General Cable | ONE COMPANY
CONNECTING THE WORLD

# Transportation Committee Updates and Wire Trends

# Transportation Wire & Assemblies

*Wiring the Moving World*
















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# Industry Associations

General Cable maintains numerous leadership positions in top industry associations, which helps position the Company on the forefront of product development in the industry.

**SELECT INDUSTRY ASSOCIATION MEMBERSHIPS**

- Chairman, SAE Cable Standards Committee
- Vice Chairman, US Technical Advisory Group for ISO TC22 SC32 WG4, Automotive Electrical Cables
- Member, ISO TC22 SC32 WG4, Automotive Electrical Cables
- Member, ISO TC22 SC32, Electrical and Electronic Components
- Member, SAE Electrical Distribution Systems Steering Committee
- Liaison, SAE Electrical Systems Group
- Chairman, SAE Ignition Standards Committee
- Member, ISO TC22 SC32 WG1, Ignition Standards
- Member, SAE IC Powertrain Steering Committee
- Member, SAE Truck and Bus Council - Electrical Committee
- Associate Member, ATA Technology and Maintenance Council (TMC)
- Member, ATA TMC S1 Committee – Electrical & Instruments
- Industry advisor, USCAR
- Technical advisor, ABYC – E11 Electrical Technical Committee
- Technical advisor, ABYC - Electric Propulsion Subcommittee

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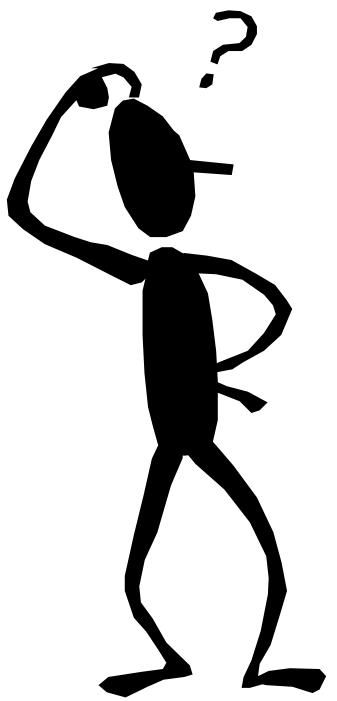
# What do I need to know to choose the proper wire?

- **Proper Wire Standard**
- **Wire Performance Requirements**
- **What does the application need ?**
  - Voltage rating
  - Temperature rating
  - Wire type – Thermoset or Thermoplastic
  - Conductor type – Copper or Aluminum
  - Wall thickness
  - Flexibility
  - Ampacity
  - Wire size
  - Wire color



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# SAE Cable Standards Committee Documents

| Document | Title | Date | Status |
|---|---|---|---|
| SAE J1127 | Low Voltage Battery Cable | Oct 18, 2012 | Revised |
| SAE J1128 | Low Voltage Primary Cable | Oct 09, 2013 | Revised |
| SAE J156 | Fusible Links | Oct 18, 2012 | Revised |
| SAE J1654 | Unshielded High Voltage Primary Cable | Oct 23, 2012 | Revised |
| SAE J1678 | Low Voltage Ultra Thin Wall Primary Cable | Oct 08, 2012 | Revised |
| SAE J2183 | 60 V and 600 V Single-Core Cables | Sep 07, 2012 | Stabilized |
| SAE J2501 | Round, Screened and Unscreened, 60 V and 600 V Multi-Core Sheathed Cables | Sep 07, 2012 | Stabilized |

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# SAE Primary Wire Selection

- **SAE J1128 Primary Wire Options:**
  - TWP - Thin Wall, Thermoplastic
  - GPT – General Purpose, Thermoplastic
  - HDT – Heavy-Duty, Thermoplastic
  - HTS – Heavy-Duty, Thermoset Elastomer
  - TXL – Thin Wall, Crosslinked Polyolefin
  - GXL – General Purpose, Crosslinked Polyolefin
  - SXL – Standard-Duty, Crosslinked Polyolefin

  - Wire Colors – 14 Available

- **SAE J1678 Primary Wire Options:**
  - U – Ultra Ultra Thin Wall
  - W – Ultra Thin Wall

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# SAE Battery Cable Selection

