



Naval Engineering Training and Operating Procedure and Standard (NETOPS) #29

Shore-To-Ship Power Connect and Disconnect Procedures

Issue Date: 6 Jan 2015

- References:**
- (a) United Facilities Criteria (UFC) 3-560-01, Electrical Safety, O & M, Ch. 4
 - (b) National Fire Protection Association (NFPA) 70E, Standard for Electrical Safety in the Workplace
 - (c) OPNAVINST 11310.3B, OPERATION AND MAINTENANCE POLICY FOR SHORE-TO-SHIP POWER
 - (d) NAVFAC Electrical SAFE SOP PWBL 005 480V Ship Connect, CH-1
 - (e) NAVFAC Electrical SAFE SOP PWBL 006 480V Ship Disconnect, CH-1
 - (f) NAVFAC Electrical SAFE SOP PWBL 007 4160V Ship Connect, CH-1
 - (g) NAVFAC Electrical SAFE SOP PWBL 008 4160V Ship Disconnect, CH-1
 - (h) NAVFAC Electrical SAFE SOP PWBL 009 480V Submarine Connect, CH-1
 - (i) NAVFAC Electrical SAFE SOP PWBL 0010 480V Submarine Disconnect, CH-1

- Encl:**
- (1) NAVFAC Electrical SAFE SOP PWBL 005 480V Ship Connect, CH-2
 - (2) NAVFAC Electrical SAFE SOP PWBL 006 480V Ship Disconnect, CH-2
 - (3) NAVFAC Electrical SAFE SOP PWBL 007 4160V Ship Connect, CH-2
 - (4) NAVFAC Electrical SAFE SOP PWBL 008 4160V Ship Disconnect, CH-2
 - (5) NAVFAC Electrical SAFE SOP PWBL 009 480V Submarine Connect, CH-2
 - (6) NAVFAC Electrical SAFE SOP PWBL 010 480V Submarine Disconnect, CH-2
 - (7) NAVFAC Electrical SAFE SOP PWBL 011 Infrared Testing of Shore Power
 - (8) Shore Power E-SAFE Implementation Plan dated 6 JAN 2015

1. **Purpose:** To issue updates to the NAVFAC Electrical SAFE Standard Operating Procedures (SOPs) for provision of shore-to-ship power services.

2. **Background:** The NAVFAC Electrical SAFE Program provides guidance to the NAVFAC enterprise for development of standard procedures so that all Public Works Departments are performing electrical shore-to-ship power operations and maintenance activities to a minimum, safe, compliant, and efficiently optimized standard, taking into consideration variations applicable to local conditions. This program is designed to fit within NAVFAC's Operational

Risk Management (ORM) principles and safety culture with a focus on mishap prevention and mitigation of hazards.

To enable safer support to our Supported Commands, significant changes were made to NAVFAC Electrical SAFE shore power SOPs. Highlights of these changes include: order of shore power cable connection; emphasis on lockout/tagout and installation of temporary protective grounds; provision of complete cable assembly from shore to ship; and adoption of thermal imaging inspections. Updates have been coordinated with Navy stakeholders to ensure NAVFAC SOPs are properly aligned to meet Supported Command requirements. In addition, the revised SOPs incorporate the requirements of references (a) through (c).

3. **Cancellation:** This NETOPS cancels References (d), (e), (f), (g), (h), and (i), which were issued with the original NETOPS #29, and replaces them with updated documents included as enclosures (1) through (6).

4. **Action.**

- NAVFAC Commands shall take all actions necessary to achieve a targeted Final Operational Capability (FOC) by 30 September 2015 for the SOPs detailed in Enclosures (1) through (7).
- The Operations Officer for the Commands listed in Enclosure (8) must provide confirmation at each milestone listed in Enclosure (8) to affirm that full implementation of the associated actions have occurred by the prescribed date. Justification and a new proposed date shall be submitted as soon as practicable for any milestone that is anticipated to be missed.

5. **Applicability and Scope.** This instruction applies to all military, civilian, and contractor personnel assigned to activities within NAVFAC that provide shore power services.

6. The technical point of contact for NAVFAC E-SAFE revisions is _____ at NAVFAC Atlantic. The point of contact for this NETOPS, and to report actions associated with the implementation timeline is _____ NAVFAC HQ.

PURPOSE

Provide standard procedures for connecting 480 Volt Shore Power to Surface Ships.

BACKGROUND

The connection of 480 Volt Shore Power to Ships is a hazardous operation. Hazards mitigated by this Standard Operating Procedure (SOP) 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 or contractor personnel and Ship Personnel are necessary to ensure the highest level of safety for all involved.

REFERENCES

A complete list of definitions may be found in NAVFAC PWBL-SAFE 01 ELECTRICAL SAFE.

References:

1. Unified Facilities Criteria (UFC) 3-560-01 Electrical Safety, O&M
2. OPNAVINST 11310.3B Operation and Maintenance Policy for Shore To Ship Power

Appendices:

- A. Test for No Voltage
- B. Test for No Voltage and Apply Temporary Protective Grounds
- C. Temporary Protective Grounds Policy for NAVFAC Employees
- D. Example of Ship Connect/Disconnect Form
- E. Ship to Shore Power Cable Insulation Record
- F. Example of Ship to Shore Tag

TOOLS, EQUIPMENT, AND PERSONAL PROTECTIVE EQUIPMENT ASSOCIATED WITH THIS PROCEDURE

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 UFC 3-560-01 Electrical Safety, NAVFAC PWBL 003 Working on or Near Exposed and Enclosed Energized Electrical Systems and PWBL 004 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems.

TRAINING, CERTIFICATION, AND RECORD KEEPING

All employees whose job requires the use of this SOP 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 trained; Authorized Employees and Qualified Persons shall be kept at a, centralized location 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.

PROCEDURES

General Information

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Ships operating in a cold iron mode. NAVFAC provides Shore Power connect and disconnect service, plus cable assemblies and maintenance, as a reimbursable activity per NAVFAC BMS B-5.2.5. Cable assemblies shall include all necessary components to allow connection from Facility Shore Power receptacles to Ship's Shore Power receptacles by Viking plug or lug and bolt with Ship-owned pigtails.
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 must provide an ungrounded correctly phased, correctly oriented (in-phase) system with an adequate number of power cables to serve the Ship 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. 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.
7. Paralleling shore transformers through the Ship electrical bus without prior NAVFAC approval 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."

Connect Procedure for Surface Ships Utilizing 480 Volt Shore Power

Step 1. Prepare for Ship's Arrival

- 1.1 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.
- 1.2 Obtain and utilize Ship Connect/Disconnect Form to record information. See Appendix D 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.
- 1.3 NAVFAC Qualified Person (QP) in Charge shall conduct a Job Brief and ensure all personnel have required equipment, tools, and PPE.

Step 2. Lay Power Cable Assemblies

- 2.1 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.
- 2.2 Place vehicle or weight handling equipment in position.
 - 2.2.1 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.
 - 2.2.2 Use a spotter when backing up or placing in tight space.
 - 2.2.3 Operators shall have a valid license, training, and certification in accordance with Command policies.
- 2.3 Shore Power cables shall be placed at the pier where the Ship will dock.
- 2.4 Lay out cables between Facility Shore Power receptacles and Ship's Shore Power receptacles. Note the following **CAUTIONS**:
 - 2.4.1 Ensure cable ends are not connected to any equipment, weight handling equipment or vehicle.
 - 2.4.2 Excess cable shall be laid in such a manner as to minimize damage from vehicle and pedestrian traffic.
 - 2.4.3 Each set of Shore Power cables should be positioned as a unit.
 - 2.4.4 Do not lay or drag cables on or over sharp and ragged objects.
 - 2.4.5 Shore power cables and terminations should be physically isolated from Shore Steam, Potable Water, Salt Water, and all other service lines.
 - 2.4.6 Do not exceed minimum cable bend radius. Per Insulated Cable Engineers Association, minimum THOF cable bend radius is 6 times the outer diameter.
 - 2.4.7 Provide adequate cable length to compensate for the rise and fall of the tide, cable slack should not dip into the water or become wedged between the ship and pier.
 - 2.4.8 Ensure cables are of proper length and size and are arranged in a neat and safe manner.
 - 2.4.9 To reduce overheating or de-rating cable, excess cable should not be coiled.
 - 2.4.10 Barricades shall be placed as necessary, to keep vehicles off cable.
 - 2.4.11 Where cables would obstruct drains or scuppers, lay cables on a pallet to allow water drainage on the pier.
 - 2.4.12 Do not hold or brace the cable in place as this may result in a foot or leg injury.

- 2.4.13 When loading or unloading Shore Power cable, 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 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.

Step 3. Inspect and Test Each Power Cable Assembly

- 3.1 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 Appendix A, NAVFAC QP shall test each phase conductor or circuit part of the cables for no voltage prior to handling.
- 3.2 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.
- 3.3 Visually inspect shore power cable assemblies for any sign of defect. Cables not passing visual inspection shall be removed from service.
- 3.3.1 Inspect cable assemblies for cracks, bulges, or indications of overheating.
- 3.3.2 Inspect cable sheath for cuts, nicks, and gouges.
- 3.3.3 As required, strip insulation from any existing cable splices and inspect for cleanliness, tightness, and good surface contact.
- 3.4 Repair defects and re-insulate as needed.
- 3.5 Clean and inspect cable connectors and lugs.
- 3.5.1 Inspect cable connectors, lugs, and each conducting surface for pitting, corrosion, and evidence of overheating. Repair or replace any deficiency.
- 3.5.2 If required by manufacturer, apply a light coat of approved grease or contact cleaner to cable connectors.
- 3.5.3 If in-line connectors are used, conduct mechanical test ensuring that locking mechanisms operate, and all parts are attached. Repair or replace any deficiency.
- 3.6 Measure insulation resistance between cable assembly conductors and each conductor and ground 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.
- 3.7 Record all cable insulation resistance reading on Ship to Shore Power Cable Insulation Record (see Appendix E) and record the lowest insulation resistance value on the Ship Connect/Disconnect Form (see Appendix D).
- 3.8 Replace Shore Power cable if it does not meet minimum insulation resistance requirements.
- 3.9 Verify phase identification markings (color coding or labeling) on the shore power cable assembly to ensure proper orientation (in-phase).
- 3.10 Attach "DANGER-HIGH VOLTAGE" signs to Shore Power cable assemblies.
- 3.11 Barricade the work area surrounding the Shore Power receptacles and portable shore power cables to the greatest extent possible.

