Matrix

HAZARD / PROCESS	Falls	Burns / Shocks	Over-exposure	Traumatic / Acute Injuries	Eye Injuries	Heat Stress
Hot Work: Welding, Cutting, and Brazing		A-17	A-25		A-12	
Ship Fitting / Unit Assembly	B-2	B-6	B-11	B-14	B-18	B-21
Rigging	C-9	C-12		C-13		
Shipboard Electrical		D-4, D-15, D-16, D-17		D-18, D-19, D-20, D-21		

OSHA

Occupational Safety and Health Administration

U.S. Department of Labor

SHIPS
SAFETY and HEALTH INJURY PREVENTION SHEETS

Working with the Shipyard Industry

Process

Shipboard Electrical

Disclaimer:

This guidance document is not a standard or regulation, and it creates no new legal obligations. It contains recommendations as well as descriptions of mandatory safety and health standards. The recommendations are advisory in nature, informational in content, and are intended to assist employers in providing a safe and healthful workplace. The Occupational Safety and Health Act requires employers to comply with safety and health standards and regulations promulgated by either federal OSHA or through an OSHA-approved State program. In addition, the Act's General Duty Clause, Section 5(a)(1), requires employers to provide their employees with a workplace free from recognized hazards likely to cause death or serious physical harm.

SAFETY and HEALTH INJURY PREVENTION SHEETS

Process: Shipboard Electrical

Introduction:

Workers in the shipyard industry face unique conditions and complex situations that put them at greater risk for injuries and/or death. This is especially true during the servicing of machinery, equipment, or systems where there is the potential for inadvertent startup or the release of hazardous energy. The complexity of these types of operations is compounded by the intricacy of the worksite; the large number of workers in the work-force; the involvement of multiple employers; and the vast array of machinery, equipment, and systems that workers may be servicing.

This guidance document is designed to highlight electrical hazards associated with shipboard electrical work. The information presented was obtained primarily from shipyard personnel and reflects actual shipyard experiences. Employers and workers are encouraged to communicate and share experiences to ensure a safe and healthful work environment for all workers.

Resource Materials:

This document does not address ergonomic exposures. Extensive research on ergonomic exposures and possible solutions in shipyard employment can be found at: http://www.osha.gov/Publications/OSHA3341shipyard.pdf.

This document also does not address exposures that occur during construction work, including construction work performed in shipyards or at other maritime job sites. For construction activity requirements, please see 29 CFR 1926.

Additional information is available from the National Institute for Occupational Safety and Health (NIOSH) and the National Shipbuilding Research Program (NSRP) at:
NIOSH: http://www.cdc.gov/niosh/topics/; and
NSRP: http://www.nsrp.org.

The diversity and dynamics of shipboard electrical work make it impossible to list all applicable standards in this document. 29 CFR Part 1915 applies to all ship repairing, shipbuilding and shipbreaking employment and its related activities, including shipboard electrical work. In some cases (e.g., work practices) the General Industry Standards contained in 29 CFR Part 1910 may be applicable (§§1910.333 – 1910.399). Guidance for applicability of standards can be found in OSHA's Shipyard Employment "Tool Bag" Directive, CPL 02-00-142 dated August 3, 2006. This directive is located on the OSHA website: www.osha.gov.

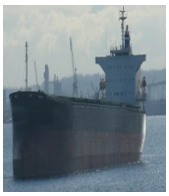
Employer Assistance:

Help for Employers (Small Businesses)

OSHA's On-site Consultation Program offers free and confidential advice to small and medium-sized businesses in all states across the country, with priority given to high-hazard worksites. On-site Consultation services are separate from enforcement and do not result in penalties or citations. Consultations from state agencies or universities work with employer to identify workplace hazards, provide advice on compliance with OSHA standards, and assist in establishing safety and health management systems. To locate the OSHA On-site Consultation Program nearest you, call 1-800-321-6742 (OSHA) or visit http://www.osha.gov/dcsp/smallbusiness/index.html.

State-plan States

States with OSHA-approved state plans may have different requirements. See http://www.osha.gov/dcsp/osp/index.html.



Shipboard Electrical Hazards

Electrical hazards are generally a result of a short, fault, or the opening or closing of an energized circuit.

A "short" occurs when a low-resistance path exists between a live wire and the ground, or between wires at different voltages. When the current is unintended, a "fault" results. Damaged insulation could cause a short, leading to arching or a fire. (see Electrical Safety: Safety and Health for Electrical Trades--Student Manual).

Electric Shock is the physical stimulation or trauma caused by the flow of electricity through the human body. It can occur during contact with or by being near live (energized) electrical parts. An electric shock can occur without direct contact with electricity. Electrocution results when death occurs from an electric shock. The most common shock-related injury is a burn.

