TECHNICAL TRAINING
UL514B & ZINC ALLOY vs. STEEL

INTRODUCTION

All electrical system products installed in commercial and residential buildings in the USA must meet any and all applicable requirements of the National Electric Code (NEC) and local building codes. Within the NEC, there is a requirement for third-party product testing and verification to specifications (i.e. "Listing") based on the NEC and others such as: Underwriters Laboratories (UL), The American Society for Testing and Materials (ASTM), or National Electrical Manufacturer's Association (NEMA). All approved, third party testing laboratories are identified by the US Department of Labor Occupational Safety & Health Administration (OSHA), and listed on their Nationally Recognized Testing Laboratories (NRTL) list.

Underwriters Laboratories (UL) is an approved NRTL, as well as the Canadian Standards Association (CSA), and Edison Testing Laboratories (ETL/INTERTEK). Each of these organizations provides product testing and verification services, which ensure a product meets the safety requirements set forth in the applicable standard. When a product is verified, it is known as being "Listed".

In order to obtain a Listing on a product, it must be evaluated to the requirements set forth in the applicable standard. To maintain the listing, random verification evaluations are performed throughout the year at the manufacturing locations which produce the listed product.

In addition to testing and compliance services, UL has developed many specifications for electrical products such as cable, conduit, and fittings. UL514B is the primary specification that electrical fittings are required to meet.

STEEL vs. ZINC ALLOY….WHAT REALLY IS THE DIFFERENCE?

The primary test requirements for Zinc Alloy and Steel (including Malleable Iron) fittings are contained in the governing specification - UL514B. Please keep in mind that Bridgeport has internal capabilities to pre-test most specification requirements in UL514B. If we do not have the capability, we will send the product directly to one of the NRTL's (UL\CSA\ETL) for evaluation. In either case, the lab representative will conduct, or witness all of the tests required for listing. We do not supply our own test data, and the evaluation/test process is completely controlled by the NRTL.

Some of the specific requirements change with trade size (i.e. pull test lbs, current test amperes, etc.). Also, regardless of the materials, the type of fitting needs to pass all applicable tests in order to be Listed – with NO exceptions.

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The following is only a sampling* of the specification requirements referenced in UL514B for Threadless Fittings (Compression, Setscrew – or Push-EMT™). Please note that a Setscrew style fitting has the same requirements as a Compression style fitting.

Other UL514B requirements will relate to material thickness, dimensional specifications, coating thickness (i.e. zinc plating), flammability (i.e. insulators, NM fittings, etc.), or the like. Evaluations are "pass" or "fail" only – meaning there is no 'almost' or 'exceeds' requirements noted in the test data or Listings.

**NOTE: Unfortunately, due to UL copyright restrictions, we cannot distribute the entire UL514B document. We can only take the most relevant excerpts from it. If you require any other specific comparisons, please let us know.*

UL514B - Requirement Examples:

Compression or Set Screw Type Conduit Fittings (For Threadless Conduit) – It is important to note that Zinc Alloy **or** Steel must meet the **same** requirements.

8.10.7 Pull Test Requirement: *A Threadless Fitting must withstand a linear pull for 1 minute when mounted to an enclosure and mated with a conduit. Rigid and EMT requirements are the same.*

½" – 300lbs.
¾" – 450 lbs.
2" - 1000 lbs.

The fitting shall not separate from the conduit or enclosure, crack, or break.

8.10.5 Bend Test Requirement: *A Threadless Fitting shall be attached to two lengths of electrical metallic tubing or conduit and the assembly shall be placed across a 760 mm (30 in) span. The bending force shall be applied at the center of the assembly and in such a manner that the assembly of the Fitting and tubing or conduit is able to be rotated. The assembly shall be rotated through one complete revolution within 1 minute. A Connector Fitting shall be attached to a coupling and the supports shall be separated an additional distance (more than the 760 mm) equal to the length of the coupling.*

½" – 20 lbs. EMT, 60 lbs. Rigid
¾" – 35 lbs. EMT, 80 lbs. Rigid
2" – 110 lbs. EMT, 160 lbs. Rigid

The fitting shall not crack, break, or become separated from the conduit.

