EWCAP ISO Wire Guidelines

Mitigating the Impact of the U.S.-Based OEM Transition from SAE to ISO-type Wire

The North American automotive wire harness industry is making the first change in the design of primary wire in many decades. The change sounds simple enough: Switch from English to Metric. OEM engineers have known for a long time that this change is inevitable as the auto industry grows more global and the benefits of a single global wire specification grew stronger. Despite the simple definition and justification, there are technical items that can challenge unprepared suppliers as both the wire-making and wire-using (harness) industries are directly impacted by this change. Awareness of the changes and possible pitfalls will help both the OEMs and the wire industry during this transition. This document summarizes the many technical issues with migration to metric wire and gives recommendations on what to look for when implementing metric wire.

Historically, North American-based automakers used thin-wall stranded insulated wire based on SAE[1] standard J1128. With everyone using a common wire, both the wire making and wire using (harness) industries knew what wire to expect and errors related to a misunderstanding on wire type were rare. The migration to “metric” wire began in 2010 and was based on the international wire specification ISO[2] 6722. Potential errors may occur during the initial transition period where there could be confusion between whether SAE or ISO wire needs to be used, and then potential confusion between all the varieties of the ISO wire could be an ongoing concern.

There are several good reasons for the switch to metric. The most significant of these reasons is that changing to ISO wire will make it possible for OEMs to use common wire and components in global vehicle wire harness applications. With SAE wire, global manufacturing was difficult as SAE wire was traditionally not readily available outside of North America, so transitioning to metric wiring harnesses in North America will ease the development of global vehicle platforms. Domestic vehicle manufacturers will make the transition with new product lines and carry-over vehicles will continue to use SAE type wire for the remaining production of those vehicles. The logistics of change will vary from one OEM to another but all will have transition plans where careful coordination is needed at many levels.

Understanding the differences between SAE and ISO wire types

The differences between SAE and ISO wire types include: Insulation thickness, finished outside diameter, stranding, wire core cross sectional area and core construction. While they are very different wire constructions, the SAE and ISO wire specifications use similar name designations, so potential confusion is built-in. The confusion arises from the wire size names. These names are just that, names, and do not indicate the actual conductor size or finished outer diameter. As an example, the stated minimum cross sectional area for a SAE “0.5mm” wire is larger than a wire produced meeting the ISO “0.5mm” requirement. In the extreme of the tolerances, the difference is 9% (0.508mm^2 versus .465mm^2). These differences result in requiring modifications to the wire harness design and manufacturing processes. They can also affect circuit function, including voltage drop and fuse protection performance. Additionally, the most affected process of the wire core size difference is the wire crimp dimension. Since crimp dimensions are sensitive to core size, crimp resistance problems will likely result if the incorrect wire is used. The countermeasure is to make sure that those involved with the processing of the crimp understand whether metric or SAE wire is being used.

Another SAE-ISO difference that influences crimping is wire symmetry. The ISO 6722 stranded primary wire specification allows both symmetric and asymmetric core bundle constructions. The SAE wire has only a symmetrical design so suppliers to North American OEMs will have to understand the new facets of core construction. These construction differences cause wire harness manufacturers to use multiple stripping and crimping process set-up variations when processing wire types with multiple construction options. It can be a lot to keep track of compared to a single process spec for the SAE wire.

After in-depth discussion and collaboration through the United States Council for Automotive Research LLC's Electrical Wiring and Component Applications Partnership (EWCAP), the U.S.-based automakers, Chrysler Group LLC, Ford Motor Company and General Motors Company, agreed to use only the symmetric version of the ISO type wire sizes smaller than 2.5mm. They will allow asymmetric construction only for sizes that are equal to or greater than 2.5mm where the process sensitivity is less due to the relatively large core area. This agreement will help greatly with complexity reduction. The differences in crimping the two wire types are described below.

Crimping is perhaps the biggest process challenge found when changing from the SAE type wire to ISO type but there are several other process changes and variations. These include:

- Wire Stripping
  The thinner insulation on ISO wire requires increased strip/cutter setup accuracy because the core strands are closer to the outer diameter surface. Insulation stripping blades set too deep can damage the conductor core strands. Blades set too shallow can fail to remove the insulation slug. When a thinner wall thickness is specified there is less material to grab to remove the cut insulation. Reduced insulation wall thickness results in a reduced dimensional process set-up window.

- Core crimping
  The difference in the core cross sectional area between SAE and ISO type wire requires requalification of the conductor core crimp. A terminal crimp validated to one crimp tool design, dimension and tolerance for SAE type wire will require requalification to be used with ISO type wire.

- Insulation crimping
  Terminal grip wings are typically designed for a specific range of insulation thickness and diameter. Insulation grip wings designed for SAE type wire insulation may not work with ISO type wire insulation due to wing length and design. Insulation grip crimp characteristics can affect strain relief, terminal fit within the terminal cavity, can damage the insulation or core, or can damage mat seals when inserting a terminal into a connector through a mat seal.

- Seal and cavity compatibility
  Connector sealing may need to be re-validated when changing from SAE to ISO wire type. Insulation thickness affects finished wire outer diameter. Seal function is dependant on seal compression and the difference between SAE and ISO cable diameters will result in different sealing characteristics. In some cases, seals will need to be retooled to accommodate the new wire dimensions.

Actions for Minimizing the Number Wires Used

A second difference between the SAE and ISO wires that needs to be highlighted is the number of wire types that are included in each. The OEMs and EWCAP are currently working with SAE to limit the varieties of wire used. The global ISO 6722 wire specification allows over 80,000 wire varieties, all officially called “ISO-6722” compliant. By agreeing to limit the wire constructions through agreements on determining which of the 80,000 wires to use (retain), we can reduce the potential complexity by over 90%. Actions are ongoing to accomplish these reductions. Specifically, SAE wire specification experts are compiling a list of the design variables that are the best candidates to be limited (such as construction and testing options found in ISO 6722), add some missing sizes and colors to the North American SAE Global wire specification and allow the North American wire suppliers to produce a single portfolio of wire sizes that will be used by Ford, General Motors, and Chrysler.

[1] Society of Automotive Engineers
[2] International Standards Organization