Electrical shock hazards can be created by:

• Defective electrical tools	• Untrained or unqualified personnel attempting electrical power connections
• Improper electrical phasing	• Damaged wire insulation as a result of hot work processes
• Inaccurate schematic drawings	• Corroded connectors due to saltwater intrusion or contact
• Worn or frayed electric cables	• Inadequate electrical isolation, failure to test for deenergization, and improper lockout/tags-plus application
• Electric cables pinched in hatches/doors	• Tools and equipment not properly grounded
• Electric cables struck by grinders/saws	• Blind-side drilling into electrical conductors

Electric Arc is the luminous electrical discharge that occurs when high voltages exist across a gap between conductors and current travels through the air. This situation is often caused by equipment failure as a result of poor maintenance or overuse.

Arc Flash is the release of heat and bright intense light from an electric arc. Temperatures have been recorded as high as 35,000°F. Exposure to these extreme temperatures both burns the skin directly and causes ignition of clothing (see National Fire Protection Association Standard, NFPA 70E, 2012). An arc flash can be spontaneous or result from bridging the gap between electrical contacts with a conductive object such as a tool or jewelry. Other causes may include dropped tools on energized conductors which create sparks, breaks or gaps in insulation, as well as the buildup of dust, corrosion, or other impurities on the surface of an insulator, creating a fault path.

Shipboard Electrical Hazards (Cont.)

Arc Blast is the explosive release of molten material from equipment caused by high amperage arcs. The pressure waves produced by an arc blast are powerful enough that workers can be knocked off, onto, or into objects. The high pressure can cause injuries such as falls, exposure to being struck by molten metal and loose materials or equipment, ruptured eardrums, and memory loss as a result of a concussion.

Protective Clothing and Other Personal Protective Equipment (PPE)

Before electrical work is performed, employers need to conduct an arc flash hazard analysis, which will help to determine safe work practices for preventing injuries, the arc flash boundary, and the appropriate level of protective clothing and other PPE for workers to use.

Some examples of safe work practices are discussed in this document and include assigning responsibility and ensuring workers are only assigned to tasks that they have been trained on; the testing of electrical equipment and circuits to verify deenergization; the implementation of an effective lockout/tags-plus system; and the use of appropriate tools.

The arc flash boundary must be determined for each arc flash hazard analysis done for a specific task. The arc flash boundary marks the point at which arc-rated (AR) protective clothing and other PPE are necessary to avoid second-degree burns. AR clothing or equipment are necessary for protection against arc flash hazards, as they are specifically designed and tested for protection against the thermal effects of an arc flash. The arc rating can be expressed in cal/cm^2.

A hazard assessment is necessary for determining the hazards present, or likely to be present, at each worksite (29 CFR 1915.152(b)). Employers must provide and ensure that workers use personal protective equipment (PPE) appropriate for protecting them against these hazards (29 CFR 1915.152(a)). For example, non-conductive goggles should be worn instead of glasses with metal frames when performing electrical work. In addition, workers should avoid wearing jewelry, including metal watches, metal fasteners on clothing, or any other conductive material when working on equipment with high amperage. The selection of PPE must be communicated to each affected employee and training provided to ensure they understand the hazards associated with the work activity and the use of the PPE determined necessary (29 CFR 1915.152(b)(2) and (e)(1)).

Protective clothing and other PPE can be determined by either calculating an incident energy analysis (which predict the amount of energy that will be generated during an electrical arc incident) or by using the tables in NFPA 70E. NFPA 70E tables are used to determine the hazard/risk category for a specific task. The hazard/risk category is assigned a number from 0 to 4 and is used to identify the required protective clothing and other PPE for the specific task (see pages D6 and D7). While NFPA 70E does not cover shipboard electrical work, protective clothing and other PPE consistent with the standard's requirements is recommended.

For more detailed information, see Chapter 1, Article 130 of NFPA 70E, 2012.

Recommended Protective Clothing & PPE by Hazard/Risk Category

Category 0

- Shirt (long sleeve)
- Trousers (long)
- Safety glasses or safety goggles (selection required)
- Hearing protection (ear canal inserts)
- Heavy duty leather gloves (as needed)

Note: If rubber insulating gloves with leather protectors are determined necessary, additional leather or arc-rated gloves are not needed. A combination of rubber insulating gloves with leather protectors is appropriate for arc flash protection.

Shirts and trousers should be made from non-melting or untreated natural fiber (e.g., cotton, wool, rayon, silk, or blends of these material with a fabric weight of at least 4.5oz/yd^2).