- **SAE J1127 Battery Cable Options:**
  - STT - Thin Wall, Thermoplastic
  - SGT – General Purpose, Thermoplastic
  - STR – Thin Wall, Thermoset Elastomer
  - SGR – General Purpose, Thermoset Elastomer
  - STX – Thin Wall, Cross-linked Polyolefin
  - SGX – General Purpose, Cross-linked Polyolefin

  - Wire Colors – 14 Available

- **SAE J1654 High Voltage Wire Options:**
  - 600V Rated
  - 1000V Rated

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# ISO TC22 SC3 WG4 Committee Documents

| Document | Title | Date | Status |
|---|---|---|---|
| ISO 6722-1 | Single Core Copper Cables<br>Core Addendum #1<br>Core Addendum #2 | October 15, 2011<br>September 15, 2012<br>Draft | Revised |
| ISO 6722-2 | Single Core Aluminum Cables | December 1, 2013 | Released |
| ISO 14572 | Multi-Core Cables | October 1, 2011 | Revised |
| ISO 17195 | Higher Voltage Cables | Draft to be cancelled | Expected to be Reassigned |
| | | | |

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# ISO Metric Wire Selection

- **ISO 6722 Scope: 60Vdc and 600V dc cable specification intended for use in road vehicle applications with limited exposure to fluids and physical abuse. Specification contains ultra-thin, thin and thick wall thicknesses and both primary and battery cable sizes.**
- **ISO 6722 Options:**
  - Insulation Thickness:
    - Ultra Thin Wall
    - Thin Wall
    - Thick Wall
  - Temperature Classes

| | |
|---|---|
| A | 85C |
| B | 100C |
| C | 125C |
| D | 150C |
| E | 175C |
| F | 200C |
| G | 225C |
| H | 250C |

Wire Size Options:
0.13mm2 - 120mm2
Primary thru Battery Cable

Wire Colors: 9 Available
- Black
- Blue
- Brown
- Green
- Orange
- Red
- Violet
- White
- Yellow

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# ISO Standard Expected Changes

- **ISO Transportation Wire standards are being rewritten and will be given a new root number broken down by parts.**

- ***Part 1: Terminology***
- ***Part 2: Test methods***
- ***Part 3: Dimensions and requirements for 30 V a.c. or 60 V d.c. single core copper conductor cables***
- ***Part 4: Dimensions and requirements for 30 V a.c. and 60 V d.c. single core aluminium conductor cables***

- **ISO 6722 and ISO 14572 will be replaced by ISO 19642 once completed.**

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# Conductor Comparison

| Specification | SAE J1128 | ISO 6722 |
|---|---|---|
| Wire Size (Name) | 20ga (0.5mm2) | 0.5mm2 |
| Min Conductor Area | 0.543mm2 | 0.465mm2 |
| | | |
| Wire Size (Name) | 18ga (0.8mm2) | 0.75mm2 |
| Min Conductor Area | 0.79mm2 | 0.698mm2 |
| | | |
| Wire Size (Name) | 16ga (1mm2) | 1mm2 |
| Min Conductor Area | 1.18mm2 | 0.932mm2 |
| | | |
| Wire Size (Name) | 14ga (2mm2) | 2mm2 |
| Min Conductor Area | 1.87mm2 | 1.83mm2 |

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# Conductor Comparison Summary

| Conductor Comparisons to SAE Standards | |
|---|---|
| | ISO Wire |
| Physical Size | < SAE |
| Resistance | > SAE |
| Voltage Drop | > SAE |
| Temp Rise | > SAE |
| Ampacity | < SAE |
| | |
| Items to consider when changing wire standards: | |
| 1. Component dimensional stack up | |
| 2. Crimp and tooling adjustment | |
| 3. Over current protection potential adjustment | |

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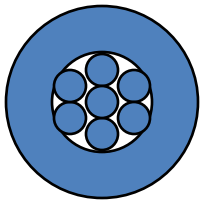
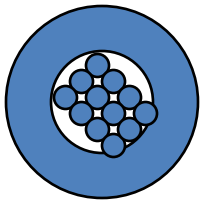
# Wire Conductor Design Options

Symmetrical



Asymmetrical



SAE conductors are symmetrical but ISO conductors offer both design options.

