



**National Electrical Manufacturers  
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## **WHITE PAPER ON LEAD IN STEEL CONDUIT**

### **What is Conduit?**

Steel Electrical Conduit products (Rigid Steel Conduit, Intermediate Metal Conduit-Steel and Electrical Metallic Tubing - Steel) are used in the electrical wiring systems in the United States. They are raceways of circular cross section (i.e. piping) designed for the physical protection and routing of electricity conductors and cables. They are also used as an equipment-grounding conductor, when installed using appropriate fittings or the associated coupling, based on the type of product. Grounding is necessary to prevent fires or shock hazards from ungrounded equipment. This combined definition is from the 2002 National Electrical Code.

### **Major Components of Conduit**

These products are principally made from a carbon steel tubular hollow with a zinc exterior coating and either zinc or an organic interior coating designed for corrosion protection. Zinc provides a superior corrosion protection for the base steel tube since it acts in a sacrificial manner with oxygen attacking the zinc rather than the steel

Underwriter's Lab (UL), using the American National Standards Institute (ANSI) consensus method, develops material standards for these products designed around the use and performance requirements for the product. Additionally, an ANSI committee managed by the National Electrical Manufacturers Association (NEMA) develops similar material standards.

Galvanized steel electrical conduits are typically rinsed in a complex chromate conversion solution to provide the zinc galvanizing corrosion protection against white rusting (bulky deposits of porous zinc oxide or hydroxide). Hexavalent chrome bearing conversion coatings are chosen for conduits because of their beneficial film properties such as: inflammability, corrosion protection, mechanical flexibility, long shelf life, electrical conductivity, ease of soldering, low toxicity since the majority of the hexavalent chromium is converted to water-insoluble trivalent chromium, pretreatment for painting, and self-healing. The additional process benefits are ease of application and handling.

The safety of these wiring systems has a long history and is covered by the National Electrical Code (NEC) published by the National Fire Protection Association (NFPA), an ANSI consensus organization. Local jurisdictions, such as states and cities typically adopt the NEC as their local electric code requirement. The NEC recognizes as acceptable the use of products listed by Underwriters Laboratory (UL) as having been approved for use after rigorous testing and follow-up inspections at the manufacturers' facilities. Steel conduit products have long been recognized as being extremely beneficial to the safe operation of our country's electrical systems.

### **Why is zinc used?**

Underwriter's Lab (UL) develops material standards for these products designed around the use and performance requirements for the product. The three standards covering steel conduit products, UL 6, UL 797 and UL 1242 have historically specified zinc as a primary coating for corrosion protection. ANSI steel conduit standards C80.1, C80.3, and C80.6 have similar material standards for these products that also require a coating of zinc. Zinc protection of many steel products enables the use of steel, one of the most recyclable materials, to be used in applications where it might not otherwise be acceptable. Hampering the use of zinc to protect steel would be counterproductive to the environment.

The principle reasons that zinc is used as a protective coating for these steel products are that zinc corrodes much more slowly than steel in natural environments and the sacrificial galvanic nature of zinc at small discontinuities in the zinc coating. This means that oxygen will attack the zinc rather than the steel and the zinc still protects the steel in those small bare spots because it's effect "spreads out." .

### **Lead Content of Zinc**

Lead is a naturally occurring impurity in the refining of zinc. The solubility of lead in zinc is approximately 1.6% at 450°C.

ASTM standard B6-00, Specification for Zinc, covers the purity of zinc bars used in the galvanizing industry and hence those used by the steel conduit industry. It allows for various impurities, some of which are naturally occurring. The ASTM acceptable level of lead for the different grades of zinc are: Prime Western zinc – 1.4% maximum lead, High Grade – 0.03% maximum lead and Special High Grade – 0.003% maximum lead.

ASTM is an internationally recognized standards development organization. Experts from around the globe gather at regular intervals to discuss updates and revisions to existing standards and to develop new standards covering nearly all facets of our world.

### **Amount of Lead on Conduit**

The lead contained in the zinc deposited on the conduit in the hot-dip process is approximately one-half of the lead concentration in the zinc bath. This is due to the grain-boundary precipitation mechanism in the hot dipping process. Thus, if the concentration of lead in the zinc bath is 0.003%, then the lead content of the zinc coating on the conduit is expected to be around 0.0015%.

In the electroplating process, which is also used for applying zinc to conduit, the lead content in the plating tank is transferred directly to the tubing and the bath has the same 0.003% lead concentration.

Both of the levels identified are well below the EU level for “lead free”, which is listed as 1000 ppm or 0.1%. These amounts are based on the zinc coating alone. When the mass of the base tubular is included in the percentage calculation, the percentage of lead concentration on finished conduit becomes virtually negligible.