Category 1

- Arc-rated long-sleeve shirt and trousers with a minimum arc rating of 4 cal/cm^2 (may substitute shirt & pants with arc-rated coverall)
- Arc-rated face shield with a minimum arc rating of 4 cal/cm^2, with wraparound guarding to protect not only the face but also the forehead, ears, and neck, or an arc flash suit hood with the same rating
- Arc-rated jacket, parka, rainwear, or hard hat liner (as needed)
- Hard hat
- Safety glasses or safety goggles (selection required)
- Hearing protection (ear canal inserts)
- Heavy duty leather gloves, unless a combination of rubber insulating gloves with leather protectors is used
- Leather work shoes (as needed)

Category 2

- Arc-rated long-sleeve shirt and trousers with a minimum arc rating of 8 cal/cm^2 (may substitute shirt & trousers with arc-rated coverall)
- Arc-rated jacket, parka, rainwear, or hard hat liner (as needed)
- Arc-rated flash suit hood or arc-rated face shield with a minimum arc rating of 8 cal/cm^2, with wraparound guarding to protect not only the face but also the forehead, ears, and neck, or balaclava-type hood with same rating
- Hard hat
- Safety glasses or safety goggles (selection required)
- Hearing protection (ear canal inserts)
- Heavy duty leather gloves, unless a combination of rubber insulating gloves with leather protectors is required
- Leather work shoes

Recommended Protective Clothing & PPE by Hazard/Risk Category (cont.)

Category 3

- Arc-rated long-sleeve shirt with a minimum arc rating of 25 cal/cm^2 (as required)
- Arc-rated trousers with a minimum arc rating of 25 cal/cm^2 (As Required)
- Arc-rated coverall with a minimum arc rating of 25 cal/cm^2 (As Required)
- Arc-rated arc flash suit jacket with a minimum arc rating of 25 cal/cm^2 (as required)
- Arc-rated arc flash suit trousers with a minimum arc rating of 25 cal/cm^2 (as required)
- Arc-rated arc flash suit hood with a minimum arc rating of 25 cal/cm^2
- Arc-rated jacket, parka, rainwear, or hard hat liner (as needed)
- Hard hat
- Safety glasses or safety goggles (selection required)
- Hearing protection (ear canal inserts)
- Arc-rated gloves unless a combination of rubber insulating gloves with leather protectors is used
- Leather work shoes

Note: An alternative is to use a total flame-resistant (FR) clothing system and hood with a minimum arc rating of 25 cal/cm^2.

Category 4

- Arc-rated long-sleeve shirt with a minimum arc rating of 40 cal/cm^2 (as required)
- Arc-rated trousers with a minimum arc rating of 40 cal/cm^2 (As Required)
- Arc-rated coverall with a minimum arc rating of 40 cal/cm^2 (As Required)
- Arc-rated arc flash suit jacket with a minimum arc rating of 40 cal/cm^2 (as required)
- Arc-rated arc flash suit trousers with a minimum arc rating of 40 cal/cm^2 (as required)
- Arc-rated arc flash suit hood with a minimum arc rating of 40 cal/cm^2
- Arc-rated jacket, parka, rainwear, or hard hat liner (as needed)
- Hard hat
- Safety glasses or safety goggles (selection required)
- Hearing protection (ear canal inserts)
- Arc-rated gloves unless a combination rubber insulating gloves with leather protectors are used
- Leather work shoes

Shipboard Electrical Hazards (Cont.)

Electrical work done during the construction of vessels involves the installation of conductive cables, wires, circuit boards, and equipment, which at some point must be activated and tested. Repair work often requires isolating and deenergizing single or multiple systems while work is done, as well as the use of electric power supplied to the vessel from an outside source (shore power). Electric shock injuries or injuries from arc flash or arc blast incidents such as burns, caused by the uncontrolled release of electrical energy, can be life-threatening. Every precaution must be taken to avoid these incidents (e.g., voltage testing).

The following OSHA standards specify safety measures that must be followed to protect workers from electrical hazards in ship repairing, shipbuilding, or shipbreaking activities:

- 29 CFR 1915.181 - Electrical Circuit and Distribution Boards, applies to the vessel's permanently installed electrical circuits and distribution systems;
- 29 CFR 1915.132 - Tools and Related Equipment, applies to temporarily installed electrical systems (such as extension cords, portable service panel, "spider box"); and
- 29 CFR 1915.89 - Control of Hazardous Energy (Lockout/Tags-plus) applies to all machinery, equipment, or systems on vessels, vessel sections, and at landside facilities where their servicing, maintenance, and repair presents the potential for the uncontrolled release of electrical energy.

Photo of arc flash incident.

Fluke Corporation "Electrical Safety Video" by Franny Olshefski

Deenergization of Electrical Equipment and Circuits

Two sources of electrical power are used during shipyard employment operations; shore side and vessel generated. Maritime workers are at greater risk for electrical shock hazards than workers in other industries because they stand on metal decks and often work in a wet environment. Before work is performed on circuits, except those being tested or adjusted, the circuits must be deenergized and checked at the point where work will be performed to ensure that they are in fact deenergized (29 CFR 1915.181(b)). Deenergizing the circuit must be correctly completed by opening the circuit breaker, opening the switch, or removing the fuse (29 CFR 1915.181(c)). The circuit must then be locked out or tagged out in accordance with 29 CFR 1915.89.

