BOUNDARY

A shock protection boundary may only be crossed by qualified persons (at a distance from a live part). A limited approach boundary is not to be crossed by unqualified persons.

If there is a need for an unqualified person(s) to cross the limited approach boundary, a qualified person must advise him or her of the possible hazards and continuously escort

the unqualified person(s) while inside the limited approach boundary. Under no circumstance is the escorted unqualified person(s) allowed to cross the restricted approach boundary.

4.4.2.4. RESTRICTED APPROACH BOUNDARY

A shock protection boundary to be crossed by only qualified persons (at a distance from a live part) that, due to its proximity to a shock hazard, requires the use of shock protection techniques and equipment when crossed.

4.4.2.5. MINIMUM APPROACH DISTANCES

Table 4-1 lists the minimum approach distances from exposed alternating current energized parts within which a qualified worker may not approach without the use of personal protective equipment appropriate for the potential electrical hazards, or place any conductive object without an approved insulating handle, unless certain other work techniques are used (such as isolation, insulation, shielding, or guarding). Table 4-2 provides similar information for direct current systems.

TABLE 4-1 QUALIFIED WORKER MINIMUM APPROACH DISTANCES – AC SYSTEMS

Nominal System Voltage Range Phase to Phase (1)	Limited Approach Boundary		Restricted Approach Boundary (2) (3)
	Exposed Movable Conductor	Exposed Fixed Circuit Part	Includes Standard Inadvertent Movement Adder
<50 V	Not specified.	Not specified.	Not specified.
50 V to 150 V	10 ft 0 in (3.0 m)	3 ft 6 in (1.0 m)	Avoid contact
>151 V to 750 V	10 ft 0 in (3.0 m)	3 ft 6 in (1.0 m)	1 ft 0 in (0.3 m)
>750 V to 15 kV	10 ft 0 in (3.0 m)	5 ft 0 in (1.5 m)	2 ft 2 in (0.7 m)
>15 kV to 36 kV	10 ft 0 in (3.0 m)	6 ft 0 in (1.8 m)	2 ft 7 in (0.8 m)
>36 kV to 46 kV	10 ft 0 in (3.0 m)	8 ft 0 in (2.5 m)	2 ft 9 in (0.8 m)

>46 kV to 72.5 kV	10 ft 0 in (3.0 m)	8 ft 0 in (2.5 m)	3 ft 3 in (1.0 m)
>72.5 kV to 121 kV	10 ft 8 in (3.3 m)	8 ft 0 in (2.5 m)	3 ft 4 in (1.0 m)
>121 kV to 145 kV	11 ft 0 in (3.4 m)	10 ft 0 in (3.0 m)	3 ft 10 in (1.2 m)

Notes:

- 1) For single phase systems select the range that is equal to the system's maximum phase to ground voltage times 1.732.
- 2) The restricted approach boundary is defined as the distance between energized parts and grounded objects without insulation, isolation, or guards.
- 3) The restricted approach distance applied to hot sticks is the distance between a worker's hand and the working end of the stick.
- 4) Only qualified workers wearing appropriate PPE are permitted to be within the arc flash boundary. The arc flash boundary is determined by an arc flash analysis. Refer to Sections 4-5, 4-6, 4-7 for PPE requirements for the intended work location.

TABLE 4-2 QUALIFIED WORKER MINIMUM APPROACH DISTANCES – DC SYSTEMS

Nominal System Voltage Range Phase to Phase (1)	Limited Approach Boundary		Restricted Approach Boundary
	Exposed Movable Conductor	Exposed Fixed Circuit Part	Includes Reduced Inadvertent Movement Adder
<50 V	Not specified	Not specified	Not specified
50 V to 300 V	10 ft 0 in (3.0 m)	3 ft 6 in (1.0 m)	Avoid contact
>300 V to 1 kV	10 ft 0 in (3.0 m)	3 ft 6 in (1.0 m)	1 ft 0 in (0.3 m)

Note: Refer to NFPA 70E for DC voltages above 1,000 V

4.4.2.6. ALTITUDE CORRECTION FOR MINIMUM APPROACH DISTANCES

Refer to Table 4-3 for altitude correction factors for work performed at elevations greater than 3,000ft (914m); the minimum approach distance is determined by multiplying the distances in Table 4-1 by the appropriate correction factor from Table 4-3.

TABLE 4-3 ALTITUDE CORRECTION FACTORS

Altitude		Correction Factor	Altitude		Correction Factor
Feet	Meters		Feet	Meters	
3,000	900	1.00	10,000	3,000	1.20
4,000	1,200	1.02	12,000	3,600	1.25
5,000	1,500	1.05	14,000	4,200	1.30
6,000	1,800	1.08	16,000	4,800	1.35
7,000	2,100	1.11	18,000	5,400	1.39
8,000	2,400	1.14	20,000	6,000	1.44
9,000	2,700	1.17			

4.4.2.7. NUMBER OF WORKERS REQUIRED

All work must be performed with a sufficient number of workers to provide a safe working environment. 29 CFR 1910.269 (*Electrical power generation, transmission, and distribution*) requires more than one worker where the hazard exposure of the work is considered to be significantly reduced by the presence of additional workers. Tables 4-4, 4-5 and 4-6 provide specific requirements for number of workers required:

TABLE 4-4 JOBS ACCEPTABLE FOR ONE ELECTRICAL WORKER

1. Work on systems in an electrically safe work condition with nominal system voltages of 600 volts ac or 250 volts dc, or less.
2. Routine electrical measurements on energized systems with nominal system voltages of 600 volts ac or 250 volts dc, or less.
3. Routine operation of metal-enclosed switchgear with nominal system voltages of 600 volts ac or 250 volts dc, or less.
4. Routine operation of metal-enclosed switchgear and pad mounted switches with nominal systems voltages greater than 600 volts ac if the activity responsible can demonstrate that conditions at the site allow this work to be performed safely.
5. Routine electrical measurements or switching using gloves and live-line tools if the worker is positioned out of reach or possible contact with energized parts.
6. Emergency repair work to safeguard the general public, if previously authorized.

TABLE 4-5 JOBS REQUIRING TWO ELECTRICAL WORKERS

Hazard Exposure	Working On
Installation, removal, or repair when working on or near lines or parts energized at:	
1. Voltages of 600 volts ac or 250 volts dc, or less.	<ul style="list-style-type: none"> • Installing portable monitoring equipment if it requires: (1) removing covers on panels rated for greater than 240 volts or (2) disturbing circuit conductors.
2. Greater than 600 volts ac or 250 volts dc.	<ul style="list-style-type: none"> • Energized lines. • De-energized lines with possible energized parts contact. • Equipment with possible energized line contact. • Mechanical equipment operation (except insulated aerial lifts) near energized parts. • Operation of insulated aerial lifts (bucket trucks). • Other work with equal or greater hazard exposure.

TABLE 4-6. WORKING IN CONFINED SPACES THAT MAY REQUIRE MORE THAN TWO WORKERS

Hazard Exposure	Additional Worker Requirement
Installation, removal, or repair when working in a confined space. Manhole or vault requirements are generally classified as confined spaces.	<ol style="list-style-type: none"> 1. An attendant with first-aid and CPR training will be available on the surface in the immediate vicinity. 2. If a hazard exists within the space, or a hazard exists or is created because of traffic patterns outside the space, the attendant may not enter the confined space. 3. If the restrictions of Item 2 above do not apply, the attendant may enter the confined space to provide assistance, but only for a brief period (other than in an emergency). For extended periods of assistance, a second worker in addition to the attendant is required.

4.4.2.8. PROHIBITED ENERGIZED WORK PRACTICES

Gloving above 600 volts and the bare hand technique 50 volts and above is prohibited.

4.4.2.9. REQUIRED SAFE WORK PRACTICES FOR ENERGIZED WORK

Procedures written for energized work shall identify safe work practices in step by step detail using the below outline as a guide.

1. Step 1 - Access job site

- 1.1 Only qualified persons shall perform energized work.
- 1.2 Examine job site, look for hazardous conditions, determine means to abate hazards.
- 1.3 Notify immediate supervisor prior to starting any energized work, if work is after hours contact SOC personnel.

2. Step 2- Job site setup

- 2.1 Arc Flash Boundary is determined by tables 4-8 and 4-10 or an arc flash risk assessment.
- 2.2 Determine limited approach boundary and restricted approach boundary using Table 4-1 or 4-2, and Table 4-3.
- 2.3 Limit access within the limited approach and flash protection boundaries to qualified personnel only.
- 2.4 Identify and clear an escape route to an area 10' or more beyond the flash protection boundary.
- 2.5 Ensure the area is well lit.
- 2.6 Determine required PPE for specific task per tables 4-8 through 4-11.
- 2.7 Identify means of emergency personnel release: either securing power or readily available insulating equipment to remove person from circuit.

3. Step 3 - Job brief

- 3.1 Conduct a pre-job briefing to address all hazards and plan work.

4. Step 4 - Inspect PPE, voltage rated tools and test instruments

- 4.1 Perform a pre-use rubber goods and hot sticks inspection per Chapter 3.
- 4.2 Perform a pre-use inspection of other PPE per Section 4.5.5.
- 4.3 Perform a pre-use inspection on voltage rated hand tools per Section 4.5.5.
- 4.4 Perform a pre-use inspection on test instruments per Section 4.5.5.

5. Step 5 - Wear PPE

- 5.1 Remove all conductive articles of clothing or jewelry.
- 5.2 Wear all PPE in Table 4-7 as required for the specific task.

6. Step 6 - Perform task

- 6.1 Follow listed requirements for work within limited approach boundaries in Section 4.4.
- 6.2 Follow listed requirements for work within minimum working Distance in Section 4.4.

4.5. MINIMUM PPE CLOTHING REQUIREMENTS

Any worker whose normal job includes working on or near exposed and enclosed electrical equipment must wear to work as a minimum:

- Arc-rated shirt (long-sleeve) and pants (or arc-rated coveralls) with minimum arc rating of 8 cal/cm² (33.47 J/cm²).
- Cotton or natural fiber underwear (conventional short sleeve t-shirt and briefs/shorts). Do not include any organizational or other insignias or decals on t-shirts.
- Leather electrical hazard-rated (EH) footwear. Note: High voltage linemen are not required to wear EH work footwear while climbing.

4.5.1. JOB SITE PPE CLOTHING REQUIREMENTS

Any employee who goes to a job site that involves working on or near exposed electrical equipment must wear all of the following (with the exception of gloves which will be dictated by the work task in Tables 4-8 through 4-11) as a minimum:

- Arc-rated shirt (long-sleeve) and pants (or arc-rated coveralls) with minimum arc rating of 8 cal/cm² (33.47 J/cm²).
- Cotton or natural fiber underwear (conventional short sleeve t-shirt and briefs/shorts). Do not include any organizational or other insignias or decals on t-shirts.
- Leather electrical hazard-rated (EH) footwear. Note: High voltage linemen are not required to wear EH footwear while climbing.
- Safety glasses (ANSI Z87.1) with non-removable side shields. Wear safety goggles (ANSI Z87.1) over metal frame and non-safety glasses.
- Hardhat (ISEA Z89.1 Type 1 Class E approved). Long hair must be secured under the hardhat. For cold weather operations, insulated hard hat liner must be arc rated. For work tasks classified as Category 2 or higher, an insulated hard hat liner does not satisfy the requirement for a sock/balaclava worn under the face shield.
- Wear leather work gloves for work tasks classified as Category 2. Wear arc-rated gloves for work tasks classified as Category 4. Voltage rated gloves with leather protectors are equivalent to arc-rated gloves. Rubber glove protectors must not be used as work gloves.

- Hearing protection using ear-canal inserts is required whenever working within the arc flash boundary. Hearing protection is also required in accordance with local procedures and whenever the sound level exceeds 84 decibels or 140 decibels peak sound level pressure for impulse or impact noise, regardless of the exposure duration. Wear a combination of insert type and circumaural types of hearing protectors (double protection) when sound levels exceed 104 dB(A).

4.5.2. REQUIRED PPE LEVEL PER ARC FLASH CATEGORY

Table 4-7 provides the required minimum PPE level to be worn as a function of the arc flash PPE category.

TABLE 4-7 REQUIRED PPE PER ARC FLASH CATEGORY

Arc Flash PPE Category	General PPE Description <small>(See notes)</small>	Required Minimum PPE Arc Rating [cal/cm ² (J/cm ²)]
0 (see Note 1)	Comply with Section 4.5.1 Job-Site PPE Clothing Requirements.	8 (33.47)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² <ul style="list-style-type: none"> • Arc-rated long-sleeve shirt and pants or arc-rated coverall • 12 cal/cm² Arc flash suit hood or 12 cal/cm² balaclava in combination with 10 cal/cm² face shield attached to hard hat. (see Note 2) • Arc-rated jacket, parka, rainwear, or hard hat liner (AN) • Protective Equipment • Hard hat (AR) • Safety glasses or safety goggles (SR) • Hearing protection (ear canal inserts) • Heavy duty leather gloves (see Note 3) • Leather footwear 	8 (33.47)
4 (see Note 4)	Arc-Rated Clothing, selected so that the System Arc Rating meets the Required Minimum Arc Rating of 40 cal/cm² <ul style="list-style-type: none"> • Arc-rated long-sleeve shirt (AR) • Arc-rated pants (AR) • Arc-rated coverall (AR) • Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) • Arc-rated arc flash suit hood • Arc-rated gloves (See Note 3) 	40 (167.36)

	<ul style="list-style-type: none"> • Arc-rated jacket, parka, rainwear, or hard hat liner (AN) • Protective Equipment • Hard hat (AR) • Safety glasses or safety goggles (SR) • Hearing protection (ear canal inserts) 	
	Leather footwear	

- **Note 1.** Outside the arc flash boundary; PPE 0 specified is in accordance with UFC 03-560-01.
- **Note 2.** Face shields are to have wrap-around guarding to protect not only the face but also the forehead, ears, and neck. Use an arc-rated balaclava with an arc-rated face shield when the back of the head is within the arc flash boundary. As an alternative, an arc-rated arc flash suit hood can be worn instead of an arc-rated face shield and balaclava.
- **Note3.** If rubber insulating gloves with leather protectors are used, additional leather or arc rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement. Voltage rated gloves with leather protectors must be used in accordance with NFPA 70E and as specified elsewhere in this document.
- **Note 4.** If an Arc Flash Risk Assessment indicates a level higher than the 40 cal/cm², energized work is not allowed under any condition. Equipment must be placed in an electrically safe work condition.
- **Note 5.** For cold weather operations, an insulated hard hat liner must be arc rated. For work tasks classified as Category 2 or higher, an insulated hard hat liner does not satisfy the requirement for a sock/balaclava worn under the face shield.
- **Note 6.** Comply with Section 4.8 Facility Manager Authorized Tasks when operating branch circuit breakers rated for 30 amperes or less used for lighting and general purpose receptacles.

4.5.3. ADDITIONAL PPE CLOTHING REQUIREMENTS

Wear arc flash rated clothing properly inside the arc flash boundary. This includes:

- Long sleeves must be rolled down and buttoned.
- The top button of shirts, coveralls, and jackets must be fastened.
- Tuck shirts into the trousers.
- Shorts are prohibited and trousers must extend the full length of the leg.
- Garments with exposed metallic fasteners must not be worn, unless the garments are properly arc rated.
- Garments, including safety harnesses, worn over arc flash rated protective clothing must be arc flash rated.

4.5.4. CLOTHING PROHIBITIONS

The following is prohibited:

- Do not wear conductive articles of jewelry (including but not limited to cloth with conductive thread, metal frame glasses, metal headgear, wristbands, watch

chains, rings, bracelets, necklaces, body jewelry and piercings) within the restricted approach boundary or where they present an electrical contact hazard with exposed energized electrical conductors or circuit parts.

- Do not wear clothing that could increase the extent of injuries when exposed to electric arcs or open flames. Clothing made from acetate, nylon, polyester, and rayon, either alone or in blends, cannot be worn as undergarments when working on or near energized equipment of greater than 50 V. Military clothing such as DCUs, field jackets, field jacket liners, Gortex jackets and pants, Gortex fleece liners, nylon cold weather gloves, nylon upper combat boots, chemical warfare suits, winter parkas, winter parka pants, all are polyester blend materials and not allowed to be worn when working on or near energized equipment of greater than 50 V. Shorts are prohibited and trousers must extend the full length of the leg.
- Do not wear anything made of celluloid or other flammable plastic when working near electric arcs or open flames. This may include cap visors, collars, and cuff protectors.
- Do not wear loose clothing, dangling sleeves, or neckties when working on or near moving machinery.
- Do not wear garments equipped with metal slides or zipper fasteners, unless the slide or fastener is effectively covered.
- Do not wear coveralls half-dressed where the top-half is wrapped around the waist area.
- Do not wear clothing in a way in which it was unintended to be worn, such as an arc-rated shirt tied around waist with the sleeves.

4.5.5. PPE, VOLTAGE RATED TOOLS, AND TEST EQUIPMENT PRE-USE INSPECTION

All PPE and voltage rated tools shall be visually inspected prior to each day's use and immediately following any incident that can reasonably be suspected of having caused damage. Insulating rubber goods shall be inspected as required by Chapter 3. PPE and voltage rated tools found to have damage that could affect its performance shall not be used on or near exposed energized conductors. Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before the equipment is used on any shift. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service and not used until repairs necessary to render the equipment safe have been made.

4.5.6. TEST INSTRUMENTS

Test instruments, equipment, and their accessories shall be rated for circuits and equipment to which they will be connected and designed for the environment to which they will be exposed, and for the manner in which they will be used.

4.6. ARC FLASH RISK ASSESSMENT

Perform and document an arc flash risk assessment in accordance with NFPA 70E, Article 130.5 or IEEE C2 Paragraph 410.A.3.a, to determine the available incident energy at the intended work location.

Note 1: Refer to UFC 3-560-01 for the delineation between NFPA 70E and IEEE C2.

Note 2: Refer to UFC 3-560-01 for Arc Flash Warning Label information.

Include the following in an arc flash risk assessment:

1. Determine if an arc flash hazard exists. If an arc flash hazard exists, include the following in the arc flash risk assessment:
 - 1.1. Appropriate safety-related work practices.
 - 1.2. The arc flash boundary.
 - 1.3. The PPE to be used within the arc flash boundary.
2. Update the arc flash risk assessment when a major modification or renovation takes place. Review the arc flash risk assessment periodically, at intervals not to exceed five years, to account for changes in the electrical distribution system that could affect the results of the arc flash risk assessment. Typical changes that could affect the arc flash risk assessment include:
 - 2.1. System design changes that affect short circuit values or electrical coordination.
 - 2.2. Protective relay and circuit breaker trip setting changes.
 - 2.3. Revisions to NFPA 70E, IEEE 1584, or IEEE C2 that affect the arc flash calculation methodology or allowed assumptions in the methodology.
 - 2.4. Lack of maintenance and testing for the protective equipment credited by the arc flash calculations.
3. Take into consideration the design of the overcurrent protective device and its opening time, including its condition of maintenance.

Note: Improper or inadequate maintenance can result in increased opening time of the overcurrent protective device, thus increasing the incident energy. Where equipment is not properly installed or maintained, PPE selection based on incident energy analysis or the PPE category method may not provide adequate protection from arc flash hazards.

4.7. ARC FLASH RISK ASSESSMENTS BASED UPON TABLES

If arc flash calculations cannot be performed in support of an arc flash risk assessment, utilize the following tables. A documented arc flash risk assessment must be performed for any condition not covered by these tables.

1. The tables were developed utilizing NFPA 70E-2015 Table 130.7(C)15(A)(a) and Table 130.7(C)15(B).
2. The tables provide guidance on the PPE, V-Rated Gloves, and V-Rated Tools required for the intended energized work activity based upon equipment

condition. The arc flash PPE category depends on the voltage, equipment class, maximum clearing time, the maximum available short circuit current and condition of the equipment.

2.1. For Equipment Condition to be Satisfactory, all the following must apply:

- The equipment is properly installed.
- The equipment is properly maintained.
- All equipment doors are closed and secured.
- All equipment covers are in place and secured.
- There is no evidence of impending failure.

2.2. Equipment Condition is Unsatisfactory if any of the following apply:

- The equipment is not properly installed.
- The equipment is not properly maintained.
- All equipment doors are open or not secured.
- All equipment covers are off or not secured.
- There is evidence of impending failure.

3. Tools used as part of the task must be rated for the line-to-line voltage of the energized equipment.
4. Table 4.8 provides “Personal Protective Equipment Requirements for Specific Tasks.”
5. Table 4.9 provides “Additional Utility Tasks for Alternating Current (AC) Systems.”
6. Table 4.10 provides “Additional Utility Tasks for Direct Current (DC) Systems.”
7. Table 4.11 provides “Requirements for Aerial (Overhead) Systems and Equipment.”
8. Confirm the maximum short circuit current available, fault clearing time, working distance, and equipment condition when using the tables.

V-rated gloves are gloves rated and tested for the maximum line to line voltage upon which work will be done

V-rated tools are tools rated and tested for the maximum line to line voltage upon which work will be done

TABLE 4-8 PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS FOR SPECIFIC TASKS

Task (Assumes equipment is energized and work is done within the arc flash boundary)	Equipment Condition	V-rated Gloves	V-rated Tools	Required PPE Level	Arc Flash Boundary
Panelboard rated 240V and below. See Note 1					
Inspection of exposed energized parts, including visual and thermographic inspection, from outside of the restricted approach boundary but within the limited approach boundary (does not include removal of covers)	Any	N	N	0	N/A
Removal or installation of covers that does not expose bare energized parts	Satisfactory	N	N		
	Unsatisfactory	N	N	2	19 in (.48m)
CB or fused switch operation	Satisfactory	N	N	0	N/A
	Unsatisfactory	N	N	2	19 in (485 mm)
Work on any energized parts, including voltage testing	Any	Y	Y		
Remove bolted covers (to expose bare energized parts)	Any	N	N		
Opening hinged covers (to expose bare energized parts)	Any	N	N		
Panelboards or other equipment rated >240V and up to 600V. See Note 1					
Inspection of exposed energized parts, including visual and thermographic inspection, from outside of the restricted approach boundary but within the limited approach boundary (does not include removal of covers)	Any	N	N	0	N/A
Removal or installation of covers that does not expose bare energized parts.	Satisfactory	N	N		
	Unsatisfactory	N	N	2	3 ft (.9 m)
CB or fused switch operations.	Satisfactory	N	N	0	N/A
	Unsatisfactory	N	N	2	3 ft (900 mm)
Work on any energized parts, including voltage testing	Any	Y	Y		
Remove bolted covers (to expose bare energized parts)	Any	N	N		
Opening hinged covers (to expose bare energized parts)	Any	N	N		

Task (Assumes equipment is energized and work is done within the arc flash boundary)	Equipment Condition	V-rated Gloves	V-rated Tools	Required PPE Level	Arc Flash Boundary
600V Class Motor Control Centers (MCC). See Note 2					
Inspection of exposed energized parts, including visual and thermographic inspection, from outside of the restricted approach boundary but within the limited approach boundary (does not include removal of covers)	Any	N	N	0	N/A
Removal or installation of covers that does not expose bare energized parts	Satisfactory	N	N		
	Unsatisfactory	N	N	2	5 ft (1.5 m)
Reading a panel meter while operating a meter switch	Any	N	N	0	N/A
Work on control circuits with exposed energized parts 120V or below	Any	Y	Y		
CB, fused switch, contactor or starter operation.	Satisfactory	N	N		
	Unsatisfactory	N	N	2	5 ft (1.5 m)
Work on any energized parts, including voltage testing	Any	Y	Y	2	5 ft (1.5 m)
Work on control circuits with exposed energized parts >120V	Any	Y	Y		
Removal of bolted covers (to expose bare energized parts)	Any	N	N		
Application of safety grounds after voltage test	Any	Y	N		
Opening hinged covers (to expose bare, energized parts)	Any	N	N		
Insertion/removal of individual starter "buckets" from MCC	Any	Y	N		
600V Class Motor Control Centers (MCC). See Note 3					
Inspection of exposed energized parts, including visual and thermographic inspection, from outside of the restricted approach boundary but within the limited approach boundary (does not include removal of covers)	Any	N	N	0	N/A
Removal or installation of covers that does not expose bare energized parts	Satisfactory	N	N		
	Unsatisfactory	N	N	4	14 ft (4.3 m)
Reading a panel meter while operating a meter switch	Any	N	N	0	N/A
Work on control circuits with exposed energized parts 120V or below	Any	Y	Y		
CB, fused switch, contactor or starter operation	Satisfactory	N	N		
	Unsatisfactory	N	N	4	14 ft (4.3 m)
Work on any energized parts, including voltage testing	Any	Y	Y	4	14 ft (4.3 m)
Work on control circuits with exposed energized parts >120V	Any	Y	Y		

Task (Assumes equipment is energized and work is done within the arc flash boundary)	Equipment Condition	V-rated Gloves	V-rated Tools	Required PPE Level	Arc Flash Boundary
600V Class Motor Control Centers (MCC). See Note 3 (CONTINUED)					
Removal of bolted covers (to expose bare energized parts)	Any	N	N	4	14 ft (4.3 m)
Application of safety grounds after voltage test	Any	Y	N		
Opening hinged covers (to expose bare, energized parts)	Any	N	N		
Insertion/removal of individual starter "buckets" from MCC	Any	Y	N		
600V Class Switchgear (with power circuit breakers or fused switches) and 600V Class Switchboards. See Note 4					
Inspection of exposed energized parts, including visual and thermographic inspection, from outside of the restricted approach boundary but within the limited approach boundary (does not include removal of covers)	Any	N	N	0	N/A
Removal or installation of covers that does not expose bare energized parts.	Satisfactory	N	N	4	20 ft (6 m)
	Unsatisfactory	N	N		
Reading a panel meter while operating a meter switch	Any	N	N	0	N/A
Work on control circuits with exposed energized parts 120V or below	Any	Y	Y		
CB or fused switch operation	Satisfactory	N	N	4	20 ft (6 m)
	Unsatisfactory	N	N		
Work on energized parts, including voltage testing	Any	Y	Y	4	20 ft (6 m)
Work on control circuits with exposed energized parts >120V	Any	Y	Y		
Insertion or removing (racking) of CB's from cubicles	Any	N	N		
Application of safety grounds after voltage test	Any	Y	N		
Opening hinged covers (to expose bare, energized parts)	Any	N	N		
Removal of bolted covers (to expose bare energized parts)	Any	N	N		

Task (Assumes equipment is energized and work is done within the arc flash boundary)	Equipment Condition	V-rated Gloves	V-rated Tools	Required PPE Level	Arc Flash Boundary
Other 600V Class (277V through 600V nominal) Equipment. See Note 2					
Inspection of exposed energized parts, including visual and thermographic inspection, from outside of the restricted approach boundary but within the limited approach boundary (does not include removal of covers)	Any	N	N	0	N/A
Removal or installation of covers that does not expose bare energized parts.	Satisfactory	N	N	0	N/A
	Unsatisfactory	N	N	2	5 ft (1.5 m)
CB or fused switch operation	Satisfactory	N	N	0	N/A
	Unsatisfactory	N	N	2	5 ft (1.5 m)
Opening hinged covers (to expose bare, energized parts)	Any	N	N		
Removal of bolted covers (to expose bare energized parts)	Any	N	N		
Work on energized parts, including voltage testing	Any	Y	Y		
Insertion or removal of revenue meters (KWH, at primary voltage and current)	Any	Y	N		
Application of safety grounds, after voltage test	Any	Y	N		
NEMA E2 (fused contactor Motor Starters 2.3KV through 7.2KV. See Note 5					
Inspection of exposed energized parts, including visual and thermographic inspection, from outside of the restricted approach boundary but within the limited approach boundary (does not include removal of covers)	Any	N	N	0	N/A
Removal or installation of covers that does not expose bare energized parts.	Satisfactory	N	N	0	N/A
	Unsatisfactory	N	N	4	40 ft (12 m)
Reading a panel meter while operating a meter switch	Any	N	N	0	N/A
Work on control circuits with exposed energized parts 120V or below	Any	Y	Y		
Contactor operation	Satisfactory	N	N	4	40 ft (12 m)
	Unsatisfactory	N	N		
Insertion or removing (racking) of CB's or starters from cubicles	Any	N	N		

Task (Assumes equipment is energized and work is done within the arc flash boundary)	Equipment Condition	V-rated Gloves	V-rated Tools	Required PPE Level	Arc Flash Boundary
NEMA E2 (fused contactor Motor Starters 2.3KV through 7.2KV See Note 5 (CONTINUED))					
Work on energized parts, including voltage testing	Any	Y	Y	4	40 ft (12 m)
Work on exposed control circuits with energized parts >120V	Any	Y	Y		
Application of safety grounds after voltage test	Any	Y	N		
Removal or opening of covers (to expose bare energized parts)	Any	N	N		
Metal Clad Switchgear, 1KV – 38KV. See Note 5					
Inspection of exposed energized parts, including visual and thermographic inspection, from outside of the restricted approach boundary but within the limited approach boundary (does not include removal of covers)	Any	N	N	0	N/A
Removal or installation of covers that does not expose bare energized parts.	Satisfactory	N	N	0	N/A
	Unsatisfactory	N	N	4	40 ft (12 m)
Reading a panel meter while operating a meter switch	Any	N	N	0	N/A
Work on control circuits with exposed energized parts 120V or below	Any	Y	Y		
CB or fused switch operation	Satisfactory	N	N	4	40 ft (12 m)
	Unsatisfactory	N	N		
Insertion or removing (racking) of CB's from cubicles	Any	N	N		
Work on energized parts, including voltage testing	Any	Y	Y		
Work on control circuits with exposed energized parts >120V	Any	Y	Y		
Application of safety grounds after voltage test	Any	Y	N		
Removal of bolted covers (to expose bare energized parts)	Any	N	N		
Opening hinged covers (to expose bare, energized parts)	Any	N	N		
Opening voltage transformer or control power transformer compartments	Any	N	N		

Task (Assumes equipment is energized and work is done within the arc flash boundary)	Equipment Condition	V-rated Gloves	V-rated Tools	Required PPE Level	Arc Flash Boundary
Other Equipment 1KV – 38KV. See Note 5					
Inspection of exposed energized parts, including visual and thermographic inspection, from outside of the restricted approach boundary but within the limited approach boundary (does not include removal of covers)	Any	N	N	0	N/A
Removal or installation of covers that does not expose bare energized parts.	Satisfactory	N	N		
	Unsatisfactory	N	N	4	40 ft (12 m)
Outdoor disconnect switch operation (gang operated from grade)	Any	N	N		
Outdoor disconnect switch operation (hook-stick operated, from grade)	Any	Y	Y		
Work on energized parts, including voltage testing	Any	Y	Y		
Removal of bolted covers (to expose bare energized parts)	Any	N	N		
Opening hinged covers (to expose bare, energized parts)	Any	N	N		
Arc Resistant Switchgear Type 1 or 2 (1KV - 38KV). See Notes 5 & 6					
Inspection of exposed energized parts, including visual and thermographic inspection, from outside of the restricted approach boundary but within the limited approach boundary (does not include removal of covers)	Any	N	N	0	N/A
Reading a panel meter while operating a meter switch	Any	N	N		
Work on control circuits with exposed energized parts 120V or below	Any	Y	Y		
	Satisfactory	N	N	4	40 ft (12 m)
Removal or installation of covers that does not expose bare energized parts.	Unsatisfactory	N	N		
	Satisfactory	N	N	0	N/A
	Unsatisfactory	N	N	4	40 ft (12 m)
	Satisfactory	N	N	0	N/A
	Unsatisfactory	N	N	4	40 ft (12 m)
	Satisfactory	N	N	0	N/A
	Unsatisfactory	N	N	4	40 ft (12 m)

Task (Assumes equipment is energized and work is done within the arc flash boundary)	Equipment Condition	V-rated Gloves	V-rated Tools	Required PPE Level	Arc Flash Boundary
Arc Resistant Switchgear Type 1 or 2 (1KV - 38KV). See Notes 5 & 6 (CONTINUED)					
Insertion or removing (racking) of voltage transformers on or off the bus	Satisfactory	N	N	0	N/A
	Unsatisfactory	N	N	4	40 ft (12 m)
Work on energized parts, including voltage testing	Any	Y	Y		
Work on control circuits with exposed energized parts >120V	Any	Y	Y		
Application of safety grounds after voltage test	Any	Y	N		
Removal of bolted covers (to expose bare energized parts)	Any	N	N		
Opening hinged covers (to expose bare, energized parts)	Any	N	N		
Opening voltage transformer or control power transformer compartments	Any	N	N		
Table 4-8 Notes:	Y = yes (required); N = no (not required); < = less than; > = greater than; PT = Potential transformer				
	Note 1. Maximum of 25 KA short circuit current available, 0.03 second (2 cycle) fault clearing time, working distance 18" (455mm)				
	Note 2. Maximum of 65 KA short circuit current available, 0.03 second (2 cycle) fault clearing time, working distance 18" (455mm)				
	Note 3. Maximum of 42 KA short circuit current available, up to 0.33 second (20 cycle) fault clearing time, working distance 18" (455mm)				
	Note 4. Maximum of 35 KA short circuit current available, 0.5 second (30 cycle) fault clearing time, working distance 18" (455mm)				
	Note 5. Maximum of 35 KA short circuit current available, 0.24 second (15 cycle) fault clearing time, working distance 36" (910mm)				
	Note 6. For Type 2 Arc resistant switchgear, clearing time of <0.5 second (30 cycle) with a prospective fault current not to exceed the arc resistant rating of the equipment is required in lieu of 0.24 second (15 cycle) fault clearing time.				

TABLE 4-9 ADDITIONAL UTILITY TASKS FOR ALTERNATING CURRENT (AC) SYSTEMS

Voltage	Task (Assumes equipment is energized and work is done within the arc flash boundary)	V-rated Gloves	V-rated Tools	Required PPE Level
<600V	Overhead line work, including lighting	Y	Y	0 Note 1
>600V	Overhead line work (specific tasks of gang-operated switch operation, phasing/voltage/current testing, installing or removing safety grounds, and installing/removing mechanical type hot line clamp/stirrups)	Y	Y Note 2	0 Note 3
>600V	Underground structures (manhole or vault) with no known problems: Routine cable inspection without touching or otherwise disturbing cables	N	N	0
>600V	Spiking a de-energized cable to ground using a remote hydraulic grounding spike. See Note 4	N	N	0
>600V	Cutting a de-energized cable using a guillotine cutter. See Note 4	N	N	0
>600V	Underground structures (manhole or vault) with no known problems: Splicing de-energized cables in structure with energized cables. See Note 5	N	Y	0
>600V	Operating (open/close) oil switches. See Note 6	Y	Y	0
>600V	Attach bucket truck's ground wire to overhead pole line neutral from bucket	Y	Y Note 2	2
>600V	Voltage testing, current testing (with hook sensing head ammeter) and phasing from bucket truck	Y	Y Note 2	2
>600V	Operating (open/close) SF ₆ vacuum and air pad mounted switches (dead front)	Y	Y	2
>600V	Operating (open/close) SF ₆ vacuum and air pad mounted switches (live front)	Y	Y	2
>600V	Overhead line work (specific tasks of disconnect switch operation, fused cutout operation and replacing fuses)	Y	Y Note 2	2

Voltage	Task (Assumes equipment is energized and work is done within the arc flash boundary)	V-rated Gloves	V-rated Tools	Required PPE Level
>600V	Operating (open/close) oil immersed load break three phase gang operated or single phase pad mount transformer switches and removal of load break elbows from various equipment	Y	Y Note 7	2
>600V	Fusing: Replacing fuses in pad mounted transformers or pad mounted switches. See Note 8	Y	Y Note 7	2
>600V	Overhead series lighting	Y	Y Note 2	2
>600V	Phasing circuits from grade (ground)	Y	Y Note 2	2
>600V	Operation of Oil Fused Cutouts. See Note 8	Y	N	2
>600V	Fusing: Operation of fused cutouts (or replacing fuses in fused cutouts) mounted inside a vault or building	Y	Y Note 2	4
>600V	Disconnecting, shorting and grounding capacitor banks	Y	Y Note 2	4
>600V	Ship to shore: Voltage testing, application of safety grounds	Y	Y	4
<600V	Application of safety grounds from grade (ground) in outdoor substations	Y	Y Note 2	4
<600V	Ship to shore: Voltage testing, testing shore power receptacle cover interlock switches and shore power receptacle	Y	Y	4
	Pad mount equipment			
>600V	Voltage, current and phasing tests	Y	Y Note 2	2
>600V	Opening hinged covers (to expose bare energized parts)	N	N	2
>600V	Removing and installing elbow test point protective caps	Y	Y Note 2	2
	Outdoor open substation, overhead pole line			
>600V	Voltage testing, current testing (with hook sensing head ammeter) and phasing from grade (ground)	N	Y Note 2	2

Voltage	Task (Assumes equipment is energized and work is done within the arc flash boundary)	V-rated Gloves	V-rated Tools	Required PPE Level
>600V	Attach bucket truck's ground wire to overhead pole line neutral from grade (ground)	Y	Y	2 Note 1
	Metal clad switchgear, motor starters, other enclosed equipment			
>600V	Voltage, current and phasing testing of exposed energized parts	Y	Y	4
>600V	Removal of bolted covers (to expose bare energized parts)	Y	Y	4
<600V	Opening hinged covers (to expose bare energized parts)	Y	Y	4
Table 4-9 Notes:				
	Note 1. Use an Arc rated safety harness.			
	Note 2. Maintain a minimum hot stick distance (distance between closest body part and tool end of the hot stick) of 6ft (2m); V-rated gloves shall always be used with live line tools.			
	Note 3. Use an Arc rated safety harness with lanyard.			
	Note 4. For manhole work, keep workers outside the manhole for this task. For direct buried cables, keep workers more than 20 ft (6.1 m) away from task.			
	Note 5. Secure all power when feasible prior to start of any work in a confined space.			
	Note 6. Must remotely operate from a minimum distance of 20 ft. (6.1m).			
	Note 7. Maintain a minimum hot stick distance (distance between closest body part and tool end of the hot stick) of 4ft (1.25m); V-rated gloves shall always be used with live line tools.			
	Note 8. De-energize upstream before performing task.			

