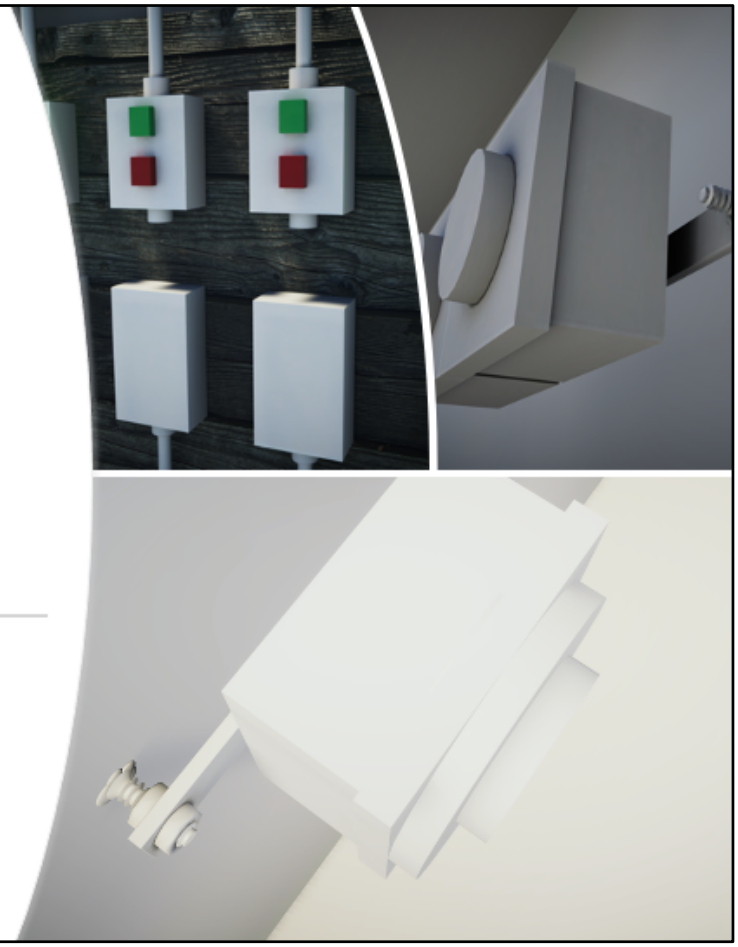
Mounting Electrical Equipment and Components



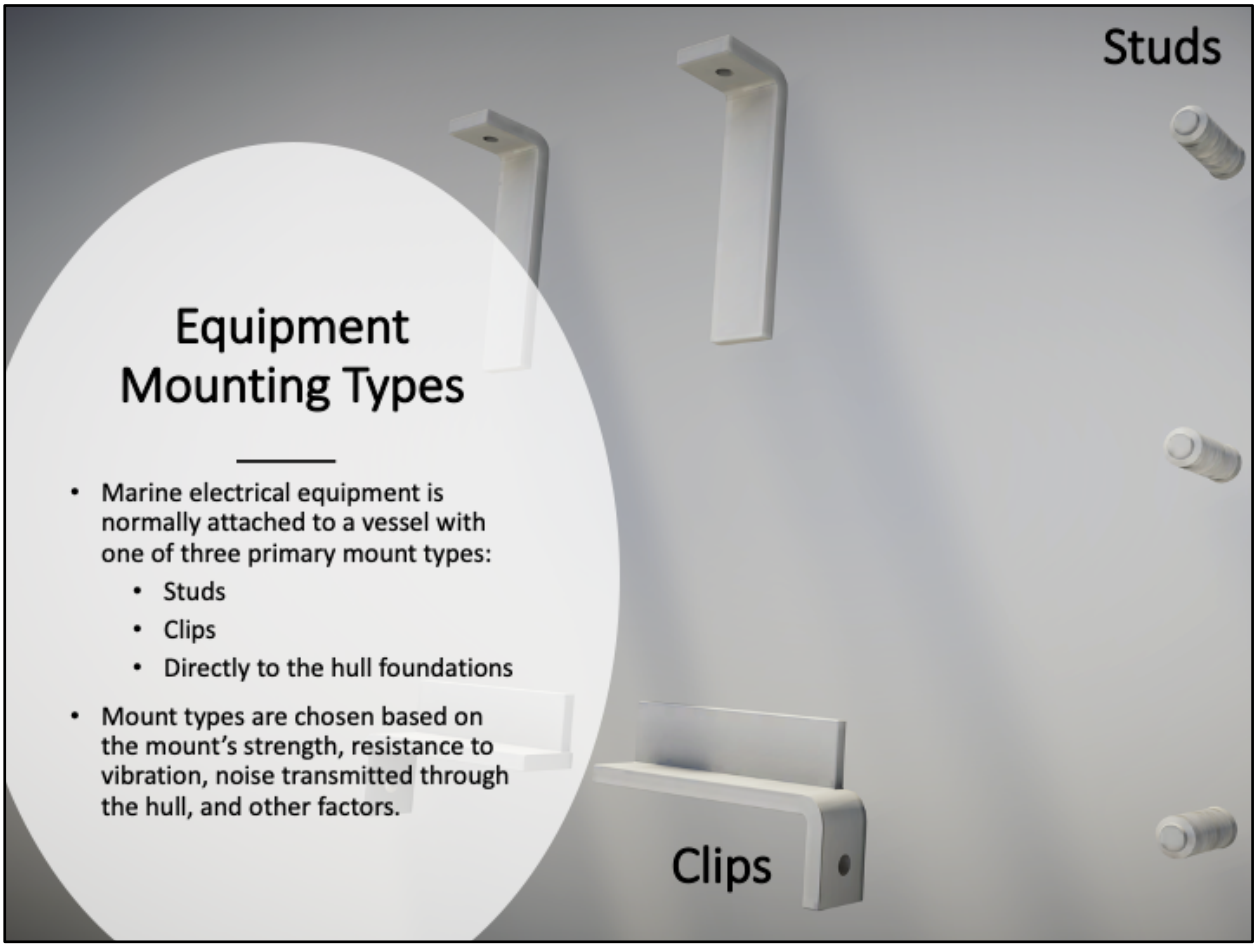
Training Objectives

- Identify some common methods used to mount electrical equipment to a vessel.
- Explain the meaning and importance of "**grounding**"
- Discuss the importance of proper selection and use of **fasteners;**
- Discuss the importance of removing paint and properly installing fasteners to ensure proper grounding;
- Explain the meaning of **Electro-Static Discharge (ESD);**
- List example ESD sources;
- Explain the importance of ESD sources;
- Explain the importance of why properly protecting electrical equipment while it is being stored and after installation to safe and effective operation.

In this lesson, you will learn about some of the most common methods of mounting electrical equipment on maritime vessels.

You will also learn how equipment should be grounded, why this is important, and how to take precautions that protect humans and equipment.

We will also discuss electro-static discharge, what it means, and how we prevent it from causing injury to personnel or damage to equipment.