The circuit breaker, switch, or fuse location must be tagged to indicate that work is occurring on the circuit. Such tags must not be removed, nor the circuit reenergized, until the work has been completed (29 CFR 1915.181(c)). When work is performed immediately adjacent to exposed energized parts, these parts must be covered (for example, insulated) or other equally safe means provided (29 CFR 1915.181(d)). In order to ensure the safety of workers, it is recommended that:

- Insulating materials (such as mats and gloves) be periodically tested or inspected;
- All electrical tools or equipment undergo a visual inspection before use;
- All portable electric hand tools and temporary lighting systems use Ground-Fault Circuit Interrupters (GFCI);
- Electrical tools and equipment be appropriate for the job to be performed; and
- Electrical equipment and tools be used with proper circuit protection for the voltage and amperage.

Improper practice - Faulty breaker box presents shock hazard.

Portable distribution panel used to supply temporary electrical power.

Circuit breakers in panel box can be used to deenergize circuits (and appropriately tagged) before working on the circuit.

Ground-Fault Circuit Interrupters (GFCIs)

During ship repairing or shipbuilding operations, it is recommended that GFCIs are used with temporary systems or portable equipment. GFCIs detect any difference in current between the two circuit wires (the energized black wires and grounded white wires). This difference in current could happen when electrical equipment is not working correctly, causing leakage current. If leakage current (a ground fault) is detected in a GFCI-protected circuit, the GFCI switches off the current in the circuit, protecting the worker from a dangerous shock. GFCIs are set at about 5 mA and are designed to protect workers from electrocution.

There are five types of GFCIs, however, in shipyards, only portable and cord-connected types are usually used. The portable types GFCIs are designed to be easily transported from one location to another. They usually contain one or more integral receptacle outlets protected by the GFCI module. Some models are designed to plug into existing non-GFCI-protected outlets, or in some cases they are connected with a cord and plug arrangement. The portable types also incorporate a no-voltage release device that will disconnect power to the outlets if any supply conductor is open. Units approved for outdoor use will be in enclosures suitable for the environment. If exposed to rain, they must be listed as rain resistant.

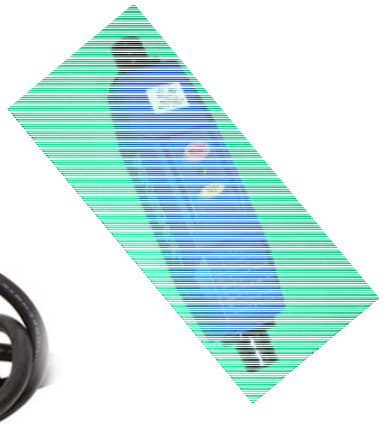
Cord-connected GFCIs have an attachment plug that incorporates a GFCI module. The plug provides protection for the cord and any equipment attached to the cord. The attachment plug has a non-standard appearance and is equipped with test and reset buttons. Like the portable type, cord-connected GFCIs incorporate a no-voltage release device that will disconnect power to the load if any supply conductor is open.

Test each GFCI before use to ensure that the ground-fault protection is still functioning. GFCIs have a built-in test circuit with test and reset buttons. The test circuit imposes an artificial ground fault on the load circuit.

Other important precautions for reducing workers' exposure to electrical hazards include: keeping equipment out of water, implementing a strong equipment maintenance program, instructing workers to keep their hands dry when plugging/unplugging equipment, and the proper grounding of equipment.

Portable-type GFCI

Cord-connected type GFCI



In-line portable type GFCI

Lockout/Tags-plus Systems

In addition to the requirements discussed previously (29 CFR 1915.132 and 1915.181), the proper deenergization and use of lockout/tags-plus applications are necessary to protect workers from the uncontrolled release of electrical energy. A tags-plus system is used when an energy-isolating device cannot be locked. It consists of at least one energy-isolating device with a tag affixed to it and at least one additional safety measure. If an energy-isolating device is capable of being locked, a lock must be used unless the use of a tags-plus system gives full worker protection, equivalent to the safety provided from the use of a lock (29 CFR 1915.89(c)(2) and (c)(4)). Locks and tags-plus applications must be used during the servicing, maintenance, and repair of machinery, equipment, or systems on vessels, vessel sections, and at landside operations.

