Best Practice

Title: Extension Cords
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Introduction

Extension cords, also referred to as portable cords, are used for temporary power connections requiring a flexible cord. They are not intended to be used as a substitute for fixed wiring of a structure, however they may (in some circumstances) be used as a temporary wiring solution (OSHA defines as less than 90 days). The National Electric Code (NEC) Article 400 addresses flexible cords as a separate category. They do not consider it to be a wiring method. The key factor for the NEC in using a temporary flexible cord is the need to move the equipment i.e. Temporary use with portable equipment.

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1. Using Extension Cords

The extension cords must be properly sized and rated for the electrical load and must be suitable for the conditions of use and location. The United States Department of Labor, Occupational Safety & Health Administration (OSHA) defines acceptable extension cords for use in construction through OSHA 29CFR 1926 Subpart K – Electrical:

> *OSHA 29CFR 1926.405(a)(2)(ii)(J)Extension cord sets used with portable electric tools and appliances shall be of three-wire type and shall be designed for hard or extra-hard usage. Flexible cords used with temporary and portable lights shall be designed for hard or extra-hard usage.*
>
> *NOTE: The National Electrical Code, ANSI/NFPA 70, in Article 400, Table 400-4, lists various types of flexible cords, some of which are noted as being designed for hard or extra-hard usage. Examples of these types of flexible cords include hard service cord (types S, ST, SO, STO) and junior hard service cord (types SJ, SJO, SJT, SJTO).*

These extension cords are constructed of multiple strands of wire in each conductor in the cord to permit flexibility. The diameter of the strands and the number of strands that comprise each conductor will define the tightest bending radius of each cord before damage to the conductors internal to the cord outer jacket occurs.

The overall size of the conductors (American Wire Gauge, AWG), will define the electrical load rating for the cord (Ampacity) and based on the resistance voltage drop on the cord will determine the maximum acceptable length for the cord for the intended use.

The AWG (also referred to as the Brown & Sharpe wire Gauge) has been used in the United States since the mid 1800's. The dimensions of the wire are called out in ASTM B258-02. The AWG was originally based on a number of steps to draw the wire to a specific diameter so the larger the number AWG is the smaller the diameter of the conductor. Stranded cables have the equivalent current carrying capacity as a solid wire but might be physically bigger in overall diameter of the conductor due to the airspace between the individual strands of wires. The AWG is typically followed by the number of conductors in the cord, for example a 10AWG (also written #10 or No.10) extension cord for 120V having 3 conductors (Hot, Neutral and Ground) be called out as 10/3. Although not directly pertaining to this document but as a matter of interest, for larger wire sizes greater than #0000 (4 aught, or 4/0AWG) they are identified by the area in thousands of circular mils (kcmil) whereby the next size up from 4/0AWG is 250 kcmil (or 250 MCM). Extension cords in our industry are limited to 18AWG to 2AWG.

The plugs and receptacles are defined by NEMA, the US National Electrical Manufacturers Association, such that the mating parts are independent of any proprietary manufacturer and have a universal fit. There are also special connectors used on specific equipment that may have unique or proprietary pin configurations that are designed into the product for a specific reason, but most follow the NEMA standards. For extension cords in our industry we deal with two basic categories: straight blades and Locking. The mating fits on the plugs and receptacles are strategically placed to match the voltage and current ratings on the plug. Some plugs and receptacles have a waterproof cord grip or strain relief to seal the electrical connections (the ultimate seal is molded plugs and receptacles on the cords), and some do not have any waterproof or water resistant seals. Depending on the application of the cord, the sealing of the cord may be important. All the extension cords meeting the OSHA requirements for construction will have a clamping arrangement so that forces pulling on the cord will not strain the actual terminal connection with the wire.