TABLE 4-10 ADDITIONAL UTILITY TASKS FOR DIRECT CURRENT (DC) SYSTEMS

Voltage	Task (Assumes equipment is energized and work is done within the arc flash boundary)	Equipment Condition	V-rated Gloves	V-rated Tools	Required PPE Level	Arc Flash Boundary
>100V and <250V	Storage batteries, dc switchboards, and other dc supply sources. Maximum arc duration and working distance: 2 sec @ 18 in.					
	Short-circuit current <4 kA	Any	Y	Y	2	3 ft
	4 kA ≤ short-circuit current < 7 kA	Any	Y	Y	2	4 ft
	7 kA ≤ short-circuit current < 15 kA	Any	Y	Y	4	6 ft
250 V ≤ and ≤ 600 V	Storage batteries, dc switchboards, and other dc supply sources. Maximum arc duration and working distance: 2 sec @ 18 in.					
	Short-circuit current 1.5 kA	Any	Y	Y	2	3 ft
	1.5 kA ≤ short-circuit current < 3 kA	Any	Y	Y	2	4 ft
	3 kA ≤ short-circuit current < 7 kA	Any	Y	Y	4	6 ft
	7 kA ≤ short-circuit current < 10 kA	Any	Y	Y	4	8 ft
Table 4-10 Notes:	Note 1. Refer to NFPA 70E for additional limitations regarding the use of the above table.					
	Note 2. Obtain the available short circuit current for a particular battery from the manufacturer or the manufacturer's manual for the battery. If this information is not available, estimate the available short circuit current for a lead acid battery from the battery performance data sheet as 10 times the 1 minute ampere capability of the cell (at 77°F (25°C) to 1.75 V per cell).					

TABLE 4-11 REQUIREMENTS FOR AERIAL (OVERHEAD) SYSTEMS AND EQUIPMENT

Phase-to-Phase Voltage (kV)	Fault Current (kA)	Category 0	Category 2
		Maximum Clearing Time (cycles)	Maximum Clearing Time (cycles)
1.1 to 15	5	320.0	2,134.0
	10	125.0	830.0
	15	69.0	460.2
	20	44.7	297.7
15.1 to 25	5	189.6	1264.0
	10	78.0	519.8
	15	45.2	301.0
	20	30.2	201.0
25.1 to 36	5	141.3	942.0
	10	59.7	398.0
	15	35.4	235.7
	20	24.0	160.0
36.1 to 46	5	107.4	716.0
	10	46.1	307.0
	15	28.3	188.5
	20	20.2	134.7

Note 1. These calculations are based on open air phase-to-ground. This table is not intended for phase-to-phase arcs or enclosed arcs (arc in a box).

Note 2. These calculations are based on a 72-inch distance from the arc to the employee and arc gaps as follows: 1 kV to 15 kV = 5.08 cm (2 in), 15.1 kV to 25 kV = 10.16 cm (4 in), 25.1 kV to 36 kV = 15.24 cm (6 in), 36.1 kV to 46 kV = 22.86 cm (9 in).

Note 3. These calculations were derived using a commercially available computer software program. Other methods are available to estimate arc exposure values and may yield slightly different but equally acceptable results.

Note 4. The use of the table in the selection of clothing is intended to reduce the amount of injury but may not prevent all burns.

Note 5. The table identifies Category 0 and Category 2 levels. Refer to Section 4.5.2 for associated PPE requirements.

Note 6. The maximum clearing time applies to the upstream protective device(s) that provides circuit protection for the intended work location.

4.8. FACILITY MANAGER AUTHORIZED TASKS

Facility Managers and Building Monitors are permitted to perform the following tasks on switchboards and panelboards rated for less than 600 volts while wearing a minimum of 8 cal/cm² (33.47 J/cm²) coveralls, leather gloves, and safety glasses:

- Opening and closing circuit breakers rated for 30 amperes or less for the purpose of circuit identification and panelboard labeling, including ground fault circuit interrupter and arc fault circuit interrupter testing.
- Operating SWD or HID rated circuit breakers used for lighting control.
- Resetting a branch circuit breaker rated for 30 amperes or less used for lighting and general purpose receptacles after a known equipment or circuit overload and the overload has been removed. If circuit breaker fails to close or immediately trips after resetting, call a qualified electrical worker to investigate.
 - *Note: If the reason for a tripped circuit breaker cannot be determined to be because of an overload, do not reclose the circuit breaker. Call a qualified electrical worker to investigate.*

4.9. ARC FLASH PPE REQUIREMENTS FOR LOW VOLTAGE CONTROL CIRCUITS

Arc flash PPE clothing is optional for work on control circuits rated for 120 volts, or less, if the control circuit is provided with upstream fusing rated for 30 amperes or less. The restricted approach boundary is “Avoid Contact” at 150 volts or less and voltage rated gloves are optional for work near 120 volt control circuits. Personnel working on these energized control circuits are required to be trained and designated as a qualified electrical worker in accordance with Chapter 1, Sections 1.5 or 1.6 for the activities that might be performed on an energized control circuit.

The following are examples of systems that might include these low-voltage control circuits:

- Elevator systems.
- HVAC systems.
- Fire alarm systems.
- Diesel generator control circuits.
- SCADA control circuits.

4.10. TRAINING, CERTIFICATIONS, AND RECORD KEEPING

Employees who are required to work on or near exposed energized electrical systems must be trained and thoroughly knowledgeable of this SOP. Training procedures are specified in Chapter 1.

4.11. NAVFAC ENERGIZED ELECTRICAL WORK PERMIT

PART I: TO BE COMPLETED BY THE REQUESTER		JOB/WORK ORDER NUMBER:
Date of Request:		
Anticipated Date Work Will Be Performed:		Dates of Permit Coverage:
(1) Description of circuit/equipment/job location:		
(2) Description of work to be done:		
(3) Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage:		
Note: Attach Copy of Outage Request Explaining Reasons for Denial		
Requester/Title:		Date:
PART II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSONS <i>DOING</i> THE WORK:		
<i>Check when complete</i>		
(1) Detailed job description procedure to be used in performing the above detailed work:		
(2) Description of the safe work practices to be employed:		
(3) Justification of why circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage:		
(4) Results of the Shock Hazard Assessment:		
(a) Voltage to which personnel will be exposed		
(b) Limited approach boundary		
(c) Restricted approach boundary		
(d) Necessary shock, personal, and other protective equipment to safely perform assigned task		
(5) Results of the arc flash assessment:		
(a) Available incident energy at the working distance or arc flash PPE category		
(b) Devices required to limit the incident energy at the working distance were calibrated and maintained		
(c) Necessary arc flash personal and other protective equipment to safely perform the assigned task		
(d) Arc Flash Boundary		
(6) Means employed to restrict the access of unqualified persons from the work area:		
(7) Evidence of completion of a job briefing, including discussion of any job-related hazards:		
(8) Job Safety Analysis (JSA) for electrical permit work completed, accepted, and attached:		
(9) Do you agree the above described work can be done safely? Yes No		
<i>(If No, return to requester)</i>		
Electrically Qualified Person: _____		Date: _____
Electrically Qualified Person: _____		Date: _____
PART III: APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:		
PWO SIGNATURE	FEC SAFETY MANAGER	FEC OPS
PART IV: FINAL APPROVAL – FEC COMMANDING OFFICER		DATE

4.12. JOB SAFETY ANALYSIS

JOB SAFETY ANALYSIS	JOB TITLE: Working On or Near Exposed and Enclosed Energized Electrical Systems		DATE:	<input type="checkbox"/> NEW
	JSA no: ESAFE Chapter 4			<input type="checkbox"/> REVISED
	TITLE OF PERSON WHO DOES JOB: All employees who work on or near exposed and enclosed energized electrical systems	SUPERVISOR:	ANALYSIS BY:	
	PLANT LOCATION: NAVFAC	DEPARTMENT: Public Works Business Line	REVIEWED BY:	
Required and/or Recommended Safe Work Practices:	All Energized Electrical Work SOP's or Energized Electrical Work Permit's must be consistent with the safe work practices and Personal Protective Equipment requirements contained in this ESAFE.		APPROVED BY:	
SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	RECOMMENDED ACTION OR PROCEDURE		
Exposed Energized Electrical Work	Electric shock, arc flash, arc flash burns, arc blast	Wear PPE as required by Chapter 4. Establish a safe work condition. Follow Chapter 2, Control of Hazardous Energy Control (LOTO).		
Troubleshooting/testing an electrical system	Electric shock, arc flash, arc flash burns, arc blast	Wear PPE as required by Chapter 4. Follow Chapter 5, Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems		
Other exposed energized electrical work	Electric shock, arc flash, arc flash burns, arc blast	Obtain either a SOP/JSA for specific task or an Activity Hazard Analysis with a Special Permission Energized Electrical Work Permit signed by NAVFAC Commanding Officer.		

CHAPTER 5 - MEASURING/TESTING PARAMETERS OF ENERGIZED HIGH AND LOW VOLTAGE ELECTRICAL SYSTEMS

5.1. PURPOSE

To establish safety related work practices and personal protective equipment (PPE) requirements for measuring/testing parameters (to perform troubleshooting and taking electrical measurements) on exposed energized electrical systems.

5.2. BACKGROUND

Energized work is “work on or near (e.g., part of tools being used or worker’s body less than restricted approach boundary) energized or potentially energized lines (i.e. grounding, live-tool work, hot stick work, gloving, and bare hand work). When a person is subject to a bare (exposed), energized conductor he or she is at risk of injury not only to themselves, but also to others nearby. The hazards of working on or near bare energized electrical conductors can result in electrical shock, electrocution, arc flash burns, arc blast, thermal burns, respiratory contamination and other physical trauma injuries related to falling or being struck by objects due to an arc blast. Most energized work on systems operating above 50 volts is prohibited.

There are certain situations when working on or near energized equipment cannot be avoided. Measuring/testing parameters of energized equipment must be undertaken to determine whether or not the system is connected and operating correctly, and if any components are defective. Operating parameters such as voltages, currents, phasing, and phase rotation must be measured energized.

The installation or removal of temporary personal protective grounding equipment, maintenance and repair work on or near energized or potentially energized electrical systems are not within the scope of this chapter.

This chapter addresses the hazards of electrical shock/electrocution, arc flash and arc blast.

5.3. TOOLS AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

The required Tools and PPE are:

- Live line tools (Hot Sticks)
- Voltage rated hand tools
- Approved high and low voltage testers
- Red danger locks (if required)
- Red danger tags (if required)
- Temporary personal protective grounds (if required)
- Arc rated (AR) long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm²

- Leather electrical hazard (EH) - rated work shoes/boots
- Non-metallic safety glasses with side shields
- Class E hard hat
- Voltage rated gloves with leather protectors
- Hearing protection (ear canal inserts)
- 12 cal/cm² Arc flash hood (sock/balaclava) in combination with 10 cal/cm² face shield attached to hard hat (if required)
- Multilayer arc flash suit, minimum 40 cal/cm² (if required)

Test instruments, hot sticks, equipment, and their accessories shall be rated for the circuits and equipment to which they will be used and designed for the environment to which they will be exposed, and for the manner in which they will be used.

PPE and voltage rated tools shall be visually inspected prior to each day's use and immediately following any incident that can reasonably be suspected of having caused damage. Insulating rubber goods and hot sticks shall be inspected as required by Chapter 3 - Use and Care of Electrical Protective Rubber Goods and Live Line Tools.

Any worker whose normal job includes working on or near exposed energized electrical conductors/equipment operating above 50V shall follow Chapter 4, Section 4.5 Minimum PPE Clothing Requirements.

Refer to Chapter 4, Section 4.7 Arc Flash Risk Assessments Based Upon Tables for PPE requirements for the specific energized task to be performed.

5.4. PROCEDURES

5.4.1. PROHIBITED ENERGIZED WORK PRACTICES

Gloving above 600 volts and the bare hand technique 50 volts and above is prohibited.

5.4.2. TROUBLE SHOOTING AND/OR TESTING (MEASURING OPERATING PARAMETERS) OF EXPOSED ENERGIZED ELECTRICAL SYSTEMS BOTH HIGH AND LOW VOLTAGE

The following steps shall be followed in the order listed below when conducting tasks related to trouble shooting and/or testing (measuring operating parameters) of exposed energized electrical systems both high and low voltage:

5.4.2.1. STEP 1 ACCESS JOB SITE

1. Only QP's shall perform measuring and testing of energized electrical systems.
2. Examine job site, look for hazardous conditions, determine means to abate hazards.
3. Notify immediate supervisor prior to measuring and testing of energized high voltage systems; if work is after hours contact SOC personnel.

5.4.2.2. STEP 2 JOB SITE SETUP

1. Flash protection boundary for low voltage systems is determined by arc flash hazard analysis or tables under Chapter 4, Section 4.7 Arc Flash Risk Assessments Based Upon Tables for PPE.
2. Determine limited approach boundary following Chapter 4, Section 4.4.2.3 and restricted approach boundary per Chapter 4, Section 4.4.2.4.
3. Limit access within the limited approach and flash protection boundaries to qualified personnel only.
4. Identify and clear an escape route to an area 10' or more beyond the flash protection boundary.
5. Ensure the area is well lit.
6. Determine required PPE for specific task per Chapter 4, Section 4.7.

5.4.2.3. STEP 3 JOB BRIEF

1. Conduct a pre-job briefing to address all hazards and plan work.

5.4.2.4. STEP 4 VOLTAGE RATED TOOLS, TEST INSTRUMENTS AND PPE

1. Test instruments, equipment, and their accessories shall be rated for circuits and equipment to which they will be connected and designed for the environment to which they will be exposed, and for the manner in which they will be used.
2. PPE and voltage rated tools shall be visually inspected prior to each day's use and immediately following any incident that can reasonably be suspected of having caused damage. Insulating rubber goods shall be inspected as required by Chapter 3. PPE and tools found to have damage that could affect its performance shall not be used on or near exposed energized conductors. Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for any defects and/or damage before the equipment is used on any shift. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged equipment shall be removed from use and equipment tagged for necessary repairs or as unserviceable.

5.4.2.5. STEP 5 WEAR PPE

1. Remove all conductive articles of clothing and jewelry.
2. Wear all PPE as required:
 - 2.1.1. All employees who approach the arc flash boundary of exposed energized electrical conductors/equipment operating at a voltage between 50 and 1000 volts shall follow the minimum PPE clothing requirements plus additional PPE as required by Chapter 4, Sections 4.5 and 4.7 for the specific tasks involved. Confirm the maximum short circuit current available, fault clearing time, and working distance for the conditions when the flash protection

boundary is required to be determined by a flash hazard analysis. Any employee not wearing the additional PPE required for the specific tasks listed in Chapter 4, Section 4.7 shall maintain a distance greater than the limited approach boundary or arc flash boundary, whichever is greater.

3. PPE for measuring/testing tasks not listed in Chapter 4, Section 4.7 shall be determined by performing an arc flash hazard analysis

5.4.2.6. STEP 6 PERFORM TASK

1. Follow listed requirements for work within limited approach boundaries.
2. Follow listed requirements for work within restricted approach boundary.

5.4.3. LOW VOLTAGE WORK NEAR OR AROUND EXPOSED ENERGIZED OVERHEAD CONDUCTORS

Because of multiple voltages on a utility pole, measuring and testing electrical systems rated less than 1000 volts occasionally requires working near overhead conductors operating at greater than 1000 volts. The approach boundaries are provided in Table 4-1 and correction factors in Table 4-3. If the lower voltage work requires working inside the limited approach boundary of the higher voltage, the worker shall be qualified for the higher voltage and wear the appropriate PPE or the overhead circuits shall be de-energized. Overhead conductors on utility poles shall always be considered exposed (bare) and energized regardless of the appearance of insulation.

5.4.4. HIGH VOLTAGE SPECIFIC REQUIREMENTS

- Only tasks listed in tables under Chapter 4, Section 4.7 are allowed by ESAFE Chapter 5.
- The tasks in tables that require measuring/testing energized bare parts require the use of hot sticks. Body parts shall be greater than distance specified in Table 4-9 from a bare energized part. Voltage rated gloves shall always be used with hot sticks.
- If applicable, verify that automatic reclosing devices have been made inoperative while work is being performed.
- Verify overcurrent protective devices that can be switched to fast trip are switched to fast trip while work is being performed.
- Phasing tests and voltage measurements at metal clad switchgear must be accomplished by using ground ball studs on outgoing cable termination pads or synchronizing check controls in conjunction with ground ball studs on outgoing cable termination pads. It is not permissible to conduct phasing tests or voltage measurements through the shutters of a high-voltage switchgear cell. Existing equipment should be retrofitted during preventive maintenance cycles.
- Overhead conductors on utility poles shall always be considered exposed (bare) regardless of the appearance of insulation.

Phasing Tests

1. Phasing testers are used to determine the phase relationships and approximate voltages on energized lines and cables. Caution: Hazardous current levels occur if different phases are tied together. Prior to paralleling two circuits determine the correct connection for each conductor by checking the voltage level between that conductor and all other conductors. The voltage across corresponding lines or phases must be zero. A typical phasing tester consists of two high-resistance units on hot sticks connected through a voltmeter. If potential transformers are available, a voltmeter can be used to measure voltages by connecting a voltmeter between the two sides. If the lines are in phase, the voltmeter will register zero. If performing phasing tests at a generator disconnect, the maximum voltage rating of the phasing tester should be at least two times the nominal rated voltage of the circuit to be tested.
2. Read and follow manufacturer's instructions for the phasing testers used. Attach phasing tester to hot sticks per notes of Table 4-9.
3. Follow the requirements of Table 4-9 and Table 4-11.
4. Check correct phase relationship. Measure all voltages on both sides of the open switch (circuit breaker). For two buses (1 and 2) correctly in phase, expect to measure
 - 4.1. Rated line-to-line voltage: 1A-1B, 1A-1C, 1B-1C, 2A-2B, 2A-2C, 2B-2C.
 - 4.2. Rated line-to-line voltage: 1A-2B, 1A-2C, 1B-2A, 1B-2C, 1C-2A, 1C-2B.
 - 4.3. Zero (or nearly zero) voltage: 1A-2A, 1B-2B, 1C-2C.

Test Point Voltage and Phasing Test Measurements

1. Some digital voltmeters and digital phasing testers include a test point feature for measuring voltage from elbow test points (underground distribution circuits).
2. Read and follow manufacturer's instructions for the voltmeter used. Attach voltmeter to hot sticks rated for the circuits being tested.
3. Follow the requirements of Table 4-9 and Table 4-11.
4. Read and follow manufacturer's instructions for the phasing testers used. Attach phasing testers to hot sticks rated for the circuits being tested.
5. Perform voltage and phasing tests:
 - 5.1. Follow the proper safety practices for removing the test point protective caps and exposing the live test points. Test point protective caps can only be removed and installed with hot sticks. Treat all exposed electrodes as energized high voltage. Measure the voltage at the elbow test points. These measurements should show that elbows are energized.
 - 5.2. Measure from one elbow test point to the other elbow test point. This reading will show either a high voltage reading indicating the elbows are out-of-phase or a zero or low voltage reading indicating the elbows are connected to the same phase.

5.3. When finished phasing tests, follow the proper safety practices for installing protective test caps.

5.4.5. OVERHEAD DISTRIBUTION WORK

Work performed from a bucket truck

- Set up and secure bucket truck. Consult bucket/auger truck SAFE or ESAMS SOPs for safety procedures. Place on emergency brake, engage the PTO (power take off), activate the truck's emergency lights, ensure barriers are set to proper distance and install wheel chocks. Consult, Traffic Control Devices (for traffic control) SAFE or ESAMS SOPs for safety procedures.
- Extend bucket truck out riggers. Ground the bucket truck through an accepted method. If the pole line neutral is used, prior to attaching a ground to an overhead pole line neutral, first test with a high voltage tester, if no voltage is detected, test with a low voltage tester. Test voltage testers on a known voltage source before and after testing the neutral for no voltage. If voltage is detected, do not use the neutral to ground the truck. Use a hot stick to test the neutral for no voltage and to attach truck's ground wire to the overhead pole line neutral. Keep ground personnel at least ten feet from bucket truck.

Measuring current and voltage parameters

- Read and follow manufacturer's instructions for ammeter or voltmeter. Note that the only current measuring device allowed to be used for high voltage by this ESAFE is a hook sensing ammeter. Attach the hook sensing ammeter or voltmeter to a hot stick(s) rated for the circuits being tested.
- Follow the requirements of Table 4-9 and Table 4-11.

5.5. RESPONSIBILITIES

The supervisor shall enforce the requirements of this ESAFE by visiting job sites and observing and taking corrective action as needed. Employees whose duties require performing work within the scope of this Chapter are responsible to use the PPE specified, plan the work to minimize time exposed to shock and arc flash hazards, and keep unqualified people from entering the limited approach and flash protection boundaries who are not wearing the required PPE and knowledgeable of the work.

5.6. JOB SAFETY ANALYSIS

JOB SAFETY ANALYSIS	JOB TITLE: Measuring/Testing Parameters of Energized Low Voltage Electrical Systems		DATE:	<input type="checkbox"/> NEW
	JSA no: ESAFE Chapter 5			<input type="checkbox"/> REVISED
	TITLE OF PERSON WHO DOES JOB: All employees who work on or near exposed and enclosed energized electrical systems	SUPERVISOR:	ANALYSIS BY:	
	PLANT LOCATION: NAVFAC	DEPARTMENT: Public Works Business Line	REVIEWED BY:	
Required and/or Recommended Safe Work Practices:	All Energized Electrical Work SOP's or Energized Electrical Work Permit's must be consistent with the safe work practices and Personal Protective Equipment requirements contained in this ESAFE.		APPROVED BY:	
SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	RECOMMENDED ACTION OR PROCEDURE		
Notification of intent to perform energized testing.	Electric shock, arc flash, arc flash burns, arc blast	Notify supervisor or SOC personnel of intent to perform energized testing.		
Access job site, Job Site setup, and Conduct Job Brief	Electric shock, arc flash, arc flash burns, arc blast	Use Tables 4-1 and 4.3 to establish boundaries. Clear escape route before start of work. Use temporary lighting if necessary		
Perform PPE pre-use inspection and voltage rated tools pre-use inspection.	Defective PPE Defective voltage rated tools	Inspect PPE and Live Line Tools per ESAFE Chapter 3. Remove conductive apparel and wear PPE as required by Chapter 4.		
Troubleshooting/testing an electrical system	Electric shock, arc flash, arc flash burns, arc blast	Follow Chapter 5, Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems		

CHAPTER 6 - ELECTRICAL MANHOLE, VAULT AND OTHER CONFINED SPACES; INSPECTION, ENTRY, AND WORK PROCEDURES

6.1. PURPOSE

To define processes for inspecting, and working in electrical manholes, vaults, confined spaces and underground. Specifically, this document outlines the minimum procedures required to determine if it is safe for qualified workers to open, enter and perform specific work in these spaces.

6.2. BACKGROUND

The work associated with this chapter carries potential electrical and non-electrical hazards. Electrical hazards generally occur when equipment is “energized” and “exposed” but can occur any time work is performed on or around electrical equipment.

Electrical Hazards include electrical shock, arc flash, and arc blast. Non-Electrical Hazards in confined spaces include low oxygen and toxic gases.

UFC 3-560-01 states that only qualified employees may work on exposed energized lines or parts of equipment, or work in areas containing unguarded, un-insulated energized lines or parts of equipment operating at 50 volts or more. Although Federal OSHA does permit work on energized systems and equipment, the preliminary requirements are very stringent. It is the policy of NAVFAC that when and wherever possible, circuits and components will be de-energized, locked, tagged out of service, and grounded, prior to commencing work on those circuits. Impacts to cost and schedule are NOT acceptable reasons to perform energized work. Energized work should only be performed after risk analysis is completed and when necessary to support a critical mission, prevent human injury, or protect property.

6.3. TOOLS AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

All electrical equipment, including insulated conductors, inside underground structures should be de-energized before allowing entry; however, if the equipment cannot be de-energized workers shall be outfitted with the Personal Protective Equipment (PPE) suitable for the hazard. Refer to ESAFE Chapter 4 when determining Arc Flash/Shock PPE to be used when performing this work.

PPE is required unless they can perform the work outside of the Arc Flash Protection Boundary or mitigate the hazard by placement of barriers. For operations where workers must remove parts of the prescribed PPE (Arc Rated Face Shield, Balaclava, and Voltage Rated Gloves) workers shall barricade/protect energized conductors or cables to increase safety. This requirement includes insulated cable. Workers shall wear the prescribed PPE while placing and securing such barriers.

CAUTION: Blast blankets are prohibited inside manholes. These types of blankets are commercially available, but are not appropriate for use inside a confined space such as a manhole.

At a minimum the worker shall:

- Place and secure an Insulating Blanket rated at the system phase to phase voltage over all energized cable splices. The Insulating blanket shall be draped over the splice in a manner that will prevent it from detaching and falling.
- Place an Arc Suppression Blanket appropriately rated for the maximum short circuit current available inside the space. The Arc Suppression Blanket shall cover the energized cables to the greatest extent practicable. The blanket shall be secured utilizing an approved method for the particular configuration of the space.
- After the placement of the protective barriers has been approved by the QPIC, worker may remove their Arc Rated Face Shield, Balaclava and Voltage Rated Gloves.

6.4. PROCEDURES

Qualified workers with both ESAFE and confined space training may enter confined spaces to perform specific work while circuits nearby remain energized, but must take precautions to ensure the work can be performed safely. Electricians and their supervisors must be familiar with the requirements of this document in its entirety for any work in enclosed spaces to be performed.

Other locations with restricted space may expose qualified workers to similar hazards. In those circumstances qualified workers and their supervisors may apply the same principles outlined in this chapter.

This chapter outlines the minimal process that must be followed; however, a specific JSA must be performed by qualified workers prior to commencing work. The final determination that all the hazards and work practices are adequate to mitigate the hazards must be determined by the Qualified Person performing the work.

Prior to commencing work in electrical manholes, vaults and confined spaces that contain energized circuits, approval must be obtained in writing. This approval must be from a person designated by the Facilities Engineering Command Public Works Department. Prior to signing, they shall review the associated documentation (e.g. JSA, Switching Orders) and report as required by local policies to receive authorization before performing the work.

Documentation

A listing of those qualified personnel to perform work in accordance with this chapter must be maintained by the Shop Supervisor.

6.4.1. QUALIFIED PERSON IN CHARGE (QPIC)

QPIC shall ensure that:

1. NAVFAC installation PWO has been notified and approved of any work that would require personnel subject to this chapter to enter a manhole, vault, or confined space containing energized equipment, cables or circuit parts.
2. Adopt such precautions, using the principles of ORM, as are within the individual's authority to prevent accidents.
3. See that the safety rules and operating procedures are observed by the employees under the direction of this individual.
4. Make all the necessary records and reports, as required.
5. Prevent unauthorized persons from approaching places where work is being done, as far as practical.
6. Prohibit the use of tools or devices unsuited to the work at hand or that have not been tested or inspected as required.
7. Ensure all workers have reviewed and acknowledged that they understand the Switching Orders and Job Safety Analysis.
8. Conduct a pre-job briefing with all the employees involved before beginning each job. A job briefing shall include hazards associated with the job, work procedures, special precautions, energy source control and PPE requirements.
9. Ensure that all workers understand, agree and acknowledge the requirements of the work to be accomplished and that the procedures and hazard controls are adequate.
10. Ensure that work shall stop if conditions that affect the work change. The QPIC shall stop current work, develop a new work plan (e.g. switching orders, Job Safety Analysis) and hold another Pre-Job Brief.
11. Ensure that all personnel are aware that anyone, including bystanders can immediately stop work in order to prevent an unsafe condition to occur.
12. Assign a work leader to be a Safety Observer that will remain on site during any work requiring entry into a space with energized circuits. The Safety Observer shall have no other responsibilities and must remain onsite. The Safety Observer and relief shall be designated on the Pre-Job Brief.
13. Perform a Job-Brief with all workers for each on coming shift or newly arriving worker.

6.4.2. AREA PROTECTION

Areas accessible to vehicular and pedestrian traffic.

- Before engaging in work that may endanger the public, safety signs or traffic control devices, or both, shall be placed conspicuously to alert approaching traffic. Where further protection is needed, suitable barrier

guards shall be erected. Where the nature of work and traffic requires it, a person shall be stationed to warn traffic while the hazard exists.

- When openings or obstructions in the street, sidewalk, walkways, or on common areas are being worked on or left unattended during the day, danger signals, such as safety signs and flags, shall be effectively displayed. Under these same conditions at night, warning lights shall be prominently displayed and excavations shall be enclosed with protective barricades.

Areas accessible to qualified personnel only.

- Safety signs shall be displayed.
- Suitable barricades shall be erected to restrict other personnel from entering the area.

Non-Qualified Personnel.

- Shall not cross or enter barricaded work areas without escorts.
- Escorts shall be qualified to safeguard non-qualified personnel in their care and ensure that the safety rules, including those governing the use of PPE, are observed.

6.4.3. SYSTEM PROTECTION

Prior to work on or near energized equipment or circuits, a determination of the potential exposure to an Arc flash shall be performed.

The assessment shall be determined by a detailed Arc hazard analysis or by use of Tables in Chapter 4, Section 4.7.

If possible place protective devices in maintenance mode and disable circuit reclosing devices.

6.4.4. PLANNING THE WORK

1. Formulate a work plan using:
 - 1.1. Single line and distribution drawings, prints, pad books and schematics.
 - 1.2. Supervisory, Control and Data Acquisition (SCADA) systems.
 - 1.3. Field investigations and reports.
 - 1.4. Customer input.
 - 1.5. Explore contingencies and alternate plans.
 - 1.6. Other relevant sources.
2. Develop and write Switching Orders.
3. Develop and write a Job Safety Analysis (JSA) that include:

- 3.1. Work Steps (e.g. Test Circuit...).
- 3.2. Associated Hazard (e.g. Arc Flash, Electrocution...).
- 3.3. The Method used to Control the Hazard (e.g. Inspect and test equipment prior to and after each use.).
4. Review, Train and Sign (Switching Orders and JSA) by:
 - 4.1. Qualified Person performing the analysis.
 - 4.2. Qualified Supervisor.
 - 4.3. QPIC.
 - 4.4. All assigned personnel involved in the work.

6.4.5. PREPARING TO WORK UNDERGROUND

1. Perform a Pre-Job Brief. Refer to Sections 6.4.1 and 6.4.4.
2. Cordon off area and provide for traffic/pedestrian control.
3. Conform to the requirements of the OPNAVINST 5100.23 Series, (Confined Space Entry Program) if applicable. This includes a Formal Rescue Plan IAW local Installation Requirements.
4. Perform appropriate lock out and tag out on circuits and automatic re-closers (hot line tags).
5. Use tools that increase mechanical leverage in order to remove/replace manhole/vault covers.
6. From outside of the space, visually inspect the manhole entrance for obvious signs of cable, equipment or structural defects.
7. From outside of the space, test for unexpected voltages. Do not enter the manhole if a voltage is detected and the circuit/equipment cannot be identified. That circuit must be de-energized and retested.
8. From outside of the space, utilize video both visual and infrared to examine the space.
9. From outside of the space, utilize Ultra Sound and Partial Discharge probes to examine the space.
10. De-water space in accordance to the Base/Facilities Best Management Practice Plan.
11. Repeat steps 6 through 10 as necessary while dewatering manhole.
12. Begin monitoring gas/oxygen levels until suitable for human occupancy. Ventilate the space naturally or with forced air as required to establish and maintain a safe breathing environment. Larger spaces may require multiple gas detectors.
13. Place the Confined Space Entry/Retrieval Device over the manhole. (e.g. Tripod, Davit).

14. Ensure a qualified top side person remains at the entrance of the space to render aid and assistance.
15. Ensure personnel inspect and use a ladder for entry into spaces > 4 feet deep.

DANGER: Shock Hazard. Ensure that portable ladders are suitable for work on or near exposed energized equipment.

16. Ensure personnel are wearing an Arc rated safety harness with lanyard.
17. Ensure all material, equipment and parts are raised and lowered with a rope that has been inspected and is suitable for that purpose.
18. Ensure personnel are aware and clear of the area prior to lowering material, equipment, and parts.

6.4.6. CABLE PULLING OPERATIONS

1. Inspect anchor points, walls and support structures to ensure they are sound.
2. If no anchors are available or unsound, the space must be rigged utilizing equipment and procedures approved. Refer to the Original Equipment Operators Manual (OEM).
3. Develop a pull rigging plan that ensures that greatest mechanical advantage, limits the tension on the cable and protects other cables.
4. Do not use steel pulling line inside manholes with energized cables.
5. All personnel must exit the space prior to pulling the cable. They may remain in the manhole to set up and position cable (light tension) and rigging prior to the pull.
6. Where impractical to exit the space (large vaults) personnel will treat the pull as if working at grade level above ground and remain clear of the pulling line and cable being pulled.

DANGER: Arc Flash and Shock Hazard. Tags alone shall not be considered distinctive cable markings. Failure to place circuits in an electrically safe work condition may result in catastrophic equipment failure and/or loss of life.

6.4.7. CABLE FAULT LOCATING

1. Follow Sections 6.4.1 through 6.4.5.
2. Personnel shall never enter a confined space, manhole, or underground utility tunnel while high potential tests are being conducted.
3. From outside of the space, personnel shall attempt to detect the generated pulse location or direction.

4. Personnel in Arc Flash Category 2 PPE, may enter a confined space, manhole, or underground utility tunnel while testing cable with an impulse generator (thumper) in order to verify the direction of the impulse. Follow Section 6.4.5 prior to entry.
5. Personnel may enter and perform high potential and impulse tests in large underground vaults as long as they can maintain the same working space per the National Electric Code.

6.4.8. SPLICING, TERMINATING, AND RACKING DE-ENERGIZED CABLE

1. Follow Sections 6.4.1 through 6.4.5.
2. Workers shall move and position their work as far away as is practicable from other circuits while splicing and/or terminating the cable.
3. Workers shall rack cables in a manner as not to disturb other circuits.
4. Workers shall tag all new circuits as per the local bases standard.
5. Workers shall obtain a Hot Work Permit prior to any work requiring an open flame. OPNAVINST 5100.23 CH 27, (Confined Space Entry Program).

6.5. ELECTRICAL MANHOLE, VAULT, CONFINED SPACE ENTRY, AND UNDERGROUND WORK

6.5.1. DIRECT BURIED CABLE

While repair work on this type of cable is not performed in a confined space, personnel must locate and expose and identify cable(s) in order to perform repairs. Workers may be exposed to the hazards encountered when working in trenches.

DANGER: Shock Hazard. Prior to any work to excavate a site to uncover cable that is direct buried; all circuits must be de-energized and then placed in an electrically safe work condition. All cables that potentially run parallel or intersect the excavation site must be de-energized and placed in an electrically safe work condition prior to excavation, troubleshooting, or repair work. Failure to place circuits in an electrically safe work condition may result in catastrophic equipment failure and/or loss of life. Defer to site specific operating procedures for details on safe excavating and trenching.

DANGER: Arc Flash: All personnel must exit the trench and be in the clear (>20ft.) (outside of the Arc Flash Protection Boundary) prior to performing switching evolutions. Failure to place circuits in an electrically safe work condition may result in catastrophic equipment failure and/or loss of life.

1. Workers shall attempt to locate all the direct buried cables in the immediate area prior to excavating the site.

2. Workers may test energized circuits at grade level outside of the trench prior to backfilling the trench, but must de-energize and place all circuits in an electrically safe work condition prior to backfilling.
3. The cable to be worked on must be positively identified by electrical means and then marked in conditions where multiple cables//circuits are in the same trench.
4. All exposed cables must be protected from damage (OSHA 1926.956) (portable shelter, solid insulation, Arc Suppression Blanket, Rubber Insulating Blanket) .
5. Prior to cutting the cable/s, it shall be grounded with a spiking tool.
6. Allowed Activities. Same as above ground except as noted in this section.

6.5.2. ELECTRICAL HAND HOLE

Hand Holes (HH) are an opening in an underground system containing cable, equipment, or both into which personnel reach, but do not enter, for the purpose of installing, operating, or maintaining cable, equipment, or both. For Pull Box see Underground Vault. Hand holes are not typically considered confined spaces, but frequently personnel work in conditions where the work space is limited and their bodies are over the work; therefore, certain work cannot be performed safely on or near energized circuits.

Prior to any work commencing, the worker must determine:

- Work required.
 - Does the work require that the all circuits in the hand hole be de-energized and in an electrically safe condition? (e.g. moving or repositioning energized cables).
 - Can the work be done with all circuits de-energized and in an electrically safe condition? (e.g. alternate feed, outage) .
 - Can the work be performed without disturbing energized circuits?
- System Configuration.
 - Are all potential energy sources identified? (e.g. connected Photo Voltaic, Generators, Co-Generation).
 - What are system voltages and load currents?
 - What is the condition and setting of the upstream protective device?
- Material, Circuit, Environmental and Location Conditions.
 - Hand Hole and cover (structurally sound)
 - Work location (traffic, limited space, uneven surfaces)
 - Weather/Time/Animals (snakes, scorpions)
 - Cable condition
 - Extent of damage from failed cable.
 - Can workers clearly identify all circuits?

- Are energized circuits physically isolated or can they be safely isolated by placement of barriers (solid insulation, arc suppression blanket, rubber insulating blanket)

Note: Abnormalities such as oil or compound leaking from cable or joints, broken cable sheaths or joint sleeves, hot localized surface temperatures of cables or joints, or joints that are swollen beyond normal tolerance are presumed to lead to or be an indication of an impending fault.

DANGER: Arc Flash Hazard. If a cable in an underground structure has any abnormalities that could lead to or be an indication of an impending fault, the defective cable must be de-energized. Failure to place circuits in an electrically safe work condition may result in catastrophic equipment failure and/or loss of life.

DANGER: Electrical Shock/Arc Flash: All electrical circuits shall be completely de-energized before starting any work that would disturb energized circuits; e.g. troubleshooting, locating/digging to expose cables, pulling cable or replacing fuses. Failure to de-energize and place circuits in an electrically safe work condition may result in catastrophic equipment failure and/or loss of life.