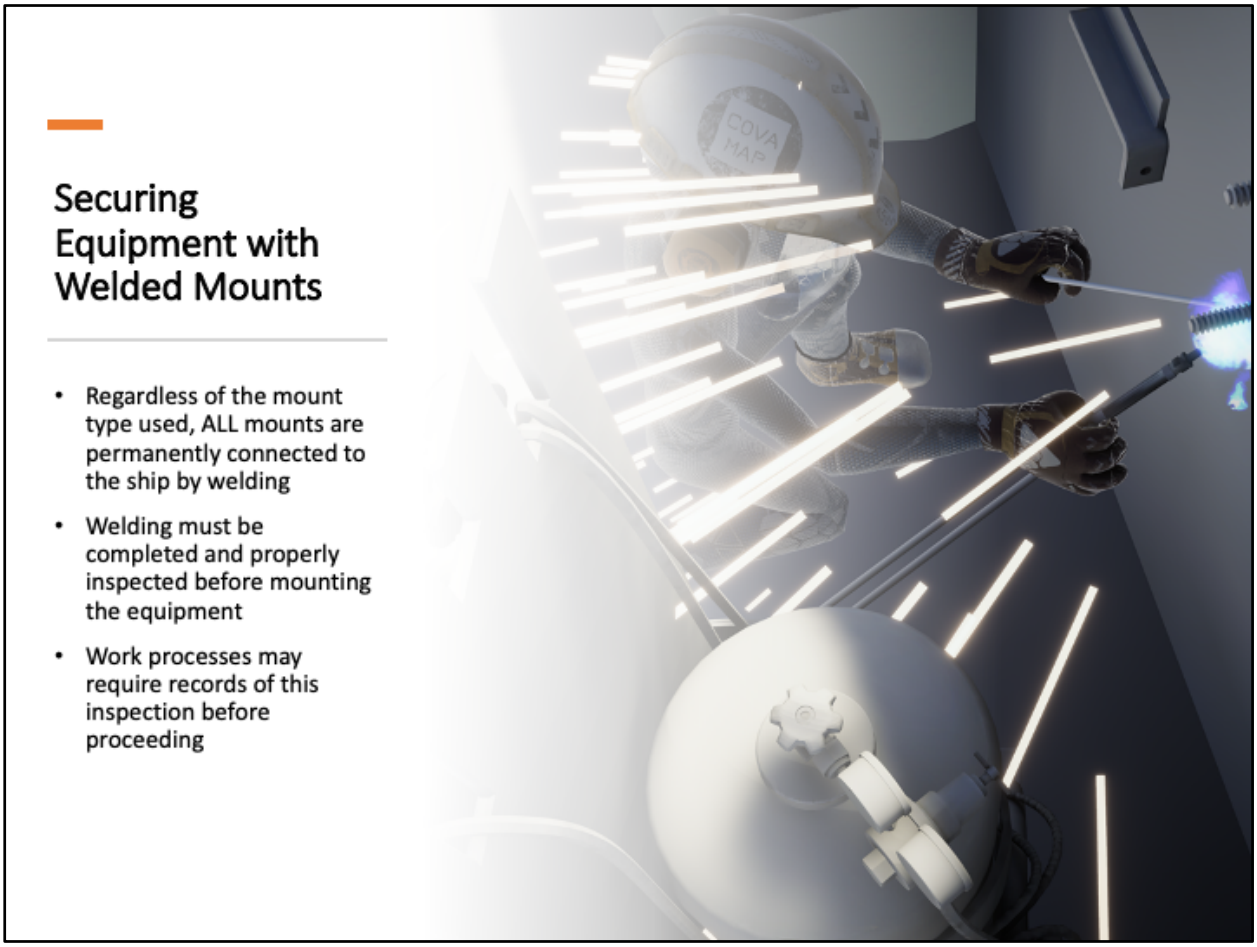
Marine electrical equipment is normally attached to vessels with one of three primary types of mounts.

Studs are threaded posts, similar to bolts, that are welded to the vessel. Equipment is mounted to studs using bolts.

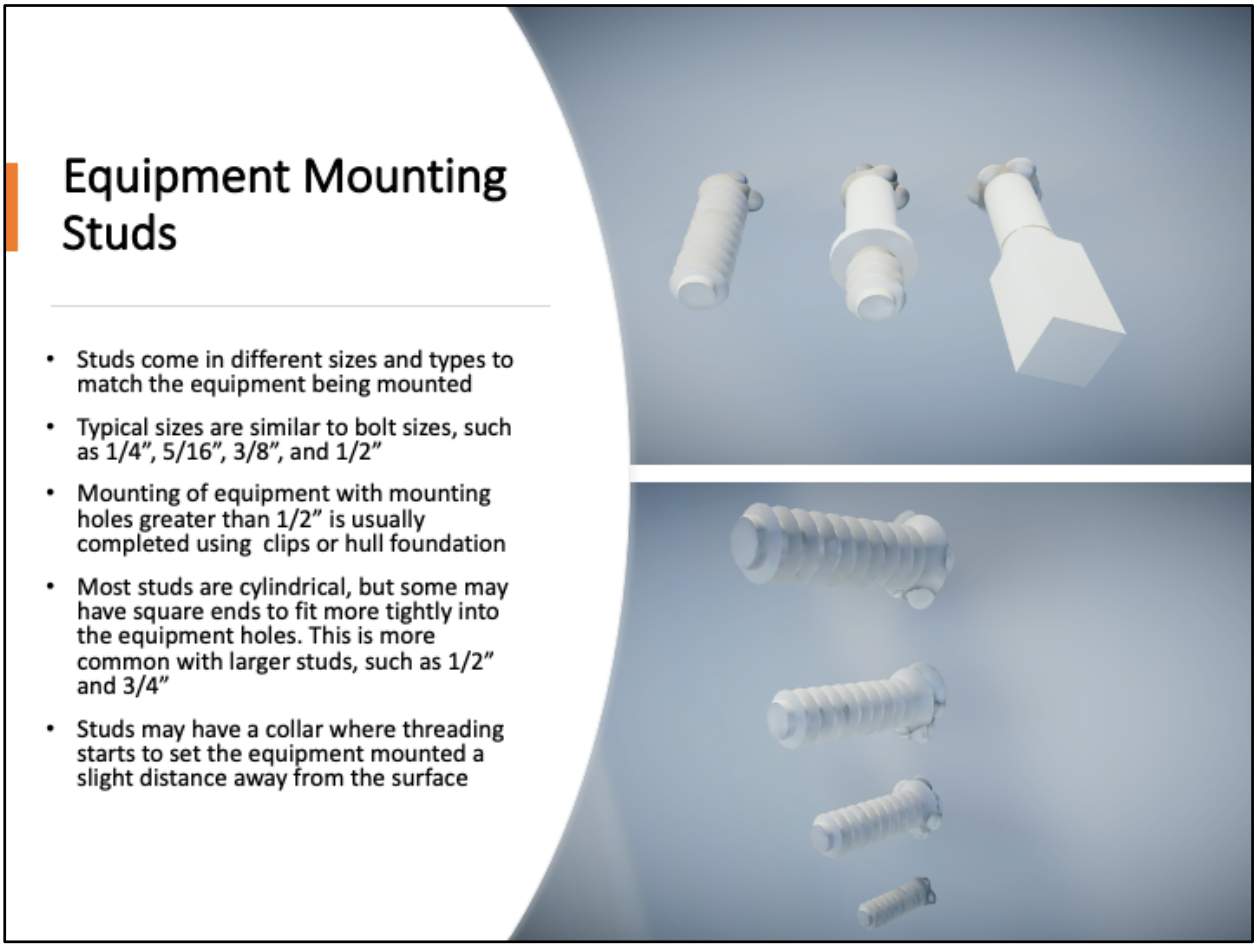
Clips provide more connecting and support surface area than bolts. This makes for a stronger mount.

Equipment may also be mounted directly to a hull foundation designed by Engineers before installation.

The type of mount that will be used is selected after considering the strength needed, the potential for vibrations which could cause metal fatigue in the mount over time, the noise transmitted into the water, and other factors.