Step 4. Inspect and Test 480 Volt Shore Receptacles

- 4.1 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.
- 4.2 NAVFAC QP, wearing appropriate PPE, shall establish Electrically Safe Working Condition.
 - 4.2.1 Open, red danger tag and red danger lock Facility Shore Power receptacle circuit breakers.
 - 4.2.2 Test Shore Power circuit breaker receptacles for no voltage.
 - 4.2.3 If appropriate, apply Temporary Protective Grounding to shore power receptacles per Appendix B and C. **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 Appendix C.
- 4.3 Carefully open/remove access cover(s) to each shore power receptacle and test for no voltage per Appendix A. 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.
- 4.4 Inspect each cover and receptacle. Clean as necessary to ensure proper operation.
 - 4.4.1 If applicable, inspect each cover gasket and each receptacle gasket for cuts, tears, cracks, and deformation.
 - 4.4.2 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.
- 4.5 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 Appendix E). If test data is unavailable or older than 12 months, perform steps 4.5.1 through 4.5.4.
 - 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.
 - 4.5.2 If temporary protective grounds were installed in accordance with Appendix C, 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.
 - 4.5.3 Record megohmmeter values on the Ship to Shore Power Cable Insulation Record (see Appendix E).
 - 4.5.4 Re-install indicator lights, appropriate fuses and reconnect appropriate meters.
- 4.6 Install/Close shore power receptacle access covers.
- 4.7 Remove red danger tags and red danger locks from Facility Shore Power receptacle circuit breakers for testing purposes, if required.
- 4.8 Test MIL-C-24368 Facility Shore Power receptacle cover interlock switches, if equipped, and indicator lights in accordance with Appendix A, NAVFAC PWBL 003 and 004.
 - 4.8.1 Close shore power receptacle circuit breakers.
 - 4.8.2 Ensure receptacle indicating lights are illuminated.
 - 4.8.3 Open shore power receptacle access cover; receptacle circuit breaker should trip and indicating light should extinguish.

- 4.8.4 Test shore power receptacle for no voltage to ensure the receptacle has been de-energized.
- 4.8.5 Close Shore Power receptacle access cover.
- 4.8.6 If so equipped, test open and close push buttons for proper operation.
- 4.9 Open Facility Shore Power circuit breakers.
- 4.10 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 NAVFAC PWBL-001 and report deficiencies to NAVFAC Supervisor.

Step 5. Shore Power Cable Rigging

- 5.1 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.
- 5.2 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 Appendix D), Ship to Shore Power Cable Insulation Record (see Appendix E), and Cable Tests/Inspections per latest OPNAVINST 11310.3 as required..
- 5.3 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 Appendix B and C. **Note:** temporary protective grounding is typically waived for 480 volt shore power. NAVFAC Authorized Employees shall install red danger tags and red danger locks.
- 5.4 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.
- 5.5 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.
- 5.6 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.
- 5.7 Load Shore Power cable assemblies from Shore to Ship. If boom trucks or cranes are used, follow appropriate boom truck and crane SOP.

Step 6. Inserting Cable Plugs Into Receptacles

- 6.1 Shore Power cable connections shall be made from the Ship's Shore Power receptacles toward the NAVFAC Shore Power receptacles.
- 6.2 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.
- 6.3 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.

- 6.4 NAVFAC QP shall verify the Facility Shore Power receptacles and Shore Power cables connected to the Ship's Shore Power receptacles are in an Electrically Safe Work Condition.
- 6.4.1 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.
- 6.4.2 While the Shore Power cable assemblies are in an Electrically Safe Work Condition, NAVFAC QP shall:
- a) Check all cable assemblies for proper phase color coding: Phase "A" is black, Phase "B" is white and Phase "C" is red.
 - b) Check all cable assemblies for proper cable phase grouping.
- 6.5 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.)
- 6.6 Fill out and attach the Ship to Shore Tag (see Appendix F) to cables at Facility Shore Power receptacle.
- 6.7 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.
- 6.8 NAVFAC personnel shall remove temporary protective grounds from Facility Shore Power circuit breaker receptacles if installed.
- 6.9 NAVFAC personnel will notify Ships Personnel that they are ready for Ship's Personnel to clear tags from Ship's Shore Power circuit breakers.
- 6.10 NAVFAC personnel shall remove red danger tags and red danger locks from the Facility Shore Power circuit breakers.
- 6.11 After receiving permission from Ship's Electrical Officer or designated representative, NAVFAC QP shall close Shore Power circuit breakers in the sequence requested by the Ship's Electrical Officer.

Step 7. Ship's Transfer To Shore Power

- 7.1 **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.
- 7.2 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.
- 7.3 **Note:** No Personnel shall move energized Shore Power cable assemblies.
- 7.4 NAVFAC personnel shall check amperage readings on all phases of each cable. The preferred method is permanently installed ammeters, however clamp-on ammeters are allowed. Verify that phase amperage readings are within 10 percent of each other. If the amperage readings

- are not within 10 percent, notify NAVFAC QP, Ship's representative, and perform a thermal infra-red imaging survey.
- 7.5 After the ship is drawing current and has reached at least 50% load for 4 hours, 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.
- 7.5.1 The NAVFAC IR survey will include the connector at the Shore Power substation receptacle to the last connector on the pier.
- 7.5.2 **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.
- 7.5.3 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 NAVFAC PWBL 001 and report deficiencies to NAVFAC Supervisor.
- 7.6 When the IR survey is complete, the Ship Connect/Disconnect Form shall be signed indicating completion of the task.

APPENDIX A: TEST FOR NO VOLTAGE

- a) 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 NAVFAC PWBL-SAFE 01 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 UFC 3-560-01 Electrical Safety.
- b) A QP shall test for no voltage per NAVFAC PWBL 004.
- c) 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.

APPENDIX B: TEST FOR NO VOLTAGE AND APPLY TEMPORARY PROTECTIVE GROUNDS

- a) 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 NAVFAC PWBL-SAFE 01. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with UFC 3-560-01 Electrical Safety. Install temporary protective grounds per Appendix C.
- b) Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP as defined in the NAVFAC PWBL-SAFE 01 using the required PPE.
- c) A QP shall test for no voltage per NAVFAC PWBL 004
- d) 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.

APPENDIX C: TEMPORARY PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

- a) 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.
- b) 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.
- c) Temporary protective grounding shall be used where:
 - 1. The possibility of induced voltages or stored electrical energy exists.
 - 2. It could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts.
- d) 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 UFC 3-560-01 Electrical Safety.
- e) Equipotential grounding, as described by UFC 3-560-01 Electrical Safety, 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.
- f) 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.
- g) 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.
- h) The location of installed temporary protective grounds shall be written on red danger tags.
- i) 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.
- j) 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.

APPENDIX D: 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:		INITIAL HOOK UP FOR ARRIVAL:		OUTAGE INFORMATION:				
<input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> NAVSEA / OTHER		<input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED		<input type="checkbox"/> SCHEDULED OUTAGE <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> UNSCHEDULED OUTAGE <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	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	METER KW HRS:	_____			
Operation of Breakers	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	List Breakers:	_____			
MEGGER Cables	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	Lowest MEGGER Value on Cables:	_____ MEGOHMS <small>(Min. Values for 480V Service is 4 Megohms; for 4,160V is 10 Megohms)</small>			
Check Current Load	<input type="checkbox"/> OK	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 For 4160V 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 amperage readings on all phases of each shore power cable. Attach additional sheets to record readings as required. If ship elects not to go back on shore power at this time, take readings as soon as possible.								
BREAKER	A-PHASE	B-PHASE	C-PHASE		BREAKER	A-PHASE	B-PHASE	C-PHASE
Ship load at least 50% for 4 hours:		<input type="checkbox"/> OK	INFRA-RED Survey Performed:		<input type="checkbox"/> OK	Need Repair? <input type="checkbox"/> YES		
Ship Electrical Officer: Print Name, Sign & Date								
PW Utilities Electrician: Print Name, Sign & Date								

APPENDIX F: SAMPLE SHIP TO SHORE TAG

CONNECT / DISCONNECT TAG DATE: _____

CABLE #s: _____

PLUG #s: _____

RECEPTACLE #: _____

OPERATOR: _____ **SHIP:** _____

PURPOSE

Provide standard procedures for disconnecting 480 Volt Shore Power to Surface Ships.

BACKGROUND

The disconnection of 480 Volt Shore Power to Ships is a hazardous operation. Hazards mitigated by this Standard Operating Procedure (SOP) 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 or contractor personnel and Ship Personnel are necessary to ensure the highest level of safety for all involved.

REFERENCES

A complete list of definitions may be found in NAVFAC PWBL-SAFE 01 ELECTRICAL SAFE.