# SAE Cable Standards Committee Responds to help customers

- **Due to challenge reported by the wire users when selecting SAE and ISO wire:**
  - Change Wire Names back to SAE Numbers
  - (Completed - Oct 2012)

    Example: 0.5mm2 back to SAE 20ga

- **Circuit resistance and voltage drop performance**
  - Change Minimum Conductor Area back to SAE Appendix A minimum CMA values
  - (Completed - Oct 2012)

# Insulation Wall Comparison

| Specification | SAE J1128 | ISO 6722 |
|---|---|---|
| Wire Size (Name) | 20ga (0.5mm2) | 0.5mm2 |
| Nom Insulation Wall | 0.40mm | 0.28mm |
| | | |
| Wire Size (Name) | 18ga (0.8mm2) | 0.75mm2 |
| Nom Insulation Wall | 0.40mm | 0.30mm |
| | | |
| Wire Size (Name) | 16ga (1mm2) | 1mm2 |
| Nom Insulation Wall | 0.40mm | 0.30mm |
| | | |
| Wire Size (Name) | 14ga (2mm2) | 2mm2 |
| Nom Insulation Wall | 0.40mm | 0.35mm |

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# Insulated Wire Comparison

| Wire Insulation Comparison to SAE Standards | |
|---|---|
| | ISO Wire |
| Insulation Wall | < SAE |
| Wire Diameter | < SAE |
| Durabilitity | < SAE |
| Available Colors | < SAE |
| | |
| | |
| Items to consider when changing wire standards: | |
| 1. Component dimensional stack up | |
| 2. Crimp and tooling adjustment | |
| 3. Over current protection potential adjustment | |

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# New and Revised Standards

- **SAE J2840 High Voltage Shielded Cable (Revision)**
  - New standard to support HV wiring needs.
  - MVC Ballot Successful and was published February 2014.
  - Requested for revision to add increased requirements for hot water and hot insulation resistance due to parasitic load and electrical failure concerns.
  - Expect that SAE J1654 Unshielded High Voltage Primary Cable will also be revised to include new test requirements.
- **SAE J1128 Low Voltage Primary Wire (Revision)**
  - Strengthening requirements for Flame Resistance and Insulation Resistance.
- **SAE J1127 Low Voltage Battery Cable (Revision)**
  - Adding 250MCM Cable Size dimensions and requirements.
  - Strengthening requirements for Flame Resistance and Insulation Resistance.
- **SAE New Work Item: Single Balanced Twisted Pair**
  - Task Force to create the 100Mb/s and 1Gb/s automotive data wire standard.
  - In cooperation with IEEE

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# North American Automotive Wire Trends

- **OEM's moving from SAE to ISO Wire Types.**
  - Increased insulation material options.
- **Higher Performance Expectations:**
  - Increased abrasion resistance and cable flexibility.
  - Anti-Capillary conductors for in-fluid applications.
  - Higher Voltages for shielded single and multi-conductor cables.
- **Alternative Conductor Materials to Save Weight and Cost.**
  - Aluminum Alloys
  - Copper Alloys
  - Copper Clad Conductors
- **Smaller Conductor Sizes to Save Weight and Cost.**
- **Higher Speed Data Cable Applications.**

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# Heavy Duty Transportation Wire Trends

- **ATA TMC RP's continue to request SAE wire be used in OEM and Maintenance applications.**
- **Higher Goals for Maintenance Technician Training**
- **Higher Performance Expectations:**
  - Longer Life or Hours of Use
  - Corrosion Resistance Materials and Anti-Capillary Conductors
  - Increased Abrasion Resistance and Cable Flexibility
  - PVC being replaced by XL materials for use in hot environments.
  - Higher Voltages for shielded single and multi-conductor cables.
  - Higher Speed Data Cable Applications.

