Tel.800-269-1462 Fax.800-311-9857
2663 Lyman Drive, Clinton, OH 44216-9731

www.ClassicConnectors.com

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# *Transmission & Distribution Hardware*

(Part 2)

By Waymon P. Goch

Part 1 covered the beginnings of T&D hardware to the formation of ANSI (American National Standards Institute) and insulator standards. ANSI was founded in 1918 as the American Engineering Standards Committee (AESC) which became the American Standards Association (ASA) in 1928, the United States of America Standards Institute (USASI) in 1966 and finally, ANSI in 1969.

ANSI does not write or develop standards but rather oversees and accredits the procedures of accredited standards developers to ensure that all standards meet established requirements for balance, consensus, and other approval criteria. There are presently approximately 275 ANSI accredited standards developers, including NEMA, IEEE, ASTM, and ASME.

It was noted in Part 1 that the history and development of T&D hardware is also a history of insulators. The two are inseparable and that continues to be the case with industry standards, dimensions and strength ratings.

T&D hardware dimensions and ultimate strength ratings are primarily dictated by the standard ANSI insulator class that the hardware is designed to support. There are presently 15 active ANSI insulator standards of which the following eight are likely to be of most interest to engineers, designers and maintenance personnel.

ANSI Insulator Standards

| | Title |
|---|---|
| C29.1 | American National Standard for Electrical Power Insulators - Test Methods |
| C29.2 | American National Standard for Insulators - Wet Process Porcelain and Toughened Glass - Suspension Type |
| C29.7 | American National Standard for Wet Process Porcelain Insulators - High Voltage Line Post Type |
| C29.11 | American National Standard for Composite Suspension Insulators for Overhead Transmission Lines - Tests |
| C29.12 | American National Standard for Insulators - Composite - Suspension Type |
| C29.13 | American National Standard for Insulators - Composite - Distribution Deadend Type |
| C29.17 | American National Standard for Insulators - Composite - Line Post Type |
| C29.19 | American National Standard for Insulators - Composite - Distribution Line Post Type |

ANSI C29.2 defines 12 standard suspension insulator classes ranging from distribution classes 52-1, 52-2, 52-9-A and 52-9-B through transmission classes 52-3, 52-5, 52-8 and 52-11 for ball and socket insulators and 52-4, 52-6, 52-10 and 52-12 for the corresponding clevis insulators.

This standard defines the cap and pin coupling dimensions for interchangeability between manufacturers as well as the mechanical and electrical requirements for each class.

The minimum ultimate tensile strength of porcelain and toughened glass suspension insulators is defined by combined M&E (mechanical and electrical) strength. Impact strength and tension proof test requirements are also defined for each class as well as minimum electrical characteristics and RIV limits.

The combined M&E strength of porcelain and glass suspension insulators is the mechanical load at which the insulator fails, either mechanically or electrically, when voltage and mechanical stress are applied simultaneously. The required test and procedures are defined in ANSI C29.1. The tension proof test is a routine test that is required on 100% of production prior to shipment.

Composite suspension insulators have equivalent requirements and ratings, as defined in the appropriate standards. There are differences in terminology because of the materials and construction. For composite suspension insulators, for example, SML (Specified Mechanical Load) is equivalent to M&E and defines the minimum ultimate tension strength of the insulator. RTL (Routine Test Load) is 50% of the insulator SML and the maximum design tension load. Every insulator is tested at its RTL prior to shipment.

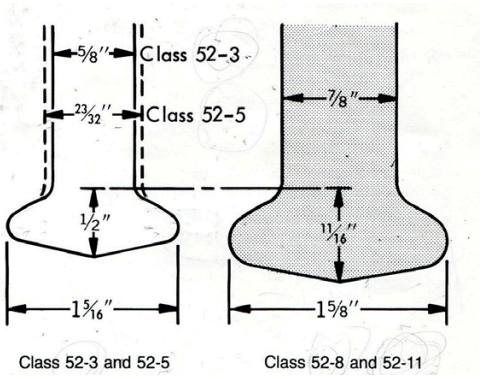
Note that these standards define minimum ultimate and routine proof tension loads but do not include recommended working loads. That responsibility resides with the user. It's up to the user to determine the safety factors he wishes to apply.

There are four ball and socket suspension insulator classes that are of primary interest to transmission line designers. Those classes are 52-3, 52-5, 52-8 and 52-11. The equivalent clevis suspension insulator classes are 52-4, 52-6, 52-9 and 52-12. For T&D hardware purposes we will focus on these four ball and socket classes and their mechanical strengths but the same relationships also apply to the clevis insulator classes.