References:

1. Unified Facilities Criteria (UFC) 3-560-01 Electrical Safety, O&M
2. OPNAVINST 11310.3B Operation and Maintenance Policy for Shore To Ship Power

Appendices:

- A. Test for No Voltage
- B. Test for No Voltage and Apply Temporary Protective Grounds
- C. Temporary Protective Grounds Policy for NAVFAC Employees
- D. Example of Ship Connect/Disconnect Form

TOOLS, EQUIPMENT, AND PERSONAL PROTECTIVE EQUIPMENT ASSOCIATED WITH THIS PROCEDURE

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 UFC 3-560-01 Electrical Safety, NAVFAC PWBL 003 Working on or Near Exposed and Enclosed Energized Electrical Systems and PWBL 004 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems.

TRAINING, CERTIFICATION, AND RECORD KEEPING

All employees whose job requires the use of this SOP 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 trained; Authorized Employees and Qualified Persons shall be kept at a, centralized location 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.

PROCEDURES

General Information

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Ships operating in a cold iron mode. NAVFAC provides Shore Power connect and disconnect service, plus cable assemblies and maintenance, as a reimbursable activity per NAVFAC BMS B-5.2.5. Cable assemblies include all necessary components to allow connection from Facility Shore Power receptacles to Ship's Shore Power receptacles by Viking plug or lug and bolt with Ship-owned pigtailed.
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 ungrounded, correctly phased, correctly-cable-oriented system with an adequate number of power cables to serve the Ship load. Where two or more power cables are connected to a Ship, cables are 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. Paralleling shore transformers through the Ship electrical bus without prior NAVFAC approval 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."

Disconnect Procedure for Surface Ships Utilizing 480 Volt Shore Power

Step 1. Ship's Load Transfer To The Ship's Generator(s)

- 1.1 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.
- 1.2 Obtain and utilize Ship Connect/Disconnect Form to record information. See Appendix D 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.
- 1.3 **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.
- 1.4 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.

Step 2. Disconnection of Shore Power Cable Plugs From Receptacles

- 2.1 Shore Power cable disconnections shall be from the NAVFAC Shore Power receptacles toward the Ship's Shore Power receptacles.
- 2.2 NAVFAC Qualified Person (QP) in Charge shall conduct a joint Job Brief, with Ship Personnel and NAVFAC Personnel, and ensure all personnel have required equipment, tools, and PPE.
- 2.3 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.
- 2.4 NAVFAC QP, wearing appropriate PPE, shall establish Electrically Safe Working Condition for Shore Power Cable Assemblies.
 - 2.4.1 Open, red danger tag and NAVFAC AEs red danger lock Facility Shore Power receptacle circuit breakers.
 - 2.4.2 Test Facility Shore Power circuit breaker receptacles for no voltage per Appendix A.
 - 2.4.3 If appropriate, apply Temporary Protective Grounding to facility shore power receptacles per Appendix B and C. 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 Appendix C.
 - 2.4.4 If no voltage is detected at facility shore power receptacles, disconnect cable assemblies by removing plugs from facility shore power receptacles.
- 2.5 Close or install shore power receptacle access covers.
- 2.6 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.
- 2.7 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.

- 2.8 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.
- 2.9 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.

Step 3. Removal of Shore Power Cable Assemblies

- 3.1 NAVFAC personnel will notify Ships Personnel that they are ready for Ship's Personnel to clear tags from Ship's Shore Power circuit breakers.
- 3.2 Place vehicle or weight handling equipment in position if used; cable can also be hand carried.
 - 3.2.1 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.
 - 3.2.2 Use a spotter when backing up or placing in tight space.
 - 3.2.3 Operators shall have a valid license, training, and certification in accordance with Command policies.
- 3.3 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.
- 3.4 Lower cable assemblies from the ship onto the pier.
- 3.5 NAVFAC and Ship's representatives sign ship connect/disconnect form verifying shore power removal is complete.
- 3.6 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.
- 3.7 NAVFAC personnel shall remove red danger tags and red danger locks from Facility Shore Power circuit breakers when required to restore operation of breakers.
- 3.8 Remove Ship to Shore Tags from cables.

APPENDIX A: TEST FOR NO VOLTAGE

- a) 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 NAVFAC PWBL-SAFE 01 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 UFC 3-560-01 Electrical Safety.
- b) A QP shall test for no voltage per NAVFAC PWBL 004.
- c) 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.

APPENDIX B: TEST FOR NO VOLTAGE AND APPLY TEMPORARY PROTECTIVE GROUNDS

- a) 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 NAVFAC PWBL-SAFE 01. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with UFC 3-560-01 Electrical Safety. Install temporary protective grounds per Appendix C.
- b) Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP as defined in the NAVFAC PWBL-SAFE 01 using the required PPE.
- c) A QP shall test for no voltage per NAVFAC PWBL 004
- d) 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.

APPENDIX C: TEMPORARY PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

- a) 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.
- b) 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.
- c) Temporary protective grounding shall be used where:
 - 1. The possibility of induced voltages or stored electrical energy exists.
 - 2. It could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts.
- d) 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 UFC 3-560-01 Electrical Safety.
- e) Equipotential grounding, as described by UFC 3-560-01 Electrical Safety, 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.
- f) 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.
- g) 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.
- h) The location of installed temporary protective grounds shall be written on red danger tags.
- i) 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.
- j) 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.

APPENDIX D: 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:		INITIAL HOOK UP FOR ARRIVAL:		OUTAGE INFORMATION:				
<input type="checkbox"/> NAVFAC PW UTILITIES		<input type="checkbox"/> SCHEDULED		<input type="checkbox"/> SCHEDULED OUTAGE				
<input type="checkbox"/> CONTRACTOR		<input type="checkbox"/> UNSCHEDULED		<input type="checkbox"/> RECONNECTING S/P				
<input type="checkbox"/> NAVSEA / OTHER				<input type="checkbox"/> UNSCHEDULED OUTAGE				
				<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	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	METER KW HRS:	_____			
Operation of Breakers	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	List Breakers:	_____			
MEGGER Cables	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	Lowest MEGGER Value on Cables:	_____ MEGOHMS			
<small>(Min. Values for 480V Service is 4 Megohms; for 4,160V is 10 Megohms)</small>								
Check Current Load	<input type="checkbox"/> OK	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 For 4160V 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 amperage readings on all phases of each shore power cable. Attach additional sheets to record readings as required. If ship elects not to go back on shore power at this time, take readings as soon as possible.								
BREAKER	A-PHASE	B-PHASE	C-PHASE		BREAKER	A-PHASE	B-PHASE	C-PHASE
Ship load at least 50% for 4 hours:		<input type="checkbox"/> OK	INFRA-RED Survey Performed:		<input type="checkbox"/> OK	Need Repair? <input type="checkbox"/> YES		
Ship Electrical Officer: Print Name, Sign & Date								
PW Utilities Electrician: Print Name, Sign & Date								

PURPOSE

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

BACKGROUND

The connection of 4160 Volt Shore Power to Ships is a hazardous operation. Hazards mitigated by this Standard Operating Procedure (SOP) 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 or contractor personnel and Ship Personnel are necessary to ensure the highest level of safety for all involved.

REFERENCES

A complete list of definitions may be found in NAVFAC PWBL-SAFE 01 ELECTRICAL SAFE.

References:

1. Unified Facilities Criteria (UFC) 3-560-01 Electrical Safety, O&M
2. OPNAVINST 11310.3B Operation and Maintenance Policy for Shore To Ship Power

Appendices:

- A. Test for No Voltage
- B. Test for No Voltage and Apply Temporary Protective Grounds
- C. Temporary Protective Grounds Policy for NAVFAC Employees
- D. Example of Ship Connect/Disconnect Form
- E. Ship to Shore Power Cable Insulation Record
- F. Example of Ship to Shore Tag

TOOLS, EQUIPMENT, AND PERSONAL PROTECTIVE EQUIPMENT ASSOCIATED WITH THIS PROCEDURE

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 UFC 3-560-01 Electrical Safety, NAVFAC PWBL 003 Working on or Near Exposed and Enclosed Energized Electrical Systems and PWBL 004 Measuring /Testing Parameters of Energized High or Low Voltage Electrical Systems.

TRAINING, CERTIFICATION, AND RECORD KEEPING

All employees whose job requires the use of this SOP 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 trained; Authorized Employees and Qualified Persons shall be kept at a, centralized location 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.

PROCEDURES

General Information

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Ships operating in a cold iron mode. NAVFAC provides Shore Power connect and disconnect service, plus cable assemblies and maintenance, as a reimbursable activity per NAVFAC BMS B-5.2.5. Cable assemblies shall include all necessary components to allow connection from Facility Shore Power receptacles to Ship's Shore Power receptacles.
2. Personnel performing Shore Power Connects and Disconnects may be exposed to AC electrical potential greater than 600 volts, AC electrical potential less than 600 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 must provide an ungrounded, correctly phased, correctly-cable-oriented system with an adequate number of power cables to serve the Ship load. When 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."

Connect Procedure for Ships Utilizing 4160 Volt Shore Power

Step 1. Prepare for Ship's Arrival

- 1.1 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.
- 1.2 Obtain and utilize Ship Connect/Disconnect Form to record information. See Appendix D 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.
- 1.3 An Authorized Official or HV Shop Supervisor shall write Switching Orders and the Switching Order Package for Shore Power.
- 1.4 NAVFAC Qualified Person in Charge shall conduct a Job Brief and ensure all personnel have required equipment, tools, and PPE.