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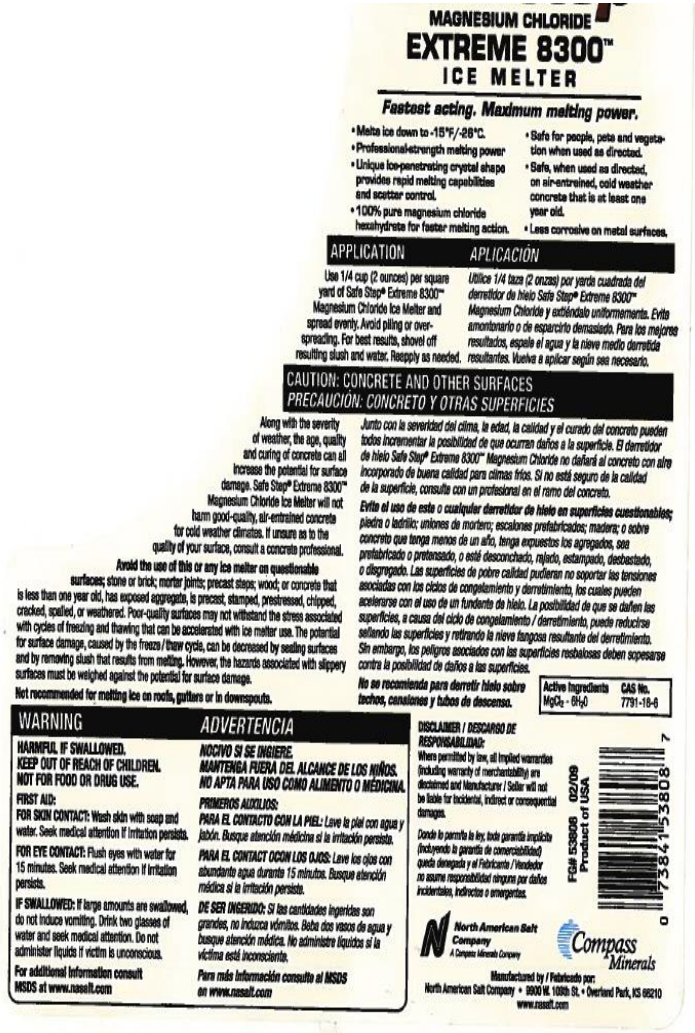
# Corrosion Challenges



MAGNESIUM CHLORIDE
EXTREME 8300™
ICE MELTER

*Fastest acting. Maximum melting power.*

- Melts ice down to -15°F/-26°C.
- Professional-strength melting power
- Unique ice-penetrating crystal shape provides rapid melting capabilities and scatter control.
- 100% pure magnesium chloride hexahydrate for faster melting action.
- Safe for people, pets and vegetation when used as directed.
- Safe, when used as directed, on air-entrained, cold weather concrete that is at least one year old.
- Less corrosive on metal surfaces.

APPLICATION

Use 1/4 cup (2 ounces) per square yard of Safe Step® Extreme 8300™ Magnesium Chloride Ice Melter and spread evenly. Avoid piling or over-spreading. For best results, shovel off resulting slush and water. Reapply as needed.

APLICACIÓN

*Utilice 1/4 taza (2 onzas) por yarda cuadrada del derretidor de hielo Safe Step® Extreme 8300™ Magnesium Chloride y extiéndalo uniformemente. Evite amontonarlo o de esparcirlo demasiado. Para los mejores resultados, espalee el agua y la nieve medio derretida resultantes. Vuelva a aplicar según sea necesario.*

CAUTION: CONCRETE AND OTHER SURFACES

*PRECAUCIÓN: CONCRETO Y OTRAS SUPERFICIES*

Along with the severity of weather, the age, quality and curing of concrete can all increase the potential for surface damage. Safe Step® Extreme 8300™ Magnesium Chloride Ice Melter will not harm good-quality, air-entrained concrete for cold weather climates. If unsure as to the quality of your surface, consult a concrete professional.

**Avoid the use of this or any ice melter on questionable surfaces;** stone or brick; mortar joints; precast steps; wood; or concrete that is less than one year old, has exposed aggregate, is precast, stamped, prestressed, chipped, cracked, spalled, or weathered. Poor-quality surfaces may not withstand the stress associated with cycles of freezing and thawing that can be accelerated with ice melter use. The potential for surface damage, caused by the freeze/thaw cycle, can be decreased by sealing surfaces and by removing slush that results from melting. However, the hazards associated with slippery surfaces must be weighed against the potential for surface damage.