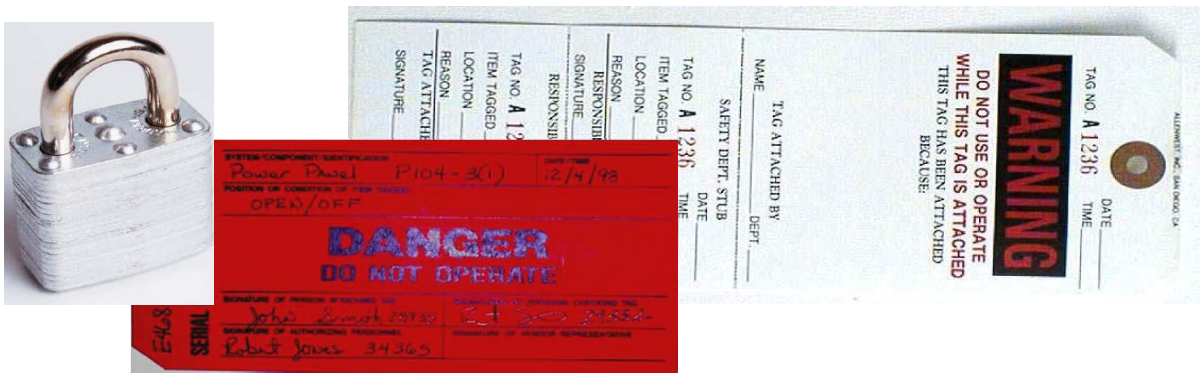
All energy sources must be identified and isolated, and the machinery, equipment, or system must be rendered inoperative before any authorized employee performs servicing (29 CFR 1915.89(c)(1)). Machinery, equipment and systems must be tested by using a properly calibrated voltmeter/instrument to verify that is has been deenergized and will not start up during servicing. Verification of deenergization and isolation must be continuously performed by each authorized employee or by the primary authorized employee in a group lockout/tags-plus application (29 CFR 1915.89(g)(1)).

Each lock and tag must be uniquely identified for the purpose of controlling hazardous energy and not used for any other purpose (29 CFR 1915.89(n)(2)).

During group lockout/tags-plus applications, when more than one authorized employee services the same machinery, equipment or system at the same time, each authorized employee must either apply a personal lockout/tags-plus system (29 CFR 1915.89(k)(2)(i)), or use an alternative procedure that affords each authorized employee an equivalent level of protection as having each authorized employee apply a personal lockout/tags-plus system (29 CFR 1915.89(k)(2)(ii)).

Example 1 - Sign a group tag (or a group tag equivalent) before servicing is started and sign off the group tag (or the group tag equivalent) when servicing is finished (29 CFR 1915.89(k)(2)(ii)(A)).

Example 2 - Attach a personal identification device to a group lockout device before servicing is started and remove the personal identification device when servicing is finished (29 CFR 1915.89(k)(2)(ii)(B)).



Worker Hierarchy of Responsibility

As noted earlier, shipyard workers face numerous issues that can complicate servicing operations, such as:

- Large and complex machinery, equipment, and systems aboard vessels and vessel sections;
- Machinery, equipment, and systems that have multiple power sources, isolation points, and types of energy; and
- Difficulty identifying all energy sources due to faulty engineering drawings and schematics.

Employers must use a hierarchy of responsibility among workers during servicing activities and provide the appropriate training (29 CFR 1915.89(o)). Only authorized employees or primary authorized employees with the appropriate training on how to avoid the electrical hazards of working on or near exposed and potentially energized parts may perform the servicing of machinery, equipment or systems.

Affected employees, who only obtain minimal training in this area, are not permitted to perform such servicing. Coordination is also a critical part of servicing machinery, equipment, and systems in shipyard employment. When the potential for the uncontrolled release of electrical energy exists during servicing operations, employers must coordinate between each of the following job functions within the hierarchy:

- **Lockout/Tags-plus Coordinator -** A worker designated by the employer to coordinate and oversee all operations involving lockout and tags-plus applications on vessels or vessel sections and at landside work areas. He/she also maintains the lockout/tags-plus log (29 CFR 1915.80(b)(15));
- **Primary Authorized Employee –** A worker designated by the employer as having responsibility for each group of authorized employees performing servicing on the same machinery, equipment, or system during a group lockout/tags-plus application (29 CFR 1915.89(k)(1)(i));
- **Authorized Employee -** A worker who performs one or more of the following lockout/tags-plus responsibilities: executes the lockout/tags-plus procedures; installs a lock or tags-plus system on machinery, equipment, or systems; or services any machine, equipment, or system under lockout/tags-plus application (29 CFR 1915.80(b)(3)); and
- **Affected Employee -** A worker who normally operates or uses the machinery, equipment, or system that is going to be serviced under lockout/tags-plus or who is working in the area where servicing is being performed under lockout/tags-plus (29 CFR 1915.80(b)(2)).

Worker Hierarchy of Responsibility (Cont.)

A lockout/tags-plus coordinator or primary authorized employee are only required under certain circumstances. The lockout/tags-plus coordinator is required under two circumstances: (1) when workers are performing multiple servicing operations on the same machinery, equipment, or systems at the same time, or (2) when multiple machinery, equipment, or systems on the same vessel or vessel section are being serviced at the same time.

Example:

On a U.S. Navy combat vessel, where a generator may supply power to the vessel's weapons system, as well as the lighting system for a particular section of a vessel, a lockout/tags-plus coordinator is required if servicing is being performed on both systems simultaneously. The use of a lockout/tags-plus coordinator in scenarios similar to this example is important in helping to protect workers. If the generator is secured to service both systems and the employee servicing the weapons system restores power to the generator to test or troubleshoot it, both the employee servicing the lighting system and the employee testing the weapon system are at risk of electrocution. However, when a lockout/tags-plus coordinator is involved (in accord with 29 CFR 1915.89(c)(7), (K)(1)(iii) and (iv)), the authorized employee servicing the weapons system must notify the coordinator of his/her intent to remove the lockout/tags-plus applications and restore power for testing before doing so. Coordination between the lockout/tags-plus coordinator and the authorized employee(s) ensures that all parties involved (e.g., authorized employee servicing the lighting system) are notified of any change in status, therefore, helping to reduce the potential for injury or death.