8.10.4 Current Resistance Requirement: *A Threadless Fitting for non-flexible metallic raceways shall be subjected to the resistance test described below:*

> *The resistance between the points specified shall not be greater than that specified in the individual requirements for the Fitting. The resistance shall be determined by passing a direct current of 30 amperes direct current (DC) through the Fitting and connections between the Fitting and the conduit, tubing, cable, box, or enclosure to which the Fitting is assembled. For connector, a threaded coupling or a plate used to simulate a box shall be allowed to be used for the test.*
>
> *For a coupling, the voltage drop shall be measured between two points, one on each section of the conduit, tubing, or cable. For a connector, the voltage drop shall be measured between a point on the conduit, tubing, or cable and a point on the box, enclosure, or threaded coupling used to simulate a box. The point on the box, enclosure, or threaded coupling shall be 1.6 mm (1/16 in) from the Fitting. The point on the conduit, tubing, or cable shall be 1.6 mm (1/16 in) from the Fitting or the contact point between the Fitting and the conduit, tubing, or cable.*

As a result of the test, the measured voltage drop shall ***not be greater than 10 millivolts. This applies to all trade sizes.***

8.9.1 Current Test Requirement: *The Fitting shall be tested as described below, as applicable:*

> *Each Fitting shall be assembled to a minimum 152 mm (6 in) length of conduit of the intended size and an unpainted, plated or unplated, steel enclosure or steel plate simulating an enclosure. The thickness of the enclosure or plate shall be 1.35 – 1.40 mm (0.053 – 0.055 in).*
>
> *The locknut shall be hand-tightened and then further tightened 1/4 turn with a hammer and a standard screwdriver or by an equivalent method. A copper wire lead, not less than 610 mm (2 ft) long, shall be connected: a) to the enclosure by a pressure wire connector, and b) to the raceway, 0.8 mm (1/32 in) from the Fitting, by a ground clamp that is sized accordingly. Pressure wire connectors shall be tightened using the torque specified.*

A test current shall be passed through the wire and Fitting assembly.

½" - 1180A for 4 seconds
¾" – 1530A for 6 seconds
2" – 3900A for 6 seconds
4" – 5050A for 9 seconds

After having carried the test current, continuity shall exist between the parts of the test assembly when measured between a point on the raceway and a point on the enclosure 6.4 mm (1/4 in) from the Fitting. An indicating device, such as an ohmmeter or battery-and-buzzer combination, shall be used to determine whether continuity exists. The Fitting shall carry the specified current for the time indicated above.

As a result of the test, the Fitting shall not crack or break, and there shall be continuity between the enclosure, Fitting, and raceway following the test. A throat insulator complies where the insulator arcs and burns as a result of the test.

6.2 Assembly Torque Requirement: *The tightening torque to be applied to a compression-type Fitting, or similar product, shall be as specified. A locknut shall be hand-tightened and then further tightened 1/4 turn with a hammer and a flat-bladed screwdriver or by an equivalent method.*

½" - 300 lbf-in
¾" - 500 lbf-in
2" – 1600 lbf-in

A screw or bolthead screw, other than a No. 8 or No. 6, that is capable of being tightened with a screwdriver shall be tightened to a torque of 3.96 N•m ***(35 lbf-in).*** *A No. 8 screw shall be tightened to a torque of 2.26 N•m* ***(20 lbf-in),*** *and a No. 6 screw shall be tightened to a torque of 1.36 N•m* ***(12 lbf-in).*** *An unslotted, bolthead screw, direct-bearing or securing a clamp, shall be wrench-tightened to a torque of 18.1 N•m* ***(160 lbf-in).***

The screw, locknut, or fitting shall not crack, break, or have stripped threads with the applied torque.

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It is important to note that the NRTL only officially tests to the specified requirement. They do not go above the requirement (i.e. 1400A instead of 1280A). No manufacturer of fittings publishes actual test data, as it has no real relevance to the listing requirement (unless it's a manufacturer specified requirement). For all intensive purposes, the product either passes or fails UL514B.

In our own lab tests, with many of the tests outlined above, we can confidently state that *our products meet or exceed the UL514B requirements.* We design our product with a safety margin in mind, so we know we will likely meet the requirements – no matter what the average field variability is. Not all manufacturers will do this (for various reasons), and you can sometimes 'see and feel' the difference. Many of the differences have to do with lowering the manufacturing cost to the bare minimum to allow the fitting to just pass the UL requirements – with limited safety margins.

> *For example, take a competitor's die cast zinc fitting locknut. It will look similar to ours, but it may only have a single, 350 degree, cast-in thread. The UL514B torque requirement for all fittings with locknuts is "hand-tight, plus 1/4 turn" - no more, no less. This locknut will likely meet the requirement and help the fitting pass subsequent tests. However, what happens when you torque it just a bit more? Like another 1/4 or 1/2 turn? Most likely, the locknut will break, strip, or jump the fitting threads. Actual use in the field is sometimes different than in a lab. Installers will keep torquing until they 'feel' it's tight enough. This may amount to that extra 1/4 to 1/2 turn. Bridgeport locknuts, with the full-cut thread and high quality zinc alloy, will meet that challenge of extra torque and not jump threads or break. Just looking at the two locknuts side by side, should easily convince the specifying engineer that Bridgeport is better, without the need for more data*.