Step 2. Lay Power Cable Assemblies

- 2.1 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.
- 2.2 Place vehicle or weight handling equipment in position.
 - 2.2.1 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.
 - 2.2.2 Use a spotter when backing up or placing in tight space.
 - 2.2.3 Operators shall have a valid license, training, and certification in accordance with Command policies.
- 2.3 Shore Power cables shall be placed at the pier where the Ship will dock.
- 2.4 Lay out cables between Shore Power receptacles and Ship's Shore Power receptacles. Note the following **CAUTIONS**:
 - 2.4.1 Ensure cable ends are not connected to any equipment, weight handling equipment or vehicle.

- 2.4.2 Excess cable shall be laid in such a manner as to minimize damage from vehicle and pedestrian traffic.
- 2.4.3 Each set of Shore Power cables should be positioned as a unit.
- 2.4.4 Do not lay or drag cables on or over sharp and ragged objects.
- 2.4.5 Shore power cables and terminations should be physically isolated from Shore Steam, Potable Water, Salt Water, and all other service lines.
- 2.4.6 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.
- 2.4.7 Provide adequate cable length to compensate for the rise and fall of the tide, cable slack should not dip into the water or become wedged between the ship and pier.
- 2.4.8 Ensure cables are of proper length and size and are arranged in a neat and safe manner.
- 2.4.9 To reduce overheating or de-rating cable, excess cable should not be coiled.
- 2.4.10 Barricades shall be placed as necessary, to keep vehicles off cable.
- 2.4.11 Where cables would obstruct drains or scuppers, lay cables on a pallet to allow water drainage on the pier.
- 2.4.12 Do not hold or brace the cable in place as this may result in a foot or leg injury.
- 2.4.13 When loading or unloading Shore Power cable, 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 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.

Step 3. Inspect and Test Each Power Cable Assembly

- 3.1 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 Appendix A, NAVFAC QP shall test each phase conductor or circuit part of the cables for no voltage prior to handling.
- 3.2 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.
- 3.3 Visually inspect shore power cable assemblies for any sign of defect. Cables not passing visual inspection shall be removed from service.
 - 3.3.1 Inspect cable assemblies for cracks, bulges, or indications of overheating.
 - 3.3.2 Inspect cable sheath for cuts, nicks, and gouges.
- 3.4 Clean and inspect cable plugs and lugs.
 - 3.4.1 Inspect cable plug and lug conducting surface for pitting, corrosion, and evidence of overheating. Repair or replace any deficiency.
 - 3.4.2 If required by connector manufacturer, apply a light coat of approved grease or contact cleaner to cable connectors.

- 3.5 Measure insulation resistance between cable assembly conductors and each conductor and ground 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.
- 3.6 Record all insulation resistance readings on Ship to Shore Power Cable Insulation Record (see Appendix E) and record the lowest insulation resistance value on the Ship Connect/Disconnect Form (see Appendix D).
- 3.7 Replace Shore Power cable if it does not meet minimum insulation resistance requirements.
- 3.8 Verify phase identification markings (color coding or labeling) of the cable assembly to ensure proper orientation (in-phase).
- 3.9 Attach "DANGER-HIGH VOLTAGE" signs to Shore Power cable assemblies every 20 feet, where possible.
- 3.10 Barricade the work area surrounding the Shore Power receptacles and portable shore power cables to the greatest extent possible.

Step 4. Inspect and Test 4160 Volt Shore Receptacles

- 4.1 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.
- 4.2 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.
 - 4.2.1 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 NAVFAC PWBL 001.
 - 4.2.2 Test Facility Shore Power circuit breakers load bus or receptacles for no voltage per Appendix B.
 - 4.2.3 Apply Temporary Protective Grounds-to Facility Shore Power circuit breakers load bus or receptacles per Appendix C.
- 4.3 Carefully remove/open access cover(s) to each shore power receptacle and test for no voltage per Appendix A. 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.
- 4.4 Inspect each cover and receptacle. Clean as necessary to ensure proper operation.
 - 4.4.1 If applicable, inspect each cover gasket and each receptacle gasket for cuts, tears, cracks, and deformation.
 - 4.4.2 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.
- 4.5 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 Appendix E). If test data is unavailable or older than 12 months, perform steps 4.5.1 through 4.5.4
 - 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.

- 4.5.2 Remove temporary 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.
- 4.5.3 Record megohmmeter values on the Ship Connect/Disconnect Form (see Appendix E).
- 4.5.4 Re-install indicator lights, appropriate fuses and reconnect appropriate meters.
- 4.6 Install/close shore power receptacle access covers.
- 4.7 Test Facility Shore Power circuit breaker load bus or receptacle for no voltage per Appendix B.
- 4.8 Apply Temporary Protective Grounds to Facility Shore Power circuit breaker load bus or receptacles per Appendix C
- 4.9 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 NAVFAC PWBL 001 and report deficiencies to NAVFAC Supervisor.

Step 5. Inserting Cable Plugs Into Shore Receptacles

- 5.1 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.
- 5.2 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 Appendix E), the Ship Connect/Disconnect Form (see Appendix D) and Cable Test Certifications.
- 5.3 Shore Power cable connections shall be made from the Facility Shore Power receptacle toward the Ship's electric bus.
- 5.4 NAVFAC QP shall verify the Facility Shore Power receptacles are in an Electrically Safe Work Condition.
- 5.5 A QP-HV wearing PPE as specified in NAVFAC PWBL 003 shall carefully remove access cover to each shore power receptacle and test for no voltage per NAVFAC PWBL 004 and as described in Appendix A to verify the receptacles and shore power cables are de-energized.
- 5.6 Verify Shore Power cables are in an Electrically Safe Work Condition.
- 5.7 Insert Shore Power cable plugs into 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 cable is in an electrically safe work condition.
- 5.8 Fill out and attach the Ship to Shore Tag (see Appendix F) to cables at receptacle.

Step 6. Shore Power Cable Rigging

- 6.1 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. 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.

- 6.2 NAVFAC QP-HV, wearing appropriate PPE, shall verify that an Electrically Safe Working Condition exist in accordance with NAVFAC PWBL 001 and 003.
- 6.3 If ship's personnel will load cables to ship, a QP-HV wearing PPE as specified in SOP PWBL 003 shall remove temporary protective grounds as specified in the switching orders and in accordance with SOP PWBL 001 and SOP PWBL 004 and as described in Appendix B and C. Anytime a NAVFAC employee handles the ship to shore power cable, temporary protective grounds must be installed.
- 6.4 Load Shore Power cable assemblies from Shore, to camels, to Ship. If boom trucks or cranes are used, follow appropriate boom truck and crane SOP.
- 6.5 If a NAVFAC operated crane or boom truck was used to load cable to ship, a QP-HV wearing PPE as specified in NAVFAC PWBL 003 shall remove temporary protective grounds as specified in the switching orders and in accordance with NAVFAC PWBL 001 and PWBL 004 and as described in Appendix B and C.
- 6.6 Ship Personnel will connect Shore Power cables to Ship's Shore Power bus in accordance with Ship's Standard Operating Procedures. 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.
- 6.7 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.
- 6.8 NAVFAC QP shall escort Ship Personnel while Ship Personnel remove their danger tags and danger locks from NAVFAC Shore Power circuit breaker cubicles.
- 6.9 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 NAVFAC PWBL 001. A QP-HV, wearing the required PPE, shall rack in circuit breaker(s) into circuit breaker cubicle(s) in accordance with the switching orders. **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.
- 6.10 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.

Step 7. Ship's Transfer To Shore Power

- 7.1 **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.

- 7.2 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.
- 7.3 **Note:** No Personnel shall move energized Shore Power cable assemblies.
- 7.4 If possible, monitor SCADA to check for imbalances between circuits or a NAVFAC QP-HV shall take amperage readings on all phases of each shore power cable.
- 7.4.1 Verify that phase amperage readings are within 10 percent of each other.
- 7.4.2 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 SOPs PWBL 003 and PWBL 004 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.
- 7.4.3 If the amperage readings are not within 10 percent, notify the NAVFAC supervisor, Ship's Electrical Officer or Ship's Reactor Electrical Assistant and perform a thermal-infra-red imaging survey.
- 7.5 After the ship is drawing current and has reached at least 50% load for 4 hours, 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.
- 7.5.1 The NAVFAC IR survey will include the connector at the Shore Power substation to the last connector on the pier.
- 7.5.2 **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.
- 7.5.3 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 E-SAFE PWBL 01 and report deficiencies to NAVFAC Supervisor.
- 7.6 When the IR survey is complete, the Ship Connect/Disconnect Form shall be signed indicating completion of the task.

APPENDIX A: TEST FOR NO VOLTAGE

- a) 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 NAVFAC PWBL-SAFE 01 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 UFC 3-560-01 Electrical Safety.
- b) A QP HV shall test for no voltage per NAVFAC PWBL 004.
- c) 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.

APPENDIX B: TEST FOR NO VOLTAGE AND APPLY TEMPORARY PROTECTIVE GROUNDS

- a) 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 UFC 3-560-01 Electrical Safety.
- b) 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 NAVFAC PWBL-SAFE 01. Install temporary protective grounds per Appendix C.
- c) A QP-HV shall test for no voltage per NAVFAC PWBL 004.
- d) 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.
- e) The Operations Center, HV Shop Supervisor and NAVFAC QP-HV shall communicate and initial off, on the switch out and temporary protective grounds sheet of the switching orders, the installation of each temporary protective ground.