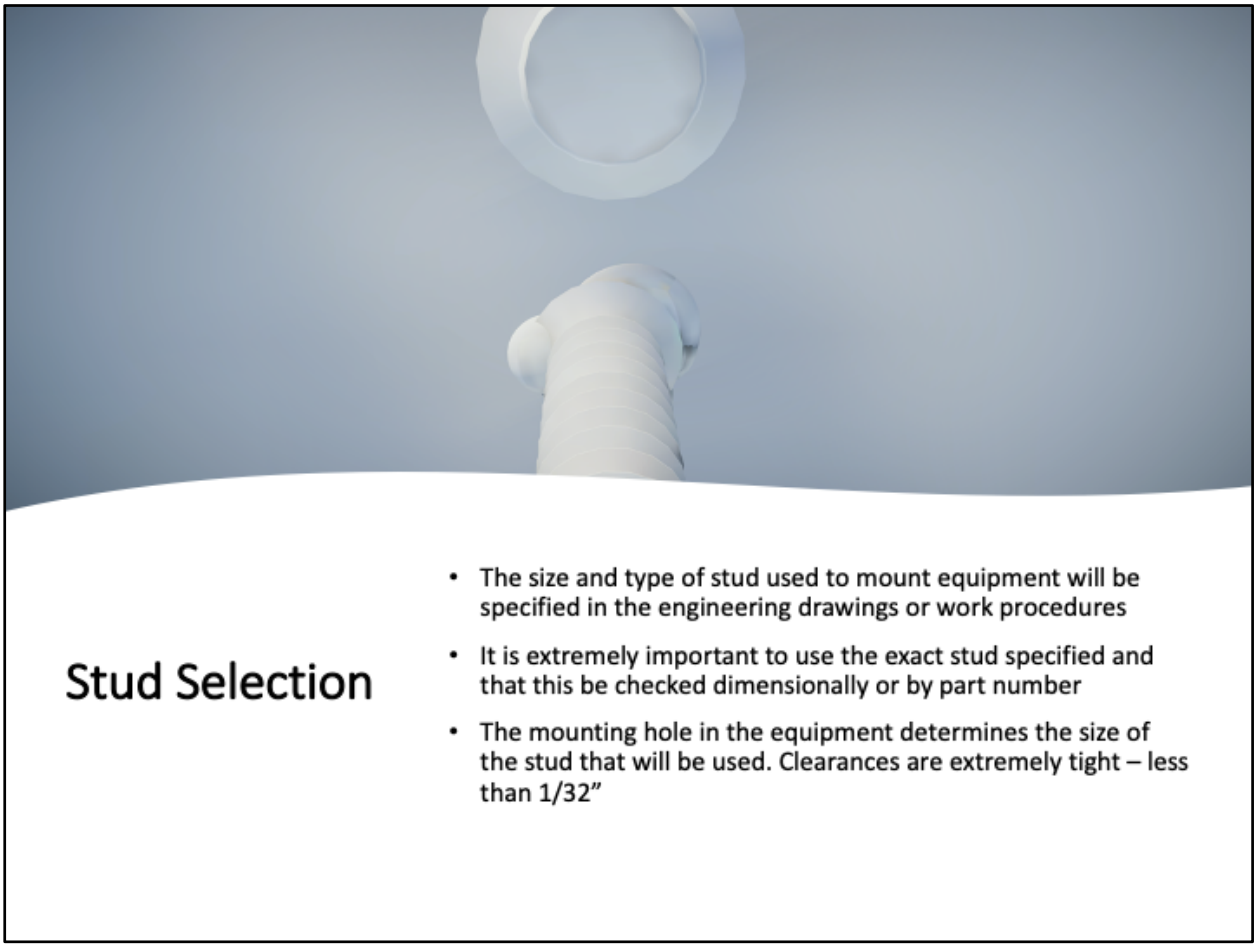
Regardless of the type of mount selected, all mounts are permanently welded to the ship before equipment is mounted. Welds must be inspected before mounting the equipment. A record of this inspection may be required in the work package.



•Studs come in different sizes and types to match the requirements of the equipment being mounted.

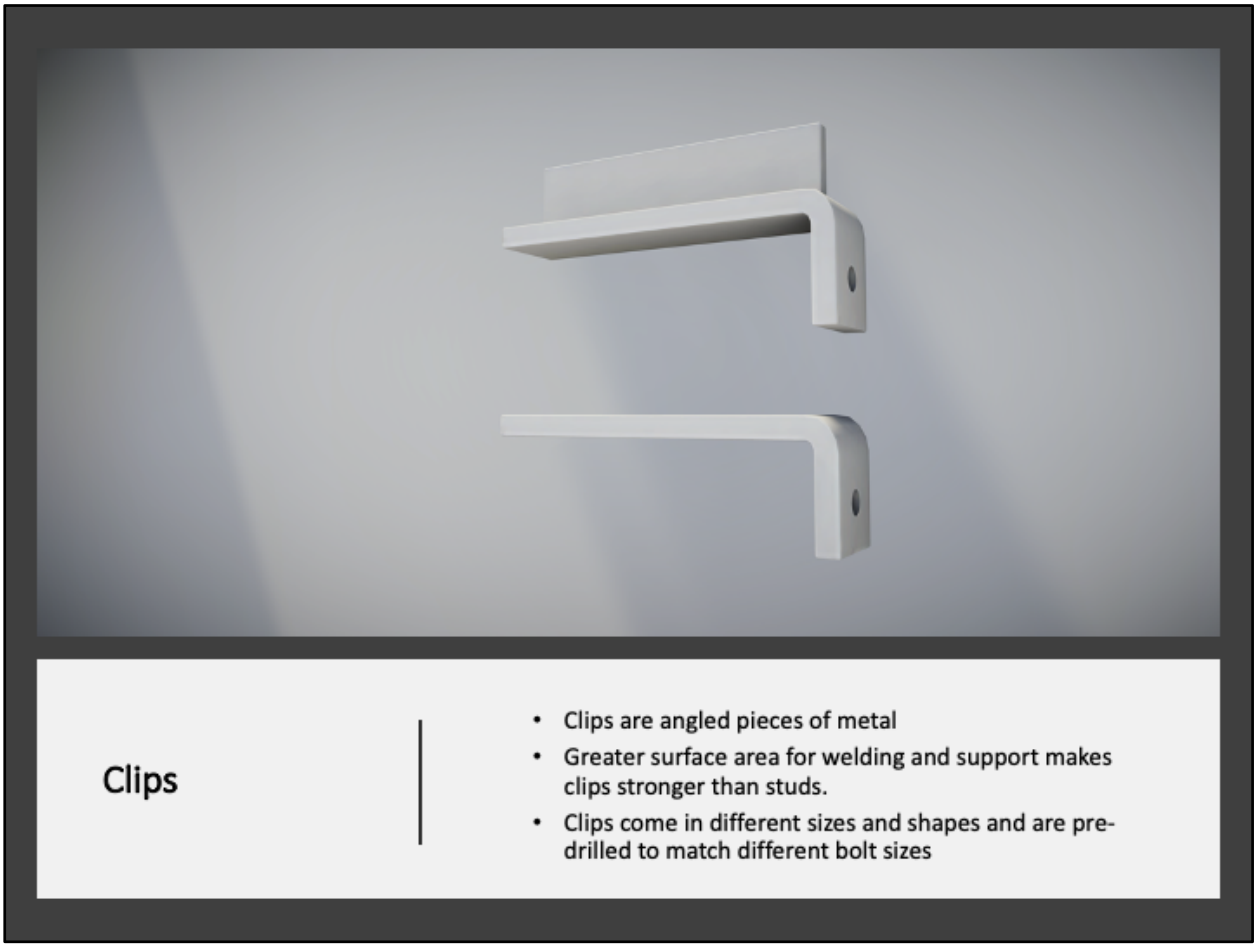
•Since nuts are used to attach the equipment mounted to the stud, sizes match typical sizes of bolts and nuts. When studs larger than ½ inch in diameter are needed, the mounting usually is completed using clips or hull foundation mounting instead. However, some equipment uses special studs with square heads at the end of the cylindrical stud. This is most often seen with larger studs such as ½ inch or ¾ inch.

•Studs may also have a collar that sets the equipment mounted away from the surface. This is done to ease future access and is used for equipment such as lighting connection boxes.



The type of stud and its size are important for ensuring that the mount will be strong enough to provide a secure, lasting connection. Studs that are too narrow may allow equipment to shift slightly during movement and lead to material failure.

Ensure the correct stud is used by checking its dimensions and, if possible, the part number.



Clips are constructed of angled pieces of metal.

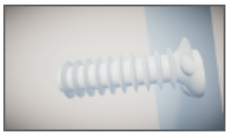
The clips are welded to the vessel and the equipment to be mounted is connected to the clips using bolts and nuts. The nuts used are usually self-locking to reduce the chance of loosening over time. Clips are pre-drilled with holes that must match the size needed for the equipment.

Because of their greater surface area for welding and support, clips provide a stronger mount than studs.

