



**TO:** To Whom It May Concern

**FROM:** Paul W Abernathy- Manager of Codes and Standards

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**RE:** Proper Torqueing - NEC® 110.3(B) and 110.14(D)

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There have been significant changes to terminating conductors in recent years, notably the need for proper torqueing of all terminations to ensure the reliability and sustainability of one of the most critical components in the electrical system. Unfortunately, many installers who complete terminations on connectors, lugs and terminals are not aware of the importance of a properly torqued connection.

Requirements for torqueing to a manufacturers specification are not new to the *National Electrical Code*®. For example, 110.3(B) has been around for decades calling for all installations to be done in accordance with the manufacturers instructions. The specified torque values provided by the manufacture are part of those instructions and are to be utilized at all installations. However, an increased number of termination failures prompted the addition of 110.14(D) of the *NEC*® to bring clarity to the importance of proper terminations and adhering to specified torque values.

While there may not be immediate ramifications to improper terminations, the long-term effects can be dangerous and quite costly. The following are some identifiable problems that improper termination techniques can cause:

- Loose connections due to improper torqueing may come loose over time and increase impedance on the conductor at the specific termination causing an elevated rise in heat. The increase heat can serve to degrade the termination and protective insulation at the termination.
- Aluminum and Copper can develop oxidation at the termination point where exposed to air. The oxidation at the improperly torqued connection may result in increased impedance at the termination resulting in increased heat, which can degrade the reliability of the termination.
- Improper torqueing and effects of the aforementioned conditions can cause *Thermal Linear Expansion Coefficient*, resulting in a fractional change in length of a particular material, for each degree of temperature change. This can cause loose connections, which could result in heating and system breakdown.
- Connection Arcing from phase to phase, phase to neutral, or even phase to ground can occur at improperly torqued terminations where bare conductive

material is torqued improperly. The resulting arcing condition due to gaps in the conductive components of the termination may lead to increased impedance of the connection, increased heat to quickly degrade the termination and ultimately the systems reliability.

- When terminations are not properly torqued the conductor from the source to the load or load to the source doesn't make a reliable connection, the installer may experience a reduced voltage or in some cases an overvoltage. In overvoltage's the losing the neutral on the line or supply side of a main load center. In reduced voltage conditions, the electrical equipment may not operate effectively and reduce the equipment's lifecycle significantly.

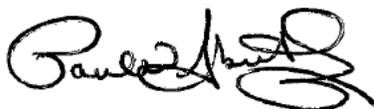
In section 110.14(D) of the 2020 *National Electrical Code*®, entitled "Terminal Connection Torque", the *NEC*® requires proper torqueing with an "approved" means for all terminations where the manufacturer has provided detailed instructions and specific torque values. The use of proper methods to meet the "torque" requirements are an important step in preventing electrical problems in the electrical distribution system, most certainly when it comes to terminations of Encore Wire products.

It should be noted that NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance." has Section 8.11 that provides some guidance in this area. Section 8.11 of this document is titled "Thread Connections and Terminations," and addresses initial installation and after initial installation.

Inspection authorities are challenged to determine overall compliance with 110.3(B) and 110.14(D) of the *NEC*®. Such as, site verification of approved methods that have supporting documentation to physical testing of random connections on the job site. In some localities the authority having jurisdiction (AHJ) have approved specific project wide affidavits from the "Master Electrician in Charge" attesting to the use of "approved" torque tools at all terminations and/or connections.

Encore Wire's Codes and Standards Team recommend that all terminations performed on our building wire products be torqued in accordance with the lug manufacturers and/or the electrical equipment manufacturer's recommendations or instructions. When those recommendations or instructions are lacking we support the use of UL 486A-B and Informative Annex I of the 2020 *National Electrical Code*®.

Best regards,



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