

100

GENERAL

2/11/2025

~	SC100	Standards Committee General Information
C	BEC	Bolted Electrical Connections

N	New Standard
R	Redrawn Standard
C	Changed Standard
~	No Change

SECTION 100

GENERAL INFORMATION

1. Purpose of Construction Standards

The purpose of Clark Public Utilities Construction Standards is to promote safe, economical, and uniform practices in the design, construction, and maintenance of CPU's electrical systems. Journey-level workers can safely operate and maintain a standard system because of familiarity with materials and equipment, and associated operating practices and ratings. Standards meet the applicable state and federal codes to ensure public safety.

2. Scope of Construction Standards

The CPU Construction Standards provide information applicable to design and construction of the CPU transmission and distribution systems.

CPU Standards are intended to cover the majority of typical installations. They do not cover every possible situation or "one of a kind" installations. The lack of a standard should not pose a problem if good engineering judgment and construction practices are followed.

3. Electrical Codes

All design and construction practices shall meet the provisions of the Washington State Electrical Construction Code and the National Electrical Safety Code in so far as they are applicable. Nothing in these standards is intended to be interpreted so as to conflict with the regulations of the state of Washington or any other regulatory bodies having jurisdiction.

4. Use of Standards

- Standards shall be adhered to on new construction.
- Standards shall be complied with on rebuilding or maintenance. When such practice is impractical, or not economically feasible, changes or additions to the standard practice will be permissible.
- Each department and each individual is expected to become familiar with those standards pertaining to their work and to adhere to those Standards. It is not the intent of standardization to, in any way, impede progress in adopting new ideas in materials, methods, or designs. On the contrary, it is expected that standardization will stimulate the use of such ideas, and through a program of trial use, incorporate into CPU standards those items which improve design and construction practices.

Rev 1: Deleted text for RIO system, corrected grammatical errors and updated language.



CONSTRUCTION STANDARDS

STANDARDS COMMITTEE
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5. Deviation from Standards

When deviations from the CPU Standards are deemed necessary, the individual responsible for the deviations must provide good reasons and make the changes only with the approval of their supervisor. The Standards Engineer shall be notified of any deviations from the standards that are expected to be repetitive.

While it is desirable that standards be adhered to as much as possible, it is also recognized that items of material and methods of assembly and construction become obsolete because of improvements, developments of new materials, or economic reasons. New and/or better methods of performing work are constantly being derived.

6. Responsibility

Responsibility for adherence to standards rests with the individual directly in charge of the work.



7. Cooperation

All department heads, as well as employees who use the standards in their work, are expected to give the standards program full cooperation and assistance and to help resolve problems that arise.

8. Continuous Improvement

The Constructions Standards program is flexible. Employees are urged to submit suggestions for improvements by either contacting the Standards Engineer or a member of the Standards Committee. Good reasons in support of the proposed change or new standard should be provided when submitting the suggestion. As a courtesy to the submitter, the Standards Committee will review all suggestions and provide a response to the individual originally providing the suggestion.

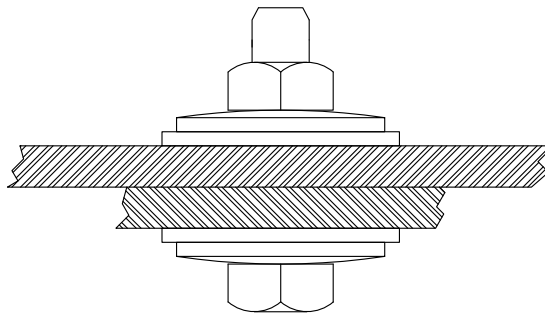
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1. General

- 1.1 Bolted connections can be broken into three categories: aluminum-to-aluminum, aluminum-to-copper and copper-to-copper. Because of the difference in thermal expansion between aluminum and copper alloys, bronze bolts must not be used on aluminum connections and aluminum bolts must not be used on copper connections. Type 304 stainless steel bolts used in conjunction with stainless steel flat and Belleville washers are suitable for all three types of connections and are the recommended standard bolt assembly for connections on CPU's electrical system.
- 1.2 Galvanized bolts, nuts and lock washers shall not be used in making electrical connections. When subjected to short circuit currents and resultant heat, the galvanizing tends to flow from under the threads, reducing the strength of the connection.
- 1.3 Aluminum bolts shall not be reused after they have been torqued.
- 1.4 To determine minimum bolt length, add 7/8" (for nut and washers) to the thickness of the terminals to be bolted together.
- 1.5 Install bolt heads down whenever possible. This will help identify loose bolt connections because they will be visible from ground level.

2. Bolted Flat Connections



- 2.1 File away burrs and ridges to reduce corona.
- 2.2 Remove oxide coatings by wire brushing all contact surfaces of the connectors until they are like new. Do not wire brush tin-plated or silver-plated contact surfaces.
- 2.3 Immediately apply a coat of inhibitor to the contact surfaces. Wire brush all of the bolted surfaces through the inhibitor. Apply additional inhibitor. Do not remove the previously applied inhibitor.
- 2.4 Assemble the connection. Use 1/2" stainless steel bolt assemblies. Assemble the bolted connection as shown in the figure above. When connecting aluminum to copper, the aluminum terminal must be placed above the copper terminal to prevent copper salts from eroding the aluminum.
- 2.5 Tighten the bolts alternately and evenly until the Belleville washers are flat then back off until the Bellevilles start to unflatten (about 1/16 of a turn). Refer to the following table for recommended torque values.