Prior to commencing work, the QPIC shall follow Sections 6.4 and 6.5.2. Refer to Chapter 4 when determining Arc Flash and Shock Hazard PPE to be used when performing this work.

Allowed Activities.

- Visually examining the hand hole.
- Inspection of conductors and splices and equipment.
- Voltage and Current measurement.
- Splicing or terminating de-energized circuits.
- Lightly dusting or wiping the cable jacket or cable tags.

6.5.3. ELECTRICAL MANHOLE AND UNDERGROUND UTILITY TUNNEL

Manholes (MH) are subsurface enclosures that personnel may enter, used for installing, operating, and maintaining cable and equipment. These include Underground Utility Tunnel Trenches (UUT) commonly found under switchgear.

Prior to any work commencing in manholes, workers must determine:

- Work required.
 - Does the work require that all the circuits in the manhole be de-energized and in an electrically safe condition (e.g. moving or repositioning energized cables).
 - Can the work be done with all circuits de-energized and in an electrically safe condition? (e.g. alternate feed, outage).
 - Can the work be performed without disturbing energized circuits?
- System Configuration.

- Are all potential energy sources identified (e.g. connected Photo Voltaic, Generators, Co-Generation).
- What are the voltages and currents involved?
- What is the condition and setting of the upstream protective device?
- What is the available Short Circuit of the system?
- Material, Circuit, Environmental and Location Conditions.
 - Manhole cover, neck, ladder, ceiling and walls (e.g. secured properly and structurally sound).
 - Obstructions blocking entrance (e.g. cable, equipment).
 - Clear working space (minimum of: horizontal 3ft, vertical 6ft).
 - Other Utilities impacting work (e.g. steam, condensate, gas).
 - Work Location (e.g. roadway, airfield, pier, open field).
 - Weather/Time/Animals
 - Extent of damage from faulted cable.
 - Cable condition, position and supports.
 - Positive cable identification. (e.g. workers clearly identify the circuits by distinctive marking or electrical tests)
 - Are energized circuits physically isolated or can they be safely isolated by placement of barriers. (e.g. Solid insulation, Arc Suppression Blanket, Rubber Insulating Blanket) .
 - Ability to control the environment. (e.g. lighting, water, air quality and temperature).

DANGER: Arc Flash and Shock Hazard. Tags alone shall not be considered distinctive cable markings. Failure to place circuits in an electrically safe work condition may result in catastrophic equipment failure and/or loss of life.

CAUTION: Blast blankets are prohibited inside manholes. These types of blankets are commercially available, but are not appropriate for use inside a confined space such as a manhole.

Note: Abnormalities such as oil or compound leaking from cable or joints, broken cable sheaths or joint sleeves, hot localized surface temperatures of cables or joints, or joints that are swollen beyond normal tolerance are presumed to lead to or be an indication of an impending fault.

DANGER: Arc Flash Hazard. If a cable in an underground structure has any abnormalities that could lead to or be an indication of an impending fault, the defective cable must be de-energized. Failure to place circuits in an electrically safe work condition may result in catastrophic equipment failure and/or loss of life.

Prior to entering the manhole follow Section 6.4.1 through 6.4.5.

If the QP in charge determines that one or more hazardous conditions exist and cannot be mitigated, all circuits must be de-energized prior to entry. The QP in charge may re-

energize the circuits if they determine that the hazardous condition has been eliminated or controlled.

DANGER: Shock/Arc Flash Hazard. Never step on cables, equipment, or their supports in order to enter or exit the space. Failure to avoid this hazard may result in catastrophic equipment failure and/or loss of life.

DANGER: Arc Flash Hazard. All personnel must exit the manhole and be in the clear prior to performing switching evolutions. Failure to place circuits in an electrically safe work condition may result in catastrophic equipment failure and/or loss of life.

DANGER: Shock and Arc Flash hazard. Re-racking energized conductors is not permitted. Failure to place circuits in an electrically safe work condition may result in catastrophic equipment failure and/or loss of life.

DANGER: Crush Hazard. Manhole covers are heavy. Never use hands or feet to wedge or prop open manhole covers. Use tools designed to remove and place the covers in a safe manner and location. Failure to avoid this hazard may result in bodily injury.

Clear Working Space. (Manhole and Underground Vault)

- Between insulated energized conductors and the floor (3 inches).
- Between insulated conductors of different circuits (0 inches).
- When splicing de-energized conductors, confirm that an 18-inch (0.5-meter) safe working distance from other energized conductors or equipment can be maintained during the work.
- Horizontal clear working space (36 inches).
- Vertical clear working space (72 inches).

Allowed Water Levels

- Standing water is permitted for the specified work activities provided that the standing water level is below energized and installed conductors and associated cable rack arm.

Allowed Activities.

- Visually examining the manhole.
- Inspection of conductors and splices and equipment.
- Voltage and current measurement.
- Lightly dusting or wiping the cable jacket or cable tags.
- Cleaning manhole (without disturbing energized cable).
- Inspecting, blowing and rodding ducts (fiberglass duct rod).

- Pulling in de-energized cable (without disturbing energized cable).
- Splicing or terminating de-energized cables.
- Cutting cables that have been recently pulled in and/or have been placed in an electrically safe working condition.
- Removing (without disturbing energized cable) abandoned equipment, cable and circuit parts that are de-energized.

6.5.4. UNDERGROUND VAULTS

Underground Vaults (VLT) are subsurface enclosures that personnel may enter. Used for installing, operating, maintaining equipment and cable. Normally configured with an access cover for personnel entry and removable covers to allow access to equipment. Underground vaults vary in size from a 2'x 3' x 3' pull box containing cable up to a large ventilated enclosure containing high and low voltage switchgear and transformers.

Personnel engaging in work on or near energized equipment, cables and circuit parts in underground vaults shall refer to Sections 6.4.2 and 6.5.3 in addition to this section. This section shall cover other work associated with the equipment and process inside electrical vaults.

The QPIC is responsible for making the assessment regarding safe entry and work constraints.

Note: Personnel can perform electrical operations and testing in large ventilated underground vaults as long as they can maintain the same working space per National Electric Code and maintain safe environmental conditions.

Caution: Arc Flash Hazard. Do not switch or rack energized equipment in or out of switchgear in an underground structure. For the Navy, comply with the NAVFACINST 5100.11 Series as follows:

All activities shall secure, whenever feasible, all electrical power prior to start of work in electrical vaults, manholes and other confined or enclosed spaces.

Allowed Activities.

- Electrically testing energized circuits.
- Racking and un-racking breakers.
- Opening and closing switches.
- Operating controls and equipment.
- Closing and opening Breakers.
- Installing, removing, and inspecting equipment.
- Maintaining, troubleshooting and repairing equipment.
- Taking oil samples

Clear Working Space. (Underground Vault)

- Between insulated energized conductors and the floor (3 inches)
- Between insulated conductors of different circuits (0 inches)
- Worker Horizontal Clear Working Space (36 inches)

Allowed Water Levels

- Standing water is permitted for the specified work activities provided that the standing water level is below energized and installed conductors and associated cable rack arm.

6.5.5. PIER ELECTRICAL MOUNDS

Are not typically considered confined spaces, but frequently personnel work in conditions where the work space is limited and their bodies are over the work; therefore, certain work cannot be performed safely on or near energized circuits. The QPIC is responsible for making the assessment regarding safe entry and work to be performed. Prior to any work commencing, workers must determine:

Work required. (M)

- Does the work require that the all circuits in the mound be de-energized and in an electrically safe condition? (e.g. moving or repositioning energized cables? Yes) .
- Can the work be done with all circuits de-energized and in an electrically safe condition? (e.g. alternate feed, outage).
- Can the work be performed without disturbing energized circuits?

System Configuration. (M)

- Are all potential energy sources identified? (e.g. connected Photo Voltaic, Generators, Co-Generation).
- What are system voltages and load currents?
- What is the condition and setting of the upstream protective device?

Material, Circuit, Environmental and Location Conditions.

- Mound door and hatch cover (structurally sound).
- Work location (traffic, limited space, uneven surfaces, pier operations).
- Weather/Time/Animals (snakes, scorpions, rodents).
- Cable condition.
- Extent of damage from failed cable.
- Can workers clearly identify all circuits?
- Are energized circuits physically isolated or can they be safely isolated by placement of barriers (solid insulation, Arc Suppression Blanket, Rubber Insulating Blanket)

Note: Abnormalities such as oil or compound leaking from cable or joints , broken cable sheaths or joint sleeves, hot localized surface temperatures of cables or joints, or joints that are swollen beyond normal tolerance are presumed to lead to or be an indication of an impending fault.

DANGER: Arc Flash Hazard. If a cable in an underground structure has any abnormalities that could lead to or be an indication of an impending fault, the defective cable must be de-energized. Failure to place circuits in an electrically safe work condition may result in catastrophic equipment failure and/or loss of life.

DANGER: Electrical Shock/Arc Flash: All electrical circuits shall be completely de-energized before starting any work that would disturb energized circuits; e.g. troubleshooting, locating/ digging to expose cables, pulling cable or replacing fuses. Failure to de-energize and place circuits in an electrically safe work condition may result in catastrophic equipment failure and/or loss of life.

Prior to commencing work, the QPIC shall follow Sections 6.4 and 6.5.5. Refer to ESAFE Chapter 4 when determining Arc Flash and Shock Hazard PPE to be used when performing this work.

Allowed Activities.

- Electrically testing energized circuits.
- Opening and closing switches.
- Operating controls.
- Closing and opening breakers.
- Installing, removing, and inspecting equipment.
- Maintaining, troubleshooting and repairing equipment.

6.5.6. SPLICING, TERMINATING, AND RACKING DE-ENERGIZED CABLE

- Workers may barricade/protect energized or de-energized cables to increase safety.
- Workers shall move and place cable away from other circuits while splicing and/or terminating the cable.
- Workers shall rack cables in a manner as not to disturb other circuits.
- Workers shall tag all new circuits as per the local bases standard.
- Workers shall obtain a Hot Work Permit prior to any work requiring an open flame. OPNAVINST 5100.23 CH 27, (Confined Space Entry Program).
- Workers must follow the procedures outline in Section 6.4.8.

6.6. TRAINING

All Employees shall be trained in and familiar with the safety related work practices, safety procedures, and other safety requirements which pertain to their respective job assignments. Employees shall also be trained in and familiar with related emergency procedures (such as manhole rescue, CPR and rendering First Aid).

At least annually, management shall determine that each employee is complying with the safety work practices and uses these practices in conducting work. Annual training shall include refresher training on confined space entry, gas detection, energized equipment testing procedures, LOTO, and First Aid at a minimum.

Employees will receive additional training under the following conditions:

- If management determines that the employee is not complying with established safe work practices.
- When new technology, equipment, or procedures are introduced into the workplace.
- The employee is required to perform tasks which are not normally performed as part of their regular duties.

CHAPTER 7 - INFRARED TESTING OF SHORE POWER

7.1. PURPOSE

Provide standard procedures for performing thermal Infrared (IR) imaging inspections on Shore Power electrical equipment and connections.

7.2. BACKGROUND

The connection of Shore Power to ships and submarines is a hazardous operation. Hazards mitigated by this Standard Operating Procedure (SOP) are: shore power equipment damage, unplanned interruption of power to vessels; personnel hazards, and the potential for electrical fires. All steps in this procedure must be followed and total compliance is critical to mitigating the hazards.

Infrared imaging inspections are intended to identify unusual thermal patterns, hot spots or exceptions on electrical systems and connections. Unusual warm thermal patterns are usually associated with an increase in resistance caused by loose or deteriorated connections, overloads, load imbalances, short circuits or faulty, improperly installed components. Unusual cool thermal patterns are usually caused by failed components.

7.3. TOOLS AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

The required Tools and PPE are:

- Arc rated (AR) long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm²
- Leather electrical hazard (EH) - rated work shoes/boots
- Non-metallic safety glasses with side shields
- Class E hard hat
- Voltage rated gloves with Leather Protectors
- Infrared Camera or Visual IR Thermometer
- Clamp-on Amp Meter

7.4. TRAINING, CERTIFICATION, and RECORD KEEPING

NAVFAC Authorized Employees (AE) or Qualified Persons (QP) performing the testing shall be designated shore power personnel that have the skills and knowledge related to the construction, installation, and operation of the electrical equipment, received safety training on the hazards involved, and trained in performing shore power connections. In addition, NAVFAC Authorized Employees or Qualified persons performing the testing shall have completed a basic level of training on the operation and use of the thermal imaging equipment by a trained and experienced thermal

imaging “User” who has conducted and/or assisted on a minimum of three thermal imaging inspections or by an infrared thermographer.

Documents associated with an active shore power connection shall be kept in a centralized location and be continuously accessible. Upon the vessels departure, documents shall be stored in a centralized location, and records shall be maintained for a minimum of one year.

7.5. GENERAL INFORMATION FOR PROCEDURES

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Ships and Submarines operating in a cold iron mode.
2. The Ship’s/Submarine’s Electrical Officer, Ship's Reactor Electrical Assistant (REA), or the Ship’s/ Submarine’s designated electrical representative is responsible for cable connections to the vessel’s generators shore power receptacles and dictating when Shore Power is energized and de-energized.
3. Personnel performing thermal infrared imaging inspections may be exposed to energized high voltage receptacles, conductors, circuits, and electrical components that are part of the ship-to-shore electrical power system. Shore Power equipment shall be considered energized unless an Electrically Safe Work Condition has been established.

7.6. PROCEDURES FOR THERMAL INFRARED TESTING

7.6.1. STEP 1 - RECORD REVIEW AND SHORE POWER LOAD

1. NAVFAC QP reviews the Ship to Shore Power Cable Insulation Record, the Ship Connect/Disconnect Form, and shore power on site to develop an inventory list of equipment to be tested in a logical, efficient order.
2. NAVFAC QP will confirm with Supervisory Control and Data Acquisition (SCADA) or the Ship’s/Submarine’s Electrical Officer, Ship's Reactor Electrical Assistant, or Ship’s/Submarine’s designated electrical representative that the vessel’s shore power load has been at 50% or more for one consecutive hour. NAVFAC QP shall perform a thermal infrared (IR) imaging inspection to ensure all Shore Power equipment is operating within safe tolerances after 1 hour of the vessel’s load being at 50% or more.

7.6.2. STEP 2 - THERMAL INFRARED INSPECTION OF SHORE POWER CABLE ASSEMBLIES

1. The IR inspection is to include the connector at the Shore Power substation receptacle to the last connector on the pier/shore.
2. The IR inspection may be qualitative (by observing images of infrared radiation, recording and presenting that information) or quantitative (by measuring temperatures of the observed patterns of infrared radiation). When a qualitative

inspection reveals a thermal anomaly, perform a quantitative inspection on the anomaly.

3. Perform thermal IR inspections in accordance with the Infrared Camera or Visual IR Thermometer manufacturer's operating or technical manual.
 - 3.1. **CAUTION:** Breakers, receptacles, and cables are energized. Personnel must adhere to Minimum Approach Distances provided in Chapter 4 of this document.
 - 3.2. No Personnel shall move energized Shore Power cable assemblies.
 - 3.3. The thermal image operator shall never walk about while the operator's attention is focused on the thermal image viewing screen. Viewing shall only be accomplished while the operator is in a steady and stable position.
 - 3.4. Objects viewed in the thermal image may be closer than they appear, therefore, the operator shall never reach out or point to an object while viewing the thermal image screen.
4. If an infrared inspection indicates a thermal anomaly, shore personnel shall trace the cable and record/track the cable info, its amperage at that instant, and the Breaker/Circuit number to which it is connected, ambient air temperature and relevant conditions on Section 7.6 Infrared Inspection Data. Shore personnel shall provide the exact location, such as marking the cable behind the boot with spray paint, and inform maintenance personnel.
 - 4.1. **NOTE:** A thermal anomaly should be viewed (imaged), or measured, from at least two angles to determine whether the thermal image, or radiation received by the thermal imager or spot radiometer, is true or contains reflections. True hot spots in thermal images do not move, disappear, or change as the angle of viewing changes.
 - 4.2. Inspect shore power cable assemblies for any sign of defect, damage or indications of overheating. If the connector loses its normal color, this is an indication that it has lost its physical strength properties, thus presenting a potential problem.

7.6.3. STEP 3 - INFRARED TEST RESULTS AND REPORTS

1. On Section 7.7, the Infrared Inspection Data sheet, assign a Severity Code based upon test results and Table 1 for each thermal anomaly. Provide a copy of Infrared Inspection Data sheet to the Ship's/Sub's Electrical Officer, Ship's Reactor Electrical Assistant (REA), or the Ship's/Sub's designated electrical representative.
2. If deficiencies are found that require immediate repair, the NAVFAC QP in charge shall conduct a job brief to coordinate and communicate with Ship's/Submarine's personnel and Port Ops for taking the affected circuit offline/de-energizing and repair or replacement of the affected equipment.
3. Note any adjustment, cleaning, or tightening of shore power cable connections in the comments on the Infrared Inspection Data sheet.

4. Do not use damaged or suspect cable assemblies for shore power connections until repairs are made or the cable assemblies pass visual and electrical inspections. Note any repairs or replacements made to the cable assemblies in the comments on the Infrared Inspection Data sheet.
5. Repeat the thermal IR inspection per the requirements of this Chapter on all repaired, replaced, adjusted, cleaned, tightened, or disconnected then reconnected shore power cable connections and equipment. Note results on the Infrared Inspection Data sheet and provide a copy to the Ship's/Submarine's Electrical Officer, Ship's Reactor Electrical Assistant (REA), or the Ship's/Submarine's designated electrical representative.

TABLE 7-1: INFRARED TEST - SEVERITY CODES

Temperature Rise or ΔT	Operational Assessment	Severity Code	Action
70°C and above	Failure Imminent	4	Equipment should be secured immediately and not operated until repairs are complete.
40°C to less than 70°C	Failure Almost Certain	3	Equipment should be secured if operating conditions permit otherwise monitored until corrective action can be taken.
20°C to less than 40°C	Failure Possible	2	Corrective action should be taken as soon as feasible.
10°C to less than 20°C	Performance Degraded	1	Corrective action should be taken at next scheduled routine maintenance period or as schedule permits.
Less than 10°C	N/A	N/A	No corrective action required.
<p>The temperature rises or ΔT's indicated above are the temperature differentials between the thermal anomaly (i.e., faulty connection or component) and the reference temperature. The reference temperature should be a similar, normal operating connection, component, or phase. Decisions regarding repair priorities and order of maintenance should be determined by the magnitude of the temperature differential and the critical nature of the equipment or system involved. Note: Shore Power Cables are rated at 90°C, single pole connectors are rated at 100°C, and terminal lugs are rated at 149°C.</p>			

7.7. INFRARED INSPECTION DATA SHEET - RECORD ALL ANOMALIES

Ship:			Ft Mark	Amb. Temp in °C	Date		
SUB No.:							
BKR No.:			Severity Code	BKR No.:			Severity Code
PH Current	Cable #	IR Temp		PH Current	Cable #	IR Temp	
PH A:				PH A:			
PH B:				PH B:			
PH C:				PH C:			
BKR No.:			Severity Code	BKR No.:			Severity Code
PH Current	Cable #	IR Temp		PH Current	Cable #	IR Temp	
PH A:				PH A:			
PH B:				PH B:			
PH C:				PH C:			
BKR No.:			Severity Code	BKR No.:			Severity Code
PH Current	Cable #	IR Temp		PH Current	Cable #	IR Temp	
PH A:				PH A:			
PH B:				PH B:			
PH C:				PH C:			
BKR No.:			Severity Code	BKR No.:			Severity Code
PH Current	Cable #	IR Temp		PH Current	Cable #	IR Temp	
PH A:				PH A:			
PH B:				PH B:			
PH C:				PH C:			
BKR No.:			Severity Code	BKR No.:			Severity Code
PH Current	Cable #	IR Temp		PH Current	Cable #	IR Temp	
PH A:				PH A:			
PH B:				PH B:			
PH C:				PH C:			
Remarks:							

NAVFAC QP: _____

Imaging System Used: _____

CHAPTER 8 - 480V SHIP CONNECT

8.1. PURPOSE

To provide the standard procedures for connecting 480 Volt Shore Power to Surface Ships.

8.2. BACKGROUND

The connection of 480 Volt Shore Power to Ships is a hazardous operation. Hazards mitigated by this chapter are: electrical shock, arc flash, arc blast, and electrical burns.

All steps in this procedure must be followed and total compliance is critical to mitigating the hazards of Shore Power Connections and Disconnections. Thorough training, job planning, and exhaustive communication between Naval Facilities Engineering Command (NAVFAC) in-house forces, contractor personnel, other DoD agencies and Ship Personnel are necessary to ensure the highest level of safety for all involved.

8.3. TOOLS AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

Any worker whose normal job includes working on or near exposed energized electrical conductors or equipment shall wear, as a minimum, Arc Rated long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm² and leather EH rated safety shoes/boots.

Tools, equipment, and additional Personal Protective Equipment (PPE) necessary to perform this procedure are provided in Chapter 4 Working on or Near Exposed and Enclosed Energized Electrical Systems and Chapter 5 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems.

8.4. TRAINING, CERTIFICATION, and RECORD KEEPING

All employees whose job requires the use of this procedure shall be trained to understand the purpose and function of the hazardous energy control program, the hazards they face, demonstrate a working level knowledge of all process steps and applicable references, and complete site specific training as required. The training requirements shall be identified and associated with the employee profile in ESAMS.

Training completion shall be registered in ESAMS. Additionally, a list of names and job titles of Authorized Employees and Qualified Persons shall be maintained by SOC personnel and available to Command employee(s) responsible for dispatching/assigning work.

At least once per year, execution of this procedure shall be audited to ensure the procedure is being followed.

8.5. GENERAL INFORMATION FOR PROCEDURES

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Ships operating in a cold iron mode.
2. Personnel performing Shore Power Connects and Disconnects may be exposed to AC electrical potential of 600 volts and less and DC electrical potential 250 volts and less. Shore Power equipment shall be considered energized unless an Electrically Safe Work Condition has been established.
3. The Ship's Electrical Officer or the Ship's designated electrical representative is responsible for making cable connections to the Ship's generators shore power receptacles and dictating when Shore Power is energized to allow Ship's load transfer to shore power.
4. Shore Power service provides an ungrounded, correctly phased system, with an adequate number of shore power cables correctly oriented to serve the Ship's load. Where two or more power cables are connected to a Ship, cables must be grouped so that all the same phases are connected together.
5. When the ship requires more than one feeder cable, total cable length for each feeder will be within plus or minus 10 percent to minimize unequal load distribution. Conductors must be the same size.
6. Only current carrying conductors are provided from shore power. A physical equipment ground connection between the Shore substation and the Ship is not provided. Ship's hull serves as an equipment ground for Ship's electrical service.
7. Paralleling shore transformers through the Ship electrical bus without prior NAVFAC approval is prohibited because it is unsafe and will result in circulating currents, overheated cables, and increased available fault current above the rating of the shore and ship equipment which could damage property and result in personal injury.
8. The area surrounding Shore Power and industrial power receptacles, plugs and portable power cables shall be barricaded to the greatest extent practicable in order to provide equipment and personnel protection.
9. The following documents were considered during the development of these procedures: "OSHA 29 CFR 1910.269 Electric Power Generation, Transmission, and Distribution", "EM 385- 1-1, Health and Safety Requirements, Sections 11 & 12", "Navy Ships Technical Manual (NSTM), Chapters 320/300", "NAVSEA Manual S0400-AD-URM-010/TUM Rev 06 Tag-out User's Manual", and "NAVFAC P307 Management of Weight Handling Equipment."

8.6. CONNECT PROCEDURE FOR SURFACE SHIPS UTILIZING 480 VOLT SHORE POWER

8.6.1. STEP 1 - PREPARE FOR SHIP'S ARRIVAL

1. Use the berthing assignment information received from Port Operations to prepare the berth for Ship's arrival or the Logistics Requirement (LOGREQ) message from the arriving Ship, which describes power and general berthing requirements.
2. Obtain and utilize Ship Connect/Disconnect Form to record information. See Section 8.10 for example. Documents associated with an active connection shall be kept in a centralized location and be continuously accessible. Upon ships departure, documents shall be stored in a centralized location, and records shall be maintained for a minimum of one year.
3. NAVFAC Qualified Person (QP) in Charge shall conduct a Job Brief and ensure all personnel have required equipment, tools, and PPE.

8.6.2. STEP 2 - LAY POWER CABLE ASSEMBLIES

1. Check berth for obstructions that may prevent safe Shore Power set up. If obstacles are present, inform NAVFAC Supervisor and Port Operations or appropriate authorities for removal.
2. Place vehicle or weight handling equipment in position.
 - 2.1. Only weight handling equipment and the following vehicles are authorized to deliver/retrieve power cables on the piers: shop mule, a line truck, a reel truck, fork lift, or a boom truck. Cable can also be hand carried.
 - 2.2. Use a spotter when backing up or placing in tight space.
 - 2.3. Operators shall have a valid license, training, and certification in accordance with Command policies.
3. Shore Power cables shall be placed at the pier where the Ship will dock.
4. Lay out cables between Facility Shore Power receptacles and Ship's Shore Power receptacles. Note the following **CAUTIONS**:
 - 4.1. Ensure cable ends are not connected to any equipment, weight handling equipment or vehicle.
 - 4.2. Excess cable shall be laid in such a manner as to minimize damage from vehicle and pedestrian traffic.
 - 4.3. Each set of Shore Power cables should be positioned as a unit.
 - 4.4. Do not lay or drag cables on or over sharp and ragged objects.
 - 4.5. Shore power cables and terminations should be physically isolated from Shore Steam, Potable Water, Salt Water, and all other service lines.

- 4.6. Do not exceed minimum cable bend radius. Per Insulated Cable Engineers Association, minimum THOF cable bend radius is 6 times the outer diameter.
- 4.7. Provide adequate cable length to compensate for the rise and fall of the tide. Cable slack should not dip into the water, rub on structures causing abrasion, or become wedged between the ship and pier.
- 4.8. Ensure cables are the proper length, size and are arranged in a neat and safe manner.
- 4.9. To reduce overheating or de-rating cable, excess cable should not be coiled or stacked on each other.
- 4.10. Barricades shall be placed as necessary, to keep vehicles off cable.
- 4.11. Where cables would obstruct drains or scuppers, lay cables on a pallet to allow water drainage on the pier.
- 4.12. Do not hold or brace the cable in place as this may result in a foot or leg injury.
- 4.13. When loading or unloading Shore Power cables, the NAVFAC Electrical QP shall ensure that: the operation of the vehicle or weight handling equipment comply with applicable SOPs, barriers are set to proper distance, wheel chocks are placed down, sets of cables are connected together, no unauthorized persons are in the area of operations that may be struck by a swinging or falling cable, boom truck outriggers are not blocked by any obstructions and are not set on top of vault covers, steam covers, or manholes, booms never swing forward of the outriggers, reel trucks have placed stabilizer jacks.

8.6.3. STEP 3 - INSPECT AND TEST EACH POWER CABLE ASSEMBLY

1. NAVFAC QP shall confirm Shore Power cable assemblies are disconnected on both ends. If the NAVFAC QP in Charge determines it is necessary to verify Shore Power cable assemblies are de-energized, NAVFAC QP shall test each phase conductor or circuit part of the cables for no voltage prior to handling, in accordance with Section 8.7.
2. NAVFAC QP shall ensure inspection/testing team maintains control of both ends of Shore Power cable assemblies to ensure these cable assemblies stay disconnected on both ends.
3. Visually inspect shore power cable assemblies for any sign of defect. Cables not passing visual inspection shall be removed from service.
 - 3.1. Inspect cable assemblies for cracks, bulges, or indications of overheating.
 - 3.2. Inspect cable sheath for cuts, nicks, and gouges.
 - 3.3. As required, strip insulation from any existing cable splices and inspect for cleanliness, tightness, and good surface contact.
4. Repair defects and re-insulate as needed.
5. Clean and inspect cable connectors and lugs.

- 5.1. Inspect cable connectors, lugs, and each conducting surface for pitting, corrosion, and evidence of overheating. Repair or replace any deficiency.
- 5.2. If required by manufacturer, apply a light coat of approved grease or contact cleaner to cable connectors.
- 5.3. If in-line connectors are used, conduct mechanical test ensuring that locking mechanisms operate, and all parts are attached. Repair or replace any deficiency.
6. Measure insulation resistance between cable assembly conductors and each conductor and ground for each circuit using a minimum 1000 volt megohmmeter. The test duration shall be one minute. Minimum insulation readings for 480-volt Shore Power cables shall be 4 megohms.
7. Record all cable insulation resistance reading on Ship to Shore Power Cable Insulation Record (see Section 8.11) and record the lowest insulation resistance value on the Ship Connect/Disconnect Form (see Section 8.10).
8. Replace Shore Power cable if it does not meet minimum insulation resistance requirements.
9. Verify phase identification markings (color coding or labeling) on the shore power cable assembly to ensure proper orientation (in-phase).
10. Attach "DANGER-HIGH VOLTAGE" signs to Shore Power cable assemblies or barricades.
11. Barricade the work area surrounding the Shore Power receptacles and portable shore power cables to the greatest extent possible.

8.6.4. STEP 4 - INSPECT AND TEST 480 VOLT SHORE RECEPTACLES

1. NAVFAC QP in Charge shall obtain the test data from the last ship connect or Annual PM performed on these 480V shore receptacles and conducts a Job Brief.
2. NAVFAC QP, wearing appropriate PPE, shall establish Electrically Safe Working Condition.
 - 2.1. Open, red danger tag and red danger lock Facility Shore Power receptacle circuit breakers.
 - 2.2. Test Shore Power circuit breaker receptacles for no voltage.
 - 2.3. If appropriate, apply Temporary Protective Grounding to shore power receptacles per Sections 8.8 and 8.9. **Note:** installing temporary protective grounds for 480-volt shore power is a rare occurrence and temporary protective grounding is usually waived by the NAVFAC QP in Charge, as allowed in Section 8.9.
3. Carefully open/remove access cover(s) to each shore power receptacle and test for no voltage per Section 8.7. Use a voltage tester to test terminals in each shore power receptacle to ensure that they are de-energized. Verify these receptacles are in an electrically safe working condition.

4. Inspect each cover and receptacle. Clean as necessary to ensure proper operation.
 - 4.1. If applicable, inspect each cover gasket and each receptacle gasket for cuts, tears, cracks, and deformation.
5. Inspect each receptacle conducting surface for pitting, corrosion, and evidence of overheating. If the receptacle is equipped with interlocks, operate each receptacle interlock switch manually; movement should be smooth with no binding or sticking.
6. If 480V shore power receptacle testing was performed within the last 12 months, record the date of test and megohms on the Ship to Shore Power Cable Insulation Record (see Section 8.11). If test data is unavailable or older than 12 months, perform steps 6.1 through 6.4 below.
 - 6.1. Disconnect equipment such as meters, indicating lights and fuses that could be damaged by a megohmmeter test or cause a false reading.
 - 6.2. If temporary protective grounds were installed in accordance with Section 8.8, remove grounds for testing purposes at Facility Shore Power circuit breaker receptacles one at a time. Use a 1000 volt megohmmeter and test the insulation resistance between each receptacle terminal and between each terminal and ground. The test duration shall be one minute. Minimum insulation resistance is four (4) megohms for 480 volt receptacles.
 - 6.3. Record megohmmeter values on the Ship to Shore Power Cable Insulation Record (see Section 8.11).
 - 6.4. Re-install indicator lights, appropriate fuses and reconnect appropriate meters.
7. Install/Close shore power receptacle access covers.
8. Remove red danger tags and red danger locks from Facility Shore Power receptacle circuit breakers for testing purposes, if required.
9. Test MIL-C-24368 Facility Shore Power receptacle cover interlock switches, if equipped, and indicator lights in accordance with Section 8.7, Chapter 4, and Chapter 5.
 - 9.1. Close shore power receptacle circuit breakers.
 - 9.2. Ensure receptacle indicating lights are illuminated.
 - 9.3. Open shore power receptacle access cover; receptacle circuit breaker should trip and indicating light should extinguish.
 - 9.4. Test shore power receptacle for no voltage to ensure the receptacle has been de-energized.
 - 9.5. Close Shore Power receptacle access cover.
 - 9.6. If so equipped, test open and close push buttons and emergency stop buttons for proper operation.

10. Open Facility Shore Power circuit breakers.
11. Repair deficiencies if time permits. If repairs cannot be made, open circuit breaker and place a caution tag and lock on the breaker in accordance with Chapter 2 and report deficiencies to NAVFAC Supervisor.

8.6.5. STEP 5 - SHORE POWER CABLE RIGGING

1. Upon Ship's arrival, NAVFAC QP in Charge shall contact Ship's Electrical Officer or the Ship's designated electrical representative to ensure required Ship's Personnel are available, determine cable connection lengths, and connection time.
2. NAVFAC and Ship's Personnel shall conduct a joint Job Brief and clearly agree on roles, responsibilities, and procedures for provision of Shore Power that meet the requirements of the applicable NAVFAC SOPs and Ship's Engineering Operational and sequencing System (EOSS) and Ship's SOPs. During the job brief, provide Ship's Electrical Officer with the Ship Connect/Disconnect Form (see Section 8.10), Ship to Shore Power Cable Insulation Record (see Section 8.11), and Cable Tests/Inspections per latest OPNAVINST 11310.3 and UFC 4-150-02 as required.
3. NAVFAC QP wearing appropriate PPE shall open, red danger tag, red danger lock Facility Shore Power circuit breakers, test for no voltage and, if applicable, apply temporary protective grounds at Shore Power circuit breaker receptacles in accordance with Sections 8.7 and 8.8. Note: temporary protective grounding is typically waived for 480-volt shore power. NAVFAC Authorized Employees shall install red danger tags and red danger locks.
4. NAVFAC QP in Charge shall obtain signatures from the Ship's Electrical Officer and Senior Electrician on the Ship Connect/Disconnect Form certifying that the Ship's Shore Power circuit breakers are open and tagged out. The NAVFAC QP in Charge then signs the Ship Connect/Disconnect Form as well.
5. When distance from Ship's electric bus to the shore power receptacle requires the connecting of two or more cables (via inline connectors or splices), these connections shall be completed prior to connecting to any Ship or Shore Power receptacles.
6. NAVFAC QP shall confirm shore power cables assemblies are disconnected on both ends or NAVFAC QP and Ship's personnel wearing appropriate PPE shall use an adequately rated voltage detector to test each phase conductor or circuit part of shore power cables to verify they are de-energized.
7. Load Shore Power cable assemblies from Shore to Ship. If boom trucks or cranes are used, follow appropriate boom truck and crane SOP.
8. Once the cables are positioned at the intended location and prior to relieving any lifting, restraining or hold down force (whether by manual or mechanical means), the cables must be sufficiently lashed down on board the ship and pier side without causing damage to the cables and tied-down to prevent unplanned/uncontrolled movement of the cable(s).

9. Care must be taken to allow sufficient slack for the cable to move freely (avoiding strain, abrasion, pinch points and water intrusion) during ebb and flow of tidal changes when the ship is berthed or at anchorage.

8.6.6. STEP 6 - INSERTING CABLE PLUGS INTO RECEPTACLES

1. Shore Power cable connections shall be made from the Ship's Shore Power receptacles toward the NAVFAC Shore Power receptacles.
2. Ship's Personnel will connect Facility Shore Power cable to Ship's Shore Power receptacle in accordance with Ship's Engineering Operational and Sequencing System (EOSS) procedures.
3. NAVFAC QP in Charge will receive from the Ship's Electrical Officer or Ship's designated electrical representative confirmation that Facility Shore Power cables are connected to Ship's Shore Power receptacles and authorization to connect cables.
4. NAVFAC QP shall verify the Facility Shore Power receptacles are in an Electrically Safe Working Condition. In addition, NAVFAC QP shall verify that Shore Power cables connected to the Ship's Shore Power Receptacles are in an Electrically Safe Work Condition as established by Ship's Forces.
 - 4.1. NAVFAC QP wearing appropriate PPE shall use an adequately rated and proven voltage detector to test each phase conductor or circuit part of the Facility Shore Power receptacles and Shore Power cables (now connected to the ship bus) to verify they are de-energized.
 - 4.2. While the Shore Power cable assemblies are in an Electrically Safe Work Condition, NAVFAC QP shall:
 - 4.2.1. Check all cable assemblies for proper phase color coding: Phase "A" is black, Phase "B" is white and Phase "C" is red.
5. NAVFAC personnel shall insert Shore Power cable plugs into Facility Shore Power receptacles. (Insert Viking Plug or single pole white plugs into white receptacles, red into red, and black into black.)
6. NAVFAC QP shall fill out and attach the Ship to Shore Tag (see Section 8.13) to cables at Facility Shore Power receptacle.
7. NAVFAC QP in Charge shall obtain the Ship's Electrical Officer signature on the Ship Connect/Disconnect Form giving permission to NAVFAC personnel to energize shore power at the agreed upon time.
8. NAVFAC personnel shall remove temporary protective grounds from Facility Shore Power circuit breaker receptacles if installed.
9. NAVFAC personnel will notify Ships Personnel that they are ready for Ship's Personnel to clear tags from Ship's Shore Power circuit breakers.
10. NAVFAC personnel shall remove red danger tags and red danger locks from the Facility Shore Power circuit breakers.

11. After receiving permission from Ship's Electrical Officer or designated representative, NAVFAC QP shall close Shore Power circuit breakers one at a time in the sequence requested by the Ship's Electrical Officer.