ANSI Class 52-3 has a combined M&E rating of 15,000 lbs and Class 52-5 is rated at 25,000 lbs. The ball dimensions are identical for both classes but the shank diameter of the 52-3 pin is 5/8" and 23/32" for the 52-5. That is what accounts for the difference in strength rating. Socket dimensions of the two Classes are identical and will accept either pin shank diameter. As a result, Class 52-3 and 52-5 balls and sockets are mechanically interchangeable.

The balls and sockets of the two higher strength Classes 52-8 (36,000 lbs M&E) and 52-11 (50,000 lbs M&E) are identical.

Following is a comparison of the pin dimensions of these four classes.

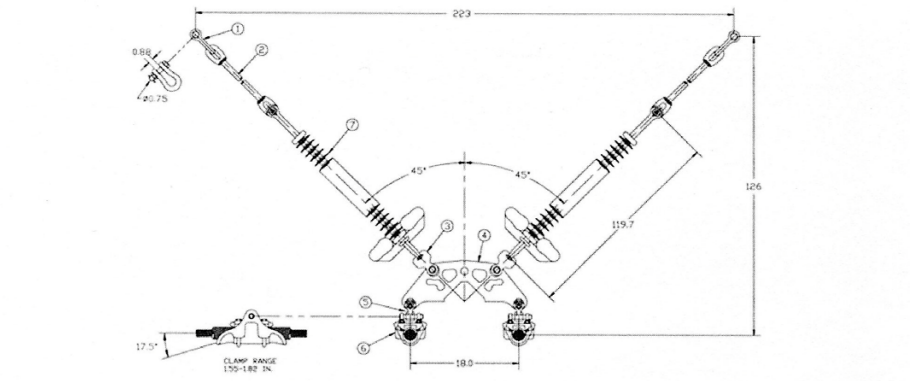



T&D hardware is typically rated on the basis of ultimate tensile strength and a review of T&D hardware suppliers' catalogs will reveal that hardware fittings designed to connect to suspension insulators will reference the ANSI insulator class and have an ultimate strength rating that equals or exceeds the M&E (or SML) rating of that particular insulator class.

There is some confusion among users regarding the meaning of T&D hardware ultimate strength rating. That ultimate strength rating is the same as suspension insulator M&E or SML. It is the minimum tension load at which the hardware fitting may fail, with failure being defined as complete rupture or elongation or deformation that renders it unsuitable for continued service.

Historically, suspension insulators and the associated T&D hardware have been applied with a 2.5 safety factor. That is a maximum service load of 40% of the insulator M&E and hardware ultimate strength rating.

The requirement that T&D hardware comply with insulator standards has minimized the need for separate T&D hardware standards and that is still true today for all hardware that connects directly to and supports the insulator. However, there are many other T&D hardware items such as yoke plates, clamps and connectors that are not directly connected to the insulator but must be coordinated with the overall assembly as shown in the following.




**(330-345kV)**

Contact HPS for assistance in selection of compatible components for specific conductor and voltage application. Ball & socket dimensions per ANSI Class 52-5.

| ITEM | CATALOG TYPE | DESCRIPTION | QTY. | MATERIAL | ULTIMATE STRENGTH LBS. |
|---|---|---|---|---|---|
| 1 | AS50BNK | Anchor Shackle | 2 | Forged Steel | 30,000 |
| 2 | HOO3036 | Oval Eye Ext. Link (36") | 2 | Forged Steel | 30,000 |
| 3 | SYC30SN | Socket Y-Clevis | 2 | Ductile Iron | 30,000 |
| 4 | YPV30172592 | Yoke Plate | 1 | Ductile Iron | 30,000 |
| 5 | YCS1690 | Y-Clevis Eye | 2 | Ductile Iron | 30,000 |
| 6 | CFS182N | Suspension Clamp | 2 | Aluminum | 25,000 |
| 7 | S030107S201B | Insulator, Susp. w/Ring | 2 | Polymer Composite | 30,000 |

(From Anderson/Fargo Catalog TS-1M)

There are several published IEEE standards that were developed by the Working Group on T&D Overhead Line Structural Material and Hardware. This WG is part of TP&C (Towers, Poles &Conductors) Subcommittee 15.11. Published standards that may be of interest include:

C135.61– Standard for Testing of Overhead Transmission and Distribution Line Hardware
C135.62 – Standard for Zinc-Coated Forged Anchor Shackles
C135.63 – Shoulder Live Line Extension Links for Overhead Line Construction

Several others are in process, including C135.64 – Standard for Slip and Pull-Out Strength Testing of Bolted Dead End Strain Clamps, which is nearing the ballot stage.

Additional work has begun to consolidate several old individual hardware standards into one comprehensive standard titled, High Line Hardware.

The TP&C Working Group on Overhead Line Structural Material and Hardware has an ongoing objective to identify areas in which additional T&D hardware standards may be beneficial to the industry and welcomes all suggestions for consideration.

Clamps and connectors will be discussed in Part 3 of this series.