APPENDIX C: TEMPORARY PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

- a) Temporary 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.
- b) Any circuit not grounded shall be considered energized except when grounding has been waived.
- c) An Electrical Utility Supervisor or designated work leader 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.
 1. The conductors and equipment have been de-energized, red danger locked, red danger tagged and tested for no voltage per Appendix (A).
 2. There is no possibility of contact with another energized source.
 3. The hazard of induced voltage is not present.
- d) One must be a QP-HV to install or 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 UFC 3-560-01 Electrical Safety.
- e) A serialized red danger tag with location(s) of installed grounds recorded shall accompany all ground placements under LOTO.
- f) Equipotential grounding, as recommended by SOP PWBL 001, UFC 3-560-01 Electrical Safety, and OSHA 29CFR 1910.269(n) "Grounding for the Protection of Employees" shall be utilized when feasible. When not feasible, grounds shall be placed as close to the work site as practical.
- g) Switching orders are required to install or remove temporary protective grounds on circuits or equipment over 600 volts. Ground locations shall be specified in the switching orders.
- h) Temporary 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 protective grounds shall be appropriately sized with the correct connection for the application.
- i) Temporary 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.

- j) 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.
- k) When a temporary 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.
- l) When a temporary 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.

APPENDIX D: 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:		INITIAL HOOK UP FOR ARRIVAL:		OUTAGE INFORMATION:				
<input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> NAVSEA / OTHER		<input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED		<input type="checkbox"/> SCHEDULED OUTAGE <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> UNSCHEDULED OUTAGE <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	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	METER KW HRS: _____				
Operation of Breakers	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	List Breakers: _____				
MEGGER Cables	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	Lowest MEGGER Value on Cables: _____ MEGOHMS <small>(Min. Values for 480V Service is 4 Megohms; for 4,160V is 10 Megohms)</small>				
Check Current Load	<input type="checkbox"/> OK	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 For 4160V 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 amperage readings on all phases of each shore power cable. Attach additional sheets to record readings as required. If ship elects not to go back on shore power at this time, take readings as soon as possible.								
BREAKER	A-PHASE	B-PHASE	C-PHASE		BREAKER	A-PHASE	B-PHASE	C-PHASE
Ship load at least 50% for 4 hours:		<input type="checkbox"/> OK	INFRA-RED Survey Performed:		<input type="checkbox"/> OK	Need Repair? <input type="checkbox"/> YES		
Ship Electrical Officer: Print Name, Sign & Date								
PW Utilities Electrician: Print Name, Sign & Date								

APPENDIX F: SHIP TO SHORE TAG

CONNECT / DISCONNECT TAG DATE: _____

CABLE #s: _____

PLUG #s: _____

RECEPTACLE #: _____

OPERATOR: _____ **SHIP:** _____

PURPOSE

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

BACKGROUND

The disconnection of 4160 Volt Shore Power to Ships is a hazardous operation. Hazards mitigated by this Standard Operating Procedure (SOP) 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 or contractor personnel and Ship Personnel are necessary to ensure the highest level of safety for all involved.

REFERENCES

A complete list of definitions may be found in NAVFAC PWBL-SAFE 01 ELECTRICAL SAFE.

References:

1. Unified Facilities Criteria (UFC) 3-560-01 Electrical Safety, O&M
2. OPNAVINST 11310.3B Operation and Maintenance Policy for Shore To Ship Power

Appendices:

- A. Test for No Voltage
- B. Test for No Voltage and Apply Temporary Protective Grounds
- C. Temporary Protective Grounds Policy for NAVFAC Employees
- D. Example of Ship Connect/Disconnect Form

TOOLS, EQUIPMENT, AND PERSONAL PROTECTIVE EQUIPMENT ASSOCIATED WITH THIS PROCEDURE

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 UFC 3-560-01 Electrical Safety, NAVFAC PWBL 003 Working on or Near Exposed and Enclosed Energized Electrical Systems and PWBL 004 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems.

TRAINING, CERTIFICATION, AND RECORD KEEPING

All employees whose job requires the use of this SOP 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 trained; Authorized Employees and Qualified Persons shall be kept at a, centralized location 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.

PROCEDURES

General Information

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Ships operating in a cold iron mode. NAVFAC provides Shore Power connect and disconnect service, plus cable assemblies and maintenance, as a reimbursable activity per NAVFAC BMS B-5.2.5. Cable assemblies include all necessary components to allow connection from Facility Shore Power receptacle or bus to Ship's Shore Power bus.
2. Personnel performing Shore Power Connects and Disconnects may be exposed to AC electrical potential greater than 600 volts, AC electrical potential less than 600 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 ungrounded, correctly phased, correctly-cable-oriented system with an adequate number of power cables to serve the Ship load. Where two or more power cables are connected to a Ship, cables are 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.”

Disconnect Procedure for Surface Ships Utilizing 4160 Volt Shore Power

Step 1. Ship’s Load Transfer To The Ship’s Generator(s)

- 1.1 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.
- 1.2 Obtain and utilize Ship Connect/Disconnect Form to record information. See Appendix D 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.
- 1.3 An Authorized Official or HV Shop Supervisor shall write Switching Orders and the Switching Order Package for Shore Power.
- 1.4 **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.
- 1.5 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.

Step 2. Disconnection of Shore Power Cable Plugs From Receptacles

- 2.1 Shore power cables shall be disconnected from the Ship’s Shore Power bus toward the Facility Shore Power receptacles.
- 2.2 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.
- 2.3 NAVFAC Qualified Person (QP) in Charge shall conduct a joint Job Brief, with Ship Personnel and NAVFAC Personnel, to ensure all personnel have required equipment, tools, and PPE.
- 2.4 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. 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 NAVFAC PWBL 001.
- 2.5 NAVFAC 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. Ship Personnel may install danger tags and danger locks, in accordance with Ship Procedures, on the Facility Shore Power circuit breakers.

- 2.6 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. If no voltage is detected, Ship personnel disconnect cable assemblies by removing cable lugs from Ship's shore power buses.
- 2.7 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.

Step 3. Removal of Shore Power Cable Assemblies

- 3.1 Place vehicle or weight handling equipment in position if used; cable can also be hand carried.
 - 3.1.1 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.
 - 3.1.2 Use a spotter when backing up or placing in tight space.
 - 3.1.3 Operators shall have a valid license, training, and certification in accordance with Command policies.
- 3.2 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.
- 3.3 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 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 protective grounds must be installed before crane or boom truck moves shore power cables.
- 3.4 NAVFAC QP-HV, wearing PPE as specified in NAVFAC PWBL 003, shall install temporary protective grounds as specified in the switching orders to facility shore power circuit breakers load bus or receptacles in accordance with NAVFAC PWBL 001 and PWBL 004 and as described in Appendix B and C.
- 3.5 NAVFAC QP HV, wearing appropriate PPE, shall test for no voltage as described in Appendix A to verify the shore power cable assemblies are de-energized. If no voltage is detected, disconnect cable assemblies by removing plugs from facility shore power receptacles.
- 3.6 Ship Personnel shall remove danger tags and/or danger locks, in accordance with Ship Procedures, on the NAVFAC Facility Shore Power circuit breakers.
- 3.7 NAVFAC QP and Ship's representatives sign ship connect/disconnect form verifying shore power removal is complete.
- 3.8 NAVFAC QP-HV and Authorized Employees, wearing appropriate PPE, shall follow switching orders prepared in accordance with NAVFAC PWBL 001 when required to restore operation of breakers.
 - 3.8.1 Remove Temporary Protective Grounds-to Facility Shore Power circuit breakers load bus or receptacles per Appendix C.

- 3.8.2 Remove the red danger locks and red danger tags from Facility shore power circuit breaker(s) cubicle(s)
- 3.8.3 Insert (rack in) circuit breaker(s) into circuit breaker cubicle(s) in accordance with switching orders and NAVFAC PWBL 001.
- 3.8.4 Remove Ship to Shore Tags from cables.

APPENDIX A: TEST FOR NO VOLTAGE

- a) 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 NAVFAC PWBL-SAFE 01 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 UFC 3-560-01 Electrical Safety.
- b) A QP HV shall test for no voltage per NAVFAC PWBL 004.
- c) 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.

APPENDIX B: TEST FOR NO VOLTAGE AND APPLY TEMPORARY PROTECTIVE GROUNDS

- a) 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 UFC 3-560-01 Electrical Safety.
- b) 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 NAVFAC PWBL-SAFE 01. Install temporary protective grounds per Appendix C.
- c) A QP-HV shall test for no voltage per NAVFAC PWBL 004.
- d) 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.
- e) The Operations Center, HV Shop Supervisor and NAVFAC QP-HV shall communicate and initial off, on the switch out and temporary protective grounds sheet of the switching orders, the installation of each temporary protective ground.

APPENDIX C: TEMPORARY PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

- a) Temporary 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.
- b) Any circuit not grounded shall be considered energized except when grounding has been waived.
- c) An Electrical Utility Supervisor or designated work leader 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.
- d) The conductors and equipment have been de-energized, red danger locked, red danger tagged and tested for no voltage per Appendix (A).
 - 1. There is no possibility of contact with another energized source.
 - 2. The hazard of induced voltage is not present.
 - 3. One must be a QP-HV to install or 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 UFC 3-560-01 Electrical Safety.
- e) A serialized red danger tag with location(s) of installed grounds recorded shall accompany all ground placements under LOTO.
- f) Equipotential grounding as recommended by SOP PWBL 001, UFC 3-560-01 "Electrical Safety O&M", and OSHA 29CFR 1910.269(n) "Grounding for the Protection of Employees" shall be utilized when feasible. When not feasible, grounds shall be placed as close to the work site as practical.
- g) Switching orders are required to install or remove temporary protective grounds on circuits or equipment over 600 volts. Ground locations shall be specified in the switching orders.
- h) Temporary 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 protective grounds shall be appropriately sized with the correct connection for the application.
- i) Temporary 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.

- j) 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.
- k) When a temporary 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.
- l) When a temporary 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.