8.6.7. STEP 7 - SHIP'S TRANSFER TO SHORE POWER

1. **CAUTION:** Ship's Personnel, in accordance with Ship's EOSS, will synchronize Ship's generators with Shore Power and transfer power from the Ship's generators to Shore Power within the shortest interval possible. If more than one Shore Power connection is to be paralleled, actual phases of Shore Power must be the same rotation and also be connected to match ship phases (orientation, in-phase). A shore power installation that has one circuit breaker supplying a number of cable sets presents a particular hazard. In this case, phase rotation and phase orientation/in-phase can be verified only by energizing all shore terminals. This situation requires special considerations and procedures. The latest designs have a separate circuit breaker on the ship and shore facility for each set of cables.
2. When the Ship's Electrical Officer has notified the NAVFAC QP that transfer is complete, NAVFAC QP in Charge shall obtain the Ship's Electrical Officer signature on the Connect/Disconnect Form thereby accepting Shore Power.
3. **Note:** No Personnel shall move energized Shore Power cable assemblies.
4. NAVFAC personnel shall check amperage readings on all phases of each cable and record them on the Shore Power Load Current Analysis Form, Section 8.12. The preferred method is permanently installed ammeters, however clamp-on ammeters are allowed.
 - 4.1. Verify that phase amperage readings are within 10 percent of each other per Shore Power Load Current Analysis Form.
 - 4.1.1. For each cable, add all three readings together and divide by three to get the average. Divide that number by 10 and all three readings should not differ from the average by more than that amount. For example, if phase A reads 230A, phase B reads 240A, and phase C reads 250A, the average is $(230+240+250)/3 = 240$. $240/10 = 24$. All three phases read within plus or minus 24 (10%) of 240 (average), so these are acceptable readings for this example.
 - 4.2. If the amperage readings are not within 10 percent, notify NAVFAC QP, Ship's representative, and perform a thermal infra-red imaging survey.
 - 4.3. The average current of each circuit must also be within 10 percent of the combined average current of all circuits. If they are not, notify NAVFAC QP for further instruction.
 - 4.4. If any circuit has zero current, open, caution lock and tag the breaker feeding that circuit.
5. After the ship is drawing current and has reached at least 50% load for 1 hour, NAVFAC QP will perform a thermal infra-red imaging (IR) survey in accordance

with NAVFAC Standard Operating Procedures to ensure all Shore Power equipment is operating within safe tolerances.

- 5.1. The NAVFAC IR survey will include the connector at the Shore Power substation receptacle to the last connector on the pier.
 - 5.2. **CAUTION:** Breakers, receptacles, and cables are energized. If deficiencies are found, NAVFAC QP in charge shall conduct a job brief to coordinate and communicate with ship personnel for taking the circuit offline/de-energizing.
 - 5.3. Repair deficiencies if time permits. If repairs cannot be made, open circuit breaker and place a caution tag and lock on the breaker in accordance with Chapter 2 and report deficiencies to NAVFAC Supervisor.
6. When the IR survey is complete, the Ship Connect/Disconnect Form shall be signed indicating completion of the task.

8.7. TEST FOR NO VOLTAGE

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a Qualified Person as defined in the Chapter 1 using the required PPE. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
2. A QP shall test for no voltage per Chapter 5.
3. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

8.8. TEST FOR NO VOLTAGE AND APPLY TEMPORARY GROUND

1. If temporary protective grounding equipment is to be used, wear the required PPE. Installing temporary protective grounds is considered working on an exposed energized electrical system. Personnel installing temporary protective grounds shall be a Qualified Person as defined in Chapter 1. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document. Install temporary protective grounds per Section 8.9.
2. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP as defined in the Chapter 1 using the required PPE.
3. A QP shall test for no voltage per Chapter 5
4. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

8.9. TEMPORARY PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

1. Temporary protective grounding requirements may be waived by the NAVFAC QP-in-charge or the Designated QP- (LV or HV) if it is not practical or that the conditions resulting from the installation of a ground would present greater hazards than working without grounds. Temporary Protective Grounding is usually waived for 480-volt shore power.
2. Temporary protective grounds are assemblies consisting of clamps, ferrules, and cable and are to be used when working on de-energized electrical conductors or equipment to minimize the possibility of accidental re-energization from unexpected sources. Grounding will cause an inadvertently energized line to become de-energized through the action of ground fault relays.
3. Temporary protective grounding shall be used where:
 - 3.1. The possibility of induced voltages or stored electrical energy exists.
 - 3.2. It could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts.
4. Only a QP can test for no voltage and install and remove temporary protective grounds. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
5. Equipotential grounding, as described in Chapter 1, Section 1.8.8, shall be used when feasible to establish a zone of equipotential. When not feasible, grounds shall be placed as close to the work site as practical.
6. Temporary protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in electrical potential. The temporary protective grounds should be installed in a manner that establishes a zone of equipotential where each employee is working.
7. Temporary protective grounds shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
8. The location of installed temporary protective grounds shall be written on red danger tags.
9. When a temporary protective ground is attached to a line/conductor or equipment, the temporary protective ground end connection shall be attached first and then the other end shall be attached by means of voltage rated gloves or voltage rated gloves with a live line tool. Use safe work practices and wear the required PPE.
10. When a temporary protective ground is to be removed, the temporary protective grounding assembly shall be removed from the line/conductor or equipment using voltage rated gloves or voltage rated gloves with a live line tool before the temporary protective ground-end connection is removed. Use safe work practices and wear the required PPE.

8.10. SAMPLE SHIP CONNECT/DISCONNECT FORM

ELECTRICAL SHORE POWER SERVICE PROCEDURE

 CONNECT

 DISCONNECT

ARRIVAL TIME:

DEPARTURE TIME:

DATE:	SHIP'S NAME:	PIER/BERTH:	VAULT:	OTHER:
REPORT IMPLEMENTED BY: <input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> OTHER	INITIAL HOOK UP FOR ARRIVAL: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED	OUTAGE INFORMATION: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> UNSCHEDULED <input type="checkbox"/> ENERGIZING S/P		
FEEDER LENGTH: _____		CABLE TYPE (480V, 4,160V OR 13.8KV): _____		
NUMBER OF CABLES USED: _____		# OF PIGTAILS USED: _____	# OF SUB PLUGS USED: _____	
INSPECT AND PERFORM THE FOLLOWING AS REQUIRED:				
Condition of Connection	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Meter KW HRS: _____	
Operation of Breakers	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	List Breakers: _____	
Megger Cables	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Lowest Megger Value on Cables: _____ MEGOHMS (Min. Megger Value: 480V - 4 Megohms, 4160V/13.8kV -10 Megohms)	
Check Current Load	Acceptable <input type="checkbox"/> Unacceptable <input type="checkbox"/>	Average Current Load: _____ AMPS		
AUTHORIZATION TO CONNECT / DISCONNECT CABLES		AUTHORIZATION TO ENERGIZE / DE-ENERGIZE BREAKERS:		
All Shipboard Breakers Are Open		Electrical Shore Power Area Aboard Ship Is Free And Clear Of Obstacles And Personnel		
Potential Energy Sources Have Been Isolated		Breaker Sequence Requested By Ship For 480V Service Or Switching Orders Have Been Prepared		
It Is Safe To Handle Shore Power Cables		Cables Are Plugged In And Are Ready To Be Energized Or De-Energized		
Ship Electrical Officer And Senior Electrician Sign:		Ship Electrical Officer Sign:		
PW Utilities Electrician: Sign, Date & Time:		PW Utilities Electrician: Sign, Date & Time		
SHIP CONNECTED / DISCONNECTED FROM FACILITY SHORE POWER				
Ship Electrical Officer: Print Name, Sign, Date, & Time				
PW Utilities Electrician: Print Name, Sign, Date, & Time				
After shore power is restored to ship, record circuit readings after the ship has a stable load. All phases and average current readings must be within 10% for of each shore power cable and circuit. Use the Shore Power Load Current Analysis form to record readings as required and attach to this document. If ship elects not to go back on shore power at this time, take readings as soon as possible.				
Ship load at least 50% for 1 hour and INFRA-RED Survey Performed: <input type="checkbox"/> Equipment Condition: Ok <input type="checkbox"/> Need Repair <input type="checkbox"/> Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>				
Ship Electrical Officer: Print Name, Sign & Date				
PW Utilities Electrician: Print Name, Sign & Date				

8.11. SAMPLE SHIP TO SHORE POWER CABLE INSULATION RECORD

Ref: OPNAVINST 11310.3 and UFC 4-150-02

Ship: _____ Berth: _____ Date: _____

1. Visually inspect cable and the terminations for damage and corrosion. Use a Megger to measure cable insulation resistance rated for the 13.8kV, 4,160V, or 480V cables under test (Minimum of 10 Megohm for 13.8kV and 4,160V and 4 Megohm for 480V). Document the Insulation Resistance readings below:

	Cable#	Plug #	A-B	B-C	C-A	A-Gnd	B-Gnd	C-Gnd	Date	Time	Signature
Ship to Shore Cable											
Receptacle to Breaker											
<p>2. Inform ship's representative of any Special Conditions or Restrictions (i.e., load current limitations, closing ship's bus ties, cables conditions, etc.)</p> <p>3. SSN/SSGN/SSBN/480 Volt surface ships cables/4160V three pole connectors and lugs/13.8kV couplers: Inspect the connectors and lugs or couplers. Clean cable plugs/couplers and inspect each conducting surface for damage, corrosion, and evidence of overheating. Only when recommended by connector manufacturer should the use of approved contact lubricant be applied to the connectors.</p>											

SPECIAL INSTRUCTIONS: Paralleling Transformers - If a ship is supplied by two transformers, the ship is not permitted to parallel these transformers through the ships bus tie. If shore transformers are paralleled though the ship's bus, circulating currents may overheat and destroy cables, transformers and switchgear on board ship, or on shore.

Ship's Representative: _____

Date: _____


NAVFAC Representative: _____

Date: _____

8.13. SHIP TO SHORE TAG

CONNECT / DISCONNECT TAG DATE: _____

CABLE #s: _____

 **PLUG #s:** _____

RECEPTACLE #: _____

OPERATOR: _____ **SHIP:** _____

8.14. 480V SHIP CONNECT INSPECTION CHECKLIST

NAME OF INSPECTOR: _____ INSTALLATION: _____
 SHIP TO BE CONNECTED: _____ LOCATION OF CONNECT: _____

ITEM		
Procedure Requirements	YES	NO
Are all personnel qualified for the required work and on the SOC personnel list?		
Are all personnel wearing appropriate PPE throughout the entire procedure?		
Did NAVFAC Qualified Person (QP) in Charge conduct a Job Brief?		
Remarks for Procedural Deficiencies:		
Step 1 – Prepare for Ship’s Arrival	YES	NO
Have power and general berthing requirements been collected from Port Operations or ship’s Logistics Requirement message?		
Was a Ship Connect Form used and accessible during the active connection process?		
Remarks for Step 1 Deficiencies:		
Step 2 – Lay Power Cable Assemblies	YES	NO
Has the berth been cleared of obstructions?		
Have S2S cables been delivered and laid out in the following manner:		
Not connected to any electrical equipment, handling equipment, or vehicles?		
Positioned to minimize damage from vehicle and pedestrian track?		
Positioned to avoid all sharp and ragged objects?		
Physically isolated from all other shore service lines?		
Doesn’t exceed the minimum bend radius? (THOF cable bend radius is 6 X OD)		
Excess cable is not coiled to avoid overheating?		
Remarks for Step 2 Deficiencies:		
Step 3 – Inspect and Test Each Power Cable Assembly	YES	NO
Have cables been checked to ensure that they were disconnected on both ends and were any connected cables tested for no voltage before continuing?		
Have cables and connectors been inspected for defects (cracks/cuts, pitting/corrosion, bulges, and failure of locking mechanisms) and been repaired/replaced as necessary?		
Have all cable assemblies been measured for insulation resistance and recorded on the Ship to Shore Power Cable Insulation Record? Were cables replaced if they did not meet the minimum insulation resistance requirements?		

Have phase identification markings (color coding or labeling) on the shore power cable assembly been verified to ensure proper phase orientation?		
Have "DANGER-HIGH VOLTAGE" signs been placed on barricades near or attached to cable assemblies?		
Has the work area surrounding the Shore Power receptacles and portable shore power cables been roped off or barricaded?		
Remarks for Step 3 Deficiencies:		
Step 4 – Inspect and Test 480V Shore Receptacles	YES	NO
Has NAVFAC QP in Charge obtained the test data from the last ship connect or Annual PM performed on the 480V shore receptacles?		
Has NAVFAC QP established an Electrically Safe Working Condition?		
Have receptacles been cleaned and inspected for defects? (pitting, corrosion, and evidence of overheating, binding or sticking in interlock switches)		
Has 480V shore power receptacle testing been performed in the last 12 months? If not, was testing performed prior to work being performed?		
If the shore power receptacles are equipped with interlock switches, were they tested for proper operation?		
If the shore power receptacles are equipped with open and close push buttons, were they tested for proper operation?		
Have Shore Power circuit breakers been opened after all testing was completed?		
Have deficiencies been repaired or caution tags and locks placed where time does not permit repair? (Also check yes if no deficiencies exist)		
Remarks for Step 4 Deficiencies:		
Step 5 – Shore Power Cable Rigging	YES	NO
Has NAVFAC Qualified Person (QP) in Charge conducted a Job Brief with NAVFAC personnel and Ship's electrical representative and provided the Ship with the Ship Connect Form, Ship to Shore Cable Insulation Record, and Cable Tests?		
Have Shore Power circuit breakers been opened and have red danger tags and red danger locks been placed and were breakers tested for no voltage?		
Did NAVFAC QP in Charge obtain signatures from the Ship's Electrical Officer and Senior Electrician on the Ship Connect Form certifying that the Ship's Shore Power circuit breakers are open and tagged out.		
Did NAVAC QP ensure that shore power cable assemblies were disconnected on both ends and did NAVFAC QP and Ship's representative test for no voltage?		

If necessary due to distance between receptacles and the Ship, have all inline connections or splices been made before connecting to any Ship or Shore Power receptacles? (Check yes if no inline connections or splices exist)		
Have Shore Power cable assemblies been loaded to the Ship following applicable SOPs and in a manner that would not cause additional stress on inline connections/splices or cause damage to ship's plug, if already attached?		
Have Shore Power cable assemblies been lashed to the Ship and Shore while allowing sufficient slack for tidal changes?		
Remarks for Step 5 Deficiencies:		
Step 6 – Inserting Cable Plugs into Receptacles	YES	NO
Did NAVFAC QP in Charge receive confirmation from Ship's electrical representative that cables have been connected to the Ship's Shore Power receptacles before proceeding?		
Did NAVFAC QP in Charge receive authorization from Ship's electrical representative to connect cables to Facility Shore Power receptacles?		
Have cables been tested for no voltage and verified to be in an electrically safe working condition after being connected to the ship?		
Have Shore Power cable plugs been connected to receptacles with Ship to Shore Tag's attached?		
Did NAVFAC QP in Charge obtain Ship's Electrical Officer's signature on the Ship Connect Form giving permission to energize shore power?		
Did NAVFAC QP notify Ship personnel that they can clear tags from Shore Power Breakers?		
Did NAVFAC personnel follow requested sequence for closing circuit breakers as requested by the Ship's Electrical Officer?		
Remarks for Step 6 Deficiencies:		
Step 7 – Ship's Transfer to Shore Power	YES	NO
Did NAVFAC QP in charge obtain signature from Ship's Electrical Officer verifying that they have accepted shore power?		
Did NAVFAC personnel check amperage readings of each cable and check for abnormalities using the Shore Power Current Analysis Worksheet?		
If abnormalities were found, were they reported to NAVFAC QP and Ship's Electrical Supervisor and was an IR survey perform on the connector and cable? (Also check yes if no abnormalities were found)		
After one-hour of at least 50% load, was an IR survey performed for all connectors?		

If any cable repairs or replacements are required based on Current Analysis or IR survey, were they completed? (Also check yes if repairs/replacements are not needed)		
If cables can not be repaired or replaced, has the Ship's Electrical representative signed off on accepting less than the original number of circuits and has the circuit been taken out of service with a caution tag hung and caution lock installed?		
Remarks for Step 7 Deficiencies:		

CHAPTER 9 - 480V SHIP DISCONNECT

9.1. PURPOSE

To provide the standard procedures for disconnecting 480 Volt Shore Power to Surface Ships.

9.2. BACKGROUND

The disconnection of 480 Volt Shore Power to Ships is a hazardous operation. Hazards mitigated by this chapter are: electrical shock, arc flash, arc blast, and electrical burns.

All steps in this procedure must be followed and total compliance is critical to mitigating the hazards associated with Shore Power Connections and Disconnections. Thorough training, job planning, and exhaustive communication between Naval Facilities Engineering Command (NAVFAC) in-house forces, contractor personnel, other DoD agencies and Ship Personnel are necessary to ensure the highest level of safety for all involved.

9.3. TOOLS AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

Any worker whose normal job includes working on or near exposed energized electrical conductors or equipment shall wear, as a minimum, Arc Rated long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm² and leather EH rated safety shoes/boots.

Tools, equipment, and additional Personal Protective Equipment (PPE) necessary to perform this procedure are provided in Chapter 4 Working on or Near Exposed and Enclosed Energized Electrical Systems and Chapter 5 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems.

9.4. TRAINING, CERTIFICATION, and RECORD KEEPING

All employees whose job requires the use of this procedure shall be trained to understand the purpose and function of the hazardous energy control program, the hazards they face, demonstrate a working level knowledge of all process steps and applicable references, and complete site specific training as required. The training requirements shall be identified and associated with the employee profile in ESAMS.

Training completion shall be registered in ESAMS. Additionally, a list of names and job titles of Authorized Employees and Qualified Persons shall be maintained by SOC personnel and available to Command employee(s) responsible for dispatching/assigning work.

At least once per year, execution of this procedure shall be audited to ensure the procedure is being followed.

9.5. GENERAL INFORMATION FOR PROCEDURES

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Ships operating in a cold iron mode.
2. Personnel performing Shore Power Connects and Disconnects may be exposed to AC electrical potential of 600 volts and less and DC electrical potential 250 volts and less. Shore Power equipment shall be considered energized unless an Electrically Safe Work Condition has been established.
3. The Ship's Electrical Officer or the Ship's designated electrical representative is responsible for making cable connections and disconnections to the Ship's generators shore power receptacles and dictating when Shore Power is de-energized to allow Ship's load transfer to ship's power.
4. Shore Power service provides an ungrounded, correctly phased system, with an adequate number of shore power cables correctly oriented to serve the Ship's load. Where two or more power cables are connected to a Ship, cables must be grouped so that all the same phases are connected together.
5. Only current carrying conductors are provided from shore power. A physical equipment ground connection between the Shore substation and the Ship is not provided. Ship's hull serves as an equipment ground for Ship's electrical service.
6. Paralleling shore transformers through the Ship electrical bus without prior NAVFAC approval is prohibited because it is unsafe and will result in circulating currents, overheated cables, and increased available fault current above the rating of the shore and ship equipment which could damage property and result in personal injury.
7. The area surrounding Shore Power and industrial power receptacles, plugs and portable power cables shall be barricaded to the greatest extent practicable in order to provide equipment and personnel protection.
8. The following documents were considered during the development of these procedures: "OSHA 29 CFR 1910.269 Electric Power Generation, Transmission, and Distribution", "EM 385-1-1, Health and Safety Requirements, Sections 11 & 12", "Navy Ships Technical Manual (NSTM), Chapters 320/300", "NAVSEA Manual S0400-AD-URM-010/TUM Rev 06 Tag-out User's Manual", and "NAVFAC P307 Management of Weight Handling Equipment."

9.6. DISCONNECT PROCEDURE FOR SURFACE SHIPS UTILIZING 480 VOLT SHORE POWER

9.6.1. STEP 1 – SHIP'S LOAD TRANSFER TO THE SHIPS'S GENERATOR

1. NAVFAC and Ship's Personnel shall conduct a joint Job Brief and clearly agree on roles, responsibilities, and procedures for disconnection of Shore Power that meet the requirements of the applicable NAVFAC Standard

Operating Procedures and Ship's Engineering Operational and sequencing System (EOSS) and Ship's Standard Operating Procedures.

2. Obtain and utilize Ship Connect/Disconnect Form to record information. See Section 9.10 for example. Documents associated with an active disconnection shall be kept in a centralized location and continuously accessible. Upon ships departure, documents shall be stored in a centralized location, and records shall be maintained for a minimum of one year.
3. CAUTION: Ship's Personnel, in accordance with Ship's EOSS, will synchronize ship's generators with shore power and transfer power from shore power to ship's generators within the shortest interval possible.
4. When the Ship's Electrical Officer has notified the NAVFAC QP that the transfer is complete, the Ship Connect/Disconnect Form shall be filled out and the NAVFAC QP in Charge shall obtain the Ship's Electrical Officer signature thereby giving shore activity personnel permission to de-energize shore power.

9.6.2. STEP 2 - DISCONNECTION OF SHORE POWER CABLE PLUGS FROM RECEPTACLES

1. Shore Power cable disconnections shall be from the NAVFAC Shore Power receptacles toward the Ship's Shore Power receptacles.
2. NAVFAC QP in Charge shall obtain signatures from the Ship's Electrical Officer and Senior Electrician on the Ship Connect/Disconnect Form certifying that the Ship's Shore Power circuit breakers are open and tagged out. The NAVFAC QP in Charge then signs the Ship Connect/Disconnect Form as well.
3. NAVFAC QP, wearing appropriate PPE, shall establish Electrically Safe Working Condition for Shore Power Cable Assemblies.
 - 3.1. NAVFAC AE removes red danger tag and opens red danger lock from Facility Shore Power receptacle circuit breakers.
 - 3.2. Test Facility Shore Power circuit breaker receptacles for no voltage per Section 9.7.
 - 3.3. If appropriate, apply Temporary Protective Grounding to facility shore power receptacles per Sections 9.7 and 9.8. Note: installing temporary protective grounds for 480 volt shore power is a rare occurrence and temporary protective grounding is usually waived by the NAVFAC QP in Charge, as allowed in Section 9.9.
 - 3.4. If no voltage is detected at facility shore power receptacles, disconnect cable assemblies by removing plugs from facility shore power receptacles.
4. Close or install shore power receptacle access covers.
5. The NAVFAC QP-in-charge and Ship's Electrical Officer or Ship's designated electrical representative ensures that an electrically safe work condition was established for the shore power cables.

6. At ship's shore power receptacles, Ship Personnel may test for no voltage, in accordance with Ship's (EOSS) and Ship's Standard Operating Procedures, to verify the shore power cables are de-energized.
7. Ship's Personnel disconnect Facility Shore Power cables from the Ship's Shore Power receptacles in accordance with Ship's Engineering Operational and Sequencing System (EOSS) procedures.
8. NAVFAC QP in Charge receives confirmation from the Ship's Electrical Officer or Ship's designated electrical representative that Facility Shore Power cables are disconnected from the Ship's Shore Power receptacles.

9.6.3. STEP 3 - REMOVAL OF SHORE POWER CABLE ASSEMBLIES

1. NAVFAC personnel will notify Ships Personnel that they are ready for Ship's Personnel to clear tags from Ship's Shore Power circuit breakers. Ship's Personnel will notify NAVFAC that they are ready for the removal of Shore Power cables after tags have been removed.
2. Place vehicle or weight handling equipment in position if used; cable can also be hand carried.
 - 2.1. Only weight handling equipment and the following vehicles are authorized to deliver/retrieve power cables on the piers: shop mule, line truck, reel truck, fork lift, or boom truck.
 - 2.2. Use a spotter when backing up or operating in tight space.
 - 2.3. Operators shall have a valid license, training, and certification in accordance with Command policies.
3. When unloading Shore Power cables, the NAVFAC Electrical QP shall ensure that: the operation of the vehicle or weight handling equipment used comply with applicable SOPs, barriers are set to proper distance, wheel chocks are placed down, sets of cables are connected together, no unauthorized persons are in the area of operations that may be struck by a swinging or falling cable, boom truck outriggers are not blocked by any obstructions and are not set on top of vault covers, steam covers, or manholes, booms never swing forward of the outriggers, reel trucks have placed stabilizer jacks.
 - 3.1. Only unlash those Shore Power Cables from the ship that have strain removed by manual or mechanical means. Leave all other shore power cables lashed to the ship to prevent unplanned/uncontrolled movement of the remaining cables.
 - 3.2. Unlash cables from the pier for storage only when the potential hazard of them falling/slipping overboard has been eliminated.
4. Lower cable assemblies from the ship onto the pier.
5. NAVFAC and Ship's representatives sign ship connect/disconnect form verifying shore power removal is complete.

6. A NAVFAC QP shall remove temporary protective grounds from load side of shore facility's shore power circuit breakers (if installed) prior to removing red danger tags and red danger locks. Installing temporary protective grounds for 480 volt shore power is a rare occurrence.
7. NAVFAC personnel shall remove red danger tags and red danger locks from Facility Shore Power circuit breakers when required to restore operation of breakers.
8. Remove Ship to Shore Tags from cables.

9.7. TEST FOR NO VOLTAGE

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a Qualified Person as defined in the Chapter 1 using the required PPE. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
2. A QP shall test for no voltage per Chapter 5.
3. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

9.8. TEST FOR NO VOLTAGE AND APPLY TEMPORARY GROUND

1. If temporary protective grounding equipment is to be used, wear the required PPE. Installing temporary protective grounds is considered working on an exposed energized electrical system. Personnel installing temporary protective grounds shall be a Qualified Person as defined in Chapter 1. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document. Install temporary protective grounds per Section 9.9.
2. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP as defined in the Chapter 1 using the required PPE.
3. A QP shall test for no voltage per Chapter 5
4. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

9.9. TEMPORARY PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

1. Temporary protective grounding requirements may be waived by the NAVFAC QP-in-charge or the Designated QP- (LV or HV) if it is not practical or that the conditions resulting from the installation of a ground would present greater hazards

than working without grounds. Temporary Protective Grounding is usually waived for 480-volt shore power.

2. Temporary protective grounds are assemblies consisting of clamps, ferrules, and cable and are to be used when working on de-energized electrical conductors or equipment to minimize the possibility of accidental re-energization from unexpected sources. Grounding will cause an inadvertently energized line to become de-energized through the action of ground fault relays.
3. Temporary protective grounding shall be used where:
 - 3.1. The possibility of induced voltages or stored electrical energy exists.
 - 3.2. It could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts.
4. Only a QP can test for no voltage and install and remove temporary protective grounds. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
5. Equipotential grounding, as described in Chapter 1, Section 1.8.8, shall be used when feasible to establish a zone of equipotential. When not feasible, grounds shall be placed as close to the work site as practical.
6. Temporary protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in electrical potential. The temporary protective grounds should be installed in a manner that establishes a zone of equipotential where each employee is working.
7. Temporary protective grounds shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
8. The location of installed temporary protective grounds shall be written on red danger tags.
9. When a temporary protective ground is attached to a line/conductor or equipment, the temporary protective ground end connection shall be attached first and then the other end shall be attached by means of voltage rated gloves or voltage rated gloves with a live line tool. Use safe work practices and wear the required PPE.
10. When a temporary protective ground is to be removed, the temporary protective grounding assembly shall be removed from the line/conductor or equipment using voltage rated gloves or voltage rated gloves with a live line tool before the temporary protective ground-end connection is removed. Use safe work practices and wear the required PPE.

9.10. SAMPLE SHIP CONNECT/DISCONNECT FORM

ELECTRICAL SHORE POWER SERVICE PROCEDURE

CONNECT

DISCONNECT

ARRIVAL TIME:

DEPARTURE TIME:

DATE:	SHIP'S NAME:	PIER/BERTH:	VAULT:	OTHER:
REPORT IMPLEMENTED BY: <input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> OTHER		INITIAL HOOK UP FOR ARRIVAL: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED		OUTAGE INFORMATION: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> UNSCHEDULED <input type="checkbox"/> ENERGIZING S/P
FEEDER LENGTH: _____		CABLE TYPE (480V, 4,160V OR 13.8KV): _____		
NUMBER OF CABLES USED: _____		# OF PIGTAILS USED: _____	# OF SUB PLUGS USED: _____	
INSPECT AND PERFORM THE FOLLOWING AS REQUIRED:				
Condition of Connection Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Meter KW HRS: _____	
Operation of Breakers Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	List Breakers: _____	
Megger Cables Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Lowest Megger Value on Cables: _____ MEGOHMS (Min. Megger Value: 480V - 4 Megohms, 4160V/13.8kV - 10 Megohms)	
Check Current Load Acceptable <input type="checkbox"/> Unacceptable <input type="checkbox"/>		Average Current Load: _____ AMPS		
AUTHORIZATION TO CONNECT / DISCONNECT CABLES		AUTHORIZATION TO ENERGIZE / DE-ENERGIZE BREAKERS:		
All Shipboard Breakers Are Open		Electrical Shore Power Area Aboard Ship Is Free And Clear Of Obstacles And Personnel		
Potential Energy Sources Have Been Isolated		Breaker Sequence Requested By Ship For 480V Service Or Switching Orders Have Been Prepared		
It Is Safe To Handle Shore Power Cables		Cables Are Plugged In And Are Ready To Be Energized Or De-Energized		
Ship Electrical Officer And Senior Electrician Sign:		Ship Electrical Officer Sign:		
PW Utilities Electrician: Sign, Date & Time:		PW Utilities Electrician: Sign, Date & Time		
SHIP CONNECTED / DISCONNECTED FROM FACILITY SHORE POWER				
Ship Electrical Officer: Print Name, Sign, Date, & Time				
PW Utilities Electrician: Print Name, Sign, Date, & Time				
After shore power is restored to ship, record circuit readings after the ship has a stable load. All phases and average current readings must be within 10% for of each shore power cable and circuit. Use the Shore Power Load Current Analysis form to record readings as required and attach to this document. If ship elects not to go back on shore power at this time, take readings as soon as possible.				
Ship load at least 50% for 1 hour and INFRA-RED Survey Performed: <input type="checkbox"/> Equipment Condition: Ok <input type="checkbox"/> Need Repair <input type="checkbox"/> Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>				
Ship Electrical Officer: Print Name, Sign & Date				
PW Utilities Electrician: Print Name, Sign & Date				

9.11. 480V SHIP DISCONNECT INSPECTION CHECKLIST

NAME OF INSPECTOR: _____ INSTALLATION: _____
 SHIP TO BE DISCONNECTED: _____ LOCATION OF DISCONNECT: _____

ITEM		
Procedure Requirements	YES	NO
Are all personnel qualified for the required work and on the SOC list?		
Are all personnel wearing appropriate PPE throughout the entire procedure?		
Did NAVFAC QP in Charge conduct a Job Brief with NAVFAC personnel and Ship's representative?		
Remarks for Procedural Deficiencies:		
Step 1 – Ship's Load Transfer to the Ship's Generator	YES	NO
Was a Ship Disconnect Form used and accessible during the disconnection process?		
Did NAVFAC QP in charge obtain signature from Ship's Electrical Officer verifying that they have returned to ship power and NAVFAC personnel can de-energize shore power?		
Remarks for Step 1 Deficiencies:		
Step 2 – Disconnection of Shore Power Cable Plugs from Receptacles	YES	NO
Did NAVFAC QP in Charge obtain signatures from the Ship's Electrical Officer and Senior Electrician on the Ship Connect/Disconnect Form certifying that the Ship's Shore Power circuit breakers are open and tagged out?		
Did NAVFAC QP open Facility Shore Power breakers and install red danger locks and red danger tags?		
Have cables been tested for no voltage prior to disconnecting from Facility Shore Power receptacles?		
Did the NAVFAC QP in Charge receive confirmation from the Ship's representative that the shore power cables were disconnected from the ship's receptacles before continuing with work?		
Remarks for Step 2 Deficiencies:		
Step 3 – Removal of Shore Power Cable Assembly	YES	NO
Did NAVFAC QP in Charge notify ship that Ship's tags can be cleared?		
Have cables been lowered to the pier using applicable SOPs and in a method to minimize potential damage to inline connectors/splices and plugs?		
Did each cable remain lashed to the ship until strain on the cable was removed by manual or mechanical means?		
Were Ship to Shore tags removed from cables?		
Remarks for Step 3 Deficiencies:		

CHAPTER 10 - 480V SUBMARINE CONNECT

10.1.PURPOSE

To provide the standard procedures for connecting 480 Volt Shore Power to Submarines.

10.2.BACKGROUND

The connection of 480 Volt Shore Power to Submarines is a hazardous operation. Hazards mitigated by this Chapter are: electrical shock, arc flash, arc blast, and electrical burns.

All steps in this procedure must be followed and total compliance is critical to mitigating the hazards of Shore Power Connections and Disconnections. Thorough training, job planning, and exhaustive communication between Naval Facilities Engineering Command (NAVFAC) in-house forces, contractor personnel, other DoD agencies and Submarine Personnel are necessary to ensure the highest level of safety for all involved.

10.3.TOOLS AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

Any worker whose normal job includes working on or near exposed energized electrical conductors or equipment shall wear, as a minimum, Arc Rated long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm² and leather EH rated safety shoes/boots.

Tools, equipment, and additional Personal Protective Equipment (PPE) necessary to perform this procedure are provided in Chapter 4 Working on or Near Exposed and Enclosed Energized Electrical Systems and Chapter 5 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems.

10.4.TRAINING, CERTIFICATION, and RECORD KEEPING

All employees whose job requires the use of this procedure shall be trained to understand the purpose and function of the hazardous energy control program, the hazards they face, demonstrate a working level knowledge of all process steps and applicable references, and complete site specific training as required. The training requirements shall be identified and associated with the employee profile in ESAMS.

Training completion shall be registered in ESAMS. Additionally, a list of names and job titles of Authorized Employees and Qualified Persons shall be maintained by SOC personnel and available to Command employee(s) responsible for dispatching/assigning work.

At least once per year, execution of this procedure shall be audited to ensure the procedure is being followed.

10.5.GENERAL INFORMATION FOR PROCEDURES

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Submarines operating in a cold iron mode.
2. Personnel performing Shore Power Connects and Disconnects may be exposed to AC electrical potential of 1000 volts and less and DC electrical potential 250 volts and less. Shore Power equipment shall be considered energized unless an Electrically Safe Work Condition has been established.
3. The Submarine's Electrical Officer is responsible for making cable connections to the Submarine's electrical bus fed by the Submarine's generators and dictating when Shore Power is energized to supply this bus.
4. Shore Power service provides an ungrounded, correctly phased system, with an adequate number of shore power cables correctly oriented to serve the Sub's load. Where two or more power cables are connected to a Sub, cables must be grouped so that all the same phases are connected together.
5. When the Submarine requires more than one feeder cable, total cable length for each feeder will be within plus or minus 10 percent to minimize unequal load distribution. Conductors must be the same size.
6. Submarine's hull serves as ground for submarine's electrical service. A physical cable ground connection between the Shore and Submarine hull can result in damaging circulating currents.
7. Paralleling shore transformers through the Submarine electrical bus without prior NAVFAC approval is prohibited because it is unsafe and can result in circulating currents, overheated cables, unbalanced loads, and increased available fault current which could damage property and result in personal injury.
8. Portable Shore Power cables used to support Submarines shall be specifically labeled for this purpose and require additional specific testing and verification prior to each use in accordance with OPNAV Instruction 11310.3C Operation and Maintenance Policy for Shore-to-Ship Power and Operations Center Implementing Guidance.
9. Circuits serving Submarines must utilize a shunt trip interlocking scheme. This procedure includes verification that the system trips all breakers associated with the service to the Submarine at that location. Some locations utilize a main breaker instead of individual receptacle breakers. The main breaker must be shunt tripped by way of an individual cable over current detection and trip scheme, if receptacle breakers are not used. All individual receptacle breakers must be shunt tripped if a main breaker is not utilized. See NAVFAC ITG FY06-03, Ship Power Service Circuit Breakers, Shunt Interlocks, for additional information and criteria concerning the design and operation of Submarine power service circuit breakers providing shore power to submarines.

10. The area surrounding Shore Power and industrial power receptacles, plugs and portable power cables shall be barricaded to the greatest extent practicable in order to provide equipment and personnel protection.
11. The following documents were considered during the development of these procedures: "OSHA 29 CFR 1910.269 Electric Power Generation, Transmission, and Distribution", "EM 385-1-1, Health and Safety Requirements, Sections 11 & 12", "Navy Ships Technical Manual (NSTM), Chapters 320/300", "NAVSEA Manual S0400-AD-URM-010/TUM Rev 06 Tag-out Users Manual", and "NAVFAC P307 Management of Weight Handling Equipment."

10.6.CONNECT PROCEDURE FOR SUBMARINES

10.6.1. STEP 1 - PREPARE FOR SUBMARINE'S ARRIVAL

1. Use the berthing assignment information received from Port Operations to prepare the berth for Submarine's arrival or the Logistics Requirement (LOGREQ) message from the arriving Submarine, which describes power and general berthing requirements.
2. Obtain and utilize Sub Connect/Disconnect Form to record information. See Section 10.10 for example. Documents associated with an active connection shall be kept in a centralized location and continuously accessible. Upon Submarines departure, documents shall be stored in a centralized location, and records shall be maintained for a minimum of one year.
3. NAVFAC Qualified Person (QP) in Charge shall conduct a Job Brief and ensure all personnel have the required equipment, tools, and PPE.

10.6.2. STEP 2 - LAY POWER CABLE ASSEMBLIES

1. Check berth for obstructions that may prevent safe Shore Power set up. If obstacles are present, inform NAVFAC Supervisor and Port Operations or appropriate authorities for removal.
2. Place vehicle or weight handling equipment in position.
 - 2.1. Only weight handling equipment and the following vehicles are authorized to deliver/retrieve power cables on the piers: shop mule, a line truck, a reel truck, fork lift, or a boom truck. Cable can also be hand carried.
 - 2.2. Use a spotter when backing up or placing in tight space.
 - 2.3. Operators shall have a valid license, training, and certification in accordance with Command policies.
3. Shore Power cables shall be placed at the pier where the Submarine will dock or berth.
4. Lay out cables between Facility Shore Power receptacles and Submarine's Shore Power receptacles. Note the following CAUTIONS:

- 4.1. Ensure cable ends are not connected to any equipment, weight handling equipment or vehicle.
- 4.2. Excess cable shall be laid in such a manner as to minimize damage from vehicle and pedestrian traffic.
- 4.3. Each set of Shore Power cables should be positioned as a unit.
- 4.4. Do not lay or drag cables on or over sharp and ragged objects.
- 4.5. Shore power cables and terminations should be physically isolated from Shore Steam, Potable Water, Salt Water, and all other service lines.
- 4.6. Do not exceed minimum cable bend radius. Per Insulated Cable Engineers Association, minimum THOF cable bend radius is 6 times the outer diameter.
- 4.7. Provide adequate cable length to compensate for the rise and fall of the tide. Cable slack should not dip into the water, rub on structures causing abrasion, or become wedged between the sub and pier.
- 4.8. Ensure cables are the proper length, size and are arranged in a neat and safe manner.
- 4.9. To reduce overheating or de-rating cable, excess cable should not be coiled or stacked on each other.
- 4.10. Barricades shall be placed as necessary, to keep vehicles off cable.
- 4.11. Where cables would obstruct drains or scuppers, lay cables on a pallet to allow water drainage on the pier.
- 4.12. Do not hold or brace the cable in place as this may result in a foot or leg injury.
- 4.13. When loading or unloading Shore Power cables, the NAVFAC Electrical QP shall ensure that: the operation of the vehicle or weight handling equipment comply with applicable SOPs, barriers are set to proper distance, wheel chocks are placed down, sets of cables are connected together, no unauthorized persons are in the area of operations that may be struck by a swinging or falling cable, boom truck outriggers are not blocked by any obstructions and are not set on top of vault covers, steam covers, or manholes, booms never swing forward of the outriggers, reel trucks have placed stabilizer jacks.

