

## **Maintaining Normal Force in Electrical Connections**

Written by John P. Cook, Entergy Nuclear Northeast  
Sunday, 01 June 2003 15:52

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**The most critical decision in aluminum to copper bolted joint design is the selection of the Belleville washer.**

A previous article by Norman Shackman, P.E. ("The Trouble with Torque in Electrical Connections," MT 11/02, pg. 24) correctly stated that two of the secrets to making and keeping reliable electrical connections are clean contact surfaces and high force. These are both inputs to what is defined as "normal force": the clamping pressure needed to drop resistance to a value low enough to provide a conductive, stable joint. The ability to maintain normal force over the lifetime of the joint determines its reliability.

In many cases this is the function of the Belleville washer. It becomes critical when joining dissimilar metal connections such as aluminum to copper which was used extensively during construction in the late 1970s and early 1980s.

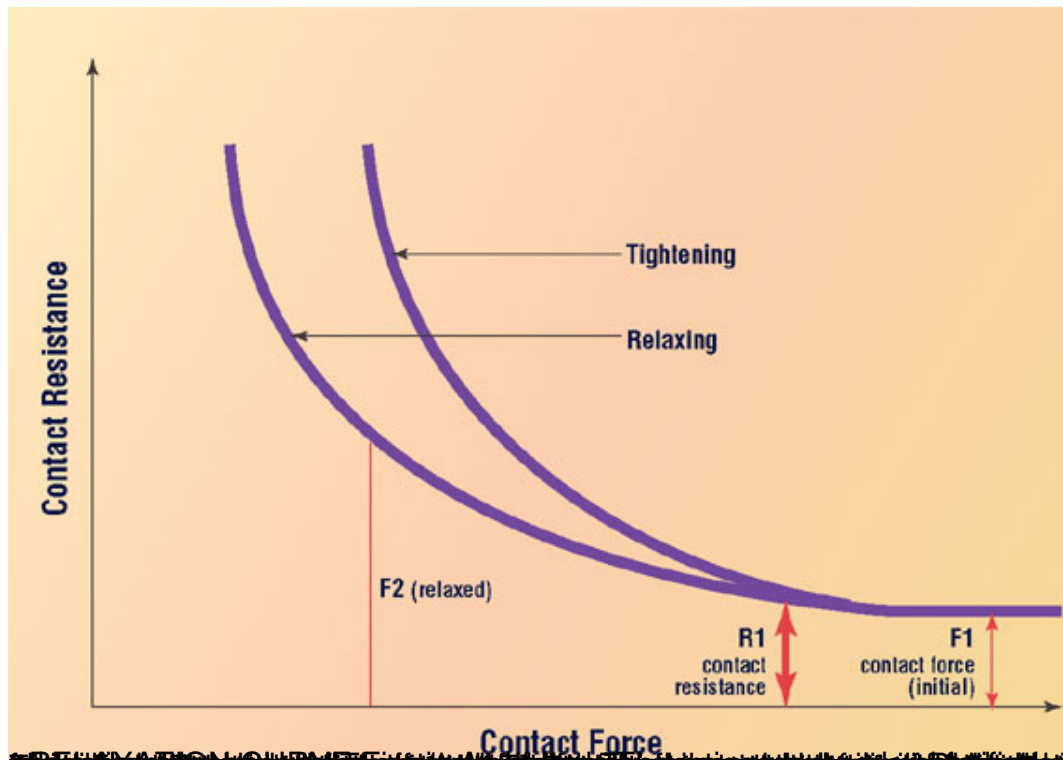
### **The cost of economics**

Use of aluminum wire was thought to be the economic savior in the construction of many large factories and electric production facilities in the late 1970s. These units required miles of cables; therefore the use of aluminum over copper created a significant cost savings. This economic decision brought with it a different failure mode than previously experienced: "creep" induced loosening of the bolted connection.

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