APPENDIX D: 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:		INITIAL HOOK UP FOR ARRIVAL:		OUTAGE INFORMATION:				
<input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> NAVSEA / OTHER		<input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED		<input type="checkbox"/> SCHEDULED OUTAGE <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> UNSCHEDULED OUTAGE <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	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	METER KW HRS: _____				
Operation of Breakers	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	List Breakers: _____				
MEGGER Cables	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	Lowest MEGGER Value on Cables: _____ MEGOHMS <small>(Min. Values for 480V Service is 4 Megohms; for 4,160V is 10 Megohms)</small>				
Check Current Load	<input type="checkbox"/> OK	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 For 4160V 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 amperage readings on all phases of each shore power cable. Attach additional sheets to record readings as required. If ship elects not to go back on shore power at this time, take readings as soon as possible.								
BREAKER	A-PHASE	B-PHASE	C-PHASE		BREAKER	A-PHASE	B-PHASE	C-PHASE
Ship load at least 50% for 4 hours:		<input type="checkbox"/> OK	INFRA-RED Survey Performed:		<input type="checkbox"/> OK	Need Repair? <input type="checkbox"/> YES		
Ship Electrical Officer: Print Name, Sign & Date								
PW Utilities Electrician: Print Name, Sign & Date								

PURPOSE

Provide standard procedures for connecting 480 volt shore power to Submarines.

BACKGROUND

The connection of 480 Volt Shore Power to Submarines is a hazardous operation. Hazards mitigated by this Standard Operating Procedure (SOP) 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 or contractor personnel and Submarine Personnel are necessary to ensure the highest level of safety for all involved.

REFERENCES

A complete list of definitions may be found in NAVFAC PWBL-SAFE 01 ELECTRICAL SAFE.

References:

1. Unified Facilities Criteria (UFC) 3-560-01 Electrical Safety, O&M
2. OPNAVINST 11310.3B Operation and Maintenance Policy for Shore To Ship Power

Appendices:

- A. Test for No Voltage
- B. Test for No Voltage and Apply Temporary Protective Grounds
- C. Temporary Protective Grounds Policy for NAVFAC Employees
- D. Example of Submarine Connect/Disconnect Form
- E. Submarine to Shore Power Cable Insulation Record
- F. Example of Submarine to Shore Tag
- G. List of Cable Certifications

TOOLS, EQUIPMENT, AND PERSONAL PROTECTIVE EQUIPMENT ASSOCIATED WITH THIS PROCEDURE

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 UFC 3-560-01 Electrical Safety, NAVFAC PWBL 003 Working on or Near Exposed and Enclosed Energized Electrical Systems and PWBL 004 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems.

TRAINING, CERTIFICATION, AND RECORD KEEPING

All employees whose job requires the use of this SOP 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 trained; Authorized Employees and Qualified Persons shall be kept at a, centralized location 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.

PROCEDURES

General Information

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Submarines operating in a cold iron mode. NAVFAC provides Shore Power connect and disconnect service, plus cable assemblies and maintenance, as a reimbursable activity per NAVFAC BMS B-5.2.5. Cable assemblies shall include all necessary components to allow connection from Facility Shore Power receptacles to Submarine's Shore Power receptacles.
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 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 must provide an ungrounded, correctly phased, correctly-cable-oriented system with an adequate number of power cables to serve the Submarine load. Where two or more power cables are connected to a Submarine, 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 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 11310.3B 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."

Connect Procedure for Submarines Utilizing 480 Volt Shore Power

Step 1. Prepare for Submarine's Arrival

- 1.1 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.
- 1.2 Obtain and utilize Ship Connect/Disconnect Form to record information. See Appendix D 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.
- 1.3 NAVFAC Qualified Person (QP) in Charge shall conduct a Job Brief and ensure all personnel have the required equipment, tools, and PPE.

Step 2. Lay Power Cable Assemblies

- 2.1 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.
- 2.2 Place vehicle or weight handling equipment in position.
 - 2.2.1 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.
 - 2.2.2 Use a spotter when backing up or placing in tight space.
 - 2.2.3 Operators shall have a valid license, training, and certification in accordance with Command policies.
- 2.3 Shore Power cables shall be placed at the pier where the Submarine will dock or berth.

- 2.4 Lay out cables between Facility Shore Power receptacles and Submarine's Shore Power receptacles. Note the following **CAUTIONS**:
- 2.4.1 Ensure cable ends are not connected to any equipment, weight handling equipment or vehicle.
 - 2.4.2 Excess cable shall be laid in such a manner as to minimize damage from vehicle and pedestrian traffic.
 - 2.4.3 Each set of Shore Power cables should be positioned as a unit.
 - 2.4.4 Do not lay or drag cables on or over sharp and ragged objects.
 - 2.4.5 Shore power cables and terminations should be physically isolated from Shore Steam, Potable Water, Salt Water, and all other service lines.
 - 2.4.6 Do not exceed minimum cable bend radius. Per Insulated Cable Engineers Association, minimum THOF cable bend radius is 6 times the outer diameter.
 - 2.4.7 Provide adequate cable length to compensate for the rise and fall of the tide, cable slack should not dip into the water or become wedged between the Submarine and pier.
 - 2.4.8 Ensure cables are of proper length and size and are arranged in a neat and safe manner.
 - 2.4.9 To reduce overheating or de-rating cable, excess cable should not be coiled.
 - 2.4.10 Barricades shall be placed as necessary, to keep vehicles off cable.
 - 2.4.11 Where cables would obstruct drains or scuppers, lay cables on a pallet to allow water drainage on the pier.
 - 2.4.12 Do not hold or brace the cable in place as this may result in a foot or leg injury.
 - 2.4.13 When loading or unloading Shore Power cable, 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 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.

Step 3. Inspect and Test Each Power Cable Assembly

- 3.1 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 Appendix A, NAVFAC QP shall test each phase conductor or circuit part of the cables for no voltage prior to handling.
- 3.2 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.
- 3.3 Visually inspect shore power cable assemblies for any sign of defect. Cables not passing visual inspection shall be removed from service.
 - 3.3.1 Inspect cable assemblies for cracks, bulges, or indications of overheating.
 - 3.3.2 Inspect cable sheath for cuts, nicks, and gouges.
 - 3.3.3 As required, strip insulation from any existing cable splices and inspect for cleanliness, tightness, and good surface contact.

- 3.4 Repair defects and re-insulate as needed.
- 3.5 Clean and inspect cable connectors.
 - 3.5.1 Inspect cable connectors and each connector conducting surface for pitting, corrosion, and evidence of overheating. Ensure conducting surface is clean and grease free.
 - 3.5.2 Inspect adapter flange for heavy corrosion that will limit tightening of the connector plug.
 - 3.5.3 If required by manufacturer, apply a light coat of approved grease or contact cleaner to cable connectors.
 - 3.5.4 Repair or replace any deficiency.
- 3.6 Measure insulation resistance between cable assembly conductors and each conductor and ground 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.
- 3.7 Record all insulation resistance readings on Submarine to Shore Power Cable Insulation Record (see Appendix E) and record the lowest insulation resistance value on the Ship Connect/Disconnect Form (see Appendix D). Include pigtails when provided.
- 3.8 Replace Shore Power cable if it does not meet minimum insulation resistance requirements.
- 3.9 Verify phase identification markings (color coding or labeling) of the cable assembly to ensure proper orientation (in-phase).
- 3.10 Attach "DANGER-HIGH VOLTAGE" signs to Shore Power cable assemblies.
- 3.11 Barricade the work area surrounding the Shore Power receptacles and portable shore power cables to the greatest extent possible.

Step 4. Inspect and Test 480 Volt Shore Receptacles

- 4.1 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.
- 4.2 NAVFAC QP and Authorized Employees, wearing appropriate PPE, shall establish Electrically Safe Working Condition.
 - 4.2.1 Open, red danger tag and red danger lock Facility Shore Power receptacle circuit breakers.
 - 4.2.2 Test Shore Power circuit breaker receptacles for no voltage.
 - 4.2.3 If appropriate, apply Temporary Protective Grounding to shore power receptacles per Appendix B and C. **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 Appendix C.
- 4.3 Carefully open/remove access cover(s) to each shore power receptacle and test for no voltage per Appendix A. 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.
- 4.4 Inspect each cover and receptacle. Clean as necessary to ensure proper operation
 - 4.4.1 If applicable, inspect each cover gasket and each receptacle gasket for cuts, tears, cracks, and deformation.

- 4.4.2 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.
- 4.5 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 Appendix E). If test data is unavailable or older than 12 months, perform steps 4.5.1 through 4.5.4.
 - 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.
 - 4.5.2 If temporary protective grounds were installed in accordance with Appendix C, 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.
 - 4.5.3 Record megohmmeter values on the Ship to Shore Power Cable Insulation Record (see Appendix E).
 - 4.5.4 Re-install indicator lights, appropriate fuses and reconnect appropriate meters.
- 4.6 Install/close shore power receptacle access covers.
- 4.7 Remove red danger tags and red danger locks from Shore Power receptacle circuit breakers for testing purposes, if required.
- 4.8 Test MIL-C-24368 facility shore power receptacle cover interlock switches (if equipped) and indicator lights in accordance with Appendix A, NAVFAC PWBL 003 and 004.
 - 4.8.1 Close shore power receptacle circuit breakers.
 - 4.8.2 Ensure receptacle indicating lights are illuminated.
 - 4.8.3 Open shore power receptacle access cover; receptacle circuit breaker should trip and indicating light should extinguish.
 - 4.8.4 Test shore power receptacle for no voltage to ensure the receptacle has been de-energized.
 - 4.8.5 Close shore power receptacle access cover.
 - 4.8.6 If so equipped, test open and close push buttons for proper operation.
- 4.9 For Submarine Shore Power, test to ensure the proper operation of the shunt trip scheme.
- 4.10 Open facility shore power circuit breakers.
- 4.11 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 NAVFAC PWBL 001 and report deficiencies to NAVFAC Supervisor.