10.6.3. STEP 3 - INSPECT AND TEST EACH POWER CABLE ASSEMBLY

1. NAVFAC QP shall confirm Shore Power cable assemblies are disconnected on both ends. If the NAVFAC QP in charge determines it is necessary to verify Shore Power cable assemblies are de-energized, in accordance with Section 10.7, NAVFAC QP shall test each phase conductor or circuit part of the cables for no voltage prior to handling.

2. NAVFAC QP shall ensure inspection/testing team maintains control of both ends of Shore Power cable assemblies during inspection and testing to ensure cable assemblies stay disconnected at both ends.
3. Visually inspect shore power cable assemblies for any sign of defect. Cables not passing visual inspection shall be removed from service.
 - 3.1. Inspect cable assemblies for cracks, bulges, or indications of overheating.
 - 3.2. Inspect cable sheath for cuts, nicks, and gouges.
 - 3.3. As required, strip insulation from any existing cable splices and inspect for cleanliness, tightness, and good surface contact.
4. Repair defects and re-insulate as needed.
5. Clean and inspect cable connectors.
 - 5.1. Inspect cable connectors and each connector conducting surface for pitting, corrosion, and evidence of overheating. Ensure conducting surface is clean and grease free.
 - 5.2. Inspect adapter flange for heavy corrosion that will limit tightening of the connector plug.
 - 5.3. If required by manufacturer, apply a light coat of approved grease or contact cleaner to cable connectors.
 - 5.4. Repair or replace any deficiency.
6. Measure insulation resistance between cable assembly conductors and each conductor and ground for each circuit using a 1000 volt megohmmeter. The test duration shall be one minute. Minimum insulation readings for 480 volt Shore Power cables shall be 4 megohms.
7. Record all insulation resistance readings on Submarine to Shore Power Cable Insulation Record (see Section 10.11) and record the lowest insulation resistance value on the Sub Connect/Disconnect Form (see Section 10.10). Include pigtailed when provided.
8. Replace Shore Power cable if it does not meet minimum insulation resistance requirements.
9. Verify phase identification markings (color coding or labeling) of the cable assembly to ensure proper orientation (in-phase).
10. Attach "DANGER-HIGH VOLTAGE" signs to Shore Power cable assemblies or barricades.
11. Barricade the work area surrounding the Shore Power receptacles and portable shore power cables to the greatest extent possible.

10.6.4. STEP 4 - INSPECT AND TEST 480 VOLT SHORE RECEPTACLES

1. NAVFAC QP in Charge shall obtain the test data from the last sub connect or Annual PM performed on these 480V shore receptacles and conducts a Job Brief.
2. NAVFAC QP and Authorized Employees, wearing appropriate PPE, shall establish Electrically Safe Working Condition.
 - 2.1. Open, red danger tag and red danger lock Facility Shore Power receptacle circuit breakers.
 - 2.2. Test Shore Power circuit breaker receptacles for no voltage.
 - 2.3. If appropriate, apply Temporary personal protective grounding to shore power receptacles per Sections 10.8 and 10.9. Note: installing temporary personal protective grounds for 480 volt Shore Power is a rare occurrence and temporary personal protective grounding is usually waived by the NAVFAC QP in Charge, as allowed in Section 10.9.
3. Carefully open/remove access cover(s) to each shore power receptacle and test for no voltage per Section 10.7. Use a voltage tester to test terminals in each shore power receptacle to ensure that they are de-energized. Verify these receptacles are in an electrically safe working condition.
4. Inspect each cover and receptacle. Clean as necessary to ensure proper operation
 - 4.1. If applicable, inspect each cover gasket and each receptacle gasket for cuts, tears, cracks, and deformation.
 - 4.2. Inspect each receptacle conducting surface for pitting, corrosion, and evidence of overheating. If the receptacle is equipped with interlocks, operate each receptacle interlock switch manually; movement should be smooth with no binding or sticking.
5. If 480V shore power receptacle testing was performed within the last 12 months, record the date of test and megohms on the Ship to Shore Power Cable Insulation Record (see Section 10.11). If test data is unavailable or older than 12 months, perform steps 5.1 through 5.4.
 - 5.1. Disconnect equipment such as meters, indicating lights and fuses that could be damaged by a megohmmeter test or cause a false reading.
 - 5.2. If temporary personal protective grounds were installed in accordance with Section 10.8, remove grounds for testing purposes at facility Shore Power circuit breaker receptacles one at a time. Use a 1000 volt megohmmeter and test the insulation resistance between each receptacle terminal and between each terminal and ground. The test duration shall be one minute. Minimum insulation resistance is four (4) megohms for 480 volt receptacles.

- 5.3. Record megohmmeter values on the Ship to Shore Power Cable Insulation Record (see Section 10.11).
- 5.4. Re-install indicator lights, appropriate fuses and reconnect appropriate meters.
6. Install/close shore power receptacle access covers.
7. Remove red danger tags and red danger locks from Shore Power receptacle circuit breakers for testing purposes, if required.
8. Test MIL-C-24368 facility shore power receptacle cover interlock switches (if equipped) and indicator lights in accordance with Section 10.10, Chapter 4, and Chapter 5.
 - 8.1. Close shore power receptacle circuit breakers.
 - 8.2. Ensure receptacle indicating lights are illuminated.
 - 8.3. Open shore power receptacle access cover; receptacle circuit breaker should trip and indicating light should extinguish.
 - 8.4. Test shore power receptacle for no voltage to ensure the receptacle has been de-energized.
 - 8.5. Close shore power receptacle access cover.
 - 8.6. If so equipped, test open and close push buttons and emergency stop buttons for proper operation.
9. For Submarine Shore Power, test to ensure the proper operation of the shunt trip scheme.
10. Open facility shore power circuit breakers.
11. Repair deficiencies if time permits. If breaker repairs cannot be made, open circuit breaker and place a caution tag and lock on the breaker in accordance with Chapter 2 and report deficiencies to NAVFAC Supervisor.

10.6.5. STEP 5 - INSERTING CABLE PLUGS INTO SHORE RECEPTACLES

1. Upon Submarine arrival, NAVFAC QP in Charge shall contact Submarine's Electrical Officer or the Submarine's designated electrical representative to ensure required Submarine's Personnel are available, determine cable connection distances and connection times.
2. NAVFAC and Submarine's Personnel shall conduct a joint Job Brief and clearly agree on roles, responsibilities, and procedures for provision of Shore Power that meet the requirements of the applicable NAVFAC Standard Operating Procedures, Submarine's Standard Operating Procedures, and NAVSEA Steam & Electric Plant Manual. During the job brief, provide Submarine's Electrical Officer with Ship to Shore Power Cable Insulation Record (see Section 10.11) and the Sub Connect/Disconnect Form (see

Section 10.10) and Cable Test Certifications during the Job Brief. Verify the accomplishment of Maintenance Standard (MS) 3420-081-089 per OPNAVINST 11310.3 step 8 was performed within the past year.

3. Shore Power cable connections shall be made from the NAVFAC Shore Power receptacle toward the Submarine's shore power receptacle.
4. NAVFAC QP shall open, red danger tag, red danger lock facility shore power circuit breakers, test for no voltage and apply temporary personal protective grounds. Temporary personal protective grounding is usually waived for 480 volt submarine shore power at shore power circuit breaker receptacles in accordance with Sections 10.8 and 10.9. NAVFAC AEs shall install red danger tags and red danger locks.
5. NAVFAC QP shall verify the Shore Power receptacles are in an Electrically Safe Work Condition.
6. While the Shore Power cable assemblies are in an Electrically Safe Work Condition, NAVFAC QP shall:
 - 6.1. Insert Shore Power cable plugs into Facility Shore Power receptacles. Ensure plug is straight and without bends that will cause misalignment or stress on the coupling.
 - 6.2. Check all cable assemblies by verifying proper phase color coding: Phase "A" is black, Phase "B" is white and Phase "C" is red.
7. Fill out and attach the Sub to Shore Tag (see Section 10.13) to cables at receptacle.

10.6.6. STEP 6 - SHORE POWER CABLE RIGGING

1. NAVAC shall make available Shore Power circuit breaker danger locks to Submarine personnel for their use during cable handling and connection to Submarine Shore Power receptacles.
 - 1.1. Submarine Personnel may install danger tags and danger locks, in accordance with Submarine Procedures, on the NAVFAC Shore Power circuit breakers. NAVFAC QP and Submarine personnel wearing appropriate PPE shall use an adequately rated voltage detector to test each phase conductor or circuit part of shore power cables to verify they are de-energized.
2. When distance from Submarine's electric bus to the shore power receptacle requires the connecting of two or more cables (connectors or splices), these connections shall be completed prior to connecting to any Submarine or Shore Power receptacles.
3. If Submarine personnel will load cables to submarine, a NAVFAC QP wearing PPE shall remove temporary personal protective grounds from Facility Shore Power circuit breaker receptacles, if installed. Installing temporary personal protective grounds for 480 volt submarine shore power is a rare occurrence.

4. Load Shore Power cable assemblies from Shore to Submarine.
 - 4.1. If boom trucks or cranes are used, follow appropriate boom truck and crane SOP.
 - 4.2. If NAVFAC operated boom crane, crane or boom truck was used to load cable to submarine, a NAVFAC QP wearing PPE shall remove temporary personal protective grounds from shore power receptacles, if installed. Installing temporary personal protective grounds for 480 volt submarine shore power is a rare occurrence.
5. Submarine Personnel will connect Shore Power cables to Submarine's Shore Power receptacles in accordance with NAVSEA Steam and Electric Plant Manual.
6. NAVFAC QP in Charge shall obtain signature of the Submarine's Electrical Officer or the Sub's designated electrical representative on the Sub Connect/Disconnect Form giving NAVFAC personnel permission to energize shore power at the agreed upon time.
7. NAVFAC QP shall escort Submarine Personnel while Submarine Personnel are clearing tags and locks from Facility Shore Power circuit breakers.
8. NAVFAC personnel shall remove red danger tags and red danger locks from the Facility Shore Power circuit breakers.
9. After receiving permission from Submarine's Electrical Officer or the Submarine's designated electrical representative, NAVFAC QP shall close Facility Shore Power circuit breakers one at a time in the sequence requested by the Submarine's Electrical Officer.

10.6.7. STEP 7 - SUBMARINE'S TRANSFER TO SHORE POWER

1. CAUTION: Submarine's Personnel, in accordance with NAVSEA Steam and Electric Plant Manual, will synchronize Submarine's generators with Shore Power and transfer power from the Submarine's generators to Shore Power within the shortest interval possible. If more than one shore power connection is to be paralleled, actual phases of shore power must be the same rotation and also be connected to match Submarine phases (orientation, in-phase). A shore power installation that has one circuit breaker supplying a number of cable sets presents a particular hazard. In this case, phase rotation and phase orientation (in-phase) can be verified only by energizing all shore terminals. This situation requires special considerations and procedures.
2. When the Submarine's Electrical Officer has notified the NAVFAC QP that transfer is complete, the Sub Connect/Disconnect Form shall be filled out and NAVFAC QP in Charge shall obtain signature of the Submarine's Electrical Officer thereby accepting Shore Power.
3. Note: No personnel shall move energized Shore Power cable assemblies.

4. NAVFAC personnel shall check amperage readings on all phases of each cable and record them on the Shore Power Load Current Analysis Form, Section 10.12. The preferred method is permanently installed ammeters, however clamp-on ammeters are allowed.
 - 4.1. Verify that phase amperage readings are within 10 percent of each other per the Shore Power Load Current Analysis Form.
 - 4.1.1. For each cable, add all three readings together and divide by three to get the average. Divide that number by 10 and all three readings should not differ from the average by more than that amount. For example, if phase A reads 230A, phase B reads 240A, and phase C reads 250A, the average is $(230+240+250)/3 = 240$. $240/10 = 24$. All three phases read within plus or minus 24 (10%) of 240 (average), so these are acceptable readings for this example.
 - 4.2. If the amperage readings are not within 10 percent, notify NAVFAC QP, Sub's representative, and perform a thermal infra-red imaging survey.
 - 4.3. The average current of each circuit must also be within 10 percent of the combined average current of all circuits. If they are not, notify NAVFAC QP for further instruction.
 - 4.4. If any circuit has zero current, open, caution lock and tag the breaker feeding that circuit.
5. After the Submarine is drawing current and has reached at least 50% load for 1 hour, NAVFAC QP will perform a thermal infra-red imaging (IR) survey in accordance with NAVFAC Standard Operating Procedures to ensure all Shore Power equipment is operating within safe tolerances.
 - 5.1. The NAVFAC IR survey will include the connector at the Shore Power substation to the last connector on the pier.
 - 5.2. CAUTION: Breakers, receptacles, and cables are energized. If deficiencies are found, NAVFAC QP in Charge shall conduct a job brief to coordinate and communicate with submarine personnel for taking the circuit offline/de-energizing.
 - 5.3. Repair deficiencies if time permits. If repairs cannot be made, open circuit breaker and place a caution tag and lock on the breaker in accordance with Chapter 2 and report deficiencies to NAVFAC Supervisor.
6. When the IR survey is complete, the Sub Connect/Disconnect Form shall be signed indicating completion of the task.

10.7. TEST FOR NO VOLTAGE

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a Qualified Person as defined in the Chapter 1 using the required PPE. This energized work will require a local Standard Operating Procedure approved, in writing, by

the Commanding Officer/Executive Officer per the requirements of this document.

2. A QP shall test for no voltage per Chapter 5.
3. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

10.8.TEST FOR NO VOLTAGE AND APPLY TEMPORARY PERSONAL PROTECTIVE GROUNDS

1. If temporary personal protective grounding equipment is to be used, wear the required PPE. Installing temporary personal protective grounds is considered working on an exposed energized electrical system. Personnel installing temporary personal protective grounds shall be a Qualified Person as defined in Chapter 1. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document. Install temporary personal protective grounds per Section 10.9.
2. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP as defined in the Chapter 1 using the required PPE.
3. A QP shall test for no voltage per Chapter 5.
4. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

10.9.TEMPORARY PERSONAL PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

1. Temporary personal protective grounding requirements may be waived by the NAVFAC QP-in-charge or the Designated QP- (LV or HV) if it is not practical or that the conditions resulting from the installation of a ground would present greater hazards than working without grounds. Temporary personal protective grounding is usually waived for 480-volt shore power.
2. Temporary personal protective grounds are assemblies consisting of clamps, ferrules, and cable and are to be used when working on de-energized electrical conductors or equipment to minimize the possibility of accidental re-energization from unexpected sources.
3. Temporary personal protective grounding shall be used where:
 - 3.1. The possibility of induced voltages or stored electrical energy exists.

- 3.2. It could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts.
4. Only a QP can test for no voltage and install and remove temporary personal protective grounds. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
 5. Equipotential grounding, as described in Chapter 1, Section 1.8.8, shall be used when feasible to establish a zone of equipotential. When not feasible, grounds shall be placed as close to the work site as practical.
 6. Temporary personal protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in electrical potential. The temporary personal protective grounds should be installed in a manner that establishes a zone of equipotential where each employee is working.
 7. Temporary personal protective grounds shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
 8. The location of installed temporary personal protective grounds shall be written on red danger tags.
 9. When a temporary personal protective ground is attached to a line/conductor or equipment, the temporary personal protective ground end connection shall be attached first and then the other end shall be attached by means of voltage rated gloves or voltage rated gloves with a live line tool. Use safe work practices and wear the required PPE.
 10. When a temporary personal protective ground is to be removed, the temporary personal protective grounding assembly shall be removed from the line/conductor or equipment using voltage rated gloves or voltage rated gloves with a live line tool before the temporary personal protective ground-end connection is removed. Use safe work practices and wear the required PPE.

10.10. SAMPLE SUBMARINE CONNECT/DISCONNECT FORM

ELECTRICAL SHORE POWER SERVICE PROCEDURE

CONNECT

DISCONNECT

ARRIVAL TIME: _____

DEPARTURE TIME: _____

DATE:	SHIP'S NAME:	PIER/BERTH:	VAULT:	OTHER:
REPORT IMPLEMENTED BY: <input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> OTHER		INITIAL HOOK UP FOR ARRIVAL: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED		
OUTAGE INFORMATION: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> UNSCHEDULED <input type="checkbox"/> ENERGIZING S/P				
FEEDER LENGTH: _____		CABLE TYPE (480V, 4,160V OR 13.8KV): _____		
NUMBER OF CABLES USED: _____		# OF PIGTAILS USED: _____	# OF SUB PLUGS USED: _____	
INSPECT AND PERFORM THE FOLLOWING AS REQUIRED:				
Condition of Connection Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Meter KW HRS: _____	
Operation of Breakers Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	List Breakers: _____	
Megger Cables Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Lowest Megger Value on Cables: _____ MEGOHMS (Min. Megger Value: 480V - 4 Megohms, 4160V/13.8kV -10 Megohms)	
Check Current Load Acceptable <input type="checkbox"/> Unacceptable <input type="checkbox"/>		Average Current Load: _____ AMPS		
AUTHORIZATION TO CONNECT / DISCONNECT CABLES		AUTHORIZATION TO ENERGIZE / DE-ENERGIZE BREAKERS:		
All Shipboard Breakers Are Open		Electrical Shore Power Area Aboard Ship Is Free And Clear Of Obstacles And Personnel		
Potential Energy Sources Have Been Isolated		Breaker Sequence Requested By Ship For 480V Service Or Switching Orders Have Been Prepared		
It Is Safe To Handle Shore Power Cables		Cables Are Plugged In And Are Ready To Be Energized Or De-Energized		
Ship Electrical Officer And Senior Electrician Sign:		Ship Electrical Officer Sign:		
PW Utilities Electrician: Sign, Date & Time:		PW Utilities Electrician: Sign, Date & Time		
SHIP CONNECTED / DISCONNECTED FROM FACILITY SHORE POWER				
Ship Electrical Officer: Print Name, Sign, Date, & Time				
PW Utilities Electrician: Print Name, Sign, Date, & Time				
After shore power is restored to ship, record circuit readings after the ship has a stable load. All phases and average current readings must be within 10% for of each shore power cable and circuit. Use the Shore Power Load Current Analysis form to record readings as required and attach to this document. If ship elects not to go back on shore power at this time, take readings as soon as possible.				
Ship load at least 50% for 1 hour and INFRA-RED Survey Performed: <input type="checkbox"/> Equipment Condition: Ok <input type="checkbox"/> Need Repair <input type="checkbox"/> Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>				
Ship Electrical Officer: Print Name, Sign & Date				
PW Utilities Electrician: Print Name, Sign & Date				

10.11. SAMPLE SHIP TO SHORE POWER CABLE INSULATION RECORD

Ref: OPNAVINST 11310.3 and UFC 4-150-02

Ship: _____ Berth: _____ Date: _____

1. Visually inspect cable and the terminations for damage and corrosion. Use a Megger to measure cable insulation resistance rated for the 13.8kV, 4,160V, or 480V cables under test (Min of 10 Megohm for 13.8kV and 4,160V and 4 Megohm for 480V). Document the Insulation Resistance readings below:

	Cable#	Plug #	A-B	B-C	C-A	A-Gnd	B-Gnd	C-Gnd	Date	Time	Signature
Ship to Shore Cable											
Receptacle to Breaker											
<p>2. Inform ship's representative of any Special Conditions or Restrictions (i.e., load current limitations, closing ship's bus ties, cables conditions, etc.)</p> <p>3. SSN/SSGN/SSBN/480 Volt surface ships cables/4160V three pole connectors and lugs/13.8kV couplers: Inspect the connectors and lugs or couplers. Clean cable plugs/couplers and inspect each conducting surface for damage, corrosion, and evidence of overheating. Only when recommended by connector manufacturer should the use of approved contact lubricant be applied to the connectors.</p>											

SPECIAL INSTRUCTIONS: Paralleling Transformers - If a ship is supplied by two transformers, the ship is not permitted to parallel these transformers through the ships bus tie. If shore transformers are paralleled though the ship's bus, circulating currents may overheat and destroy cables, transformers and switchgear on board ship, or on shore.

Ship's Representative: _____ Date: _____
 NAVFAC Representative: _____ Date: _____

10.13. SAMPLE SUBMARINE TO SHORE TAG

CONNECT / DISCONNECT TAG DATE: _____

CABLE #s: _____

PLUG #s: _____

RECEPTACLE #: _____

OPERATOR: _____ **SUB:** _____

10.14. 480V SUB CONNECT INSPECTION CHECKLIST

NAME OF INSPECTOR: _____ INSTALLATION: _____
 SUB TO BE CONNECTED: _____ LOCATION OF CONNECT: _____

ITEM	YES	NO
Procedure Requirements		
Are all personnel qualified for the required work and on the SOC list?		
Are all personnel wearing appropriate PPE throughout the entire procedure?		
Did NAVFAC Qualified Person (QP) in Charge conduct a Job Brief?		
Remarks for Procedural Deficiencies:		
Step 1 – Prepare for Sub’s Arrival	YES	NO
Have power and general berthing requirements been collected from Port Operations or sub’s Logistics Requirement message?		
Was a Sub Connect Form used and accessible during the active connection process?		
Remarks for Step 1 Deficiencies:		
Step 2 – Lay Power Cable Assemblies	YES	NO
Has the berth been cleared of obstructions?		
Have S2S cables been delivered and laid out in the following manner:		
Not connected to any electrical equipment, handling equipment, or vehicles?		
Positioned to minimize damage from vehicle and pedestrian track?		
Positioned to avoid all sharp and ragged objects?		
Physically isolated from all other shore service lines?		
Doesn’t exceed the minimum bend radius? (THOF cable bend radius is 6 X OD)		
Excess cable is not coiled to avoid overheating?		
Remarks for Step 2 Deficiencies:		
Step 3 – Inspect and Test Each Power Cable Assembly	YES	NO
Have cables been checked to ensure that they were disconnected on both ends and were any connected cables tested for no voltage before continuing?		
Have cables and connectors been inspected for defects (cracks/cuts, pitting/corrosion, bulges, and failure of locking mechanisms) and been repaired/replaced as necessary?		
Have all cable assemblies been measured for insulation resistance and recorded on the Ship to Shore Power Cable Insulation Record? Were cables replaced if they did not meet the minimum insulation resistance requirements?		

Have phase identification markings (color coding or labeling) on the shore power cable assembly been verified to ensure proper phase orientation?		
Have "DANGER-HIGH VOLTAGE" signs been placed on barricades near or attached to cable assemblies?		
Has the work area surrounding the Shore Power receptacles and portable shore power cables been roped off or barricaded?		
Remarks for Step 3 Deficiencies:		
Step 4 – Inspect and Test 480V Shore Receptacles	YES	NO
Has NAVFAC QP in Charge obtained the test data from the last ship connect or Annual PM performed on the 480V shore receptacles?		
Has NAVFAC QP established an Electrically Safe Working Condition?		
Have receptacles been cleaned and inspected for defects? (pitting, corrosion, and evidence of overheating, binding or sticking in interlock switches)		
Has 480V shore power receptacle testing been performed in the last 12 months? If not, was testing performed prior to work being performed?		
If the shore power receptacles are equipped with interlock switches, were they tested for proper operation?		
If the shore power receptacles are equipped with open and close push buttons, were they tested for proper operation?		
Have Shore Power circuit breakers been opened after all testing was completed?		
Have deficiencies been repaired or caution tags and locks placed where time does not permit repair? (Also check yes if no deficiencies exist)		
Remarks for Step 4 Deficiencies:		
Step 5 – Inserting Cable Plugs into Receptacles	YES	NO
Has NAVFAC Qualified Person (QP) in Charge conducted a Job Brief with NAVFAC personnel and Sub's electrical representative and provided the Sub with the Sub Connect Form, Ship to Shore Cable Insulation Record, and Cable Tests?		
Has NAVFAC QP in Charge verified that the requirement of Maintenance Standard (MS) 3420-081-089, per OPNAVINST 11310.3B was performed within the last year?		
Have Facility Shore Power circuit breakers been opened and have red danger tags and red danger locks been placed and were breakers tested for no voltage?		
Did NAVAC QP ensure that shore power cable assemblies were disconnected on both ends and did NAVFAC QP and Sub's representative test for no voltage?		
Did NAVFAC QP ensure that Shore Power receptacles were in an Electrically Safe Work Condition?		

Have Shore Power cable plugs been connected to receptacles with Sub to Shore Tag's attached?		
Remarks for Step 5 Deficiencies:		
Step 6 – Shore Power Cable Rigging	YES	NO
Did NAVFAC QP in Charge conduct a Job Brief with Sub's forces and NAVFAC personnel?		
Did NAVFAC QP provide red danger locks to Sub's forces and have them fill out the Sub Connect/Disconnect form as appropriate for cable handling?		
Did NAVFAC QP in charge and Sub's forces verify that shore power cables were de-energized prior to moving cables to sub?		
Have Shore Power cable assemblies been loaded to the Sub following applicable SOPs and in a manner that would not cause additional stress on inline connections/splices or cause damage to sub's plug?		
Have Shore Power cable assemblies been lashed to the Sub and Shore while allowing sufficient slack for tidal changes?		
Did NAVFAC QP in Charge obtain the signature of Sub's Electrical Officer or Sub's electrical representative on the Sub Connect/Disconnect Form indicating that the shore power cables are connected to the Sub and giving NAVFAC QP permission to energize shore power at the agreed upon time?		
Have Sub's forces removed their red danger locks and returned them to NAVFAC?		
Did NAVFAC QP notify Sub's forces to clear tags from Shore Power breakers?		
Have NAVFAC placed red danger locks and red danger tags been removed from Shore Power breakers?		
Did NAVFAC personnel follow requested sequence for closing circuit breakers as requested by the Sub's Electrical Officer?		
Remarks for Step 6 Deficiencies:		
Step 7 – Sub's Transfer to Shore Power	YES	NO
Did NAVFAC QP in charge obtain signature from Sub's Electrical Officer verifying that they have accepted shore power?		
Did NAVFAC personnel check amperage readings of each cable and check for abnormalities using the Shore Power Current Analysis Worksheet?		
If abnormalities were found, were they reported to NAVFAC QP and Sub's Electrical Supervisor and was an IR survey perform on the connector and cable? (Also check yes if no abnormalities were found)		
After one-hour of at least 50% load, was an IR survey performed for all connectors?		

<p>If any cable repairs or replacements are required based on Current Analysis or IR survey, were they completed? (Also check yes if repairs/replacements are not needed)</p>		
<p>If cables cannot be repaired or replaced, has the Sub's Electrical representative signed off on accepting less than the original number of circuits and has the circuit been taken out of service with a caution tag hung and caution lock installed?</p>		
<p>Remarks for Step 7 Deficiencies:</p>		

CHAPTER 11 - 480V SUBMARINE DISCONNECT

11.1.PURPOSE

Provide standard procedures for disconnecting 480 Volt Shore Power to Submarines.

11.2.BACKGROUND

The disconnection of 480 Volt Shore Power to Submarines is a hazardous operation. Hazards mitigated by this Chapter are: electrical shock, arc flash, arc blast, and electrical burns.

All steps in this procedure must be followed and total compliance is critical to mitigating the hazards associated with Shore Power Connections and Disconnections. Thorough training, job planning, and exhaustive communication between Naval Facilities Engineering Command (NAVFAC) in-house forces, contractor personnel, other DoD agencies and Submarine Personnel are necessary to ensure the highest level of safety for all involved.

11.3.TOOLS AND PERSONAL PROTECTIVE EQUIPMENT

Any worker whose normal job includes working on or near exposed energized electrical conductors or equipment shall wear, as a minimum, Arc Rated long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm² and leather EH rated safety shoes/boots.

Tools, equipment, and additional Personal Protective Equipment (PPE) necessary to perform this procedure are provided in Chapter 4 Working on or Near Exposed and Enclosed Energized Electrical Systems and Chapter 5 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems.

11.4.TRAINING, CERTIFICATION, AND RECORD KEEPING

All employees whose job requires the use of this procedure shall be trained to understand the purpose and function of the hazardous energy control program, the hazards they face, demonstrate a working level knowledge of all process steps and applicable references, and complete site specific training as required. The training requirements shall be identified and associated with the employee profile in ESAMS.

Training completion shall be registered in ESAMS. Additionally, a list of names and job titles of Authorized Employees and Qualified Persons shall be maintained by SOC personnel and available to Command employee(s) responsible for dispatching/assigning work.

At least once per year, execution of this procedure shall be audited to ensure the procedure is being followed.

11.5.GENERAL INFORMATION FOR PROCEDURES

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Submarines operating in a cold iron mode.
2. Personnel performing Shore Power Connects and Disconnects may be exposed to AC electrical potential of 1000 volts and less and DC electrical potential 250 volts and less. Shore Power equipment shall be considered energized unless an Electrically Safe Work Condition has been established.
3. The Submarine's Electrical Officer or the Submarine's designated electrical representative is responsible for making cable connections and disconnections to the Submarine's generators shore power receptacles and dictating when Shore Power is de-energized to allow Submarine's load transfer to Submarine's power.
4. Shore Power service provides an ungrounded, correctly phased system, with an adequate number of shore power cables correctly oriented to serve the Sub's load. Where two or more power cables are connected to a Sub, cables must be grouped so that all the same phases are connected together.
5. Submarine's hull serves as ground for Submarine's electrical service. A physical cable ground connection between the Shore and Submarine hull can result in damaging circulating currents.
6. Paralleling shore transformers through the Submarine electrical bus without prior NAVFAC approval is prohibited because it is unsafe and will result in circulating currents, overheated cables, and increased available fault current above the rating of the shore and Submarine equipment which could damage property and result in personal injury.
7. Circuits serving Submarines utilize a shunt trip interlocking scheme. Some locations utilize a main breaker instead of individual receptacle breakers. See NAVFAC ITG FY06-03, Ship Power Service Circuit Breakers, Shunt Interlocks, for additional information and criteria concerning the design and operation of Submarine power service circuit breakers providing shore power to submarines.
8. The area surrounding Shore Power and industrial power receptacles, plugs and portable power cables shall be barricaded to the greatest extent practicable in order to provide equipment and personnel protection.
9. The following documents were considered during the development of these procedures: "OSHA 29 CFR 1910.269 Electric Power Generation, Transmission, and Distribution", "EM 385-1-1, Health and Safety Requirements, Sections 11 & 12", "Navy Ships Technical Manual (NSTM), Chapters 320/300", "NAVSEA Manual S0400-AD-URM-010/TUM Rev 06 Tag-out Users Manual", and "NAVFAC P307 Management of Weight Handling Equipment."

11.6.DISCONNECT PROCEDURE FOR SUBMARINES

11.6.1. STEP 1 - SUBMARINE'S LOAD TRANSFER TO THE SUBMARINE'S GENERATOR(S)

1. NAVFAC and Submarine's Personnel shall conduct a joint Job Brief and clearly agree on roles, responsibilities, and procedures for disconnection of Shore Power that meet the requirements of the applicable NAVFAC Standard Operating Procedures, Submarine's Standard Operating Procedures, and NAVSEA Steam & Electric Plant Manual.
2. Obtain and utilize Sub Connect/Disconnect Form to record information. See Section 11.10 for example. Documents associated with an active disconnection shall be kept in a centralized location and continuously accessible. Upon Submarines departure, documents shall be stored in a centralized location, and records shall be maintained for a minimum of one year.
3. CAUTION: Submarine's Personnel, in accordance with NAVSEA Steam and Electric Plant Manual, will synchronize Submarine's generators with Shore Power and transfer power from Shore Power to the Submarine's generators within the shortest interval possible.
4. When the Submarine's Electrical Officer has notified the NAVFAC QP that the transfer is complete, the Sub Connect/Disconnect Form shall be filled out and the NAVFAC QP in Charge shall obtain the Submarine's Electrical Officer signature on the Sub Connect/Disconnect Form thereby giving permission to shore activity personnel to de-energize shore power.

11.6.2. STEP 2 - DISCONNECTION OF SHORE POWER CABLE PLUGS FROM RECEPTACLES

1. Shore Power cable disconnections shall be from the Submarine's Shore Power receptacles toward the NAVFAC Shore Power receptacles.
2. Submarine personnel shall verify submarine's shore power circuit breakers are open and danger tags installed in accordance with Submarine's Standard Operating Procedures, NAVSEA Steam & Electric Plant Manual, and Submarine's safety procedures.
3. NAVFAC QP, wearing appropriate PPE, shall establish Electrically Safe Working Condition for Shore Power Cable Assemblies.
 - 3.1. Open, red danger tag and red danger lock Facility Shore Power receptacle circuit breakers.
4. NAVAC shall make available Shore Power circuit breaker danger locks to Submarine personnel for their use during cable handling and disconnection from Submarine Shore Power receptacles.
 - 4.1. Submarine Personnel may install danger tags and danger locks, in accordance with Submarine Procedures, on the NAVFAC Shore Power circuit breakers.

5. At the Submarine's shore power receptacles, Submarine personnel test for no voltage in accordance with Submarine's Standard Operating Procedures, NAVSEA Steam & Electric Plant Manual, and Submarine's safety procedures to verify the shore power cables are de-energized.
 - 5.1. If no voltage is detected, Submarine personnel disconnect cable assemblies by removing plugs from Submarine's shore power receptacles.
6. The Submarine's Electrical Officer or Submarine's designated electrical representative and the NAVFAC QP-in-charge shall ensure that an electrically safe work condition was established for the Shore Power cables.

11.6.3. STEP 3 - REMOVAL OF SHORE POWER CABLE ASSEMBLIES

1. Place vehicle or weight handling equipment in position if used; cable can also be hand carried.
 - 1.1. Only weight handling equipment and the following vehicles are authorized to deliver/retrieve power cables on the piers: shop mule, a line truck, a reel truck, fork lift, or a boom truck.
 - 1.2. Use a spotter when backing up or placing in tight space.
 - 1.3. Operators shall have a valid license, training, and certification in accordance with Command policies.
2. When loading or unloading Shore Power cable, the NAVFAC Electrical QP shall ensure that: the operation of the vehicle or weight handling equipment used comply with applicable SOPs, barriers are set to proper distance, wheel chocks are placed down, sets of cables are connected together, no unauthorized persons are in the area of operations that may be struck by swinging or falling cable, boom truck outriggers are not blocked by any obstructions and are not set on top of vault covers, steam covers, or manholes, booms never swing forward of the outriggers, reel trucks have placed stabilizer jacks.
3. Submarine personnel lower shore power cable assemblies from the Submarine onto the pier. If a NAVFAC operated boom crane, crane or boom truck is used to load shore power cable from the Sub onto the pier, apply temporary personal protective grounds if appropriate, before the crane or boom truck moves shore power cables.
4. If appropriate, apply Temporary personal protective grounding to shore power receptacles per Sections 11.8 and 11.9. Note: installing temporary personal protective grounds for 480 volt shore power is a rare occurrence and temporary personal protective grounding is usually waived by the NAVFAC QP in Charge, as allowed in Section 11.9.
5. At the Facility Shore Power receptacles NAVFAC QP, wearing appropriate PPE, shall test for no voltage.
 - 5.1. If no voltage is detected, disconnect cable assemblies by removing plugs from facility shore power receptacles.
6. Close or install shore power receptacle access covers.

7. Submarine's Personnel shall remove danger tags and danger locks, in accordance with Sub Procedures, on the NAVFAC Facility Shore Power circuit breakers.
8. NAVFAC and Submarine's representatives sign Sub connect/disconnect form verifying shore power removal is complete.
9. A NAVFAC QP wearing PPE shall remove temporary personal protective grounds from Facility Shore Power circuit breaker receptacles, (if installed) prior to removing red danger tags and red danger locks. Installing temporary personal protective grounds for 480 volt shore power is a rare occurrence.
10. NAVFAC personnel shall remove their red danger locks and red danger tags from Facility Shore Power circuit breakers when required to restore operation of breakers.
11. Remove Sub to Shore Tags from cables.

11.7. TEST FOR NO VOLTAGE

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a Qualified Person as defined in the Chapter 1 using the required PPE. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
2. A QP shall test for no voltage per Chapter 5.
3. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

11.8. TEST FOR NO VOLTAGE AND APPLY TEMPORARY PROTECTIVE GROUNDS

1. If temporary personal protective grounding equipment is to be used, wear the required PPE. Installing temporary personal protective grounds is considered working on an exposed energized electrical system. Personnel installing temporary personal protective grounds shall be a Qualified Person as defined in Chapter 1. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document. Install temporary personal protective grounds per Section 11.9.
2. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP as defined in the Chapter 1 using the required PPE.
3. A QP shall test for no voltage per Chapter 5.
4. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

11.9.TEMPORARY PERSONAL PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

1. Temporary personal protective grounding requirements may be waived by the NAVFAC QP-in-charge or the Designated QP-(LV or HV) if it is not practical or that the conditions resulting from the installation of a ground would present greater hazards than working without grounds. Temporary personal protective grounding is usually waived for 480-volt shore power.
2. Temporary personal protective grounds are assemblies consisting of clamps, ferrules, and cable and are to be used when working on de-energized electrical conductors or equipment to minimize the possibility of accidental re-energization from unexpected sources. Grounding will cause an inadvertently energized line to become de-energized through the action of ground fault relays.
3. Temporary personal protective grounding shall be used where:
 - 3.1. The possibility of induced voltages or stored electrical energy exists.
 - 3.2. It could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts.
4. Only a QP can test for no voltage and install and remove temporary personal protective grounds. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
5. Equipotential grounding, as described in Chapter 1, Section 1.8.8, shall be used when feasible to establish a zone of equipotential. When not feasible, grounds shall be placed as close to the work site as practical.
6. Temporary personal protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in electrical potential. The temporary personal protective grounds should be installed in a manner that establishes a zone of equipotential where each employee is working.
7. Temporary personal protective grounds shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
8. The location of installed temporary personal protective grounds shall be written on red danger tags.
9. When a temporary personal protective ground is attached to a line/conductor or equipment, the temporary personal protective ground end connection shall be attached first and then the other end shall be attached by means of voltage rated gloves or voltage rated gloves with a live line tool. Use safe work practices and wear the required PPE.
10. When a temporary personal protective ground is to be removed, the temporary personal protective grounding assembly shall be removed from the line/conductor or equipment using voltage rated gloves or voltage rated gloves with a live line tool

before the temporary personal protective ground-end connection is removed. Use safe work practices and wear the required PPE.