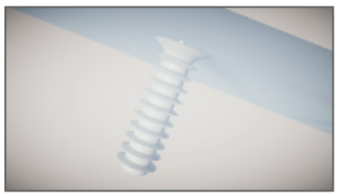
Inspecting Studs Prior to Equipment Mounting

- Never permanently mount equipment before the studs, clips, or foundation have been inspected.
- Weld inspections include checking for:
  - Alignment
  - Undercut
  - Lack of Fusion
  - Welds all the way around
  - Paint has been applied
  - Insulation has been installed if required

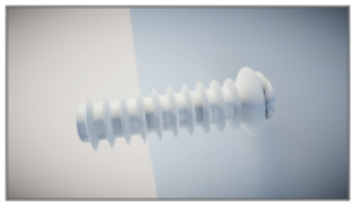
Undercut – Base Material



Undercut – Stud



Lack of Fusion

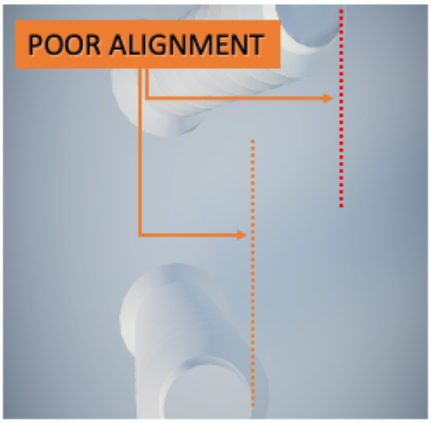


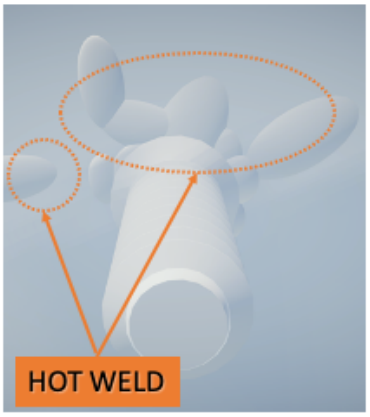
No 360 weld

Never permanently mount any equipment until the studs, clips, or foundation have been properly inspected.

Stud weld inspections should include checking for:

- Alignment
- Undercut – where the weld reduces the cross-sectional thickness of the base metal
- Lack of fusion – also called cold lapping, this means that the weld material and the base plate surface are not fused, meaning that the two materials are not “melted together” where they meet but rather the welding material sits upon the base material
- Welding completely around the stud – there are no gaps or missing sections
- Proper application of paint – Paint is ALWAYS required for corrosion resistance, and
- Insulation has been properly installed, if required by the drawing



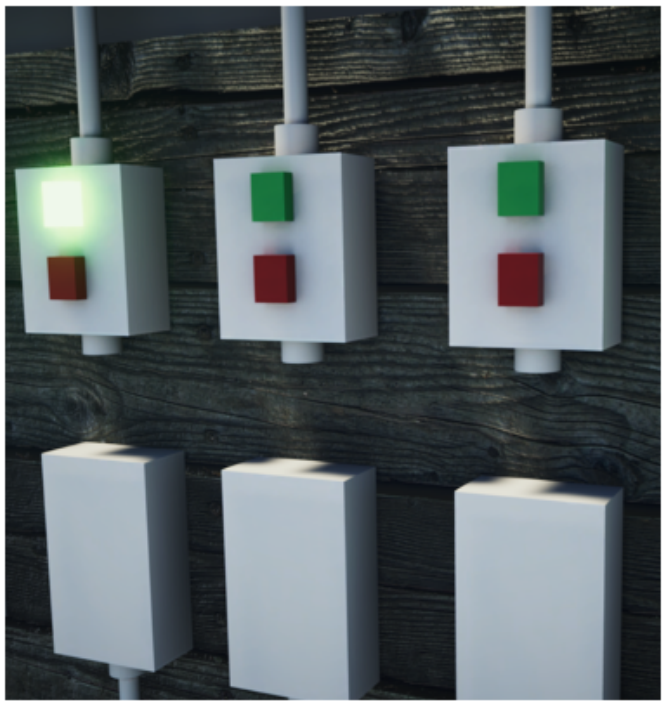


Poorly Mounted Stud Examples

Mounts that use a foundation are stronger than those using studs or clips.

Foundations are used to mount load centers, large transformers, electronic equipment cabinets, or other heavy equipment.

Foundations



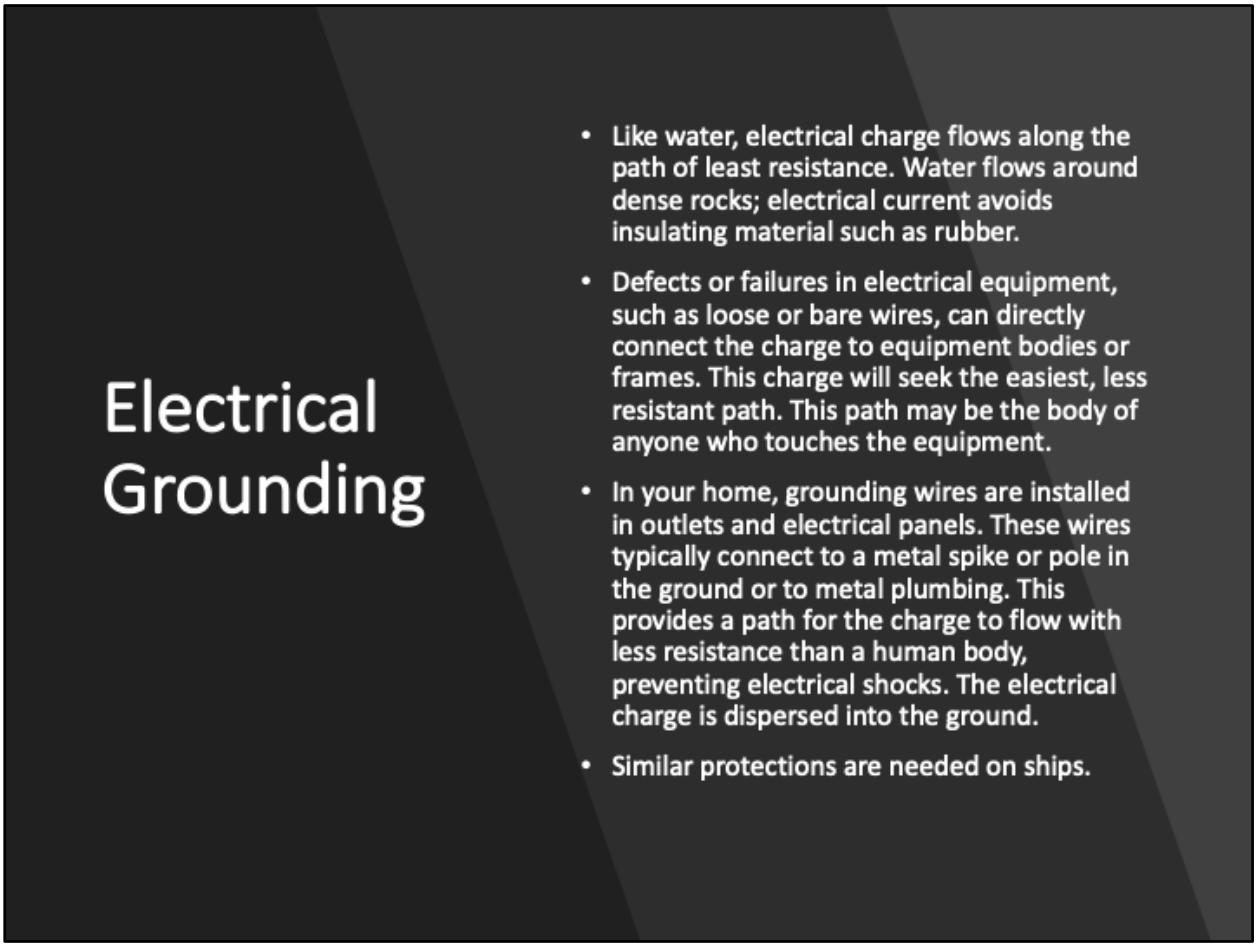
Indicator lights and master switches mounted to a hull foundation

Load centers, large transformers, nuclear or electronic equipment cabinets, and other heavy equipment are normally mounted to a foundation.

