

How to Torque Electrical Connections?

“TOOL BOX TRAINING”



Introduction:

1. Loose electrical connections are common place and can easily be identified and corrected when addressed properly.
2. The secret to making and keeping reliable electrical connections is contained in two elements: start with clean contact surfaces, and apply the correct force.
3. When it comes to electrical connections there are many. Some of which are; (a) solid connections (e.g., bus bars), (b) lug connections (e.g., switchgears), (c) molded terminal connection (e.g., breakers), (d) screw terminals (e.g., control panel terminal strip).

General Rules which must be followed:

1. Never over torque a Fastener. To over-torque a Fastener can cause it to stretch beyond normal limits causing Fastener breakage, loosening of Fastener by stripping, and even conductor damage.
2. Never under torque Fasteners because it can cause the Fastener to loosen. Poor electrical connections can create electrical noise (power quality issues) by vibrating and creating arc at the connection.
3. Ensure you know the torque specification. **All of the major companies who manufacture electrical components have Torque Specifications for their equipment, ask for it.**
4. Ensure your electricians own and know how to use a torque wrench. When all else fails read the instructions.
5. Use infrared thermography and a multi-meter to check for possible loose connections (high resistive connections which can be measured will result in increased heat). Infrared thermography is a much safer and quicker method to verify.

Fastener Failure Modes:

- **Overloading** – Force exceeds Fastener strength, Fastener loosens or shears. Any

electrician who hasn't used a torque wrench has experienced this at least once.

- **Over-Torque** - damaging the threads, deforming the hardware (stripping), or damaging the current capacity of the conductor depending upon conductor type (solid vs. stranded).
- **Under-Torque** - allowing a joint to come loose. It may also allow the joint to flex and thus fail under fatigue. Also results in high resistive connections.
- **Brinelling** – caused by poor quality washers, leading to a loss of clamp load and failure of the joint. On solid connections such as buss bars, Belleville spring washers should be used as they are designed to help maintain proper tightness at the joints of bus bars and cable connections as the bus material expands and contracts under load.
- **Corrosion** – caused by the disintegration of an engineered material due to electrochemical oxidation of metals in reaction with an oxidant such as oxygen, this is why Fasteners must be lubricated unless stated by the equipment manufacturer. This is especially true between aluminum and copper connections. Clean contact surfaces are a function of cleaning procedures, which includes joint compounds such as Alnox® (similar and dissimilar materials), or NO-OX-ID (similar materials).

Definitions:

Torque Wrench:

- A torque wrench is a tool used to precisely apply a specific torque to a fastener such as a nut or Fastener.
- A torque wrench is used where the tightness of screws and Fasteners is crucial.
- It allows the operator to measure the torque applied to the fastener so it can be matched to the specifications for a particular application. This permits proper tension and loading of all parts.
- Torque Screwdriver is often needed when making electrical terminal connections and works off the

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same principals as mentioned above for the torque wrench.

How to Torque a Fastener?

Using the most common torque wrench which is a “click type” follow these steps;

Step 1: Preset torque value on torque wrench as determined by the equipment manufacturer; or if not available a common torque specification chart. (see below)

Note: When using lubrication make sure to use the appropriate values as found in the tables below.

Step 2: Torque the Fastener to the point where the desired torque is reached, signaling the desired torque by causing a click sound (some torque wrenches will not allow a Fastener to be torque above the setting however some will, be sure and purchase the best torque wrench/screwdriver possible)

If you have questions send me an email at rsmith@gpallied.com or you can contact Chris Colson at colsonc@alliedreliability.com

US STANDARD FASTENERS⁴
BOLT TORQUE VALUES FOR ELECTRICAL CONNECTIONS

Part 1 Heat-Treated Steel - Cadmium or Zinc Plated				
Grade	SAE 1&2	SAE 5	SAE 7	SAE 8
Head Marking				
Minimum Tensile (Strength) (lb/in ²)	64K	105K	133K	150K
Bolt Diameter in Inches	Torque (Pound-Feet)			
1/4	4	6	8	8
5/16	7	11	15	18
3/8	12	20	27	30
7/16	19	32	44	48
1/2	30	48	68	74
9/16	42	70	96	105
5/8	59	96	135	145
3/4	96	160	225	235
7/8	150	240	350	380
1.0	225	370	530	570

Part 2 Silicon Bronze Fasteners ^b Torque (Pound-Feet)		
Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

- a. Consult manufacturer for equipment supplied with metric fasteners.
- b. This table is based on bronze alloy bolts having a minimum tensile strength of 70,000 pounds per square inch.

US Standard Fasteners^a
Bolt Torque Values for Electrical Connections

Part 3 Aluminum Alloy Fasteners ^c Torque (Pound-Feet)	
Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

Part 4 Stainless Steel Fasteners ^d Torque (Pound-Feet)	
Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

- a. Consult manufacturer for equipment supplied with metric fasteners.
- c. This table is based on aluminum alloy bolts having a minimum tensile strength of 55,000 pounds per square inch.
- d. This table is to be used for the following hardware types:
Bolts, cap screws, nuts, flat washers, locknuts (18-8 alloy)
Belleville washers (302 alloy).