11.10. SAMPLE SUBMARINE CONNECT/DISCONNECT FORM

ELECTRICAL SHORE POWER SERVICE PROCEDURE

CONNECT

DISCONNECT

ARRIVAL TIME:

DEPARTURE TIME:

DATE:	SHIP'S NAME:	PIER/BERTH:	VAULT:	OTHER:
REPORT IMPLEMENTED BY: <input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> OTHER		INITIAL HOOK UP FOR ARRIVAL: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED		
OUTAGE INFORMATION: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> UNSCHEDULED <input type="checkbox"/> ENERGIZING S/P				
FEEDER LENGTH: _____		CABLE TYPE (480V, 4,160V OR 13.8KV): _____		
NUMBER OF CABLES USED: _____		# OF PIGTAILS USED: _____		# OF SUB PLUGS USED: _____
INSPECT AND PERFORM THE FOLLOWING AS REQUIRED:				
Condition of Connection Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>		Meter KW HRS: _____
Operation of Breakers Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>		List Breakers: _____
Megger Cables Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>		Lowest Megger Value on Cables: _____ MEGOHMS (Min. Megger Value: 480V - 4 Megohms, 4160V/13.8kV -10 Megohms)
Check Current Load Acceptable <input type="checkbox"/> Unacceptable <input type="checkbox"/>		Average Current Load: _____ AMPS		
AUTHORIZATION TO CONNECT / DISCONNECT CABLES		AUTHORIZATION TO ENERGIZE / DE-ENERGIZE BREAKERS:		
All Shipboard Breakers Are Open		Electrical Shore Power Area Aboard Ship Is Free And Clear Of Obstacles And Personnel		
Potential Energy Sources Have Been Isolated		Breaker Sequence Requested By Ship For 480V Service Or Switching Orders Have Been Prepared		
It Is Safe To Handle Shore Power Cables		Cables Are Plugged In And Are Ready To Be Energized Or De-Energized		
Ship Electrical Officer And Senior Electrician Sign:		Ship Electrical Officer Sign:		
PW Utilities Electrician: Sign, Date & Time:		PW Utilities Electrician: Sign, Date & Time		
SHIP CONNECTED / DISCONNECTED FROM FACILITY SHORE POWER				
Ship Electrical Officer: Print Name, Sign, Date, & Time				
PW Utilities Electrician: Print Name, Sign, Date, & Time				
After shore power is restored to ship, record circuit readings after the ship has a stable load. All phases and average current readings must be within 10% for of each shore power cable and circuit. Use the Shore Power Load Current Analysis form to record readings as required and attach to this document. If ship elects not to go back on shore power at this time, take readings as soon as possible.				
Ship load at least 50% for 1 hour and INFRA-RED Survey Performed: <input type="checkbox"/> Equipment Condition: Ok <input type="checkbox"/> Need Repair <input type="checkbox"/> Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>				
Ship Electrical Officer: Print Name, Sign & Date				
PW Utilities Electrician: Print Name, Sign & Date				

11.11. 480V SUB DISCONNECT INSPECTION CHECKLIST

NAME OF INSPECTOR: _____ INSTALLATION: _____

SUB TO BE DISCONNECTED: _____ LOCATION OF DISCONNECT: _____

ITEM		
Procedure Requirements	YES	NO
Are all personnel qualified for the required work and on the SOC list?		
Are all personnel wearing appropriate PPE throughout the entire procedure?		
Did NAVFAC Qualified Person (QP) in Charge conduct a Job Brief with NAVFAC personnel and Sub's representative?		
Remarks for Procedural Deficiencies:		
Step 1 – Sub's Load Transfer to the Sub's Generator	YES	NO
Was a Sub Disconnect Form used and accessible during the disconnection process?		
Did NAVFAC QP in charge obtain signature from Sub's Electrical Officer verifying that they have returned to sub power and NAVFAC personnel can de-energize shore power?		
Remarks for Step 1 Deficiencies:		
Step 2 – Establish an Electrically Safe Work Condition for Shore Power Cables	YES	NO
Did NAVFAC QP in Charge obtain signatures from the Sub's Electrical Officer and Senior Electrician on the Sub Connect/Disconnect Form certifying that the Sub's Shore Power circuit breakers are open and tagged out?		
Did NAVFAC QP open Facility Shore Power breakers and install red danger locks and red danger tags?		
Did NAVFAC QP provide red danger locks to Sub's forces for use on Facility shore power breakers and have them fill out the Sub Connect/Disconnect form?		
Have cables been tested for no voltage prior to disconnecting?		
Remarks for Step 2 Deficiencies:		
Step 3 – Disconnect Facility Shore Power Cable Plugs From Sub's Shore Power Receptacles	YES	NO
Did the NAVFAC QP in Charge receive confirmation from the Sub's representative that the shore power cables were disconnected from the sub's receptacles before continuing with work?		

Did the NAVFAC QP confirm that the shore power cables were disconnected from the sub's receptacles and test the facility shore power cables for no voltage?		
Remarks for Step 3 Deficiencies:		
Step 4 – Removal of Facility Shore Power Cable Assemblies From Sub	YES	NO
Have cables been removed from the sub and loaded to the pier using applicable SOPs and in a method to minimize potential damage to inline connectors/splices and plugs?		
Did cables remain lashed to the sub until strain on the cable was removed by manual or mechanical means?		
Remarks for Step 4 Deficiencies:		
Step 5 – Disconnect Facility Shore Power Cable Plugs From Facility Shore Power Receptacles	YES	NO
Have Sub's forces removed their red danger locks and returned them to NAVFAC?		
Did the NAVFAC QP test the facility shore power cables for no voltage and ensure they were in an electrically safe work condition?		
Did the NAVFAC personnel remove red danger tags and red danger locks?		
Did NAVFAC QP in Charge and Sub's electrical representative sign the Sub Connect/Disconnect Form verifying that shore power removal is complete?		
Were Sub to Shore tags removed from cables?		
Remarks for Step 5 Deficiencies:		

CHAPTER 12 - 4160V SHIP CONNECT

12.1. PURPOSE

Provide standard procedures for connecting 4160-volt Shore Power to Surface Ships. This procedure applies to CVNs, LHD-8 and DDG-1000s.

12.2. BACKGROUND

The connection of 4160 Volt Shore Power to Ships is a hazardous operation. Hazards mitigated by this Chapter are: electrical shock, arc flash, arc blast, and electrical burns.

All steps in this procedure must be followed and total compliance is critical to mitigating the hazards of Shore Power Connections and Disconnections. Thorough training, job planning, and exhaustive communication between Naval Facilities Engineering Command (NAVFAC) in-house forces, contractor personnel, other DoD agencies and Ship Personnel are necessary to ensure the highest level of safety for all involved.

12.3. TOOLS AND PERSONAL PROTECTIVE EQUIPMENT

Any worker whose normal job includes working on or near exposed energized electrical conductors or equipment shall wear, as a minimum, Arc Rated long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm² and leather EH rated safety shoes/boots.

Tools, equipment, and additional Personal Protective Equipment (PPE) necessary to perform this procedure are provided in Chapter 4 Working on or Near Exposed and Enclosed Energized Electrical Systems and Chapter 5 Measuring /Testing Parameters of Energized High or Low Voltage Electrical Systems.

12.4. TRAINING, CERTIFICATION, AND RECORD KEEPING

All employees whose job requires the use of this procedure shall be trained to understand the purpose and function of the hazardous energy control program, the hazards they face, demonstrate a working level knowledge of all process steps and applicable references, and complete site specific training as required. The training requirements shall be identified and associated with the employee profile in ESAMS.

Training completion shall be registered in ESAMS. Additionally, a list of names and job titles of Authorized Employees and Qualified Persons shall be maintained by SOC personnel and available to Command employee(s) responsible for dispatching/assigning work.

At least once per year, execution of this procedure shall be audited to ensure the procedure is being followed.

12.5. GENERAL INFORMATION FOR PROCEDURES

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Ships operating in a cold iron mode.
2. Personnel performing Shore Power Connects and Disconnects may be exposed to AC electrical potential greater than 1000 volts, AC electrical potential less than 1000 volts, and DC electrical potential 250 volts and less. Shore Power equipment shall be considered energized unless an Electrically Safe Work Condition has been established.
3. The Ship's Electrical Officer, Ship's Reactor Electrical Assistant (REA) or designated representative is responsible for making cable connections to the Ship's electrical bus fed by the Ship's generators and dictating when Shore Power is energized to supply this bus.
4. Shore Power circuit breakers shall be open and racked out as required except during testing or when connected to Ship.
5. Shore Power service provides an ungrounded, correctly phased system, with an adequate number of shore power cables correctly oriented to serve the Ship's load. Where two or more power cables are connected to a Ship, cables must be grouped so that all the same phases are connected together.
6. When the Ship requires more than one feeder cable, total cable length for each feeder will be within plus or minus 10 percent to minimize unequal load distribution. Conductors must be the same size.
7. Ship's hull serves as ground for Ship's electrical service. A physical cable ground connection between the Shore and Ship hull can result in damaging circulating currents.
8. **Note:** The CVN68 Class SPM specifically prohibits the paralleling of forward and aft shore power and NAVSEA 05/08 must approve any deviations from these procedures. NAVFAC cannot authorize deviations. If a Ship is supplied by two or more Shore transformers, Ship Personnel 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 NAVFAC authorizes the parallel operation of shore transformers. 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.
9. 4160 volt Shore Power cables shall not be spliced under any conditions.
10. 4160 volt Shore Power receptacles should be key interlocked, if equipped, with their associated 4160 volt substation circuit breakers for safety reasons.
11. The area surrounding Shore Power and industrial power receptacles, plugs and portable power cables shall be barricaded to the greatest extent practicable in order to provide equipment and personnel protection.
12. The following documents were considered during the development of these procedures: "OSHA 29 CFR 1910.269 Electric Power Generation, Transmission,

and Distribution”, “EM 385-1-1, Health and Safety Requirements, Sections 11 & 12”, “Navy Ships Technical Manual (NSTM), Chapters 320/300”, “NAVSEA Manual S0400-AD-URM-010/TUM Rev 06 Tag-out Users Manual”, and “NAVFAC P307 Management of Weight Handling Equipment.”

12.6. CONNECT PROCEDURE FOR SHIPS UTILIZING 4160 VOLT SHORE POWER

12.6.1. STEP 1 - PREPARE FOR SHIP’S ARRIVAL

1. Use the berthing assignment information received from Port Operations to prepare the berth for Ship’s arrival or the Logistics Requirement (LOGREQ) message from the arriving Ship, which describes power and general berthing requirements.
2. Obtain and utilize Ship Connect/Disconnect Form to record information. See Section 12.10 for example. Documents associated with an active connection shall be kept in a centralized location and continuously accessible. Upon ships departure, documents shall be stored in a centralized location, and records shall be maintained for a minimum of one year.
3. An Authorized Official or HV Shop Supervisor shall write Switching Orders and the Switching Order Package for Shore Power.
4. NAVFAC Qualified Person in Charge shall conduct a Job Brief and ensure all personnel have required equipment, tools, and PPE.

12.6.2. STEP 2 - LAY POWER CABLE ASSEMBLIES

1. Check berth for obstructions that may prevent safe Shore Power set up. If obstacles are present, inform NAVFAC Supervisor and Port Operations or appropriate authorities for removal.
2. Place vehicle or weight handling equipment in position.
 - 2.1. Only weight handling equipment and the following vehicles are authorized to deliver/retrieve power cables on the piers: shop mule, a line truck, a reel truck, fork lift, or a boom truck. Cable can also be hand carried.
 - 2.2. Use a spotter when backing up or placing in tight space.
 - 2.3. Operators shall have a valid license, training, and certification in accordance with Command policies.
3. Shore Power cables shall be placed at the pier where the Ship will dock.
4. Lay out cables between Shore Power receptacles and Ship’s Shore Power receptacles. Note the following **CAUTIONS**:
 - 4.1. Ensure cable ends are not connected to any equipment, weight handling equipment or vehicle.
 - 4.2. Excess cable shall be laid in such a manner as to minimize damage from vehicle and pedestrian traffic.

- 4.3. Each set of Shore Power cables should be positioned as a unit.
- 4.4. Do not lay or drag cables on or over sharp and ragged objects.
- 4.5. Shore power cables and terminations should be physically isolated from Shore Steam, Potable Water, Salt Water, and all other service lines.
- 4.6. Do not exceed minimum cable bend radius. Per Insulated Cable Engineers Association, minimum THOF cable bend radius is 6 times the outer diameter and is 8 times the outer diameter for 15kv SHD cable.
- 4.7. Provide adequate cable length to compensate for the rise and fall of the tide. Cable slack should not dip into the water, rub on structures causing abrasion, or become wedged between the ship and pier.
- 4.8. Ensure cables are the proper length, size and are arranged in a neat and safe manner.
- 4.9. To reduce overheating or de-rating cable, excess cable should not be coiled or stacked on each other.
- 4.10. Barricades shall be placed as necessary, to keep vehicles off cable.
- 4.11. Where cables would obstruct drains or scuppers, lay cables on a pallet to allow water drainage on the pier.
- 4.12. Do not hold or brace the cable in place as this may result in a foot or leg injury.
- 4.13. When loading or unloading Shore Power cables, the NAVFAC Electrical QP shall ensure that: the operation of the vehicle or weight handling equipment comply with applicable SOPs, barriers are set to proper distance, wheel chocks are placed down, sets of cables are connected together, no unauthorized persons are in the area of operations that may be struck by a swinging or falling cable, boom truck outriggers are not blocked by any obstructions and are not set on top of vault covers, steam covers, or manholes, booms never swing forward of the outriggers, reel trucks have placed stabilizer jacks.

12.6.3. STEP 3 - INSPECT AND TEST EACH POWER CABLE ASSEMBLY

1. NAVFAC QP shall confirm Shore Power cable assemblies are disconnected on both ends. If the NAVFAC QP in Charge determines it is necessary to verify Shore Power cable assemblies are de-energized, in accordance with Section 12.7, NAVFAC QP shall test each phase conductor or circuit part of the cables for no voltage prior to handling.
2. NAVFAC QP shall ensure inspection/testing team maintains control of both ends of Shore Power cable assemblies during inspection and testing to ensure cable assemblies stay disconnected at both ends.
3. Visually inspect shore power cable assemblies for any sign of defect. Cables not passing visual inspection shall be removed from service.

- 3.1. Inspect cable assemblies for cracks, bulges, or indications of overheating.
- 3.2. Inspect cable sheath for cuts, nicks, and gouges.
4. Clean and inspect cable plugs and lugs.
 - 4.1. Inspect cable plug and lug conducting surface for pitting, corrosion, and evidence of overheating. Repair or replace any deficiency.
 - 4.2. If required by connector manufacturer, apply a light coat of approved grease or contact cleaner to cable connectors.
5. Measure insulation resistance between cable assembly conductors and each conductor and ground for each circuit using a 5000 volt megohmmeter. Insulation resistance must be measured across all pieces of portable shore power cable providing power to the ship. Minimum insulation readings for 4160-volt Shore Power cables shall be 10 megohms.
6. Record all insulation resistance readings on Ship to Shore Power Cable Insulation Record (see Section 12.11) and record the lowest insulation resistance value on the Ship Connect/Disconnect Form (Section 12.10).
7. Replace Shore Power cable if it does not meet minimum insulation resistance requirements.
8. Verify phase identification markings (color coding or labeling) of the cable assembly to ensure proper orientation (in-phase).
9. Attach "DANGER-HIGH VOLTAGE" signs to Shore Power cable assemblies or barricades every 20 feet, where possible.
10. Barricade the work area surrounding the Shore Power receptacles and portable shore power cables to the greatest extent possible.

12.6.4. STEP 4 - INSPECT AND TEST 4160 VOLT SHORE RECEPTACLES

1. NAVFAC QP in Charge shall obtain the test data from the last ship connect or Annual PM performed on these 4160V shore receptacles and conducts a Job Brief.
2. NAVFAC QP-HV and Authorized Employees, wearing appropriate PPE, shall establish an Electrically Safe Working Condition. NAVFAC personnel shall follow switching orders prepared in accordance with UFC 3-560-01 and SOP PWBL 001.
 - 2.1. Open, remove from cubicle (rack out), red danger tag and red danger lock Facility Shore Power receptacle circuit breakers in accordance with switching orders and Chapter 2.
 - 2.2. Test Facility Shore Power circuit breakers load bus or receptacles for no voltage per Section 12.7.
 - 2.3. Apply Temporary personal protective grounds-to Facility Shore Power circuit breakers load bus or receptacles per Section 12.9.

3. Carefully remove/open access cover(s) to each shore power receptacle and test for no voltage per Section 12.7. Use a voltage detector to test terminals in each shore power receptacle to ensure that they are de-energized. Verify these receptacles are in an electrically safe working condition.
4. Inspect each cover and receptacle. Clean as necessary to ensure proper operation.
 - 4.1. If applicable, inspect each cover gasket and each receptacle gasket for cuts, tears, cracks, and deformation.
 - 4.2. Inspect each receptacle conducting surface for pitting, corrosion, and evidence of overheating. If the receptacle is equipped with interlocks, Inspect key interlock for proper operation.
5. If 4160V shore power receptacle testing was performed within the last 12 months, record the date of test and megohms on the Ship to Shore Power Cable Insulation Record (see Section 12.11). If test data is unavailable or older than 12 months, perform steps 5.1 through 5.4
 - 5.1. Disconnect equipment such as meters, indicating lights and fuses that could be damaged by a megohmmeter test or cause a false reading.
 - 5.2. Remove temporary personal protective grounds for testing purposes at load side of Facilities Shore Power receptacle circuit breaker one at a time. Use a 5000 volt megohmmeter and test the insulation resistance between each receptacle terminal and between each terminal and ground. Minimum insulation resistance is 10 megohms for 4160 volt receptacles.
 - 5.3. Record megohmmeter values on the Ship to Shore Power Cable Insulation Record (see Section 12.11).
 - 5.4. Re-install indicator lights, appropriate fuses and reconnect appropriate meters.
 - 5.5. Test Facility Shore Power circuit breaker load bus or receptacle for no voltage per Section 12.7
 - 5.6. Apply Temporary personal protective grounds to Facility Shore Power circuit breaker load bus or receptacles per Section 12.8.
6. Install/close shore power receptacle access covers.
7. Repair deficiencies if time permits. If repairs cannot be made, open circuit breaker and place a caution tag and lock on the breaker in accordance with Chapter 2 and report deficiencies to NAVFAC Supervisor.

12.6.5. STEP 5 - INSERTING CABLE PLUGS INTO SHORE RECEPTACLES

1. Upon Ship's arrival, NAVFAC QP in Charge shall contact Ship's Electrical Officer, (REA) or designated representative to ensure required Ship's Personnel are available, determine cable connection lengths and cable connection times.
2. NAVFAC and Ship's Personnel shall conduct a joint Job Brief and clearly agree on roles, responsibilities, and procedures for provision of Shore Power that meet the

requirements of the applicable NAVFAC Standard Operating Procedures and Ship's Standard Operating Procedures. During the brief, provide Ship's Electrical Officer, REA, or designated representative with a copy of the Ship to Shore Power Cable Insulation Record (see Section 12.11), the Ship Connect/Disconnect Form (see Section 12.10) and Cable Test Certifications.

3. Shore Power cable connections shall be made from the Facility Shore Power receptacle toward the Ship's electric bus.
4. NAVFAC QP shall verify the Facility Shore Power receptacles are in an Electrically Safe Work Condition.
5. A QP-HV wearing PPE as specified in Chapter 4 shall carefully remove access cover to each shore power receptacle and test for no voltage per Chapter 5 and as described in Section 12.7 to verify the receptacles and shore power cables are de-energized.
6. Verify Shore Power cables are in an Electrically Safe Work Condition.
7. Insert Shore Power cable plugs into Facility Shore Power receptacles.
 - 7.1. NAVFAC QP shall check all cable assemblies for proper phase color coding: Phase "A" is black, Phase "B" is white and Phase "C" is red. This is performed while the cable is in an electrically safe work condition.
8. Fill out and attach the Ship to Shore Tag (see Section 12.13) to cables at receptacle.

12.6.6. STEP 6 - SHORE POWER CABLE RIGGING

1. NAVFAC shall make available Shore Power circuit breaker red danger locks to Ship personnel for their use during cable handling and cable connection to Ship Shore Power bus.
 - 1.1. Ship Personnel may install danger tags and danger locks, in accordance with Ship Procedures, on the NAVFAC Shore Power circuit breakers. NAVFAC QP and Ship personnel wearing appropriate PPE shall use an adequately rated voltage detector to test each phase conductor or circuit part of shore power cables to verify they are de-energized.
2. NAVFAC QP-HV, wearing appropriate PPE, shall verify that an Electrically Safe Working Condition exist in accordance with Chapters 2 and 4.
3. Anytime a NAVFAC employee handles the Ship to Shore Power cable, temporary personal protective grounds must be installed. If a NAVFAC operated crane or boom truck will be used to load Shore Power cable from the ship onto the pier, temporary personal protective grounds must be installed before crane or boom truck moves Shore Power cables. If Ship's Personnel will load Shore Power cables to ship, a QP-HV wearing PPE as specified in Chapter 4 shall remove temporary personal protective grounds as specified in the switching orders and in accordance with the requirements of this document.
4. Load Shore Power cable assemblies from Shore, to camels, to Ship.

- 4.1. If boom trucks or cranes are used, follow appropriate boom truck and crane SOP.
- 4.2. If a NAVFAC operated crane or boom truck was used to load cable to ship, a QP-HV wearing PPE as specified in Chapter 4 shall remove temporary personal protective grounds as specified in the switching orders and in accordance with Chapter 2 and Chapter 5 and as described in Sections 12.8 and 12.9.
5. Ship Personnel will connect Shore Power cables to Ship's Shore Power bus in accordance with Ship's Standard Operating Procedures.
 - 5.1. All black color coded Shore Power cables should be connected to Ship's Shore Power bus Phase A, all white color coded shore power cables should be connected to Ship's Shore Power bus Phase B and all red color coded shore power cables should be connected to Ship's Shore Power bus Phase C.
6. NAVFAC QP in Charge shall obtain signature of the Ship's Electrical Officer, REA, or designated representative on the Ship Connect/Disconnect Form giving NAVFAC personnel permission to energize shore power at the agreed upon time.
7. NAVFAC QP shall escort Ship Personnel while Ship Personnel remove their danger tags and danger locks from NAVFAC Shore Power circuit breaker cubicles.
8. NAVFAC personnel shall remove their red danger locks and red danger tags from NAVFAC facility circuit breaker(s) cubicle(s) as specified in the switching orders and in accordance with Chapter 2. A QP-HV, wearing the required PPE, shall rack in circuit breaker(s) into circuit breaker cubicle(s) in accordance with the switching orders.
 - 8.1. **Note:** Some Shore facilities have one 4160 volt circuit breaker serving one 400 ampere shore power receptacle and therefore one 400 ampere shore power cable. Some shore facilities have one 4160 volt circuit breaker serving two 400 ampere shore power receptacles and therefore two 400 ampere shore power cables. Some shore facilities have one 4160 volt circuit breaker serving four 400 ampere shore power receptacles and therefore four 400 ampere shore power cables.
9. After receiving permission from Ship's Electrical Officer, REA, or designated representative, a NAVFAC QP shall close Facility Shore Power circuit breakers in the sequence requested by the Ship's Electrical Officer, REA, or designated representative.

12.6.7. STEP 7 - SHIP'S TRANSFER TO SHORE POWER

1. **CAUTION:** Ship's Personnel, in accordance with Ship's Standard Operating Procedures, will synchronize Ship's generators with Shore Power and transfer power from the Ship's generators to Shore Power within the shortest interval possible. If more than one shore power connection is to be paralleled, actual phases of shore power must be the same rotation and also be connected to match Ship phases (orientation, in-phase). A shore power installation that has one circuit breaker supplying a number of cable sets presents a particular hazard. In this case, phase

rotation and phase orientation (in-phase) can be verified only by energizing all shore terminals. This situation requires special considerations and procedures.

2. When the Ship's Electrical Officer, REA, or designated representative has notified the NAVFAC QP that transfer is complete, the Ship Connect/Disconnect Form shall be filled out and NAVFAC QP in Charge shall obtain signature of the Ship's Electrical Officer, REA, or designated representative thereby accepting Shore Power.
 - 2.1. **Note:** No Personnel shall move energized Shore Power cable assemblies.
3. NAVFAC personnel shall check amperage readings on all phases of each cable and record them on the Shore Power Load Current Analysis Form, Section 12.12. The preferred method is permanently installed ammeters, however clamp-on ammeters are allowed.
 - 3.1. This can be accomplished by using the 4160 Volt circuit breakers ammeters for the scheme where one circuit breaker serves one receptacle. For schemes where one 4160 Volt circuit breaker feeds two or four receptacles, ammeters on the protective devices for the individual 400 ampere shore power cable can be used or the secondary Current Transformer (CT) on these circuits can be read or a NAVFAC QP-HV wearing and using PPE required by Chapters 3 & 4 and using a hook sensing head ammeter attached to a live line tool records amperage readings on all phases of each shore power cable. This requires adequate clearance for use of a live line tool and the ability to have access to each shore power cable phase.
 - 3.2. Verify that phase amperage readings are within 10 percent of each other per the Shore Power Load Current Analysis Form.
 - 3.2.1. For each cable, add all three readings together and divide by three to get the average. Divide that number by 10 and all three readings should not differ from the average by more than that amount. For example, if phase A reads 230A, phase B reads 240A, and phase C reads 250A, the average is $(230+240+250)/3 = 240$. $240/10 = 24$. All three phases read within plus or minus 24 (10%) of 240 (average), so these are acceptable readings for this example.
 - 3.3. If the amperage readings are not within 10 percent, notify NAVFAC QP, Ship's representative, and perform a thermal infra-red imaging survey.
 - 3.4. The average current of each circuit must also be within 10 percent of the combined average current of all circuits. If they are not, notify NAVFAC QP for further instruction.
 - 3.5. If any circuit has zero current, open, caution lock and tag the breaker feeding that circuit.
4. After the ship is drawing current and has reached at least 50% load for 1 hour, NAVFAC QP will perform a thermal infra-red imaging (IR) survey in accordance with NAVFAC Standard Operating Procedures to ensure all Shore Power equipment is operating within safe tolerances.

- 4.1. The NAVFAC IR survey will include the connector at the Shore Power substation to the last connector on the pier.
- 4.2. **CAUTION:** Breakers, receptacles, and cables are energized. If deficiencies are found, NAVFAC QP in charge shall conduct a job brief to coordinate and communicate with ship personnel for taking the circuit offline/de-energizing.
- 4.3. Repair deficiencies if time permits. If repairs cannot be made, open circuit breaker and place a caution tag and lock on the breaker in accordance with E-SAFE PWBL 01 and report deficiencies to NAVFAC Supervisor.
5. When the IR survey is complete, the Ship Connect/Disconnect Form shall be signed indicating completion of the task.

12.7. TEST FOR NO VOLTAGE

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a Qualified Person as defined in the Chapter 1 using the required PPE. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
2. A QP HV shall test for no voltage per Chapter 5.
3. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

12.8. TEST FOR NO VOLTAGE AND APPLY TEMPORARY PERSONAL PROTECTIVE GROUNDS

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP-HV as defined in the Electrical SAFE PWBL-SAFE 01 and use the required PPE. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
2. If temporary personal protective grounding equipment is to be used, wear the required PPE. Installing temporary personal protective grounds is considered working on an exposed energized electrical system. Personnel installing temporary personal protective grounds shall be a Qualified Person as defined in Chapter 1. Install temporary personal protective grounds per Section 12.9.
3. A QP-HV shall test for no voltage per Chapter 5.
4. If voltage is present, stop work review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.
5. The SOC personnel, HV Shop Supervisor and NAVFAC QP-HV shall communicate and initial off, on the switch out and temporary personal protective grounds sheet of the switching orders, the installation of each temporary personal protective ground.

12.9. TEMPORARY PERSONAL PROTECTIVE GROUND POLICY FOR NAVFAC PERONNEL

1. Temporary personal protective grounds are assemblies consisting of clamps, ferrules, and cable capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
2. Any circuit not grounded shall be considered energized except when grounding has been waived.
3. An Electrical Utility Supervisor or QP-HV, as specified in Chapter 1, Section 1.8.8.1, can waive the grounding requirement if it can be demonstrated that installation of grounds is impractical or that the installation of grounds would present a greater hazard than working without grounds. Waiving of grounds shall be documented on the switch out sheet of the switching orders. In this case, the conductors and equipment may be treated as de-energized provided the following conditions are met.
 - 3.1. The conductors and equipment have been de-energized, red danger locked, red danger tagged and tested for no voltage per Section 12.7.
 - 3.2. There is no possibility of contact with another energized source.
 - 3.3. The hazard of induced voltage is not present.
4. One must be a QP-HV to install or remove temporary personal protective grounds. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
5. A serialized red danger tag with location(s) of installed grounds recorded shall accompany all ground placements under LOTO.
6. Equipotential grounding, as described in Chapter 1, Section 1.8.8, shall be utilized when feasible. When not feasible, grounds shall be placed as close to the work site as practical.
7. Switching orders are required to install or remove temporary personal protective grounds on circuits or equipment over 1000 volts. Ground locations shall be specified in the switching orders.
8. Temporary personal protective grounds shall be constructed in accordance with ASTM F855, "Specification for Temporary Protective Grounds to be used on De-energized Electrical Power Lines and Equipment," and installed in accordance with UFC 3-560-01 "Electrical Safety O&M," OSHA 29CFR 1910.269(n) "Grounding for the Protection of Employees" and IEEE Std 1246 "IEEE Guide for Temporary Protective Grounding Systems Used in Substations." Temporary personal protective grounds shall be appropriately sized with the correct connection for the application.
9. Temporary personal protective grounds shall have an impedance low enough to cause immediate operation of protective devices in case of accidental energizing of the lines or equipment.

10. Conductors to be grounded shall be cleaned of oxidation or other conditions that would reduce conductivity at the point the clamp is to be installed.
11. When a temporary personal protective ground is attached to a line/conductor or equipment, the ground-end connection shall be attached first and then the other end shall be attached by means of voltage rated gloves with a live line tool. Use safe work practices and wear the required PPE.
12. When a temporary personal protective ground is to be removed, the grounding device shall be removed from the line/conductor or equipment using voltage rated gloves with a live line tool before the ground-end connection is removed. Use safe work practices and wear the required PPE.

12.10. SAMPLE SHIP CONNECT/DISCONNECT FORM

ELECTRICAL SHORE POWER SERVICE PROCEDURE

 CONNECT

 DISCONNECT

ARRIVAL TIME:

DEPARTURE TIME:

DATE:	SHIP'S NAME:	PIER/BERTH:	VAULT:	OTHER:
REPORT IMPLEMENTED BY: <input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> OTHER		INITIAL HOOK UP FOR ARRIVAL: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED		OUTAGE INFORMATION: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> ENERGIZING S/P
FEEDER LENGTH: _____		CABLE TYPE (480V, 4,160V OR 13.8KV): _____		
NUMBER OF CABLES USED: _____		# OF PIGTAILS USED: _____	# OF SUB PLUGS USED: _____	
INSPECT AND PERFORM THE FOLLOWING AS REQUIRED:				
Condition of Connection	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Meter KW HRS: _____	
Operation of Breakers	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	List Breakers: _____	
Megger Cables	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Lowest Megger Value on Cables: _____ MEGOHMS (Min. Megger Value: 480V - 4 Megohms, 4160V/13.8kV -10 Megohms)	
Check Current Load	Acceptable <input type="checkbox"/> Unacceptable <input type="checkbox"/>	Average Current Load: _____ AMPS		
AUTHORIZATION TO CONNECT / DISCONNECT CABLES		AUTHORIZATION TO ENERGIZE / DE-ENERGIZE BREAKERS:		
All Shipboard Breakers Are Open		Electrical Shore Power Area Aboard Ship Is Free And Clear Of Obstacles And Personnel		
Potential Energy Sources Have Been Isolated		Breaker Sequence Requested By Ship For 480V Service Or Switching Orders Have Been Prepared		
It Is Safe To Handle Shore Power Cables		Cables Are Plugged In And Are Ready To Be Energized Or De-Energized		
Ship Electrical Officer And Senior Electrician Sign:		Ship Electrical Officer Sign:		
PW Utilities Electrician: Sign, Date & Time:		PW Utilities Electrician: Sign, Date & Time		
SHIP CONNECTED / DISCONNECTED FROM FACILITY SHORE POWER				
Ship Electrical Officer: Print Name, Sign, Date, & Time				
PW Utilities Electrician: Print Name, Sign, Date, & Time				
After shore power is restored to ship, record circuit readings after the ship has a stable load. All phases and average current readings must be within 10% for of each shore power cable and circuit. Use the Shore Power Load Current Analysis form to record readings as required and attach to this document. If ship elects not to go back on shore power at this time, take readings as soon as possible.				
Ship load at least 50% for 1 hour and INFRA-RED Survey Performed: <input type="checkbox"/> Equipment Condition: Ok <input type="checkbox"/> Need Repair <input type="checkbox"/> Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>				
Ship Electrical Officer: Print Name, Sign & Date				
PW Utilities Electrician: Print Name, Sign & Date				

12.11. SAMPLE SHIP TO SHORE POWER CABLE INSULATION RECORD

Ref: OPNAVINST 11310.3 and UFC 4-150-02

Ship: _____ Berth: _____ Date: _____

2. Visually inspect cable and the terminations for damage and corrosion. Use a Megger to measure cable insulation resistance rated for the 13.8kV, 4,160V, or 480V cables under test (Min of 10 Megohm for 13.8kV and 4,160V and 4 Megohm for 480V). Document the Insulation Resistance readings below:

	Cable#	Plug #	A-B	B-C	C-A	A-Gnd	B-Gnd	C-Gnd	Date	Time	Signature
Ship to Shore Cable											
Receptacle to Breaker											
<p>2. Inform ship's representative of any Special Conditions or Restrictions (i.e., load current limitations, closing ship's bus ties, cables conditions, etc.)</p> <p>3. SSN/SSGN/SSBN/480 Volt surface ships cables/4160V three pole connectors and lugs/13.8kV couplers: Inspect the connectors and lugs or couplers. Clean cable plugs/couplers and inspect each conducting surface for damage, corrosion, and evidence of overheating. Only when recommended by connector manufacturer should the use of approved contact lubricant be applied to the connectors.</p>											

SPECIAL INSTRUCTIONS: Paralleling Transformers - If a ship is supplied by two transformers, the ship is not permitted to parallel these transformers through the ships bus tie. If shore transformers are paralleled though the ship's bus, circulating currents may overheat and destroy cables, transformers and switchgear on board ship, or on shore.

Ship's Representative: _____

Date: _____

NAVFAC Representative: _____

Date: _____

12.13. SAMPLE SHIP TO SHORE TAG

CONNECT / DISCONNECT TAG DATE: _____

CABLE #s: _____

PLUG #s: _____

RECEPTACLE #: _____

OPERATOR: _____ **SHIP:** _____

12.14. 4160V SHIP CONNECT INSPECTION CHECKLIST

NAME OF INSPECTOR: _____ INSTALLATION: _____
 SHIP TO BE CONNECTED: _____ LOCATION OF CONNECT: _____

ITEM		
Procedure Requirements	YES	NO
Are all personnel qualified for the required work and on the SOC list?		
Are all personnel wearing appropriate PPE throughout the entire procedure?		
Did NAVFAC Qualified Person (QP) in Charge conduct a Job Brief?		
Remarks for Procedural Deficiencies:		
Step 1 – Prepare for Ship’s Arrival	YES	NO
Have power and general berthing requirements been collected from Port Operations or ship’s Logistics Requirement message?		
Has an Authorized Official written switching orders?		
Was a Ship Connect Form used and accessible during the active connection process?		
Remarks for Step 1 Deficiencies:		
Step 2 – Lay Power Cable Assemblies	YES	NO
Has the berth been cleared of obstructions?		
Have S2S cables been delivered and laid out in the following manner:		
Not connected to any electrical equipment, handling equipment, or vehicles?		
Positioned to minimize damage from vehicle and pedestrian track?		
Positioned to avoid all sharp and ragged objects?		
Physically isolated from all other shore service lines?		
Doesn’t exceed the minimum bend radius? (THOF cable bend radius is 6 X OD)		
Excess cable is not coiled to avoid overheating?		
Remarks for Step 2 Deficiencies:		
Step 3 – Inspect and Test Each Power Cable Assembly	YES	NO
Have cables been checked to ensure that they were disconnected on both ends and were any connected cables tested for no voltage before continuing?		
Have cables and connectors been inspected for defects (cracks/cuts, pitting/corrosion, bulges, and failure of locking mechanisms) and been repaired/replaced as necessary?		
Have all cable assemblies been measured for insulation resistance and recorded on the Ship to Shore Power Cable Insulation Record? Were cables replaced if they did not meet the minimum insulation resistance requirements?		