When mounting very heavy equipment such as load centers, large transformers, and electronic equipment cabinets, foundations are used.

Foundation mounts are stronger than those using studs or clips.

In the picture shown, electrical equipment has been permanently mounted to a phenolic plate. Phenolic material is a type of plastic that provides excellent electrical insulation and does not have to be grounded. However, the phenolic foundation shown should have been painted.



Flowing water takes the path of least resistance, avoiding walls, rocks, or other objects. Electrical charge works in a similar way, taking the path that provides the least resistance. Insulating materials like rubber have high resistance; metal wires and especially copper wires have very low resistance. Compared to the materials used to provide insulation for electrical equipment, human bodies have low resistance.

Electrical equipment that has a fault may allow a direct connection to the bodies or frames of lighting fixtures, appliances, tools, or other electrical equipment. When this happens, a person who touches the faulty equipment could provide a low resistance path for the electrical charge and be shocked.

For this reason, the electrical systems in all modern homes are grounded. A bare copper wire parallels power cables and electrical equipment and includes a third “prong” in the plug – the round one in three wire systems, that provides a direct path to ground a current. If a problem in a circuit allows electrical charge outside the design path, the grounding wire provides the lowest resistance to ground preventing equipment or humans from being that path..

Grounding Equipment

- Proper equipment grounding provides a physical electrical connection to the earth via the ship's hull. This connection may be made via grounding straps, a grounding wire in hardwired power cables, or electrical outlets.
- **ALL** electrical equipment **must be** grounded to ensure the equipment functions properly.
- When equipment is properly connected, a ground will cause current to "surge" through the lowest resistance path (the ground wire). The surge causes circuit breakers to trip open.
- Grounding improves safety by providing a path with lower resistance than through the body of someone who comes in contact with it.
- Grounding equipment mounted on a foundation requires that the equipment make metal-to-metal contact with the foundation. To ensure a good connection, clean an area equivalent to 1½ times the diameter of the mounting hole to attach ground.

On ships, grounded circuits connect to the ship's hull. Because the hull sits in water, any charge on the hull is immediately dispersed to the earth.

Equipment is grounded to the hull using grounding straps, ground wires in power cables, grounded electrical outlets, or by direct metal-to-metal contact for equipment mounted to foundations.

All electrical equipment must be grounded. If a fault occurs, the electrical charge follows the lowest resistance path.
This means the current will go through the grounding wire or strap to the hull and into the surrounding water.
Circuit breakers sense the sudden increase in current and trip open. This provides personnel safety and reduces the chance of equipment damage.
When grounding equipment directly to a foundation, clean an area at lest 1 ½ times the diameter of the mounting holes to attach the ground and ensure that there is direct metal-to-metal contact.

We say that equipment has been permanently mounted if we expect the equipment to remain in place for 25 or more years, even though future modifications or maintenance will require the equipment to be removed.

To make it easier to remove equipment that has been in place for so long, we use a compound called anti-seize. To use anti-seize on a foundation, remove all paint from both the mount and the equipment where necessary to ensure direct metal-to-metal contact and apply anti-seize. When using studs or bolts, use anti-seize on the threads.

Anti-seize contains petroleum jelly and zinc and can be difficult to clean up. It also causes stains. Use it sparingly and only where required.

Fasteners - Bolts

- Bolts (and nuts) are used to mount equipment to:
  - Clips
  - Hull foundations
- Bolts come in different grades and materials. Using the correct bolt is very important.
- Bolt types most often used for mounting include:
  - Grade 5 (3 marks on the bolt head)
  - Grade 8 (6 marks on the bolt head)
  - 316 CRES (**C**orrosion **Re**sistant Stainless **S**teel, no grade markings) – used where exposed to weather

Grade 5

Grade 8

CRES

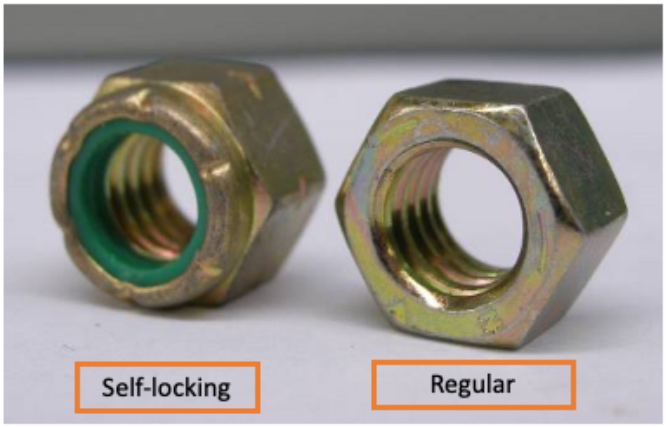
Bolts are the primary means of mounting equipment to clips and hull foundations. Bolts come in many different grades and materials and using the correct bolt is very important.

Grade 5 and Grade 8 bolts are the classes most often used for mounting equipment. You can tell the grade of these bolts by counting the marks on the bolt head and adding two. Grade 5 bolts have three marks. Grade 8 bolts have six marks.

Corrosion Resistant Stainless Steel or CRES bolts have no grade markings. These are most often used where the equipment is exposed to weather.

Fasteners - Nuts

- Nuts are used when mounting equipment with bolts and also when mounting directly to studs
- The material and grade of the nut must match that of the bolt or as specified for studs.
- Either regular or self-locking nuts may be required for the mount
- Self-locking nuts have a nylon insert that reduces the chance that a nut will loosen over time

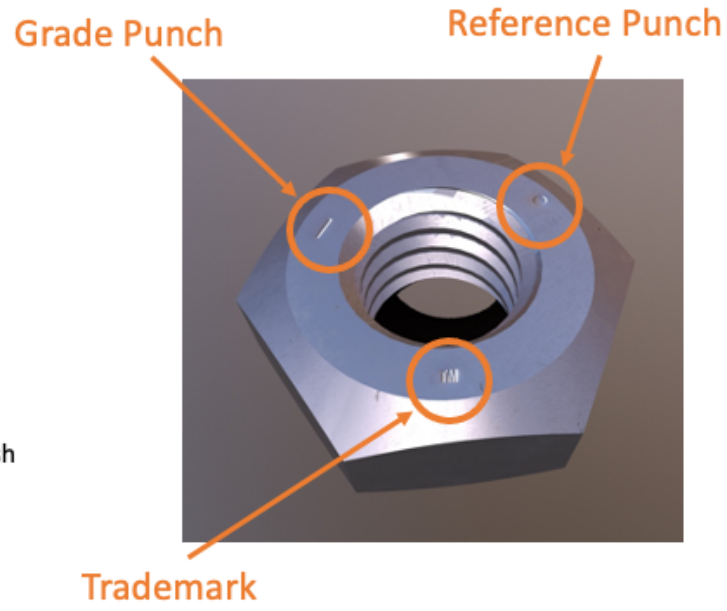


Nuts are used when mounting equipment to bolts or studs. The material and grade of the nut must match the material and grade of the bolt or stud.

Some mounts may require the use of self-locking nuts. These are a special type of nut with a nylon insert that reduces the chance that a nut will work loose over time.