Step 5. Inserting Cable Plugs Into Shore Receptacles

- 5.1 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.
- 5.2 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 Appendix E) and the Ship Connect/Disconnect Form (see Appendix D) 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.
- 5.3 Shore Power cable connections shall be made from the NAVFAC Shore Power receptacle toward the Submarine's shore power receptacle.
 - 5.4 NAVFAC QP shall open, red danger tag, red danger lock facility shore power circuit breakers, test for no voltage and apply temporary protective grounds. (Temporary Protective Grounding is usually waived for 480 volt submarine shore power) at shore power circuit breaker receptacles in accordance with Appendix B and C. NAVFAC AEs shall install red danger tags and red danger locks.
 - 5.5 NAVFAC QP shall verify the Shore Power receptacles are in an Electrically Safe Work Condition.
 - 5.6 While the Shore Power cable assemblies are in an Electrically Safe Work Condition, NAVFAC QP shall:
 - 5.6.1 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.
 - 5.6.2 Check all cable assemblies by verifying proper phase color coding: Phase "A" is black, Phase "B" is white and Phase "C" is red.
 - 5.6.3 Check all cable assemblies for proper cable phase grouping.
 - 5.7 Fill out and attach the Ship to Shore Tag (see Appendix F) to cables at receptacle.

Step 6. Shore Power Cable Rigging

- 6.1 NAVFAC 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.
 - 6.1.1 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.
- 6.2 If Submarine personnel will load cables to submarine, a NAVFAC QP wearing PPE shall remove temporary protective grounds from Facility Shore Power circuit breaker receptacles, if installed. Installing temporary protective grounds for 480 volt submarine shore power is a rare occurrence.
- 6.3 Load Shore Power cable assemblies from Shore to Submarine. If boom trucks or cranes are used, follow appropriate boom truck and crane SOP.
- 6.4 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.
- 6.5 If NAVFAC operated boom crane, crane or boom truck was used to load cable to submarine, a NAVFAC QP wearing PPE shall remove temporary protective grounds from shore power receptacles, if installed. Installing temporary protective grounds for 480 volt submarine shore power is a rare occurrence.
- 6.6 Submarine Personnel will connect Shore Power cables to Submarine's Shore Power receptacles in accordance with NAVSEA Steam and Electric Plant Manual.

- 6.7 NAVFAC QP in Charge shall obtain signature of the Submarine's Electrical Officer or the Sub's designated electrical representative on the Ship Connect/Disconnect Form giving NAVFAC personnel permission to energize shore power at the agreed upon time.
- 6.8 NAVFAC QP shall escort Submarine Personnel while Submarine Personnel are clearing tags and locks from Facility Shore Power circuit breakers.
- 6.9 NAVFAC personnel shall remove red danger tags and red danger locks from the Facility Shore Power circuit breakers.
- 6.10 After receiving permission from Submarine's Electrical Officer or the Submarine's designated electrical representative, NAVFAC QP shall close Facility Shore Power circuit breakers in the sequence requested by the Submarine's Electrical Officer.

Step 7. Submarine's Transfer To Shore Power

- 7.1 **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.
- 7.2 When the Submarine's Electrical Officer 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 Submarine's Electrical Officer thereby accepting Shore Power.
- 7.3 **Note:** No personnel shall move energized Shore Power cable assemblies.
- 7.4 NAVFAC personnel shall check amperage readings on all phases of each cable with permanently installed ammeters (preferred method), or a clamp-on amp meter. Verify that phase amperage readings are within 10 percent of each other. If the amperage readings are not within 10 percent, notify NAVFAC QP in Charge, Submarine's electrical representative, and perform a thermal infra-red imaging survey.
- 7.5 After the Submarine is drawing current and has reached at least 50% load for 4 hours, 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.
 - 7.5.1 The NAVFAC IR survey will include the connector at the Shore Power substation to the last connector on the pier.
 - 7.5.2 **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.
 - 7.5.3 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 E-SAFE PWBL 01 and report deficiencies to NAVFAC Supervisor.
- 7.6 When the IR survey is complete, the Ship Connect/Disconnect Form shall be signed indicating completion of the task.

APPENDIX A: TEST FOR NO VOLTAGE

- a) 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 NAVFAC PWBL-SAFE 01 using the required PPE. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer per UFC 3-560-01 Electrical Safety.
- b) A QP shall test for no voltage per NAVFAC PWBL 004.
- c) 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.

APPENDIX B: TEST FOR NO VOLTAGE AND APPLY TEMPORARY PROTECTIVE GROUNDS

- a) 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 NAVFAC PWBL-SAFE 01. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with UFC 3-560-01 Electrical Safety. Install temporary protective grounds per Appendix C.
- b) Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP as defined in the NAVFAC PWBL-SAFE 01 using the required PPE.
- c) A QP shall test for no voltage per NAVFAC PWBL 004
- d) 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.

APPENDIX C: TEMPORARY PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

- a) 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.
- b) 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.
- c) Temporary protective grounding shall be used where:
 - 1. The possibility of induced voltages or stored electrical energy exists.
 - 2. It could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts.
- d) 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 UFC 3-560-01 Electrical Safety.
- e) Equipotential grounding, as described by UFC 3-560-01 Electrical Safety, 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.
- f) 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.
- g) 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.
- h) The location of installed temporary protective grounds shall be written on red danger tags.
- i) 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.
- j) 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.

APPENDIX D: 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:		INITIAL HOOK UP FOR ARRIVAL:		OUTAGE INFORMATION:				
<input type="checkbox"/> NAVFAC PW UTILITIES		<input type="checkbox"/> SCHEDULED		<input type="checkbox"/> SCHEDULED OUTAGE				
<input type="checkbox"/> CONTRACTOR		<input type="checkbox"/> UNSCHEDULED		<input type="checkbox"/> RECONNECTING S/P				
<input type="checkbox"/> NAVSEA / OTHER				<input type="checkbox"/> UNSCHEDULED OUTAGE				
				<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	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	METER KW HRS:	_____			
Operation of Breakers	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	List Breakers:	_____			
MEGGER Cables	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	Lowest MEGGER Value on Cables:	_____ MEGOHMS			
<small>(Min. Values for 480V Service is 4 Megohms; for 4,160V is 10 Megohms)</small>								
Check Current Load	<input type="checkbox"/> OK	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 For 4160V 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 amperage readings on all phases of each shore power cable. Attach additional sheets to record readings as required. If ship elects not to go back on shore power at this time, take readings as soon as possible.								
BREAKER	A-PHASE	B-PHASE	C-PHASE		BREAKER	A-PHASE	B-PHASE	C-PHASE
Ship load at least 50% for 4 hours:		<input type="checkbox"/> OK	INFRA-RED Survey Performed:		<input type="checkbox"/> OK	Need Repair? <input type="checkbox"/> YES		
Ship Electrical Officer: Print Name, Sign & Date								
PW Utilities Electrician: Print Name, Sign & Date								

APPENDIX F: SAMPLE SHIP TO SHORE TAG

CONNECT / DISCONNECT TAG DATE: _____

CABLE #s: _____

PLUG #s: _____

RECEPTACLE #: _____

OPERATOR: _____ **SHIP:** _____

PURPOSE

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

BACKGROUND

The disconnection of 480 Volt Shore Power to Submarines is a hazardous operation. Hazards mitigated by this Standard Operating Procedure (SOP) 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 or contractor personnel and Submarine Personnel are necessary to ensure the highest level of safety for all involved.

REFERENCES

A complete list of definitions may be found in NAVFAC PWBL-SAFE 01 ELECTRICAL SAFE.

References:

1. Unified Facilities Criteria (UFC) 3-560-01 Electrical Safety, O&M
2. OPNAVINST 11310.3B Operation and Maintenance Policy for Shore To Ship Power

Appendices:

- A. Test for No Voltage
- B. Test for No Voltage and Apply Temporary Protective Grounds
- C. Temporary Protective Grounds Policy for NAVFAC Employees
- D. Example of Ship Connect/Disconnect Form

TOOLS, EQUIPMENT, AND PERSONAL PROTECTIVE EQUIPMENT ASSOCIATED WITH THIS PROCEDURE

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 UFC 3-560-01 Electrical Safety, NAVFAC PWBL 003 Working on or Near Exposed and Enclosed Energized Electrical Systems and PWBL 004 Measuring/Testing Parameters of Energized High or Low Voltage Electrical Systems.

TRAINING, CERTIFICATION, AND RECORD KEEPING

All employees whose job requires the use of this SOP 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 trained; Authorized Employees and Qualified Persons shall be kept at a centralized location 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.

PROCEDURES

General Information

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Submarines operating in a cold iron mode. NAVFAC provides Shore Power connect and disconnect service, plus cable assemblies and maintenance, as a reimbursable activity per NAVFAC BMS B-5.2.5. Cable assemblies include all necessary components to allow connection from Facility Shore Power receptacles to Submarine's Shore Power receptacles.
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 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 ungrounded, correctly phased, correctly-cable-oriented system with an adequate number of power cables to serve the Submarine load. Where two or more power cables are connected to a Submarine, cables are 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 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.”

Disconnect Procedure for Submarines Utilizing 480 Volt Shore Power

Step 1. Submarine’s Load Transfer To The Submarine’s Generator(s)

- 1.1 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.
- 1.2 Obtain and utilize Ship Connect/Disconnect Form to record information. See Appendix D 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.
- 1.3 **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.
- 1.4 When the Submarine’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 Submarine’s Electrical Officer signature on the Ship Connect/Disconnect Form thereby giving permission to shore activity personnel to de-energize shore power.