Have phase identification markings (color coding or labeling) on the shore power cable assembly been verified to ensure proper phase orientation?		
Have "DANGER-HIGH VOLTAGE" signs been placed on barricades near or attached to cable assemblies?		
Has the work area surrounding the Shore Power receptacles and portable shore power cables been roped off or barricaded?		
Remarks for Step 3 Deficiencies:		
Step 4 – Inspect and Test 4160V Shore Receptacles	YES	NO
Has NAVFAC QP in Charge obtained the test data from the last ship connect or Annual PM performed on the 4160V shore receptacles?		
Have switching orders been followed to de-energize shore power circuit breakers?		
Have facility shore power circuit breakers been opened, removed from cubicle (racked out), and have red danger tags and red danger locks been installed?		
Has NAVFAC QP-HV tested for no voltage, installed temporary protective grounds and established an Electrically Safe Working Condition?		
Have receptacles been cleaned and inspected for defect? (pitting, corrosion, and evidence of overheating, binding or sticking in interlock switches)		
Have 4160V shore power receptacles been tested in the last 12 months? If not, was testing performed prior to work being performed?		
Have Shore Power circuit breakers been opened and tested for no voltage after all testing was completed?		
Have temporary protective grounds been reinstalled after testing was completed?		
Have deficiencies been repaired or caution tags and locks placed where time does not permit repair? (Also check yes if no deficiencies exist)		
Remarks for Step 4 Deficiencies:		
Step 5 – Inserting Cable Plugs into Shore Receptacles	YES	NO
Has NAVFAC QP in Charge conducted a Job Brief with NAVFAC personnel and Ship's electrical representative and provided the Ship with the Ship Connect Form, Ship to Shore Cable Insulation Record, and Cable Tests?		
Have Shore Power circuit breakers been opened and have red danger tags and red danger locks been placed and were breakers tested for no voltage?		
Did NAVAC QP ensure that shore power cable assemblies were disconnected on both ends and did NAVFAC QP-HV test for no voltage?		
Have Shore Power cable plugs been connected to Facility shore power receptacles with Ship to Shore Tag's attached?		

Did NAVFAC QP-HV check all cable assemblies for proper phase identification markings (color coding or labeling) to ensure proper phase orientation?		
Remarks for Step 5 Deficiencies:		
Step 6 – Shore Power Cable Rigging	YES	NO
Did NAVFAC QP in Charge make red danger locks available to ship's forces for use during cable handling?		
If necessary due to distance between receptacles and the Ship, have all inline connections or splices been made before connecting to any Ship or Shore Power receptacles? (Check yes if no inline connections or splices exist)		
Have Shore Power cable assemblies been loaded to the Ship following applicable SOPs and in a manner that would not cause additional stress on inline connections/splices or cause damage to ship's plug, if already attached?		
Have Shore Power cable assemblies been lashed to the Ship and Shore while allowing sufficient slack for tidal changes?		
Did NAVFAC QP in Charge obtain Ship's Electrical Officer's signature on the Ship Connect Form giving permission to energize shore power?		
Have Ship's forces removed their red danger locks from Facility Shore Power breakers and returned them to NAVFAC?		
Have NAVFAC placed red danger locks and red danger tags been removed from Facility Shore Power breakers?		
Did NAVFAC personnel follow requested sequence for closing circuit breakers as requested by the Ship's Electrical Officer?		
Remarks for Step 6 Deficiencies:		
Step 7 – Ship's Transfer to Shore Power	YES	NO
Did NAVFAC QP in charge obtain signature from Ship's Electrical Officer verifying that they have accepted shore power?		
Did NAVFAC personnel check amperage readings of each cable and check for abnormalities using the Shore Power Current Analysis Worksheet?		
If abnormalities were found, were they reported to NAVFAC QP and Ship's Electrical Supervisor and was an IR survey perform on the connector and cable? (Also check yes if no abnormalities were found)		
After one-hour of at least 50% load, was an IR survey performed for all connectors?		
If any cable repairs or replacements are required based on Current Analysis or IR survey, were they completed? (Also check yes if repairs/replacements are not needed)		

If cables can not be repaired or replaced, has the Ship's Electrical representative signed off on accepting less than the original number of circuits and has the circuit been taken out of service with a caution tag hung and caution lock installed?		
Remarks for Step 7 Deficiencies:		

CHAPTER 13- 4160V SHIP DISCONNECT

13.1. PURPOSE

Provide standard procedures for disconnecting 4160 Volt Shore Power to Surface Ships. This procedure applies to CVNs, LHD-8 and DDG-1000s.

13.2. BACKGROUND

The disconnection of 4160 Volt Shore Power to Ships is a hazardous operation. Hazards mitigated by this Chapter are: electrical shock, arc flash, arc blast, and electrical burns.

All steps in this procedure must be followed and total compliance is critical to mitigating the hazards associated with Shore Power Connections and Disconnections. Thorough training, job planning, and exhaustive communication between Naval Facilities Engineering Command (NAVFAC) in-house forces, contractor personnel, other DoD agencies and Ship Personnel are necessary to ensure the highest level of safety for all involved.

13.3. TOOLS AND PERSONAL PROTECTIVE EQUIPMENT

Any worker whose normal job includes working on or near exposed energized electrical conductors or equipment shall wear, as a minimum, Arc Rated long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm² and leather EH rated safety shoes/boots.

Tools, equipment, and additional Personal Protective Equipment (PPE) necessary to perform this procedure are provided in Chapter 4 Working on or Near Exposed and Enclosed Energized Electrical Systems and Chapter 5 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems.

13.4. TRAINING, CERTIFICATION, AND RECORD KEEPING

All employees whose job requires the use of this procedure shall be trained to understand the purpose and function of the hazardous energy control program, the hazards they face, demonstrate a working level knowledge of all process steps and applicable references, and complete site specific training as required. The training requirements shall be identified and associated with the employee profile in ESAMS.

Training completion shall be registered in ESAMS. Additionally, a list of names and job titles of Authorized Employees and Qualified Persons shall be maintained by SOC personnel and available to Command employee(s) responsible for dispatching/assigning work.

At least once per year, execution of this procedure shall be audited to ensure the procedure is being followed.

13.5. GENERAL INFORMATION FOR PROCEDURES

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Ships operating in a cold iron mode.
2. Personnel performing Shore Power Connects and Disconnects may be exposed to AC electrical potential greater than 1000 volts, AC electrical potential less than 1000 volts, and DC electrical potential 250 volts and less. Shore Power equipment shall be considered energized unless an Electrically Safe Work Condition has been established.
3. The Ship's Electrical Officer, Ship's Reactor Electrical Assistant (REA) or designated representative is responsible for making cable connections and disconnections to the Ship's generators shore power receptacles and dictating when Shore Power is de-energized to allow Ship's load transfer to Ship's power.
4. Shore Power service provides an ungrounded, correctly phased system, with an adequate number of shore power cables correctly oriented to serve the Ship's load. Where two or more power cables are connected to a Ship, cables must be grouped so that all the same phases are connected together.
5. Ship's hull serves as ground for Ship's electrical service. A physical cable ground connection between the Shore and Ship hull can result in damaging circulating currents.
6. 4160 volt Shore Power receptacles should be key interlocked, if equipped, with their associated 4160 volt substation circuit breakers for safety reasons.
7. Shore Power circuit breakers shall be open except during testing or when connecting the ship to shore power.
8. **Note:** The CVN68 Class SPM specifically prohibits the paralleling of forward and aft shore power and NAVSEA 05/08 must approve any deviations from these procedures. NAVFAC cannot authorize deviations. If a Ship is supplied by two or more Shore transformers, Ship Personnel 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 NAVFAC authorizes the parallel operation of shore transformers. 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.
9. The area surrounding Shore Power and industrial power receptacles, plugs and portable power cables shall be barricaded to the greatest extent practicable in order to provide equipment and personnel protection.
10. The following documents were considered during the development of these procedures: "OSHA 29 CFR 1910.269 Electric Power Generation, Transmission, and Distribution", "EM 385-1-1, Health and Safety Requirements, Sections 11 & 12", "Navy Ships Technical Manual (NSTM), Chapters 320/300", "NAVSEA Manual S0400-AD-URM-010/TUM Rev 06 Tag-out Users Manual", and "NAVFAC P307 Management of Weight Handling Equipment."

13.6. DISCONNECT PROCEDURE FOR SURFACE SHIPS UTILIZING 4160 VOLT SHORE POWER

13.6.1. STEP 1 - SHIP'S LOAD TRANSFER TO THE SHIP'S GENERATOR(S)

1. NAVFAC and Ship's Personnel shall conduct a joint Job Brief and clearly agree on roles, responsibilities, and procedures for disconnection of Shore Power that meet the requirements of the applicable NAVFAC Standard Operating Procedures, Ship's Standard Operating Procedures, and NAVSEA Steam & Electric Plant Manual.
2. Obtain and utilize Ship Connect/Disconnect Form to record information. See Section 13.10 for example. Documents associated with an active disconnection shall be kept in a centralized location and continuously accessible. Upon Ships departure, documents shall be stored in a centralized location, and records shall be maintained for a minimum of one year.
3. An Authorized Official or HV Shop Supervisor shall write Switching Orders and the Switching Order Package for Shore Power.
4. **CAUTION:** Ship's Personnel, in accordance with Ship's Standard Operating Procedures, will synchronize Ship's generators with Shore Power and transfer power from shore power to the Ship's generators within the shortest interval possible.
5. When the Ship's Electrical Officer, REA, or designated representative has notified the NAVFAC QP that transfer is complete, the Ship Connect/Disconnect Form shall be filled out and the NAVFAC QP in Charge shall obtain the signature of the Ship's Electrical Officer, REA, or designated representative thereby giving shore activity personnel permission to de-energize shore power.

13.6.2. STEP 2 - DISCONNECTION OF SHORE POWER CABLE PLUGS FROM RECEPTACLES

1. Shore power cables shall be disconnected from the Ship's Shore Power bus toward the Facility Shore Power receptacles.
2. Ship personnel shall verify Ship's shore power circuit breakers are open and danger tags installed in accordance with Ship's Standard Operating Procedures, NAVSEA Steam & Electric Plant Manual, and Ship's safety procedures.
3. NAVFAC QP-HV and Authorized Employees, wearing appropriate PPE, shall establish an Electrically Safe Working Condition. NAVFAC personnel shall follow switching orders prepared in accordance with PWBL 001.
 - 3.1. Open, remove from cubicle (rack out), red danger tag and red danger lock Facility Shore Power receptacle circuit breakers in accordance with switching orders and Chapter 2.
4. NAVAC shall make available Shore Power circuit breaker danger locks to Ship personnel for their use during cable handling and disconnection from Ship Shore Power receptacles.

- 4.1. Ship Personnel may install danger tags and danger locks, in accordance with Ship Procedures, on the Facility Shore Power circuit breakers.
5. At the Ship's shore power bus, Ship personnel test for no voltage in accordance with Ship's Standard Operating Procedures, NAVSEA Steam & Electric Plant Manual, and Ship's safety procedures to verify the busses are de-energized.
 - 5.1. If no voltage is detected, Ship personnel disconnect cable assemblies by removing cable lugs from Ship's shore power buses.
6. The Ship's electrical officer or Ship's designated electrical representative and NAVFAC QP-in-charge shall ensure that an electrically safe work condition was established for the shore power cables.

13.6.3. STEP 3 - REMOVAL OF SHORE POWER CABLE ASSEMBLIES

1. Place vehicle or weight handling equipment in position if used; cable can also be hand carried.
 - 1.1. Only weight handling equipment and the following vehicles are authorized to deliver/retrieve power cables on the piers: shop mule, a line truck, a reel truck, fork lift, or a boom truck.
 - 1.2. Use a spotter when backing up or placing in tight space.
 - 1.3. Operators shall have a valid license, training, and certification in accordance with Command policies.
2. When loading or unloading Shore Power cable, the NAVFAC Electrical QP shall ensure that: the operation of the vehicle or weight handling equipment used comply with applicable SOPs, barriers are set to proper distance, wheel chocks are placed down, sets of cables are connected together, no unauthorized persons are in the area of operations that may be struck by swinging or falling cable, boom truck outriggers are not blocked by any obstructions and are not set on top of vault covers, steam covers, or manholes, booms never swing forward of the outriggers, reel trucks have placed stabilizer jacks.
3. Ship personnel lower shore power cable assemblies from the Ship onto the pier. Anytime a NAVFAC employee handles the ship to shore power cables, temporary personal protective grounds shall be installed. If a NAVFAC operated crane or boom truck is used to load shore power cable from the ship onto the pier, temporary personal protective grounds must be installed before crane or boom truck moves shore power cables.
4. NAVFAC QP-HV, wearing PPE as specified in Chapter 4, shall install temporary personal protective grounds as specified in the switching orders to facility shore power circuit breakers load bus or receptacles in accordance with Chapters 2 and 5 and as described in Sections 13.8 and 13.9.
5. NAVFAC QP HV, wearing appropriate PPE, shall test for no voltage as described in Section 13.7 to verify the shore power cable assemblies are de-energized.
 - 5.1. If no voltage is detected, disconnect cable assemblies by removing plugs from facility shore power receptacles.

6. Ship Personnel shall remove danger tags and/or danger locks, in accordance with Ship Procedures, on the NAVFAC Facility Shore Power circuit breakers.
7. NAVFAC QP and Ship's representatives sign ship connect/disconnect form verifying shore power removal is complete.
8. NAVFAC QP-HV and Authorized Employees, wearing appropriate PPE, shall follow switching orders prepared in accordance with Chapter 2 when required to restore operation of breakers.
 - 8.1. Remove Temporary personal protective grounds to Facility Shore Power circuit breakers load bus or receptacles per Section 13.9.
 - 8.2. Remove the red danger locks and red danger tags from Facility shore power circuit breaker(s) cubicle(s)
 - 8.3. Insert (rack in) circuit breaker(s) into circuit breaker cubicle(s) in accordance with switching orders and Chapter 2.
 - 8.4. Remove Ship to Shore Tags from cables.

13.7. TEST FOR NO VOLTAGE

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a Qualified Person as defined in the Chapter 1 using the required PPE. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
2. A QP HV shall test for no voltage per Chapter 5.
3. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

13.8. TEST FOR NO VOLTAGE AND APPLY TEMPORARY PERSONAL PROTECTIVE GROUNDS

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP-HV as defined in the Electrical SAFE PWBL-SAFE 01 and use the required PPE. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
2. If temporary personal protective grounding equipment is to be used, wear the required PPE. Installing temporary personal protective grounds is considered working on an exposed energized electrical system. Personnel installing temporary personal protective grounds shall be a Qualified Person as defined in Chapter 1. Install temporary personal protective grounds per Section 13.9.
3. A QP-HV shall test for no voltage per Chapter 5.

4. If voltage is present, stop work review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.
5. The SOC personnel, HV Shop Supervisor and NAVFAC QP-HV shall communicate and initial off, on the switch out and temporary personal protective grounds sheet of the switching orders, the installation of each temporary personal protective ground.

13.9. TEMPORARY PERSONAL PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

1. Temporary personal protective grounds are assemblies consisting of clamps, ferrules, and cable capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
2. Any circuit not grounded shall be considered energized except when grounding has been waived.
3. An Electrical Utility Supervisor or QP-HV, as specified in Chapter 1, Section 1.8.8.1, can waive the grounding requirement if it can be demonstrated that installation of grounds is impractical or that the installation of grounds would present a greater hazard than working without grounds. Waiving of grounds shall be documented on the switch out sheet of the switching orders. In this case, the conductors and equipment may be treated as de-energized provided the following conditions are met.
 - 3.1. The conductors and equipment have been de-energized, red danger locked, red danger tagged and tested for no voltage per Section 13.7.
 - 3.2. There is no possibility of contact with another energized source.
 - 3.3. The hazard of induced voltage is not present.
4. One must be a QP-HV to install or remove temporary personal protective grounds. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
5. A serialized red danger tag with location(s) of installed grounds recorded shall accompany all ground placements under LOTO.
6. Equipotential grounding, as described in Chapter 1, Section 1.8.8, shall be utilized when feasible. When not feasible, grounds shall be placed as close to the work site as practical.
7. Switching orders are required to install or remove temporary personal protective grounds on circuits or equipment over 1000 volts. Ground locations shall be specified in the switching orders.
8. Temporary personal protective grounds shall be constructed in accordance with ASTM F855," Specification for Temporary Protective Grounds to be used on De-energized Electrical Power Lines and Equipment," and installed in accordance with UFC 3-560-01 "Electrical Safety", OSHA 29CFR 1910.269(n) "Grounding for the

Protection of Employees” and IEEE Std 1246 “IEEE Guide for Temporary Protective Grounding Systems Used in Substations.” Temporary personal protective grounds shall be appropriately sized with the correct connection for the application.

9. Temporary personal protective grounds shall have an impedance low enough to cause immediate operation of protective devices in case of accidental energizing of the lines or equipment.
10. Conductors to be grounded shall be cleaned of oxidation or other conditions that would reduce conductivity at the point the clamp is to be installed.
11. When a temporary personal protective ground is attached to a line/conductor or equipment, the ground-end connection shall be attached first and then the other end shall be attached by means of voltage rated gloves with a live line tool. Use safe work practices and wear the required PPE.
12. When a temporary personal protective ground is to be removed, the grounding device shall be removed from the line/conductor or equipment using voltage rated gloves with a live line tool before the ground-end connection is removed. Use safe work practices and wear the required PPE.

13.10. SAMPLE SHIP CONNECT/DISCONNECT FORM

ELECTRICAL SHORE POWER SERVICE PROCEDURE

CONNECT

DISCONNECT

ARRIVAL TIME: _____

DEPARTURE TIME: _____

DATE:	SHIP'S NAME:	PIER/BERTH:	VAULT:	OTHER:
REPORT IMPLEMENTED BY: <input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> OTHER		INITIAL HOOK UP FOR ARRIVAL: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED		OUTAGE INFORMATION: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> UNSCHEDULED <input type="checkbox"/> ENERGIZING S/P
FEEDER LENGTH: _____		CABLE TYPE (480V, 4,160V OR 13.8KV): _____		
NUMBER OF CABLES USED: _____		# OF PIGTAILS USED: _____		# OF SUB PLUGS USED: _____
INSPECT AND PERFORM THE FOLLOWING AS REQUIRED:				
Condition of Connection	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Meter KW HRS: _____	
Operation of Breakers	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	List Breakers: _____	
Megger Cables	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Lowest Megger Value on Cables: _____ MEGOHMS (Min. Megger Value: 480V - 4 Megohms, 4160V/13.8kV -10 Megohms)	
Check Current Load	Acceptable <input type="checkbox"/> Unacceptable <input type="checkbox"/>	Average Current Load: _____ AMPS		
AUTHORIZATION TO CONNECT / DISCONNECT CABLES			AUTHORIZATION TO ENERGIZE / DE-ENERGIZE BREAKERS:	
All Shipboard Breakers Are Open			Electrical Shore Power Area Aboard Ship Is Free And Clear Of Obstacles And Personnel	
Potential Energy Sources Have Been Isolated			Breaker Sequence Requested By Ship For 480V Service Or Switching Orders Have Been Prepared	
It Is Safe To Handle Shore Power Cables			Cables Are Plugged In And Are Ready To Be Energized Or De-Energized	
Ship Electrical Officer And Senior Electrician Sign:			Ship Electrical Officer Sign:	
PW Utilities Electrician: Sign, Date & Time:			PW Utilities Electrician: Sign, Date & Time	
SHIP CONNECTED / DISCONNECTED FROM FACILITY SHORE POWER				
Ship Electrical Officer: Print Name, Sign, Date, & Time				
PW Utilities Electrician: Print Name, Sign, Date, & Time				
After shore power is restored to ship, record circuit readings after the ship has a stable load. All phases and average current readings must be within 10% for of each shore power cable and circuit. Use the Shore Power Load Current Analysis form to record readings as required and attach to this document. If ship elects not to go back on shore power at this time, take readings as soon as possible.				
Ship load at least 50% for 1 hour and INFRA-RED Survey Performed: <input type="checkbox"/> Equipment Condition: Ok <input type="checkbox"/> Need Repair <input type="checkbox"/> Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>				
Ship Electrical Officer: Print Name, Sign & Date				
PW Utilities Electrician: Print Name, Sign & Date				

13.11. 4160V SHIP DISCONNECT INSPECTION CHECKLIST

NAME OF INSPECTOR: _____ INSTALLATION: _____

SHIP TO BE DISCONNECTED: _____ LOCATION OF DISCONNECT: _____

ITEM		
Procedure Requirements	YES	NO
Are all personnel qualified for the required work and on the SOC list?		
Are all personnel wearing appropriate PPE throughout the entire procedure?		
Did NAVFAC Qualified Person (QP) in Charge conduct a Job Brief with NAVFAC personnel and Ship's representative?		
Remarks for Procedural Deficiencies:		
Step 1 – Ship's Load Transfer to the Ship's Generator	YES	NO
Was a Ship Disconnect Form used and accessible during the disconnection process?		
Has an Authorized Official written switching orders?		
Did NAVFAC QP in charge obtain signature from Ship's Electrical Officer verifying that they have returned to ship power and NAVFAC can de-energize shore power?		
Remarks for Step 1 Deficiencies:		
Step 2 – Disconnection of Shore Power Cable Plugs from Receptacles	YES	NO
Did NAVFAC QP-HV open and remove from cubicle (rack out) Facility Shore Power breakers and install red danger locks and red danger tags?		
Did NAVFAC QP in Charge make red danger locks available to ship's forces for use during cable handling?		
Did the NAVFAC QP in Charge receive confirmation from the Ship's representative that the shore power cables were disconnected from the ship's receptacles before continuing with work?		
Have cables been tested for no voltage prior to removal from the ship?		
Remarks for Step 2 Deficiencies:		
Step 3 – Removal of Shore Power Cable Assembly	YES	NO
Have cables been lowered to the pier using applicable SOPs and in a method to minimize potential damage to inline connectors/splices and plugs?		

Did cables remain lashed to the ship until strain on the cable was removed by manual or mechanical means?		
Have temporary personal protective grounds been installed prior to removing receptacles from Facility Shore Power receptacles?		
Have plugs been removed from receptacles and S2S tags removed from cables?		
Have Ship's forces removed their red danger locks from Facility Shore Power breakers and returned them to NAVFAC?		
Have NAVFAC QP in Charge and Ship's Electrical Representative signed the Disconnect Form verifying that shore power removal is complete?		
Remarks for Step 3 Deficiencies:		

CHAPTER 14 - 13.8KV SHIP CONNECT

14.1. PURPOSE

Provide standard procedures for connecting 13,800 Volt Shore Power to Surface Ships. This procedure applies to CVN 78.

14.2. BACKGROUND

The connection of 13.8 kV Shore Power to ships is a hazardous operation. Hazards mitigated by this Chapter are: electrical shock, arc flash, arc blast, and electrical burns.

All steps in this procedure must be followed and total compliance is critical to mitigating the hazards of Shore Power Connections and Disconnections. Thorough training, job planning, and exhaustive communication between Naval Facilities Engineering Command (NAVFAC) in-house forces, contractor personnel, other DoD agencies and ship personnel are necessary to ensure the highest level of safety for all involved.

14.3. TOOLS AND PERSONAL PROTECTIVE EQUIPMENT

Any worker whose normal job includes working on or near exposed energized electrical conductors or equipment shall wear, as a minimum, Arc Rated long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm² and leather Electrical Hazard rated safety shoes/boots.

Tools, equipment, and additional Personal Protective Equipment (PPE) necessary to perform this procedure are provided in Chapter 4 Working on or Near Exposed and Enclosed Energized Electrical Systems and Chapter 5 Measuring /Testing Parameters of Energized High or Low Voltage Electrical Systems.

14.4. TRAINING, CERTIFICATION, RECORD KEEPING

All employees whose job requires the use of this procedure shall be trained to understand the purpose and function of the hazardous energy control program, the hazards they face, demonstrate a working level knowledge of all process steps and applicable references, and complete site specific training as required. The training requirements shall be identified and associated with the employee profile in ESAMS.

Training completion shall be registered in ESAMS. Additionally, a list of names and job titles of Authorized Employees and Qualified Persons shall be maintained by SOC personnel and available to Command employee(s) responsible for dispatching/assigning work.

At least once per year, execution of this procedure shall be audited to ensure the procedure is being followed.

14.5. GENERAL INFORMATION FOR PROCEDURE

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to ships operating in a cold iron mode.
2. Personnel performing Shore Power connects and disconnects may be exposed to AC electrical potential greater than 1000 volts, AC electrical potential less than 1000 volts, and DC electrical potential 250 volts and less. Shore Power equipment shall be considered energized unless an Electrically Safe Work Condition has been established.
3. The Ship's Electrical Officer, Ship's Reactor Electrical Assistant (REA) or designated electrical representative is responsible for making cable connections to the ship's electrical bus fed by the ship's generators and dictating when Shore Power is energized to supply this bus.
4. Shore Power circuit breakers shall be open and racked out as required except during testing or when connected to Ship.
5. Shore Power service provides an ungrounded, correctly phased system, with an adequate number of shore power cables correctly oriented to serve the Ship's load. Where two or more power cables are connected to a Ship, cables must be grouped so that all the same phases are connected together.
6. When the ship requires more than one feeder cable, total cable length for each feeder will be within plus or minus 10 percent of each other to minimize unequal cable impedance. Conductors must be copper and have the same diameter size as the other paralleled conductors.
7. Ship's hull serves as ground for ship's electrical service. A physical cable ground connection between the shore and ship hull can result in damaging circulating currents.
8. **Note:** The CVN Class Propulsion Plant Manual (PPM) specifically prohibits the paralleling of forward and aft Shore Power and NAVSEA 05/08 must approve any deviations from these procedures. NAVFAC cannot authorize deviations. If a ship is supplied by two or more Shore transformers, Ship Personnel 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 NAVFAC authorizes the parallel operation of shore transformers. 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.
9. 13.8 kV Shore Power cables shall not be spliced under any conditions.
10. 13.8 kV Shore Power receptacles should be key interlocked, if equipped, with their associated 13.8 kV substation circuit breakers for safety reasons.

11. The area surrounding Shore Power and industrial power receptacles, plugs and portable power cables shall be barricaded to the greatest extent practicable in order to provide equipment and personnel protection.
12. The following documents were considered during the development of these procedures: "OSHA 29 CFR 1910.269 Electric Power Generation, Transmission, and Distribution", "EM 385-1-1, Health and Safety Requirements, Sections 11 & 12", "Navy Ships Technical Manual (NSTM), Chapters 320/300", "NAVSEA Manual S0400-AD-URM-010/TUM Rev 06 Tag-out User's Manual", and "NAVFAC P307 Management of Weight Handling Equipment."

14.6. CONNECT PROCEDURE FOR SHIPS UTILIZING 13.8 kV SHORE POWER

14.6.1. STEP 1 - PREPARE FOR SHIP'S ARRIVAL

1. Use the berthing assignment information received from Port Operations to prepare the berth for ship's arrival or the Logistics Requirement (LOGREQ) message from the arriving Ship, which describes power and general berthing requirements.
2. Obtain and utilize Ship Connect/Disconnect Form to record information. See Section 14.10 for example. Documents associated with an active connection shall be kept in a centralized location and continuously accessible. Upon ships departure, documents shall be stored in a centralized location, and records shall be maintained for a minimum of one year.
3. An Authorized Official or HV Shop Supervisor shall write Switching Orders and the Switching Order Package for Shore Power.
4. NAVFAC Qualified Person in Charge shall conduct a job brief and ensure all personnel have required equipment, tools, and PPE.

14.6.2. STEP 2 - LAY POWER CABLE ASSEMBLIES

1. Check berth for obstructions that may prevent safe Shore Power set up. If obstacles are present, inform NAVFAC Supervisor and Port Operations or appropriate authorities for removal.
2. Place vehicle or weight handling equipment in position.
 - 2.1. Only weight handling equipment and the following vehicles are authorized to deliver/retrieve power cables on the piers: shop mule, a line truck, a reel truck, fork lift, or a boom truck. Cable can also be hand carried.
 - 2.2. Use a spotter when backing up or placing in tight space.
 - 2.3. Operators shall have a valid license, training, and certification in accordance with Command policies.
3. Shore Power cables shall be placed at the pier where the ship will dock.
4. Lay out cables between Shore Power receptacles and Ship's Shore Power receptacles. Note the following **CAUTIONS**:

- 4.1. Ensure cable ends are not connected to any equipment, weight handling equipment or vehicle.
- 4.2. Excess cable shall be laid in such a manner as to minimize damage from vehicle and pedestrian traffic.
- 4.3. Each set of Shore Power cables should be positioned as a unit.
- 4.4. Do not lay or drag cables on or over sharp and ragged objects.
- 4.5. Shore Power cables and terminations should be physically isolated from shore steam, potable water, salt water, and all other service lines.
- 4.6. Do not exceed minimum cable bend radius. Per Insulated Cable Engineers Association, minimum THOF cable bend radius is eight (8) times the outer diameter for 15kV SHD type cable.
- 4.7. Provide adequate cable length to compensate for the rise and fall of the tide. Cable slack should not dip into the water, rub on structures causing abrasion, or become wedged between the ship and pier.
- 4.8. Ensure cables are the proper length, size and are arranged in a neat and safe manner.
- 4.9. To reduce overheating or de-rating cable, excess cable should not be coiled or stacked on each other.
- 4.10. Barricades shall be placed as necessary, to keep vehicles off cable.
- 4.11. Where cables would obstruct drains or scuppers, lay cables on a pallet to allow water drainage on the pier.
- 4.12. Do not hold or brace the cable in place as this may result in a foot or leg injury.
- 4.13. When loading or unloading Shore Power cables, the NAVFAC Electrical QP shall ensure that: the operation of the vehicle or weight handling equipment comply with applicable SOPs, barriers are set to proper distance, wheel chocks are placed down, sets of cables are connected together, no unauthorized persons are in the area of operations that may be struck by a swinging or falling cable, boom truck outriggers are not blocked by any obstructions and are not set on top of vault covers, steam covers, or manholes, booms never swing forward of the outriggers, reel trucks have placed stabilizer jacks.

14.6.3. STEP 3 - INSPECT AND TEST EACH POWER CABLE ASSEMBLY

1. NAVFAC QP shall confirm Shore Power cable assemblies are disconnected on both ends. If the NAVFAC QP in Charge determines it is necessary to verify Shore Power cable assemblies are de-energized, in accordance with Section 14.7, NAVFAC QP shall test each phase conductor or circuit part of the cables for no voltage prior to handling.

2. NAVFAC QP shall ensure inspection/testing team maintains control of both ends of Shore Power cable assemblies during inspection and testing to ensure cable assemblies stay disconnected at both ends.
3. Visually inspect Shore Power cable assemblies for any sign of defect. Cables not passing visual inspection shall be removed from service.
 - 3.1. Inspect cable assemblies for cracks, bulges, or indications of overheating.
 - 3.2. Inspect cable sheath for cuts, nicks, and gouges.
4. Clean and inspect high voltage shore connection plugs and lugs.
 - 4.1. Inspect cable plug and lug conducting surface for damage, corrosion, and evidence of overheating. Repair deficiencies or replace as necessary.
 - 4.2. If required by the connector manufacturer, apply a light coat of manufacturer approved grease or contact cleaner to the cable connectors.
5. Measure insulation resistance between cable assembly conductors and each conductor and ground for each circuit using a 5,000V megohmmeter. Insulation resistance must be measured across all pieces of portable Shore Power cable providing power to the ship. Minimum test voltage is 2,500VDC, minimum insulation readings for 13.8 kV Shore Power cables shall be 10 megohms.
6. Record all insulation resistance readings on Ship to Shore Power Cable Insulation Record (see Section 14.11) and record the lowest insulation resistance value on the Ship Connect/Disconnect Form (see Section 14.10).
7. Replace Shore Power cable if it does not meet minimum insulation resistance requirements.
8. Verify phase identification markings (color coding or labeling) of the cable assembly to ensure proper orientation (in-phase) between the Shore and Ship Shore Power cable plugs and lugs. NAVFAC QP shall check all cable assemblies for proper phase color coding: Phase "A" is black, Phase "B" is white and Phase "C" is red. This is performed while the cables are in an electrically safe work condition
9. Attach "DANGER-HIGH VOLTAGE" signs or high voltage caution tape to Shore Power cable assemblies or barricades every 20 feet, where possible.
10. Barricade the work area surrounding the Shore Power receptacles and portable Shore Power cables to the greatest extent possible.

14.6.4. STEP 4 - INSPECT AND TEST 13.8 KV SHORE RECEPTACLES

1. NAVFAC QP in Charge shall obtain the test data from the last ship connect or Annual PM performed on these 13.8kV Shore receptacles and conducts a job brief.
2. NAVFAC QP-HV and Authorized Employees, wearing appropriate PPE, shall establish an "Electrically Safe Working Condition." NAVFAC personnel shall follow switching orders prepared in accordance with UFC 3-560-01 and SOP PWBL 001.

- 2.1. Open, remove from cubicle (rack out), red danger tag and red danger lock Facility Shore Power receptacle circuit breakers in accordance with switching orders and Chapter 2.
- 2.2. Test Facility Shore Power circuit breakers load bus or receptacles for no voltage per Section 14.8.
- 2.3. Apply temporary personal protective grounds to Facility Shore Power circuit breakers, load bus, or receptacles per Section 14.9.
3. Carefully remove/open access cover(s) to each Shore Power receptacle and test for no voltage per Section 14.7. Use a voltage detector to test terminals in each Shore Power receptacle to ensure that they are de-energized. Verify these receptacles are in an electrically safe working condition.
4. Inspect each cover and receptacle. Clean as necessary to ensure proper operation.
 - 4.1. If applicable, inspect each cover gasket and each receptacle gasket for cuts, tears, cracks, and deformation.
 - 4.2. When inspecting socket type contacts, look for damage to the contact band such as missing or damaged louvers. Inspect each receptacle conducting surface for corrosion, damage, and evidence of overheating. If the receptacle is equipped with interlocks, inspect key interlock for proper operation.
5. If 13.8kV Shore Power receptacle testing was performed within the last 12 months, record the date of test and results on the Ship to Shore Power Cable Insulation Record (see Section 14.11). If test data is unavailable or older than 12 months, perform steps 5.1 through 5.4
 - 5.1. Disconnect equipment such as meters, indicating lights and fuses that could be damaged by a megohmmeter test or cause a false reading.
 - 5.2. Remove temporary personal protective grounds for testing purposes at load side of Facilities Shore Power receptacle circuit breaker one at a time. Use a 15kV megohmmeter; test the insulation resistance between each receptacle terminal and between each terminal and ground. Minimum insulation resistance is 10 megohms for 13.8 kV receptacles.
 - 5.3. Record megohmmeter values on the Ship Connect/Disconnect Form (see Section 14.11).
 - 5.4. Re-install indicator lights, appropriate fuses and reconnect appropriate meters.
 - 5.5. Test Facility Shore Power circuit breaker, load bus, or receptacle for no voltage per Section 14.7.
 - 5.6. Apply temporary personal protective grounds to the Facility Shore Power circuit breaker, load bus, or receptacles per Section 14.8.
6. Install/close Shore Power receptacle access covers.
7. Repair deficiencies if time permits. If repairs cannot be made, open circuit breaker and place a caution tag and lock on the breaker in accordance with Chapter 2 and report deficiencies to NAVFAC Supervisor.

14.6.5. STEP 5 - INSERTING CABLE PLUGS INTO SHORE RECEPTACLES

1. Upon the ship's arrival, NAVFAC QP in Charge shall contact Ship's Electrical Officer, (REA) or designated representative to ensure required ship's personnel are available, determine cable connection lengths and cable connection times.
2. NAVFAC and ship's personnel shall conduct a joint job brief and clearly agree on roles, responsibilities, and procedures for provision of Shore Power that meet the requirements of the applicable NAVFAC SOPs and Ship's SOPs. During the brief, provide Ship's Electrical Officer, REA, or designated representative with a copy of the Ship to Shore Power Cable Insulation Record (see Section 14.11), the Ship Connect/Disconnect Form (see Section 14.10) and Cable Test Certifications.
3. Shore Power cable connections shall be made from the Facility Shore Power receptacle toward the Ship's electric bus.
4. NAVFAC QP shall verify the Facility Shore Power receptacles are in an electrically safe work condition.
5. A QP-HV wearing PPE as specified in Chapter 4 shall carefully remove access cover to each Shore Power receptacle and test for no voltage per Chapter 5 and as described in Section 14.7 to verify the receptacles and Shore Power cables are de-energized.
6. Verify Shore Power cables are in an electrically safe work condition.
7. Insert Shore Power cable plugs into the Facility Shore Power receptacles. NAVFAC QP shall check all cable assemblies for proper phase color coding: Phase "A" is black, Phase "B" is white and Phase "C" is red. This is performed while the cables are in an electrically safe work condition.
8. Fill out and attach the Ship to Shore Tag (see Section 14.13) to cables at receptacle.

14.6.6. STEP 6 - SHORE POWER CABLE RIGGING

1. NAVFAC shall make available Shore Power circuit breaker red danger locks to ship personnel for their use during cable handling and cable connection to Ship's Shore Power bus.
 - 1.1. Ship personnel may install danger tags and danger locks, in accordance with ship procedures, on the NAVFAC Shore Power circuit breakers. NAVFAC QP and Ship personnel wearing appropriate PPE shall use an adequately rated voltage detector to test each phase conductor or circuit part of Shore Power cables to verify they are de-energized.
2. NAVFAC QP-HV, wearing appropriate PPE, shall verify that an electrically safe working condition exists in accordance with Chapters 2 and 4.
3. Anytime a NAVFAC employee handles the Ship to Shore Power cable, temporary personal protective grounds must be installed. If a NAVFAC operated crane or boom truck will be used to load Shore Power cable from the ship onto the pier, temporary personal protective grounds must be installed before crane or boom

truck moves Shore Power cables. If Ship's Personnel will load Shore Power cables to ship, a QP-HV wearing PPE as specified in Chapter 4 shall remove temporary personal protective grounds as specified in the switching orders and in accordance with the requirements of this document.