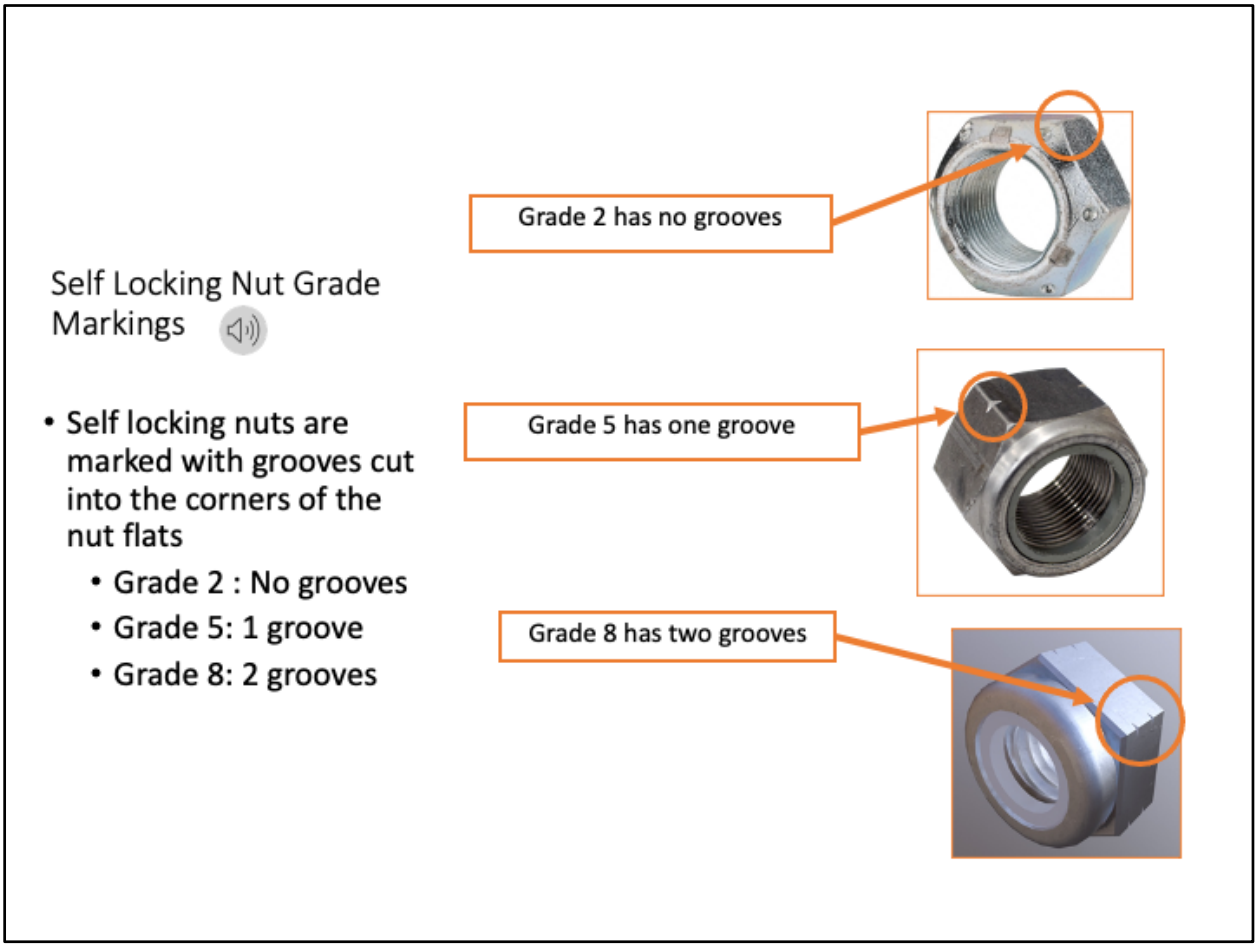
Nut Identification Markings

- Nuts are usually marked on one face
- Nut markings can be similar to those used for bolts
  - No markings on Grade 2 nuts
  - Grade 5 nuts have three slashes, raised dots, or letter codes
  - Grade 8 nuts have six marks
- Nuts may also be marked with a reference "punch mark" and a dash
  - Grade 5: Dash one flat away from reference punch
  - Grade 8: Dash two flats away from reference punch

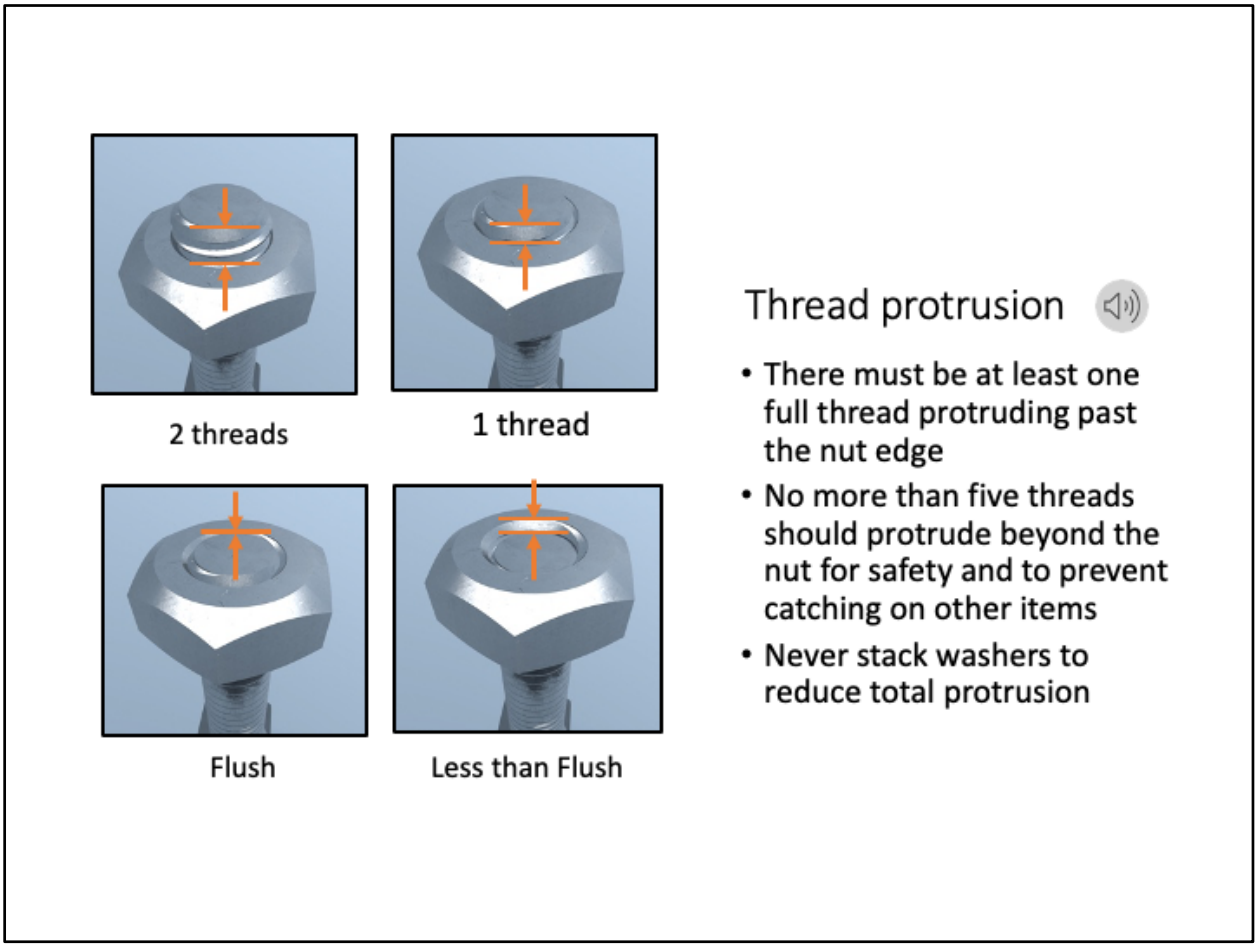


Nut Identification Markings – Grade markings are usually on one face of a nut and nuts often use the same system as on bolts. Grade 2 nuts have no markings, Grade 5 nuts have 3 marks, and grade 8 nuts have 6 marks.

Sometimes, nuts may use a reference punch system to show the grade. A punch mark – a dot imprint on the face – provides the reference point. A Dash mark one flat side away from the punch mark indicates Grade 5 and one two flats away indicates Grade 8. This picture shows the grade marking two flat sides away from the reference punch, so this is a Grade 8 nut. The graphic also shows the manufacturer's trademark.



Self Locking Nut Grade Markings - Self-locking nuts may have grade markings on the side edges instead of on the face. The left-most picture shows a self-locking nut with no grooves on the edge, the center picture show one with one groove, and the right-most picture one with two grooves in the edge.