Recommended Torque Values for Commonly Used Bolts

		Stainless Steel 304 or Silicon Bronze		Aluminum 6061 - T6	
Bolt Size - Threads/In	Condition of Threads	Inch-lb	Foot-lb	Inch-lb	Foot-lb
3/8" - 16	Dry	240	20	180	15
	Lubricated	180	15	180	15
1/2" - 13	Dry	480	40	360	30
	Lubricated	360	30	300	25
5/8" - 11	Dry	840	70	720	60
	Lubricated	600	50	480	40
3/4" - 10	Dry	1200	100	1140	95
	Lubricated	1020	85	720	60
7/8" - 9	Dry	1800	150	1560	130
	Lubricated	1440	120	900	75
1" - 8	Dry	2400	200	1920	160
	Lubricated	1920	160	1140	95

3.0 Application of Tension for Bolt Clamping

For bolted electrical connections it is necessary to have adequate clamping pressure which is obtained by the correct application of tension to the bolts at the assembly.

There are several ways to achieve the proper tension to a bolt in critical applications. CPU has approved the following methods:

1. Use of torque wrench
2. Turn-of-the-nut method
3. Load indicating washers (Belleville washers)

Tension Measuring Method	% Accuracy	Relative Cost
Feel (Operator's Judgement)	+/- 35	1
*Torque Wrench	+/- 25	1.5
*Turn-of-the-Nut	+/- 15	3
*Load Indicating Washers	+/- 10	7
Fastener Elongation	+/- 3 to 5	15
Strain Gages	+/- 1	20

* CPU approved methods



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BOLTED ELECTRICAL CONNECTIONS

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3.1 Use of Torque Wrench

For proper tensioning of bolts, a torque wrench will be used to tighten a bolt by applying the appropriate torque value as given in the table "Recommended Torque Values for Commonly Used Bolts" on page 2.

3.2 Turn-of-the-Nut Method

The Industrial Fastener Institute has developed a means of properly tensioning structural steel bolting by what is known as the "Turn-of-the-Nut" method. This method applies only to bolts with UNC threads.

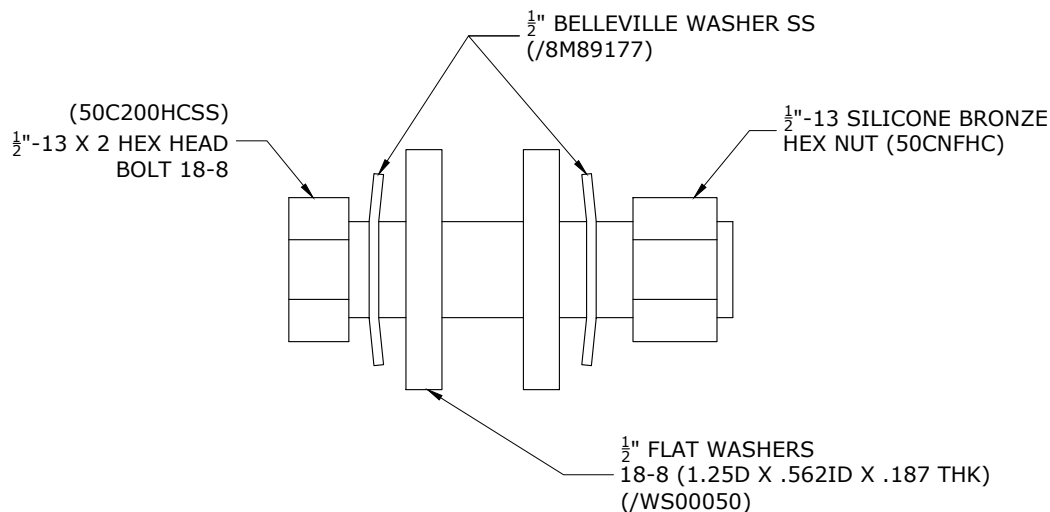
Turn-of-the-nut tightening process encompasses a low initial "threshold" torque to achieve "snug tight" condition followed by a prescribed amount of nut turning to develop the required tension. This technique has gained acceptance for installation of high strength structural bolts and can be extrapolated down for reliable use on smaller fasteners as long as assumptions upon which the technique is based are considered. For instance, the ideal snug tight condition will vary with each application.

The Research Council for Structural Connections published *Specification for Structural Joints Using High-Strength Bolts* (2014) which recommends a turn count based on the length and diameter of the steel bolt in the connection. According to Table 8.2 in the RCSC specification, when installing a 1/2" bolt use 1/2 turns for lengths 2-4" and 2/3 turns for lengths 4-6".



3.3 Load Indicating Washers (Belleville Washers)

Not applicable to aluminum bolts. For non-aluminum bolts, Belleville spring washers and wide-series flat steel washers shall be used. Care shall be taken to install the Belleville washers with the crown up toward the nut or bolthead, with the concave side at the Belleville bearing on a heavy duty, wide-series flat washer with a larger diameter than the Belleville. Bellevilles shall be tightened to flat and then backed off 1/16 of a turn.

For proper tensioning of bolts, a Belleville washer will be used that has a load-to-flat value approximately equal to but not exceeding 80% of the yield strength of the bolt.



Rev. 1 - Added belleville washer drawing for clarity.

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