FAQ's:

1. ***"Zinc Alloy has a "low melting point" as compared to Steel."*** - In most applications the objection to Zinc fittings due to a low melting point is completely without merit. It is true that the melting point of steel typically used in fittings is around 2500°F and the Zinc Alloy is around 800°F. However, the conductor insulation inside the conduit and fittings will typically melt and combust at a much lower temperature, which averages about 290°F to 750°F – depending on insulation type. As a comparison, paper combusts at around 450°F, and concrete starts to break down at >400°F, and wood combusts at 572°F. For all practical purposes, most buildings will likely be a total loss at temperatures of 500°F and up. The point is that life safety is not compromised by using a Zinc Alloy fitting in place of a Steel fitting. Both materials meet all applicable requirements of the NEC.

2. ***"Steel has a higher tensile strength than Zinc Alloy.*** "- The tensile strength of steel alloy typically used in fittings is 45,000 psi to 90,000 psi and Zinc Alloy is 41,000 psi to 45,000 psi. However, within the NEC, UL514B, Federal Specification A-A-50553, and other related specifications, all that is required of the fitting is to meet the mechanical requirement specifications (i.e. UL514B). If a fitting was required to have a higher tensile strength, then why wouldn't it be made with something like a Titanium Alloy, with a tensile strength of over 100,000 psi? The reason is simple. Designers and manufacturers will use the most practical and cost effective material required to meet the specifications. Just because Steel may have a higher tensile strength, does not necessarily mean it will outperform Zinc Alloy in all other requirements. Plus, who wants to pay for a $100 fitting, when a $0.50 fitting will do the same job?

3. ***"Steel has a higher electrical conductivity and current carrying capability."*** - Both materials perform equally within the realm of UL514B, and they will both likely exceed the UL514B specifications. Current carrying capability is not only determined by material, but also by overall design. Unless there is an out of the ordinary specific electrical system design, there should be no objection to Zinc Alloy fittings used in a standard installation**.**

4. ***"Zinc Alloy Fittings outperform Zinc-Plated Steel Fittings with regards to corrosion resistance."*** - If the zinc plating on a steel fitting is compromised (i.e. scratched, nicked, etc.), or if the plating is not of the required thickness (impossible to tell just by looking at it), the steel fitting will most likely rust up in short order (even when exposed to mildly moist environments – such as in new construction not fully closed in). Zinc Alloy by itself has superior, integral corrosion resistance all the way through the fitting material.

5. ***"Zinc Alloy Fittings outperform Steel Fittings when it comes to dimensional consistency."*** - Due to the die casting process, the result is a 'net shape' component, which is the same from the first to the millionth copy. The same cannot be said for formed Steel fittings. Variations in material hardness, forming or thread rolling processes make the fitting very difficult to control dimensionally. The result is on-the-job frustration with a fitting that will not fit correctly onto a conduit due to an ID issue, a locknut or compression nut that will not thread easily onto the fitting body, or a setscrew that immediately strips out of the formed boss. Quality, Zinc Alloy fittings eliminate this frustration in the field. By using only certified Zinc Alloy, Bridgeport can consistently manufacture the highest quality fittings available.

6. ***"Zinc Alloy Fittings are all made out of "pot metal" and can't possibly be equal to Steel in performance."*** – This is absolutely false. First, the term "pot-metal" is a slang term meant to describe an alloy without a metallurgical standard. Second, these alloys are cheap, and highly unpredictable due to their uncontrolled elemental variations. Bridgeport only uses Zinc Alloys certified to American Society for Testing and Materials (ASTM) standard B86 - *Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings*. The ASTM B86 Standard specifically defines the alloy constituents by percentage (i.e. Zinc, Aluminum, Magnesium, Copper, etc.), and their precise quantities. It also further defines the properties of the alloys, including tensile strength, elongation, shear strength, hardness, and impact strength. Without a certified Zinc Alloy, it would be close to impossible to manufacture a fitting with high quality and consistency.

7. ***"Compression Fittings are more secure than Setscrew Fittings."*** – Within the realm of UL514B, there is no difference with regards to performance. The pull test, bend test, current test, resistance test, etc. requirements are identical for both fittings. However, there are other functional advantages of one over the other such as: All compression fittings are concrete tight – without tape; all setscrew fittings can be fastened with just a screwdriver; or there are no Raintight versions of Setscrew fittings available. Each feature needs to be applied to the application and preferences of the customer.

In summary, from an end user point of view, Zinc Alloy Fittings certainly have the functional edge over their plated-Steel equivalents. From a specification point of view, there should be no technical reason to exclude Zinc Alloy fittings from consideration. Bridgeport Quality, Service, and Support all should be considered as part of a specification.

If there are any questions related to this document, please contact the Engineering Department at Bridgeport Fittings.