Thread Protrusion – Thread protrusion or thread engagement refers to how much the externally threaded, male portion of a fastener engages with the internally threaded, female fastener or material. The two fastener pieces must have a complete engagement to ensure sufficient strength. However, it is also important that the bolt or stud does not protrude too far past the nut. This could cause a safety hazard – for example, a trip hazard – and also make the fastener susceptible to being damaged by coming into contact with other equipment.

In general, at least one full thread length is required above the top of the nut or plastic insert, but no more than five threads should protrude. Never stack multiple washers to decrease thread protrusion.

Alignment

- **DO NOT** ream (enlarge) the mounting hole(s) on the foundation or the equipment to make it fit.
- Studs can only be bent slightly (+/- 5°) in order to match the holes.
  - You may have to cut off a stud and reshoot it in order to achieve proper alignment.
- After all fasteners are tightened, ensure that doors, panel shields, covers or drawers can open and shut freely. If not, this indicates adjustments to the foundation are necessary.
  - **DO NOT** force doors and drawers to shut.
    ADJUST your foundation instead.

Shipboard equipment mounts must be tight and strong to prevent vibrations or sudden movements from breaking the equipment loose.

Reaming holes can weaken the mount. NEVER do this. Instead, ensure that all mounts are correctly manufactured or prepared.

Studs can be bent only slightly – less than 5° -- to fit into holes. Check this from at least two sides of the stud. Achieving acceptable alignment may mean that you will have to cut off a stud and reshoot it.

After ensuring that all studs are acceptable, mount the equipment ensuring that it is level. Tighten fasteners and then ensure that equipment doors, panel shields, covers, or drawers can be opened and closed without binding. IF they do not, make adjustments to the foundation as necessary. Do not force doors and drawers to shut – adjust the foundation instead.

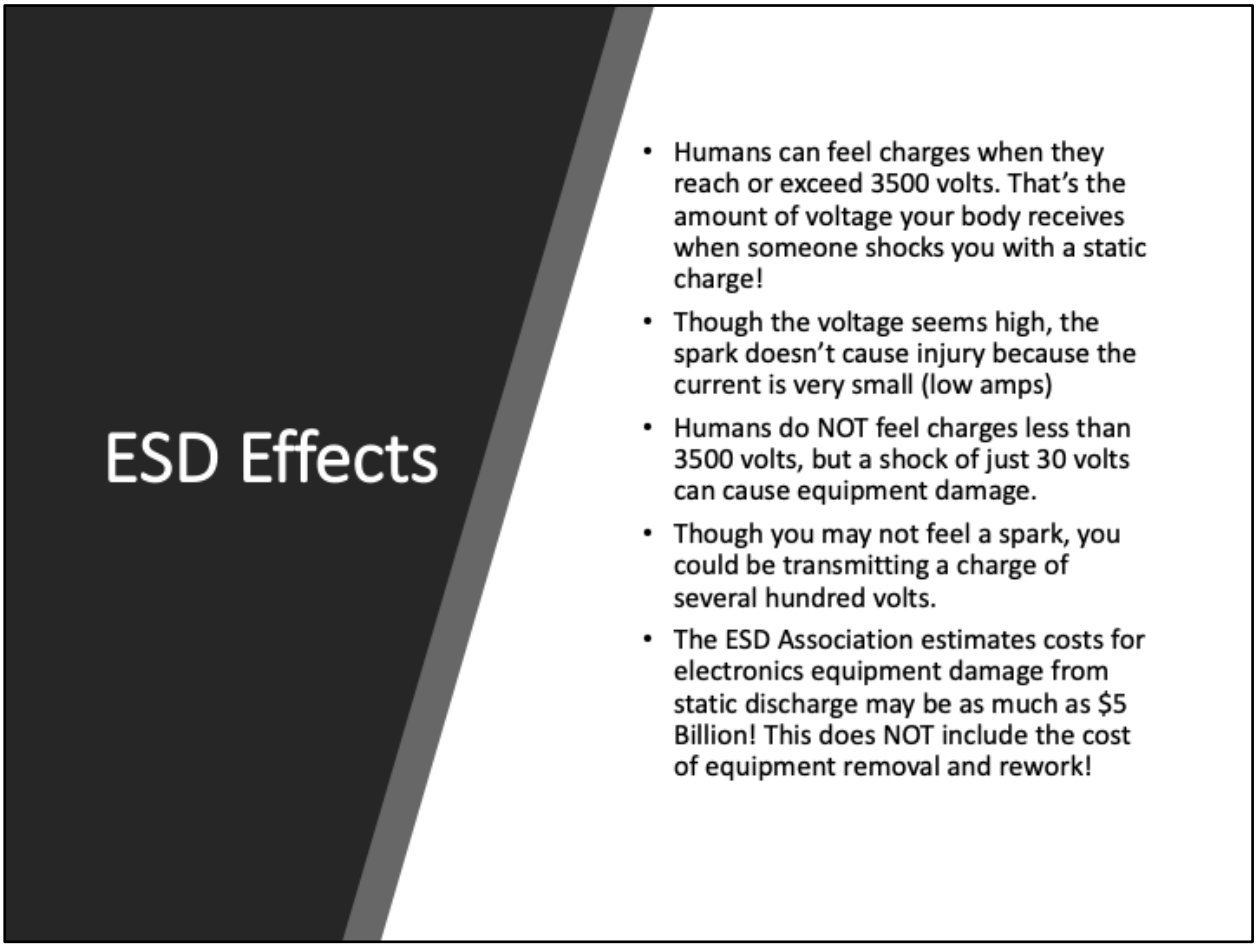
,

Electrostatic Discharge (ESD)

- ESD is the sudden flow of electrical charge between two objects caused by contact, an electrical short, or breakdown of insulation material subjected to very high voltages that causes it to suddenly begin conducting current
- Examples of ESD include
  - The static charge that makes your hair stand up when combed
  - The static cling that makes clothes stick together when taken out of the dryer
  - The shock you feel when you drag your feet while walking across a rug and then touch a doorknob (or another person)

- Electrostatic Discharge or ESD is the sudden flow of electrical charge between two objects caused by contact, an electrical short, or breakdown of insulation material subjected to very high voltages that causes it to suddenly begin conducting current

- Lightning may be the most spectacular type of ESD with which you are familiar. Other examples include
  - The static charge that makes your hair stand up when combed
  - The static cling that makes stick clothes together when taken out of the dryer
  - The shock you feel when you drag your feet while walking across a rug and then touch a doorknob (or another person)