During group servicing operations, a primary authorized employee is required and determines the safe exposure status of each authorized employee in the group with regard to the lockout/tags-plus system (29 CFR 1915.89(k)(1)(ii)). The primary authorized employee also obtains approval from the lockout/tags-plus coordinator to apply and remove the lockout/tags-plus system (29 CFR 1915.89(k)(1)(iii)) and coordinates the servicing operation with the coordinator (29 CFR 1915.89(k)(1)(iv)).

Energized Equipment/ Testing

While it is not recommended or favored, there may be certain situations where it is necessary for employees to work on energized machinery, equipment or systems, for example when testing or troubleshooting a particular piece of equipment or system. In such situations, it is crucial to ensure that only trained employees that are qualified to work on energized circuits or equipment are assigned such tasks. The employer must notify all affected and authorized employees of the work and implement the necessary safety precautions to protect workers.

Many shipyards require a specific permit to be signed by designated representative(s) from both the ship and shipyard before work on energized equipment occurs. In addition, appropriate personal protective equipment (PPE) and insulated tools, such as non-conductive hooks, must be used. When testing or adjusting energized circuits, a rubber mat, duck board, or other suitable insulation must be used underfoot when an insulated deck does not exist (29 CFR 1915.181(b)).

Examples of machinery, equipment, or systems requiring servicing aboard a vessel.

Other Electrical Hazards

Vessel Radar and Communication Systems

- The servicing of vessel radar and communication systems must be done safely and in accord with 29 CFR 1915.89, Control of Hazardous Energy, which requires the systems to be incapable of energizing or emitting radiation before any employee begins work (29 CFR 1915.85(a) and (b)).

Shore Power

- When a vessel is supplied by electric shore power, the employer must take the following precautions before energizing any of the vessel's circuits: the vessel must be grounded, each circuit to be energized must be equipped with over-current protection that does not exceed the rated current-carrying capacity of the conductors, and each circuit to be energized must be in a serviceable condition (29 CFR 1915.83(c)(1), (c)(2)) and (c)(3)). Overcurrent protection devices include circuit breakers and fuses.

- A responsible vessel's representative, a contractor, or other qualified person (i.e., with proper training, knowledge, or experience) must inspect each circuit to be energized, to determine that it is in a safe condition before the electric shore power source is energized (29 CFR 1915.83(c)(3)).

Process: Shipboard Electrical

Electrical hazards that may result in shocks, burns, and electrocution.

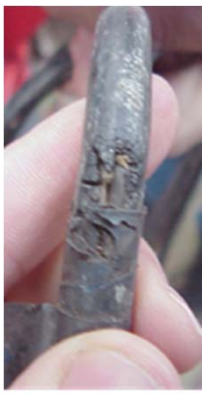
Problems

Dangerous Power Connections

Shipyard electricians are not the only workers who affect electrical safety. Unqualified personnel may attempt electrical power connections that pose a risk to themselves and others.

Problems

Damaged Extension Cord Plugs



Temporary power cord connectors can become damaged and present a risk for shipboard burns and shocks.

Solutions

Shipyard electricians should always be on the lookout for situations where a lack of knowledge, awareness, or concern has created a risk of burns and shocks.

When these situations are discovered, the risk should be immediately addressed and supervisors in the area notified. The use of GFCIs for temporary power can save lives.

Solutions

Connections and insulation of electric cords must be maintained in a safe condition (29 CFR 1915.83(b)(3)).

Employers have the responsibility to train personnel on recognizing damaged temporary power cords and their risk.

OSHA Occupational Safety and Health Administration
U.S. Department of Labor

Process: Shipboard Electrical

Electrical hazards that may result in shocks, burns, and electrocution

Problems

Temporary Lighting Systems

Poorly maintained temporary lighting systems can create a risk of burns and shocks. Missing bulbs and protective cages are a common risk.

Solutions

Temporary lighting systems should be regularly inspected to ensure that there are no open sockets or damaged/missing protective cages. Damaged equipment must be immediately fixed or removed from service.

Problems

Accidental Energizing of Equipment

The unexpected start-up of a piece of equipment or distribution panel being worked on exposes workers to the risk of electrocution.

Solutions

A comprehensive lockout/tags-plus program with detailed employee training is required by OSHA standards and is a proven way to protect shipboard electrical workers from becoming the victims of shock or electrocution.