**Not recommended for melting ice on roofs, gutters or in downspouts.**

*Junto con la severidad del clima, la edad, la calidad y el curado del concreto pueden todos incrementar la posibilidad de que ocurran daños a la superficie. El derretidor de hielo Safe Step® Extreme 8300™ Magnesium Chloride no dañará al concreto con aire incorporado de buena calidad para climas fríos. Si no está seguro de la calidad de la superficie, consulte con un profesional en el ramo del concreto.*

***Evite el uso de esto o cualquier derretidor de hielo en superficies cuestionables;*** *piedra o ladrillo; uniones de mortero; escalones prefabricados; madera; o sobre concreto que tenga menos de un año, tenga expuestos los agregados, sea prefabricado o pretensado, o esté desconchado, rajado, estampado, deshastado, o disgregado. Las superficies de pobre calidad pudieran no soportar las tensiones asociadas con los ciclos de congelamiento y derretimiento, los cuales pueden acelerarse con el uso de un fundente de hielo. La posibilidad de que se dañen las superficies, a causa del ciclo de congelamiento / derretimiento, puede reducirse sellando las superficies y retirando la nieve fangosa resultante del derretimiento. Sin embargo, los peligros asociados con las superficies resbalosas deben sopesarse contra la posibilidad de daños a las superficies.*

***No se recomienda para derretir hielo sobre techos, canalones y tubos de descenso.***

| Active Ingredients | CAS No. |
|---|---|
| $MgCl_2 \cdot 6H_2O$ | 7791-18-6 |

WARNING

**HARMFUL IF SWALLOWED.**
**KEEP OUT OF REACH OF CHILDREN.**
**NOT FOR FOOD OR DRUG USE.**

**FIRST AID:**

**FOR SKIN CONTACT:** Wash skin with soap and water. Seek medical attention if irritation persists.

**FOR EYE CONTACT:** Flush eyes with water for 15 minutes. Seek medical attention if irritation persists.

**IF SWALLOWED:** If large amounts are swallowed, do not induce vomiting. Drink two glasses of water and seek medical attention. Do not administer liquids if victim is unconscious.

**For additional information consult MSDS at www.nasalt.com**

ADVERTENCIA

***NOCIVO SI SE INGIERE.***
***MANTENGA FUERA DEL ALCANCE DE LOS NIÑOS.***
***NO APTA PARA USO COMO ALIMENTO O MEDICINA.***

***PRIMEROS AUXILIOS:***

***PARA EL CONTACTO CON LA PIEL:*** *Lave la piel con agua y jabón. Busque atención médicina si la irritación persiste.*

***PARA EL CONTACT OCON LOS OJOS:*** *Lave los ojos con abundante agua durante 15 minutos. Busque atención médica si la irritación persiste.*

***DE SER INGERIDO:*** *Si las cantidades ingeridas son grandes, no induzca vómitos. Beba dos vasos de agua y busque atención médica. No administre líquidos si la víctima está inconsciente.*

***Para más información consulte al MSDS en www.nasalt.com***

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Where permitted by law, all implied warranties (including warranty of merchantability) are disclaimed and Manufacturer / Seller will not be liable for incidental, indirect or consequential damages.

*Donde le permita la ley, toda garantía implícita (incluyendo la garantía de comercialidad) queda denegada y el Fabricante / Vendedor no asume responsabilidad ninguna por daños incidentales, indirectos o emergentes.*

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# SAE Primary Wire with Anti-Capillary Conductors

- **SAE J1128, J-2549 with Anti-Capillary Conductors**
- Low voltage primary cable with a conductor that will not allow moisture or other fluids to wick through into end electronics. This added layer of corrosion protection is intended for use in applications where fluids and environmental cycling presents risk to customer applications.

# Heavy Duty Truck Industry
# ATA TMC Lessons Learned

**Transportation Wire Performance must be aligned with Application Requirements**

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# Truck Fleet Survey Responses
# Components defined as to where incidents occurred.

- Wiring harnesses 48
- Battery 5
- Battery cable 35
- Circuit breaker/fuse 10
- Fusible link 6
- Directional flasher 2
- DRL module 3
- Alternator 2
- Switches 2
- Relays 6
- Radio/amp/CB 2
- Inverter 5
- Cigar lighter/power plug 6
- Heater/AC blower motors 2
- Key/ignition switch 2

Lessons Learned:

- Use of proper primary electrical cable when designing and servicing a wire harness.
- PVC Wire Types no longer used in the engine compartment (RP166 and RP167).
- Abrasion and Corrosion Resistance are key wiring performance characteristics.

# Thank You for the Opportunity

- **Please send questions and comments:**
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