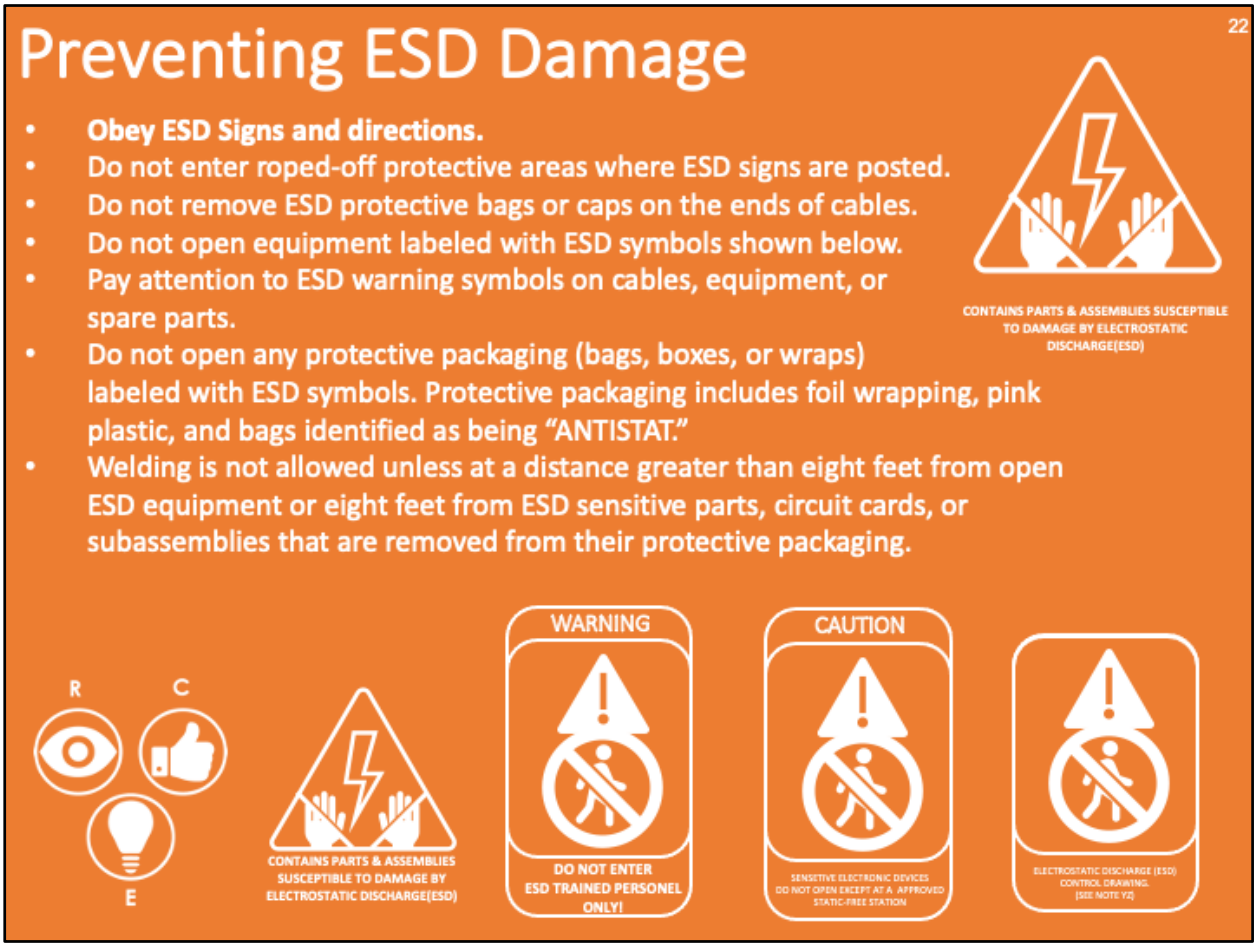


Humans are able to feel charges of 3500 volts or more. When someone drags their feet across a rug and then touches you to cause a shock, that is the amount of voltage your body is receiving!

You aren't injured by this because the amount of current that flows through your body is very small.

However, equipment damage can occur from static discharges as low as 30 volts. That is why it is so important to observe precautions. Equipment may be damaged by ESD that you cannot feel.

The ESD Association estimates costs for electronics equipment damage from static discharge may be as much as $5 Billion! This does NOT include the cost of equipment removal and rework!



Do not enter roped-off protective areas where ESD signs are posted without authorization. Work in these areas requires special training. Entry by others or you could cause serious, expensive damage even if equipment is never touched.

Unless and until authorized, do not remove ESD protective bags or caps on the ends of cables. These barriers help prevent a charge from reaching sensitive components!

Pay attention to ESD warning symbols on cables, equipment, or spare parts and do not open equipment labeled with ESD symbols unless authorized. Only specially trained employees are to open protective packages labeled with ESD symbols. ESD protective packaging includes foil wrapping, pink plastic, and bags identified as being "ANTISTAT."

Welding is permissible in any space so long as the welding takes place at a distance greater than eight feet from open ESD equipment or ESD sensitive parts, circuit cards, or subassemblies that are removed from their protective packaging.

Electronic cards and modules susceptible to electrostatic discharge damage must be stored in approved, anti-static packaging.

This packaging includes three layers designed to conduct electrical charges away from the cards or modules, insulate the cards or modules from external charges, and dissipate any static charge that may develop. The packaging may also be padded with bubble wrap for physical protection.

Storing ESD Sensitive Equipment & Materials

- Equipment subject to damage from ESD must be properly stored prior to installation
- Proper storage includes protection from damage from
  - Dust
  - Moisture
  - Weather
  - Physical shock

Equipment susceptible to damage from electrostatic discharge must be carefully stored prior to installation to prevent damage.

Materials must be protected from anything that might cause a buildup of static electricity such as dust, moisture, or the weather as well as from direct physical shock that might occur if it was jostled or accidently contacted by other equipment or materials.

Electrostatic Discharge-sensitive equipment and materials must be properly stored before installation, while installed, and anytime it is removed.

We must be careful that any materials we use to protect ESD material do not inadvertently cause damage.

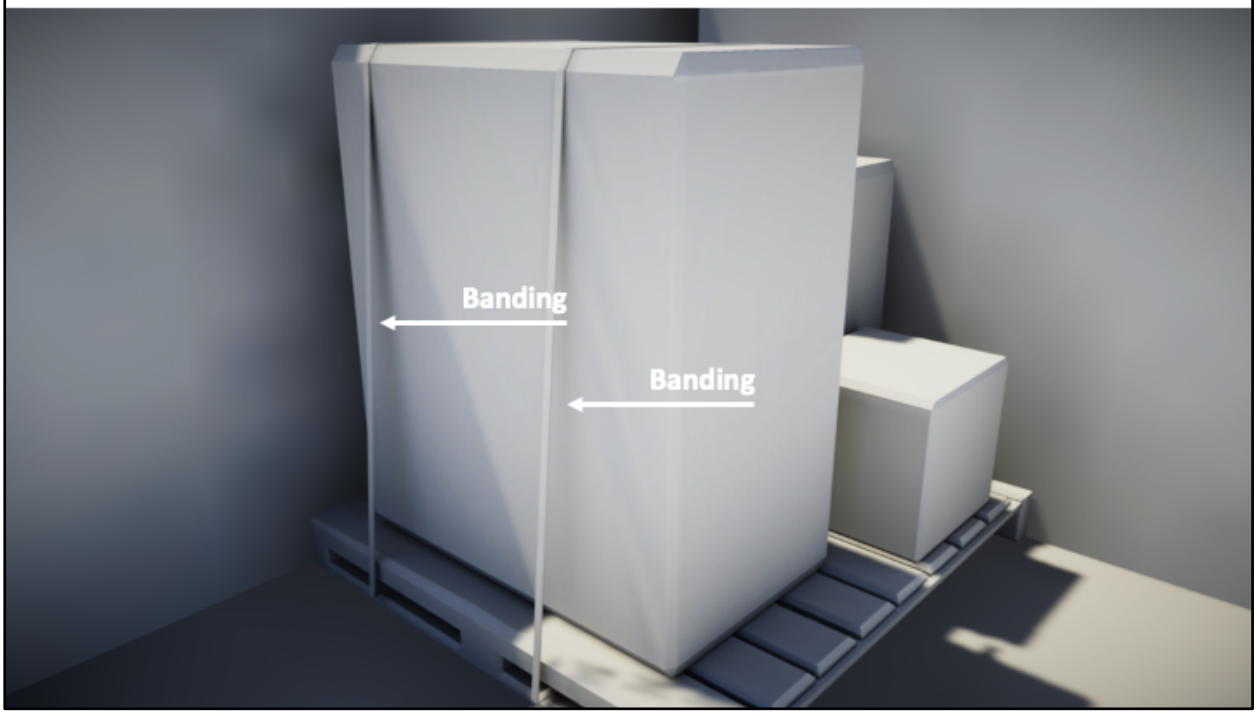
Equipment should be covered with materials that do not contribute to or conduct static charges as well as materials providing physical protection.

Industrial environments provide significant challenges to ESD equipment protection. Some activities, such as grinding and sandblasting, create significant airborne contamination while also generating static charges. Materials such as Herculite, a brand of materials that includes strong, waterproof, non-conducting vinyl sheets provides an effective barrier. Tape must be used to ensure a tight, secure fit. Bubble wrap or packing foam provide protection from physical shock and dust contamination but must themselves be protected from damage from hot work by a fire-retardant material.

Close off louvers, the air vents in cabinets, and any openings alongside switches with tape.

Equipment Protection

•Stored equipment should be placed on pallets to prevent water damage.



When not installed, equipment should be kept on pallets to reduce the chance of damage from water that might enter on the deck. Equipment should be securely attached to the pallet to keep it from being tipped over.