Process: Shipboard Electrical

Electrical hazards that may result in shocks, burns, and electrocution

CASE HISTORY

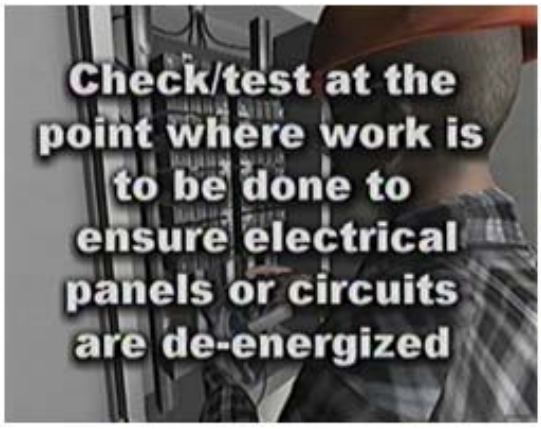
A shipyard electrical worker was about to begin work in an energized panel. He looked at the drawings and then locked out the circuit.

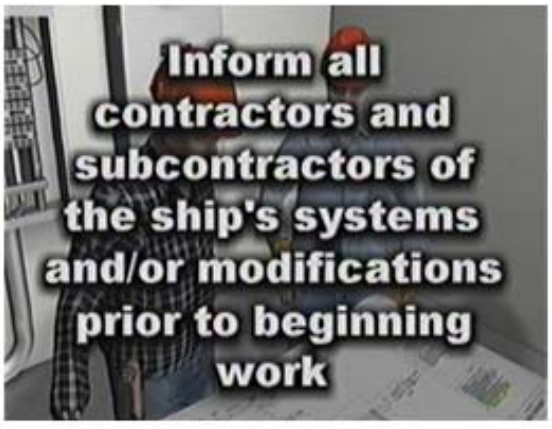
Without testing to make sure that the panel was de-energized, he reached into the panel to begin work.

The worker made contact with an energized circuit and was electrocuted.

Analysis and Preventive Measures

Despite system modifications, which made the worker's set of drawings inaccurate, this incident could have been prevented by voltage testing the electrical panel before starting work. Taking the time to perform a simple voltage test can ensure that electrical workers safely complete their shift. When working on an electrical circuit it is important to isolate not only the circuit being worked on, but all other circuits where the possibility of contact with energized parts exists. This is because many feeds may supply power to a particular circuit. The use of lockout/tags-plus applications is essential to ensuring the safety of workers.





Process: Shipboard Electrical

Electrical hazards that may result in arc flash

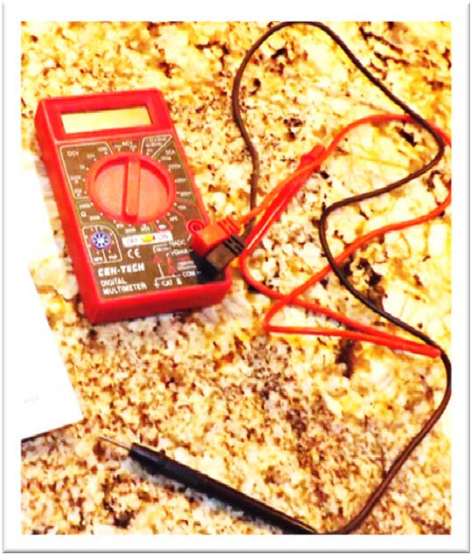
Problems

Working on Energized Machinery, Equipment, or Systems

Failure to effectively deenergize and isolate all energy sources before servicing can lead to severe injury or death.

Solutions

Before work begins, properly isolate and deenergize the machinery, equipment, or system being worked on. Always test the machinery, equipment, or system for voltage before work is started or resumed, and wear the appropriate PPE for the hazard/risk category (see tables at pages D6 and D7).



Problems

Electrical Equipment Failure or Dropped Tool

Equipment failure or a dropped tool can cause sparks that may lead to an arc flash or blast.

Solutions

Ensure that the tools, meters, and other equipment used for servicing equipment are regularly maintained in good condition and are suitable for the voltage and current levels of the machinery, equipment, or system being worked on. Insulated tools may be necessary.

Wear the appropriate PPE for the hazard/risk category (see tables at pages D6 and D7).

Process: Shipboard Electrical

Electrical hazards that may result in arc flash

Problem

Workers wearing/having a conductive material on their person (e.g., jewelry, tools).

An arc flash or blast can reach temperatures up to 35,000°F, capable of igniting clothing or causing second- or third-degree burns to exposed skin. Conductive tools or materials worn by workers can create a pathway for the flow of electricity, leading to severe injury and possible death.

Solutions

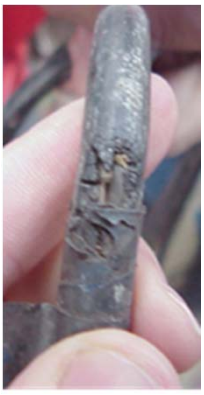
Avoid wearing jewelry, including metal watches, metal fasteners on clothing, or any other conductive material.

Non-conductive safety goggles should be worn to protect the eyes instead of glasses with metal frames.