Step 2. Disconnection of Shore Power Cable Plugs From Receptacles

- 2.1 Shore Power cable disconnections shall be from the Submarine’s Shore Power receptacles toward the NAVFAC Shore Power receptacles.
- 2.2 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.
- 2.3 NAVFAC Qualified Person (QP) in Charge shall conduct a joint Job Brief, with Ship Personnel and NAVFAC Personnel, to ensure all personnel have required equipment, tools, and PPE.
- 2.4 NAVFAC QP, wearing appropriate PPE, shall establish Electrically Safe Working Condition for Shore Power Cable Assemblies. Open, red danger tag and red danger lock Facility Shore Power receptacle circuit breakers.
- 2.5 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. Submarine Personnel may install danger tags and danger locks, in accordance with Submarine Procedures, on the NAVFAC Shore Power circuit breakers.
- 2.6 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. If no voltage is detected, Submarine personnel disconnect cable assemblies by removing plugs from Submarine’s shore power receptacles.

- 2.7 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.

Step 3. Removal of Shore Power Cable Assemblies

- 3.1 Place vehicle or weight handling equipment in position if used; cable can also be hand carried.
- 3.1.1 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.
- 3.1.2 Use a spotter when backing up or placing in tight space.
- 3.1.3 Operators shall have a valid license, training, and certification in accordance with Command policies.
- 3.2 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.
- 3.3 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 ship onto the pier, apply temporary protective grounds if appropriate, before the crane or boom truck moves shore power cables.
- 3.4 If appropriate, apply Temporary Protective Grounding to shore power receptacles per Appendix B and C. 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 Appendix C.
- 3.5 At the Facility Shore Power receptacles NAVFAC QP, wearing appropriate PPE, shall test for no voltage. If no voltage is detected, disconnect cable assemblies by removing plugs from facility shore power receptacles.
- 3.6 Close or install shore power receptacle access covers.
- 3.7 Submarine's Personnel shall remove danger tags and danger locks, in accordance with Ship Procedures, on the NAVFAC Facility Shore Power circuit breakers.
- 3.8 NAVFAC and Submarine's representatives sign ship connect/disconnect form verifying shore power removal is complete.
- 3.9 A NAVFAC QP wearing PPE shall remove temporary protective grounds from Facility Shore Power circuit breaker receptacles, (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.
- 3.10 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.
- 3.11 Remove Ship to Shore Tags from cables.

APPENDIX A: TEST FOR NO VOLTAGE

- a) 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 NAVFAC PWBL-SAFE 01 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 UFC 3-560-01 Electrical Safety.
- b) A QP shall test for no voltage per NAVFAC PWBL 004.
- c) 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.

APPENDIX B: TEST FOR NO VOLTAGE AND APPLY TEMPORARY PROTECTIVE GROUNDS

- a) 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 NAVFAC PWBL-SAFE 01. This energized work will require a local Standard Operating Procedure approved, in writing, by the Commanding Officer/Executive Officer in accordance with UFC 3-560-01 Electrical Safety. Install temporary protective grounds per Appendix C.
- b) Because voltage testing is considered working on an exposed energized electrical system, employees performing voltage testing shall be a QP as defined in the NAVFAC PWBL-SAFE 01 using the required PPE.
- c) A QP shall test for no voltage per NAVFAC PWBL 004
- d) 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.

APPENDIX C: TEMPORARY PROTECTIVE GROUND POLICY FOR NAVFAC PERSONNEL

- a) 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.
- b) 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.
- c) Temporary protective grounding shall be used where:
 - 1. The possibility of induced voltages or stored electrical energy exists.
 - 2. It could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts.
- d) 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 UFC 3-560-01 Electrical Safety, O&M.
- e) Equipotential grounding as described by UFC 3-560-01 Electrical Safety O&M 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.
- f) 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.
- g) 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.
- h) The location of installed temporary protective grounds shall be written on red danger tags.
- i) 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.
- j) 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.

APPENDIX D: 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:		INITIAL HOOK UP FOR ARRIVAL:		OUTAGE INFORMATION:				
<input type="checkbox"/> NAVFAC PW UTILITIES <input type="checkbox"/> CONTRACTOR <input type="checkbox"/> NAVSEA / OTHER		<input type="checkbox"/> SCHEDULED <input type="checkbox"/> UNSCHEDULED		<input type="checkbox"/> SCHEDULED OUTAGE <input type="checkbox"/> RECONNECTING S/P <input type="checkbox"/> UNSCHEDULED OUTAGE <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	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	METER KW HRS: _____				
Operation of Breakers	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	List Breakers: _____				
MEGGER Cables	<input type="checkbox"/> OK	Need Repair?	<input type="checkbox"/> YES	Lowest MEGGER Value on Cables: _____ MEGOHMS <small>(Min. Values for 480V Service is 4 Megohms; for 4,160V is 10 Megohms)</small>				
Check Current Load	<input type="checkbox"/> OK	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 For 4160V 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 amperage readings on all phases of each shore power cable. Attach additional sheets to record readings as required. If ship elects not to go back on shore power at this time, take readings as soon as possible.								
BREAKER	A-PHASE	B-PHASE	C-PHASE		BREAKER	A-PHASE	B-PHASE	C-PHASE
Ship load at least 50% for 4 hours:		<input type="checkbox"/> OK	INFRA-RED Survey Performed:		<input type="checkbox"/> OK	Need Repair? <input type="checkbox"/> YES		
Ship Electrical Officer: Print Name, Sign & Date								
PW Utilities Electrician: Print Name, Sign & Date								

PURPOSE

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

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. Cool exceptions are usually caused by failed components.

REFERENCES

A list of definitions may be found in NAVFAC PWBL-SAFE 01 ELECTRICAL SAFE.

References:

1. Unified Facilities Criteria (UFC) 3-560-01 Electrical Safety, O&M
2. OPNAVINST 11310.3B Operation and Maintenance Policy for Shore To Ship Power
3. NAVFAC PWBL-SAFE 01, PWBL 001 through PWBL 010
4. S9086-RJ-STM-010: NSTM 504 Section 17, Infrared Thermal Imaging Systems

Appendices:

- A. Infrared Inspection Data

TOOLS, EQUIPMENT, AND PERSONAL PROTECTIVE EQUIPMENT ASSOCIATED WITH THIS PROCEDURE

Tools: Infrared Camera or Visual IR Thermometer, Clamp-on Amp Meter.

PPE: Arc Rated long sleeve shirt and pants (or coveralls) with a minimum arc rating of 8 cal/cm², leather Electrical Hazard (EH) rated safety shoes/boots, Hard Hat, Safety Glasses, and Voltage Rated Gloves.

TRAINING, CERTIFICATION, AND RECORD KEEPING

NAVFAC Authorized Employees (AE) or Qualified Persons (QP) performing the testing shall be Utility Energy Management 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.

PROCEDURES

General Information

1. NAVFAC Electric Utility Systems are utilized to provide dockside electrical service (Shore Power) to Ships and Submarines operating in a cold iron mode. NAVFAC provides Shore Power connect and disconnect service, plus cable assemblies and maintenance, as a reimbursable activity per NAVFAC BMS B-5.2.5. Cable assemblies include all necessary components to allow connection from Facility Shore Power receptacles to vessel's Shore Power receptacles.
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.

Procedure for Infrared Testing of Shore Power Cable Assemblies

Step 1. Record Review and Shore Power Load

- 1.1 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.
- 1.2 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 four consecutive hours. NAVFAC QP shall perform a thermal infrared (IR) imaging inspection to ensure all Shore Power equipment is operating within safe tolerances within 24 hours of the vessel's transfer to shore power.

Step 2. Thermal Infrared Inspection of Shore Power Cable Assemblies

- 2.1 The IR inspection is to include the connector at the Shore Power substation receptacle to the last connector on the pier.
- 2.2 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.
- 2.3 Perform thermal IR inspections in accordance with the Infrared Camera or Visual IR Thermometer manufacturer's operating or technical manual.
 - 2.3.1 **CAUTION:** Breakers, receptacles, and cables are energized. Personnel must adhere to Minimum Approach Distances provided in Unified Facilities Criteria 3-560-01 Electrical Safety, O&M.
 - 2.3.2 No Personnel shall move energized Shore Power cable assemblies.
 - 2.3.3 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.
 - 2.3.4 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.
- 2.4 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 onto Appendix A "Infrared Inspection Data". Shore personnel shall provide the exact location, such as marking the cable behind the boot with a grease pen, and inform maintenance personnel.
 - 2.4.1 **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.
 - 2.4.2 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.

Step 3. Infrared Test Results and Reports

- 3.1 On Appendix A, 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/Submarine's Electrical Officer, Ship's Reactor Electrical Assistant (REA), or the Ship's/Submarine's designated electrical representative.
- 3.2 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.
- 3.3 Note any adjustment, cleaning, or tightening of shore power cable connections in the comments on the Infrared Inspection Data sheet.
- 3.4 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.

- 3.5 Repeat the thermal IR inspection 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.

Temperature Rise or ΔT	Operational Assessment	Severity Code	Action
70°C and above	Failure Imminent	****	Equipment should be secured immediately and not operated until repairs are complete.
40°C to less than 70°C	Failure Almost Certain	***	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	**	Corrective action should be taken as soon as feasible.
10°C to less than 20°C	Performance Degraded	*	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>			

TABLE 1: INFRARED TEST - SEVERITY CODES

Infrared Inspection Data (Record all thermal anomalies)

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

NAVFAC QP: _____

Imaging System Used: _____