4. Load Shore Power cable assemblies from shore, to camels/booms, to ship.
 - 4.1. If boom trucks or cranes are used, follow appropriate boom truck and crane SOP.
 - 4.2. Do not lift Shore Power cables to ship by the plug.
5. If a NAVFAC employee operated crane or boom truck was used to load cable to ship, a QP-HV wearing PPE as specified in Chapter 4 shall remove temporary personal protective grounds as specified in the switching orders and in accordance with Chapters 1 and 4, and as described in Appendices B and C.
6. Ship personnel will connect Shore Power cable plugs to the Ship's Shore Power receptacles in accordance with ship's SOPs.
7. All black color coded Shore Power cables should be connected to ship's Shore Power bus Phase A, all white color coded Shore Power cables should be connected to Ship's Shore Power bus Phase B and all red color coded Shore Power cables should be connected to Ship's Shore Power bus Phase C. NAVFAC QP in Charge shall obtain signature of the Ship's Electrical Officer, REA, or designated representative on the Ship Connect/Disconnect Form giving NAVFAC personnel permission to energize Shore Power at the agreed upon time.
8. NAVFAC QP shall escort ship personnel while ship personnel remove their danger tags and danger locks from NAVFAC Shore Power circuit breaker cubicles.
9. NAVFAC personnel shall remove their red danger locks and red danger tags from NAVFAC Facility circuit breaker(s) cubicle(s) as specified in the switching orders and in accordance with Chapter 2. A QP-HV, wearing the required PPE, shall rack in circuit breaker(s) into circuit breaker cubicle(s) in accordance with the switching orders.
 - 9.1. **Note:** Some shore facilities have one 13.8 kV circuit breaker serving one 400 ampere Shore Power receptacle and therefore one 400 ampere Shore Power cable. Some shore facilities have one 13.8 kV circuit breaker serving two 400 ampere Shore Power receptacles and therefore two 400 ampere Shore Power cables. Some shore facilities have one 13.8 kV circuit breaker serving four 400 ampere Shore Power receptacles and therefore four 400 ampere Shore Power cables.
10. After receiving permission from Ship's Electrical Officer, REA, or designated representative, a NAVFAC QP shall close Facility Shore Power circuit breakers in the sequence requested by the Ship's Electrical Officer, REA, or designated representative.

14.6.7. STEP 7 - SHIP'S TRANSFER TO SHORE POWER

1. **CAUTION:** Ship's personnel, in accordance with Ship's SOPs, will synchronize ship's generators with Shore Power and transfer power from the Ship's generators to Shore Power within the shortest interval possible. Actual phases of Shore Power must be the same rotation and also be connected to match ship phases (orientation, in-phase).
2. When the Ship's Electrical Officer, REA, or designated representative has notified the NAVFAC QP that transfer is complete, the Ship Connect/Disconnect Form shall be filled out and NAVFAC QP in Charge shall obtain signature of the Ship's Electrical Officer, REA, or designated representative thereby accepting Shore Power.
3. **Note:** No personnel may move energized Shore Power cable assemblies.
4. NAVFAC personnel shall check amperage readings on all phases of each cable and record them on the Shore Power Load Current Analysis Form, Section 14.12. The preferred method is permanently installed ammeters, however clamp-on ammeters are allowed.
 - 4.1. This can be accomplished by using the 13.8 kV circuit breakers ammeters for the scheme where one circuit breaker serves one receptacle.
 - 4.2. Verify that phase amperage readings are within 10 percent of each other per the Shore Power Load Current Analysis Form.
 - 4.2.1. For each cable, add all three readings together and divide by three to get the average. Divide that number by 10 and all three readings should not differ from the average by more than that amount. For example, if phase A reads 230A, phase B reads 240A, and phase C reads 250A, the average is $(230+240+250)/3 = 240$. $240/10 = 24$. All three phases read within plus or minus 24 (10%) of 240 (average), so these are acceptable readings for this example.
 - 4.3. If the amperage readings are not within 10 percent, notify NAVFAC QP, Ship's representative, and perform a thermal infra-red imaging survey.
 - 4.4. The average current of each circuit must also be within 10 percent of the combined average current of all circuits. If they are not, notify NAVFAC QP for further instruction.
 - 4.5. If any circuit has zero current, open, caution lock and tag the breaker feeding that circuit.
5. After the ship is drawing current and has reached at least 50% load for 1 hour, NAVFAC QP will perform a thermal infra-red imaging (IR) survey in accordance with NAVFAC SOPs to ensure all Shore Power equipment is operating within safe tolerances.
 - 5.1. The NAVFAC IR survey will include the connector at the Shore Power substation to the last connector on the pier.

- 5.2. **CAUTION:** Breakers, receptacles, and cables are energized. If deficiencies are found, NAVFAC QP in charge shall conduct a job brief to coordinate and communicate with ship personnel for taking the circuit offline/de-energizing.
- 5.3. Repair deficiencies if time permits. If repairs cannot be made, de-energize the circuit, place a caution tag and lock on the breaker in accordance with E-SAFE PWBL 01 and report deficiencies to NAVFAC Supervisor.
6. When the IR survey is complete, the Ship Connect/Disconnect Form shall be signed indicating completion of the task.

14.7. TEST FOR NO VOLTAGE

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be Qualified Persons as defined in the Chapter 1 using the required PPE. This energized work will require a local SOP approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
2. A QP HV shall test for no voltage per Chapter 5.
3. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

14.8. TEST FOR NO VOLTAGE AND APPLY TEMPORARY PERSONAL PROTECTIVE GROUNDS

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP-HV as defined in the Electrical SAFE PWBL-SAFE 01 and use the required PPE. This energized work will require a local SOP approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
2. If temporary personal protective grounding equipment is to be used, wear the required PPE. Installing temporary personal protective grounds is considered working on an exposed energized electrical system. Personnel installing temporary personal protective grounds shall be a Qualified Person as defined in Chapter 1. Install temporary personal protective grounds per Section 14.9.
3. A QP-HV shall test for no voltage per Chapter 5.
4. If voltage is present, stop work review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.
5. The SOC personnel, HV Shop Supervisor and NAVFAC QP-HV shall communicate and initial off, on the switch out and temporary personal protective grounds sheet of the switching orders, the installation of each temporary personal protective ground.

14.9. TEMPORARY PERSONAL PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

1. Temporary personal protective grounds are assemblies consisting of clamps, ferrules, and cable capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
2. Any circuit not grounded shall be considered energized except when grounding has been waived.
3. An Electrical Utility Supervisor or QP-HV, as specified in Chapter 1, Section 1.8.8.1, can waive the grounding requirement if it can be demonstrated that installation of grounds is impractical or that the installation of grounds would present a greater hazard than working without grounds. Waiving of grounds shall be documented on the switch out sheet of the switching orders. In this case, the conductors and equipment may be treated as de-energized provided the following conditions are met.
 - 3.1. The conductors and equipment have been de-energized, red danger locked, red danger tagged and tested for no voltage per Section 14.7.
 - 3.2. There is no possibility of contact with another energized source.
 - 3.3. The hazard of induced voltage is not present.
4. One must be a QP-HV to install or remove temporary personal protective grounds. This energized work will require a local SOP approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
5. A serialized red danger tag with location(s) of installed grounds recorded shall accompany all ground placements under LOTO.
6. Equipotential grounding, as described in Chapter 1, Section 1.8.8, shall be utilized when feasible. When not feasible, grounds shall be placed as close to the work site as practical.
7. Switching orders are required to install or remove temporary personal protective grounds on circuits or equipment over 1000 volts. Ground locations shall be specified in the switching orders.
8. Temporary personal protective grounds shall be constructed in accordance with ASTM F855, "Specification for Temporary Protective Grounds to be used on De-energized Electrical Power Lines and Equipment," and installed in accordance with UFC 3-560-01 "Electrical Safety O&M," OSHA 29CFR 1910.269(n) "Grounding for the Protection of Employees" and IEEE Std 1246 "IEEE Guide for Temporary Protective Grounding Systems Used in Substations." Temporary personal protective grounds shall be appropriately sized with the correct connection for the application.
9. Temporary personal protective grounds shall have an impedance low enough to cause immediate operation of protective devices in case of accidental energizing of the lines or equipment.

10. Conductors to be grounded shall be cleaned of oxidation or other conditions that would reduce conductivity at the point the clamp is to be installed.
11. When a temporary personal protective ground is attached to a line/conductor or equipment, the ground-end connection shall be attached first and then the other end shall be attached by means of voltage rated gloves with a live line tool. Use safe work practices and wear the required PPE.
12. When a temporary personal protective ground is to be removed, the grounding device shall be removed from the line/conductor or equipment using voltage rated gloves with a live line tool before the ground-end connection is removed. Use safe work practices and wear the required PPE.

14.10. SAMPLE SHIP CONNECT/DISCONNECT FORM

ELECTRICAL SHORE POWER SERVICE PROCEDURE

CONNECT

DISCONNECT

ARRIVAL TIME: _____

DEPARTURE TIME: _____

DATE:	SHIP'S NAME:	PIER/BERTH:	VAULT:	OTHER:
REPORT IMPLEMENTED BY: <input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> OTHER		INITIAL HOOK UP FOR ARRIVAL: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED		OUTAGE INFORMATION: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> UNSCHEDULED <input type="checkbox"/> ENERGIZING S/P
FEEDER LENGTH: _____		CABLE TYPE (480V, 4,160V OR 13.8KV): _____		
NUMBER OF CABLES USED: _____		# OF PIGTAILS USED: _____		# OF SUB PLUGS USED: _____
INSPECT AND PERFORM THE FOLLOWING AS REQUIRED:				
Condition of Connection	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Meter KW HRS: _____	
Operation of Breakers	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	List Breakers: _____	
Megger Cables	Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>	Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Lowest Megger Value on Cables: _____ MEGOHMS (Min. Megger Value: 480V - 4 Megohms, 4160V/13.8kV -10 Megohms)	
Check Current Load	Acceptable <input type="checkbox"/> Unacceptable <input type="checkbox"/>	Average Current Load: _____ AMPS		
AUTHORIZATION TO CONNECT / DISCONNECT CABLES			AUTHORIZATION TO ENERGIZE / DE-ENERGIZE BREAKERS:	
All Shipboard Breakers Are Open			Electrical Shore Power Area Aboard Ship Is Free And Clear Of Obstacles And Personnel	
Potential Energy Sources Have Been Isolated			Breaker Sequence Requested By Ship For 480V Service Or Switching Orders Have Been Prepared	
It Is Safe To Handle Shore Power Cables			Cables Are Plugged In And Are Ready To Be Energized Or De-Energized	
Ship Electrical Officer And Senior Electrician Sign:			Ship Electrical Officer Sign:	
PW Utilities Electrician: Sign, Date & Time:			PW Utilities Electrician: Sign, Date & Time	
SHIP CONNECTED / DISCONNECTED FROM FACILITY SHORE POWER				
Ship Electrical Officer: Print Name, Sign, Date, & Time				
PW Utilities Electrician: Print Name, Sign, Date, & Time				
After shore power is restored to ship, record circuit readings after the ship has a stable load. All phases and average current readings must be within 10% for of each shore power cable and circuit. Use the Shore Power Load Current Analysis form to record readings as required and attach to this document. If ship elects not to go back on shore power at this time, take readings as soon as possible.				
Ship load at least 50% for 1 hour and INFRA-RED Survey Performed: <input type="checkbox"/> Equipment Condition: Ok <input type="checkbox"/> Need Repair <input type="checkbox"/> Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>				
Ship Electrical Officer: Print Name, Sign & Date				
PW Utilities Electrician: Print Name, Sign & Date				

14.11. SAMPLE SHIP TO SHORE POWER CABLE INSULATION RECORD

Ref: OPNAVINST 11310.3 and UFC 4-150-02

Ship: _____ Berth: _____ Date: _____

3. Visually inspect cable and the terminations for damage and corrosion. Use a Megger to measure cable insulation resistance rated for the 13.8kV, 4,160V, or 480V cables under test (Min of 10 Megohm for 13.8kV and 4,160V and 4 Megohm for 480V). Document the Insulation Resistance readings below:

	Cable#	Plug #	A-B	B-C	C-A	A-Gnd	B-Gnd	C-Gnd	Date	Time	Signature
Ship to Shore Cable											
Receptacle to Breaker											
<p>2. Inform ship's representative of any Special Conditions or Restrictions (i.e., load current limitations, closing ship's bus ties, cables conditions, etc.)</p> <p>3. SSN/SSGN/SSBN/480 Volt surface ships cables/4160V three pole connectors and lugs/13.8kV couplers: Inspect the connectors and lugs or couplers. Clean cable plugs/couplers and inspect each conducting surface for damage, corrosion, and evidence of overheating. Only when recommended by connector manufacturer should the use of approved contact lubricant be applied to the connectors.</p>											

SPECIAL INSTRUCTIONS: Paralleling Transformers - If a ship is supplied by two transformers, the ship is not permitted to parallel these transformers through the ships bus tie. If shore transformers are paralleled though the ship's bus, circulating currents may overheat and destroy cables, transformers and switchgear on board ship, or on shore.

Ship's Representative: _____

Date: _____

NAVFAC Representative: _____

Date: _____

14.13. SHIP TO SHORE TAG

CONNECT / DISCONNECT TAG DATE: _____

CABLE #s: _____

PLUG #s: _____

RECEPTACLE #: _____

OPERATOR: _____ **SHIP:** _____

14.14. 13.8kV SHIP CONNECT INSPECTION CHECKLIST

NAME OF INSPECTOR: _____ INSTALLATION: _____
 SHIP TO BE CONNECTED: _____ LOCATION OF CONNECT: _____

ITEM		
Procedure Requirements	YES	NO
Are all personnel qualified for the required work and on the SOC list?		
Are all personnel wearing appropriate PPE throughout the entire procedure?		
Did NAVFAC Qualified Person (QP) in Charge conduct a Job Brief?		
Remarks for Procedural Deficiencies:		
Step 1 – Prepare for Ship’s Arrival	YES	NO
Have power and general berthing requirements been collected from Port Operations or ship’s Logistics Requirement message?		
Has an Authorized Official written switching orders?		
Was a Ship Connect Form used and accessible during the active connection process?		
Remarks for Step 1 Deficiencies:		
Step 2 – Lay Power Cable Assemblies	YES	NO
Has the berth been cleared of obstructions?		
Have S2S cables been delivered and laid out in the following manner:		
Not connected to any electrical equipment, handling equipment, or vehicles?		
Positioned to minimize damage from vehicle and pedestrian track?		
Positioned to avoid all sharp and ragged objects?		
Physically isolated from all other shore service lines?		
Doesn’t exceed the minimum bend radius?		
Excess cable is not coiled to avoid overheating?		
Remarks for Step 2 Deficiencies:		
Step 3 – Inspect and Test Each Power Cable Assembly	YES	NO
Have cables been checked to ensure that they were disconnected on both ends and were any connected cables tested for no voltage before continuing?		
Have cables and connectors been inspected for defects (cracks/cuts, pitting/corrosion, bulges, and failure of locking mechanisms) and been repaired/replaced as necessary?		
Have all cable assemblies been measured for insulation resistance and recorded on the Ship to Shore Power Cable Insulation Record? Were cables replaced if they did not meet the minimum insulation resistance requirements?		

Have phase identification markings (color coding or labeling) on the shore power cable assembly been verified to ensure proper phase orientation?		
Have "DANGER-HIGH VOLTAGE" signs been placed on barricades near or attached to cable assemblies?		
Has the work area surrounding the Shore Power receptacles and portable shore power cables been roped off or barricaded?		
Remarks for Step 3 Deficiencies:		
Step 4 – Inspect and Test 13.8kV Shore Receptacles	YES	NO
Has NAVFAC QP in Charge obtained the test data from the last ship connect or Annual PM performed on the 13.8kV shore receptacles?		
Have switching orders been followed to de-energize shore power circuit breakers?		
Have facility shore power circuit breakers been opened, removed from cubicle (racked out), and have red danger tags and red danger locks been installed?		
Has NAVFAC QP-HV tested for no voltage, installed temporary protective grounds and established an Electrically Safe Working Condition?		
Have receptacles been cleaned and inspected for defect? (pitting, corrosion, and evidence of overheating, binding or sticking in interlock switches)		
Have 13.8kV shore power receptacles been tested in the last 12 months? If not, was testing performed prior to work being performed?		
Have Shore Power circuit breakers been opened and tested for no voltage after all testing was completed?		
Have temporary protective grounds been reinstalled after testing was completed?		
Have deficiencies been repaired or caution tags and locks placed where time does not permit repair? (Also check yes if no deficiencies exist)		
Remarks for Step 4 Deficiencies:		
Step 5 – Inserting Cable Plugs into Shore Receptacles	YES	NO
Has NAVFAC QP in Charge conducted a Job Brief with NAVFAC personnel and Ship's electrical representative and provided the Ship with the Ship Connect Form, Ship to Shore Cable Insulation Record, and Cable Tests?		
Have Shore Power circuit breakers been opened and have red danger tags and red danger locks been placed and were breakers tested for no voltage?		
Did NAVAC QP ensure that shore power cable assemblies were disconnected on both ends and did NAVFAC QP-HV test for no voltage?		
Have Shore Power cable plugs been connected to Facility shore power receptacles with Ship to Shore Tag's attached?		

Did NAVFAC QP-HV check all cable assemblies for proper phase identification markings (color coding or labeling) to ensure proper phase orientation?		
Remarks for Step 5 Deficiencies:		
Step 6 – Shore Power Cable Rigging	YES	NO
Did NAVFAC QP in Charge make red danger locks available to ship's forces for use during cable handling?		
If necessary due to distance between receptacles and the Ship, have all inline connections or splices been made before connecting to any Ship or Shore Power receptacles? (Check yes if no inline connections or splices exist)		
Have Shore Power cable assemblies been loaded to the Ship following applicable SOPs and in a manner that would not cause additional stress on inline connections/splices or cause damage to ship's plug, if already attached?		
Have Shore Power cable assemblies been lashed to the Ship and Shore while allowing sufficient slack for tidal changes?		
Did NAVFAC QP in Charge obtain Ship's Electrical Officer's signature on the Ship Connect Form giving permission to energize shore power?		
Have Ship's forces removed their red danger locks from Facility Shore Power breakers and returned them to NAVFAC?		
Have NAVFAC placed red danger locks and red danger tags been removed from Facility Shore Power breakers?		
Did NAVFAC personnel follow requested sequence for closing circuit breakers as requested by the Ship's Electrical Officer?		
Remarks for Step 6 Deficiencies:		
Step 7 – Ship's Transfer to Shore Power	YES	NO
Did NAVFAC QP in charge obtain signature from Ship's Electrical Officer verifying that they have accepted shore power?		
Did NAVFAC personnel check amperage readings of each cable and check for abnormalities using the Shore Power Current Analysis Worksheet?		
If abnormalities were found, were they reported to NAVFAC QP and Ship's Electrical Supervisor and was an IR survey perform on the connector and cable? (Also check yes if no abnormalities were found)		
After one-hour of at least 50% load, was an IR survey performed for all connectors?		
If any cable repairs or replacements are required based on Current Analysis or IR survey, were they completed? (Also check yes if repairs/replacements are not needed)		

If cables can not be repaired or replaced, has the Ship's Electrical representative signed off on accepting less than the original number of circuits and has the circuit been taken out of service with a caution tag hung and caution lock installed?		
Remarks for Step 7 Deficiencies:		

CHAPTER 15 - 13.8KV SHIP DISCONNECT

15.1. PURPOSE

Provide standard procedures for disconnecting 13,800 Volt Shore Power to surface ships. This procedure applies to CVN 78.

15.2. BACKGROUND

The disconnection of 13.8kV Volt Shore Power to Ships is a hazardous operation. Hazards mitigated by this Chapter are: electrical shock, arc flash, arc blast, and electrical burns.

All steps in this procedure must be followed and total compliance is critical to mitigating the hazards associated with Shore Power Connections and Disconnections. Thorough training, job planning, and exhaustive communication between Naval Facilities Engineering Command (NAVFAC) in-house forces, contractor personnel, other DoD agencies and Ship Personnel are necessary to ensure the highest level of safety for all involved.

15.3. TOOLS AND PERSONAL PROTECTIVE EQUIPMENT

Any worker whose normal job includes working on or near exposed energized electrical conductors or equipment shall wear, as a minimum, Arc Rated long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm² and leather Electrical Hazard rated safety shoes/boots.

Tools, equipment, and additional Personal Protective Equipment (PPE) necessary to perform this procedure are provided in Chapter 4 Working on or Near Exposed and Enclosed Energized Electrical Systems and Chapter 5 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems.

15.4. TRAINING, CERTIFICATION, AND RECORD KEEPING

All employees whose job requires the use of this procedure shall be trained to understand the purpose and function of the hazardous energy control program, the hazards they face, demonstrate a working level knowledge of all process steps and applicable references, and complete site specific training as required. The training requirements shall be identified and associated with the employee profile in ESAMS.

Training completion shall be registered in ESAMS. Additionally, a list of names and job titles of Authorized Employees and Qualified Persons shall be maintained by SOC personnel and available to Command employee(s) responsible for dispatching/assigning work.

At least once per year, execution of this procedure shall be audited to ensure the procedure is being followed.

15.5. GENERAL INFORMATION FOR PROCEDURE

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Ships operating in a cold iron mode.
2. Personnel performing Shore Power Connects and Disconnects may be exposed to AC electrical potential greater than 1000 volts, AC electrical potential less than 1000 volts and DC electrical potential 250 volts and less. Shore power equipment shall be considered energized unless an Electrically Safe Work Condition has been established.
3. The Ship's Electrical Officer, Ship's Reactor Electrical Assistant (REA) or designated representative is responsible for making cable connections and disconnections to the Ship's generators Shore Power receptacles and dictating when Shore Power is de-energized to allow Ship's load transfer to Ship's power.
4. Shore Power service provides an ungrounded, correctly phased system, with an adequate number of shore power cables correctly oriented to serve the Ship's load. Where two or more power cables are connected to a Ship, cables must be grouped so that all the same phases are connected together.
5. Ship's hull serves as ground for Ship's electrical service. A physical cable ground connection between the Shore and Ship hull can result in damaging circulating currents.
6. 13.8kV Shore Power receptacles should be key interlocked, if equipped, with their associated 13.8 kV substation circuit breakers for safety reasons.
7. Shore Power circuit breakers shall be open except during testing or when connecting the Ship to Shore Power.
8. **Note:** The CVN Class Propulsion Plant Manual (PPM) specifically prohibits the paralleling of forward and aft Shore Power and NAVSEA 05/08 must approve any deviations from these procedures. NAVFAC cannot authorize deviations. If a ship is supplied by two or more shore transformers, Ship Personnel 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 NAVFAC authorizes the parallel operation of shore transformers. 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.
9. The area surrounding Shore Power and industrial power receptacles, plugs and portable power cables shall be barricaded to the greatest extent practicable in order to provide equipment and personnel protection.
10. The following documents were considered during the development of these procedures: "OSHA 29 CFR 1910.269 Electric Power Generation, Transmission, and Distribution", "EM 385-1-1, Health and Safety Requirements, Sections 11 & 12", "Navy Ships Technical Manual (NSTM), Chapters 320/300", "NAVSEA Manual S0400-AD-URM-010/TUM Rev 06 Tag-out Users Manual", and "NAVFAC P307 Management of Weight Handling Equipment."

15.6. DISCONNECT PROCEDURE FOR SURFACE SHIPS UTILIZING 13800 VOLT SHORE POWER

15.6.1. STEP 1 - SHIP'S LOAD TRANSFER TO THE SHIP'S GENERATOR(S)

1. NAVFAC and Ship's Personnel shall conduct a joint Job Brief and clearly agree on roles, responsibilities, and procedures for disconnection of Shore Power that meet the requirements of the applicable NAVFAC SOPs, Ship's SOPs, and NAVSEA Steam & Electric Plant Manual.
2. Obtain and utilize Ship Connect/Disconnect Form to record information. See 15.10 for example. Documents associated with an active disconnection shall be kept in a centralized location and continuously accessible. Upon Ships departure, documents shall be stored in a centralized location, and records shall be maintained for a minimum of one year.
3. An Authorized Official or HV Shop Supervisor shall write Switching Orders and the Switching Order Package for Shore Power.
4. **CAUTION:** Ship's Personnel, in accordance with Ship's SOPs, will synchronize Ship's generators with Shore Power and transfer power from Shore Power to the Ship's generators within the shortest interval possible.
5. When the Ship's Electrical Officer, REA, or designated representative has notified the NAVFAC QP that transfer is complete, the Ship Connect/Disconnect Form shall be filled out and the NAVFAC QP in Charge shall obtain the signature of the Ship's Electrical Officer, REA, or designated representative thereby giving shore activity personnel permission to de-energize Shore Power.

15.6.2. STEP 2 - DISCONNECTION OF SHORE POWER CABLE PLUGS FROM RECEPTACLES

1. Shore Power cables shall be disconnected from the Ship's Shore Power bus toward the Facility Shore Power receptacles.
2. Ship personnel shall verify Ship's Shore Power circuit breakers are open and danger tags installed in accordance with Ship's SOPs, NAVSEA Steam & Electric Plant Manual, and Ship's safety procedures.
3. NAVFAC QP-HV and Authorized Employees, wearing appropriate PPE, shall establish an Electrically Safe Working Condition. NAVFAC personnel shall follow switching orders prepared in accordance with PWBL 001.
 - 3.1. Open, remove from cubicle (rack out), red danger tag and red danger lock Facility Shore Power receptacle circuit breakers in accordance with switching orders and Chapter 2.
4. NAVAC shall make available Shore Power circuit breaker danger locks to Ship personnel for their use during cable handling and disconnection from Ship Shore Power receptacles.

- 4.1. Ship Personnel may install danger tags and danger locks, in accordance with Ship Procedures, on the Facility Shore Power circuit breakers.
5. At the Ship's Shore Power bus, Ship personnel test for no voltage in accordance with Ship's SOPs, NAVSEA Steam & Electric Plant Manual, and Ship's safety procedures to verify the busses are de-energized.
 - 5.1. If no voltage is detected, Ship personnel disconnect cable assemblies by removing cable couplers from Ship's Shore Power buses.
6. The Ship's electrical officer or Ship's designated electrical representative and NAVFAC QP-in-charge shall ensure that an electrically safe work condition was established for the Shore Power cables.

15.6.3. STEP 3 - REMOVAL OF SHORE POWER CABLE ASSEMBLIES

1. Place vehicle or weight handling equipment in position.
 - 1.1. Only weight handling equipment and the following vehicles are authorized to deliver/retrieve power cables on the piers: shop mule, a line truck, a reel truck, fork lift, or a boom truck. Cable can also be hand carried.
 - 1.2. Use a spotter when backing up or placing in tight space.
 - 1.3. Operators shall have a valid license, training, and certification in accordance with Command policies.
2. When loading or unloading Shore Power cable, the NAVFAC Electrical QP shall ensure that: the operation of the vehicle or weight handling equipment used comply with applicable SOPs, barriers are set to proper distance, wheel chocks are placed down, sets of cables are connected together, no unauthorized persons are in the area of operations that may be struck by swinging or falling cable, boom truck outriggers are not blocked by any obstructions and are not set on top of vault covers, steam covers, or manholes, booms never swing forward of the outriggers, reel trucks have placed stabilizer jacks.
 - 2.1. Do not lift Shore Power cables to ship by the plug. Ship personnel lower Shore Power cable assemblies from the Ship to camels/booms onto the pier.
3. Anytime a NAVFAC employee handles the ship to Shore Power cables, temporary personal protective grounds shall be installed. If a NAVFAC operated crane or boom truck will be used to load Shore Power cable from the ship onto the pier, temporary personal protective grounds must be installed before crane or boom truck moves Shore Power cables.
4. NAVFAC QP-HV, wearing PPE as specified in Chapter 4, shall install temporary personal protective grounds as specified in the switching orders to Facility Shore Power circuit breakers load bus or receptacles in accordance with Chapters 2 and 5, and as described in Appendices B and C.
5. NAVFAC QP HV, wearing appropriate PPE, shall test for no voltage as described in Section 15.7 to verify the Shore Power cable assemblies are de-energized.

- 5.1. If no voltage is detected, disconnect cable assemblies by removing Shore Power couplers from Facility Shore Power receptacles.
- 5.2. Re-install protective covers to keep interior of the couplers clean while disconnected.
6. Ship Personnel shall remove danger tags and/or danger locks, in accordance with Ship Procedures, on the NAVFAC Facility Shore Power circuit breakers.
7. NAVFAC QP and Ship's representatives sign ship connect/disconnect form verifying Shore Power removal is complete.
8. NAVFAC QP-HV and Authorized Employees, wearing appropriate PPE, shall follow switching orders prepared in accordance with Chapter 2 when required to restore operation of breakers.
 - 8.1. Remove Temporary personal protective grounds-to Facility Shore Power circuit breakers load bus or receptacles per Section 15.8.
 - 8.2. Remove the red danger locks and red danger tags from Facility Shore Power circuit breaker(s) cubicle(s)
 - 8.3. Insert (rack in) circuit breaker(s) into circuit breaker cubicle(s) in accordance with switching orders and Chapter 2.
 - 8.4. Remove Ship to Shore Tags from cables.

15.7. TEST FOR NO VOLTAGE

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a Qualified Person as defined in the Chapter 1 using the required PPE. This energized work will require a local SOP approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
2. A QP HV shall test for no voltage per Chapter 5.
3. If voltage is present, stop work and review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.

15.8. TEST FOR NO VOLTAGE AND APPLY TEMPORARY PERSONAL PROTECTIVE GROUNDS

1. Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP-HV as defined in the Electrical SAFE PWBL-SAFE 01 and use the required PPE. This energized work will require a local SOP approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
2. If temporary personal protective grounding equipment is to be used, wear the required PPE. Installing temporary personal protective grounds is considered working on an exposed energized electrical system. Personnel installing temporary

personal protective grounds shall be a Qualified Person as defined in Chapter 1. Install temporary personal protective grounds per Section 15.9.

3. A QP-HV shall test for no voltage per Chapter 5.
4. If voltage is present, stop work review all available information in order to find the energy source. Investigate until resolved using safe work practices and required PPE.
5. The SOC personnel, HV Shop Supervisor and NAVFAC QP-HV shall communicate and initial off, on the switch out and temporary personal protective grounds sheet of the switching orders, the installation of each temporary personal protective ground.

15.9. TEMPORARY PERSONAL PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

1. Temporary personal protective grounds are assemblies consisting of clamps, ferrules, and cable capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
2. Any circuit not grounded shall be considered energized except when grounding has been waived.
3. An Electrical Utility Supervisor or QP-HV, as specified in Chapter 1, Section 1.8.8.1, can waive the grounding requirement if it can be demonstrated that installation of grounds is impractical or that the installation of grounds would present a greater hazard than working without grounds. Waiving of grounds shall be documented on the switch out sheet of the switching orders. In this case, the conductors and equipment may be treated as de-energized provided the following conditions are met.
 - 3.1. The conductors and equipment have been de-energized, red danger locked, red danger tagged and tested for no voltage per Section 15.7.
 - 3.2. There is no possibility of contact with another energized source.
 - 3.3. The hazard of induced voltage is not present.
4. One must be a QP-HV to install or remove temporary personal protective grounds. This energized work will require a local SOP approved, in writing, by the Commanding Officer/Executive Officer in accordance with the requirements of this document.
5. A serialized red danger tag with location(s) of installed grounds recorded shall accompany all ground placements under LOTO.
6. Equipotential grounding, as described in Chapter 1, Section 1.8.8, shall be utilized when feasible. When not feasible, grounds shall be placed as close to the work site as practical.
7. Switching orders are required to install or remove temporary personal protective grounds on circuits or equipment over 1000 volts. Ground locations shall be specified in the switching orders.

8. Temporary personal protective grounds shall be constructed in accordance with ASTM F855, "Specification for Temporary Protective Grounds to be used on De-energized Electrical Power Lines and Equipment," and installed in accordance with UFC 3-560-01 "Electrical Safety", OSHA 29CFR 1910.269(n) "Grounding for the Protection of Employees" and IEEE Std 1246 "IEEE Guide for Temporary Protective Grounding Systems Used in Substations." Temporary personal protective grounds shall be appropriately sized with the correct connection for the application.
9. Temporary personal protective grounds shall have an impedance low enough to cause immediate operation of protective devices in case of accidental energizing of the lines or equipment.
10. Conductors to be grounded shall be cleaned of oxidation or other conditions that would reduce conductivity at the point the clamp is to be installed.
11. When a temporary personal protective ground is attached to a line/conductor or equipment, the ground-end connection shall be attached first and then the other end shall be attached by means of voltage rated gloves with a live line tool. Use safe work practices and wear the required PPE.
12. When a temporary personal protective ground is to be removed, the grounding device shall be removed from the line/conductor or equipment using voltage rated gloves with a live line tool before the ground-end connection is removed. Use safe work practices and wear the required PPE.

15.10. SAMPLE SHIP CONNECT/DISCONNECT FORM

ELECTRICAL SHORE POWER SERVICE PROCEDURE

CONNECT

DISCONNECT

ARRIVAL TIME: _____

DEPARTURE TIME: _____

DATE:	SHIP'S NAME:	PIER/BERTH:	VAULT:	OTHER:
REPORT IMPLEMENTED BY: <input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> OTHER		INITIAL HOOK UP FOR ARRIVAL: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED		
OUTAGE INFORMATION: <input type="checkbox"/> SCHEDULED <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> UNSCHEDULED <input type="checkbox"/> ENERGIZING S/P				
FEEDER LENGTH: _____		CABLE TYPE (480V, 4,160V OR 13.8KV): _____		
NUMBER OF CABLES USED: _____		# OF PIGTAILS USED: _____	# OF SUB PLUGS USED: _____	
INSPECT AND PERFORM THE FOLLOWING AS REQUIRED:				
Condition of Connection Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Meter KW HRS: _____	
Operation of Breakers Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	List Breakers: _____	
Megger Cables Ok <input type="checkbox"/> Need Repair <input type="checkbox"/>		Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>	Lowest Megger Value on Cables: _____ MEGOHMS (Min. Megger Value: 480V - 4 Megohms, 4160V/13.8kV -10 Megohms)	
Check Current Load Acceptable <input type="checkbox"/> Unacceptable <input type="checkbox"/>		Average Current Load: _____ AMPS		
AUTHORIZATION TO CONNECT / DISCONNECT CABLES			AUTHORIZATION TO ENERGIZE / DE-ENERGIZE BREAKERS:	
All Shipboard Breakers Are Open			Electrical Shore Power Area Aboard Ship Is Free And Clear Of Obstacles And Personnel	
Potential Energy Sources Have Been Isolated			Breaker Sequence Requested By Ship For 480V Service Or Switching Orders Have Been Prepared	
It Is Safe To Handle Shore Power Cables			Cables Are Plugged In And Are Ready To Be Energized Or De-Energized	
Ship Electrical Officer And Senior Electrician Sign:			Ship Electrical Officer Sign:	
PW Utilities Electrician: Sign, Date & Time:			PW Utilities Electrician: Sign, Date & Time	
SHIP CONNECTED / DISCONNECTED FROM FACILITY SHORE POWER				
Ship Electrical Officer: Print Name, Sign, Date, & Time				
PW Utilities Electrician: Print Name, Sign, Date, & Time				
After shore power is restored to ship, record circuit readings after the ship has a stable load. All phases and average current readings must be within 10% for of each shore power cable and circuit. Use the Shore Power Load Current Analysis form to record readings as required and attach to this document. If ship elects not to go back on shore power at this time, take readings as soon as possible.				
Ship load at least 50% for 1 hour and INFRA-RED Survey Performed: <input type="checkbox"/> Equipment Condition: Ok <input type="checkbox"/> Need Repair <input type="checkbox"/> Repaired? Yes <input type="checkbox"/> No <input type="checkbox"/>				
Ship Electrical Officer: Print Name, Sign & Date				
PW Utilities Electrician: Print Name, Sign & Date				

15.11. 13.8kV SHIP DISCONNECT INSPECTION CHECKLIST

NAME OF INSPECTOR: _____ INSTALLATION: _____
 SHIP TO BE DISCONNECTED: _____ LOCATION OF DISCONNECT: _____

ITEM	YES	NO
Procedure Requirements		
Are all personnel qualified for the required work and on the SOC list?		
Are all personnel wearing appropriate PPE throughout the entire procedure?		
Did NAVFAC Qualified Person (QP) in Charge conduct a Job Brief with NAVFAC personnel and Ship's representative?		
Remarks for Procedural Deficiencies:		
Step 1 – Ship's Load Transfer to the Ship's Generator		
Was a Ship Disconnect Form used and accessible during the disconnection process?		
Has an Authorized Official written switching orders?		
Did NAVFAC QP in charge obtain signature from Ship's Electrical Officer verifying that they have returned to ship power and NAVFAC can de-energize shore power?		
Remarks for Step 1 Deficiencies:		
Step 2 – Disconnection of Shore Power Cable Plugs from Receptacles		
Did NAVFAC QP-HV open and remove from cubicle (rack out) Facility Shore Power breakers and install red danger locks and red danger tags?		
Did NAVFAC QP in Charge make red danger locks available to ship's forces for use during cable handling?		
Did the NAVFAC QP in Charge receive confirmation from the Ship's representative that the shore power cables were disconnected from the ship's receptacles before continuing with work?		
Have cables been tested for no voltage prior to removal from the ship?		
Remarks for Step 2 Deficiencies:		
Step 3 – Removal of Shore Power Cable Assembly		
Have cables been lowered to the pier using applicable SOPs and in a method to minimize potential damage to inline connectors/splices and plugs?		

Did cables remain lashed to the ship until strain on the cable was removed by manual or mechanical means?		
Have temporary personal protective grounds been installed prior to removing receptacles from Facility Shore Power receptacles?		
Have plugs been removed from receptacles and S2S tags removed from cables?		
Have Ship's forces removed their red danger locks from Facility Shore Power breakers and returned them to NAVFAC?		
Have NAVFAC QP in Charge and Ship's Electrical Representative signed the Disconnect Form verifying that shore power removal is complete?		
Remarks for Step 3 Deficiencies:		