Conduct a hazard analysis to identify safety measures and the appropriate type of personal protective equipment (PPE) or other protective equipment for the hazard/risk category (see tables at pages D6 and D7).

Problem

Dust, corrosion, or other impurities on the surface of a conductor/breaks or gaps in insulation.



Damaged insulation on high-voltage wiring and dust or other impurities accumulated on equipment can create a pathway for the flow of electricity and may possibly lead to an arch flash or blast when high-voltage components are involved.

Solutions

Equipment should be kept in safe working condition and free of dust or other impurities. During construction or extensive repair activities that generate dust/debris that is difficult to eliminate, equipment should be protected through the use of barriers (e.g., sheeting or flame-retardant tarps).

To prevent the intrusion of metal filings, employers should follow regular cleaning schedules or place electrical enclosures under positive pressure.

Equipment and wiring must be suitable for the specific installation and environmental conditions present.

Electrical hazards that may result in arc flash

CASE HISTORY #1

An electrician was working on a circuit breaker panel that he thought was deenergized. After completing the work, the electrician was closing one of the enclosure doors when an arc flash occurred. Electric current from the energized panel moved through the air to the closed panel door. The rapid release of energy caused the panel door to fly open, hitting the worker and knocking him unconscious as the panel continued to arc.

ANALYSIS & PREVENTIVE MEASURES

Although the electrician believed that all power had been deenergized from the electrical panel, this incident could have been prevented by voltage testing the electrical panel before starting work. Taking the time to perform a simple test can ensure workers' safety.

Often arc flashes occur when reenergizing panels after maintenance. Proper cleaning is one method of reducing this hazard.

CASE HISTORY #2

An electrician and a coworker were retrofitting dated equipment, installing new buckets on a switch gear. The electrician mechanically disconnected the switch, but he did not test it to verify deenergization. As he attempted to remove the switch from the switch gear, an arc flash occurred. The electrician was severely burned and suffered acute respiratory stress.

ANALYSIS & PREVENTIVE MEASURES

Disconnecting the switch was not sufficient to prevent the flow of electricity through the equipment. The equipment should have been voltage tested to verify that it was deenergized before beginning work, as all sources of power to the equipment were not secured.

MINI-POSTERS

Is that circuit you're about to work on correctly deenergized and secured?

How much do you want to bet on it?

Ever get that nagging feeling that something is missing?

Don’t allow unsafe electrical practices and equipment at your job site.

Temporary lights require bulbs and protective cages.

Temporary power cords require grounding pins.

Establishing an Injury and Illness Prevention Program

The key to a safe and healthful work environment is a comprehensive injury and illness prevention program.

Injury and illness prevention programs are systems that can substantially reduce the number and severity of workplace injuries and illnesses, while reducing costs to employers. Thousands of employers across the United States already manage safety using illness and injury prevention programs, and OSHA believes that all employers can and should do the same. Thirty-four states have requirements or voluntary guidelines for workplace injury and illness prevention programs. Most successful injury and illness prevention programs are based on a common set of key elements. These include management leadership, worker participation, hazard identification, hazard prevention and control, education and training, and program evaluation and improvement. Visit OSHA's illness and injury prevention program web page at **www.osha.gov/dsg/topics/safetyhealth** for more information.

How Can OSHA Help?

OSHA has compliance assistance specialists throughout the nation who can provide information to employers and workers about OSHA standards, short educational programs on specific hazards or OSHA rights and responsibilities, and information on additional compliance assistance resources. Contact your local OSHA office for more information.

OSHA's On-Site Consultation Program offers free and confidential advice for small businesses with fewer than 250 employees at a site (and no more than 500 employees nationwide) to help identify and correct hazards at your worksite. On-site consultation services are separate from enforcement and do not result in penalties or citations. To locate the OSHA Consultation Office nearest you, visit OSHA's website or call 1-800-321-OSHA (6742).

OSHA's Cooperative Programs: OSHA offers cooperative programs under which businesses, labor groups and other organizations can work cooperatively with OSHA. To find out more about these programs, visit **http://www.osha.gov/dcsp/compliance_assistance/index_programs.html**.

Worker Rights

Workers have the right to:

- Working conditions that do not pose a risk of serious harm.
- Receive information and training (in a language and vocabulary they understand) about workplace hazards, methods to prevent them, and the OSHA standards that apply to their workplace.
- Review records of work-related injuries and illnesses.
- Get copies of test results that find and measure hazards.
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA's rules. OSHA will keep all identities confidential.
- Exercise their rights under the law without retaliation or discrimination

For more information, see **OSHA's page for workers**.

Contact OSHA

For questions or to get information or advice, to report an emergency, to report a fatality or catastrophe, to order publications, to file a confidential complaint, or to request OSHA's free on site consultation service, contact your nearest OSHA office, visit www.osha.gov, or call OSHA at 1-800-321-OSHA (6742), TTY 1-877-889-5627.

Many states operate their own occupational safety and health programs approved by OSHA. States enforce similar standards that may have different or additional requirements. A list of state plans is **available**.