> *OSHA 29CFR 1926.405(g)(2)(iv) Strain relief. Flexible cords shall be connected to devices and fittings so that strain relief is provided which will prevent pull from being directly transmitted to joints or terminal screws.*

One of the main defining characteristics of OSHA approved extension cords is in the outer jacket. OSHA references the NEC and calls out hard or extra-hard rated cords. The S is the extra-hard service grade and the SJ is hard service. The difference between the S and SJ can be significant. The SJ (also referred to as Junior) has a thinner outer thermoset jacket than the S, so it is limited to 300 volts Maximum but it is significantly lighter weight to carry. The S Cord has a thick outer rubber thermoset insulation jacket and conductors that is rated up to 600 volts (important for 480V equipment) and it is very heavy. The S cord also offers much more abrasion resistance and cord durability.

If the S or SJ is followed by an O then the outer jacket is oil resistant. It is it a double-O (OO) then both the outer jacket and the insulation on the individual conductors are oil resistant.

The SJT or ST is basically the same ratings as the SJ and S respectively. The T denotes a thermoplastic insulated conductors and outer jacket.

The W (like SOOW) at the end would signify that the cord is rated for outdoor use with W for wet or water but it also includes sunlight UV protection.

Remember per OSHA, the extension cords are not a substitute for fixed wiring of a structure. They are not to be run through holes in walls, ceilings or floors, doors, windows, or similar openings. They are not to be concealed behind building walls, ceilings or floors.

OSHA 29CFR 1926.405(g)(1)(iii) Prohibited uses. Unless necessary for a use permitted in paragraph (g)(1)(i) of this section, flexible cords and cables shall not be used:

OSHA 29CFR 1926.405(g)(1)(iii)(A) As a substitute for the fixed wiring of a structure;

OSHA 29CFR 1926.405(g)(1)(iii)(B) Where run through holes in walls, ceilings, or floors;

OSHA 29CFR 1926.405(g)(1)(iii)(C) Where run through doorways, windows, or similar openings, except as permitted in paragraph (a)(2)(ii)(1) of this section;

OSHA 29CFR 1926.405(g)(1)(iii)(D) Where attached to building surfaces; or

OSHA 29CFR 1926.405(g)(1)(iii)(E) Where concealed behind building walls, ceilings, or floors.

Extension cords are not under rugs or carpet because (among other things) it can lead to overheating or can conceal damage.

Extension cords are not attached to building surfaces. Do not staple, or hang from nails or suspend by wire. Attaching them to the building can cause damage to both the inside cords and the outer jacket.

OSHA 29CFR 1926.416(e)(2) Extension cords shall not be fastened with staples, hung from nails, or suspended by wire.

In addition to the OSHA 29CFR 1929 Subpart K standards, OSHA publishes clarifications in the form of letters from time to time and posts them at www.osha.gov

OSHA requirements are set by statute, standards and regulations. Our interpretation letters explain these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA's interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. Also, from time to time we update our guidance in response to new information. To keep apprised of such developments, you can consult OSHA's website at http://www.osha.gov.

May 20, 2010

Letter # 20090115-8796

Re: Multi-Employer obligations with respect to electrical cords.

Question #1: On a construction worksite where there are subcontractors and a general contractor, which employers are subject to an OSHA citation for electrical cords that violate subpart K standards?

Answer #1: Pursuant to the OSH Act and the Multi-Employer Citation Policy,[1] any employer that exposes one of its employees to the hazards created by an unsafe electrical cord on a construction site may be subject to an OSHA citation. In situations where an employer's own employees are not exposed to a hazard, that employer may still be subject to OSHA coverage if the employer qualifies as a "creating," "correcting," or "controlling" employer. Please refer to the attached Multi-Employer Citation Policy for further guidance.

Question #2: On a construction worksite where there are subcontractors and a general contractor, which employer has the right to take a hazardous electrical cord out of service?

Answer #2: This is a contractual matter that is not governed by OSHA; however, more than one employer may be subject to an OSHA citation here, as discussed above.

Sincerely,

Bill Parsons, Acting Director
Directorate of Construction

Electrical cord shall only be used for the purpose they were intended. Never use them as a hoisting cable or to hang things from.

OSHA 29CFR 1926.302(a)(2) The use of electric cords for hoisting or lowering tools shall not be permitted.

2. Double Insulated Handtools (Using two-prong tools with a three-prong extension cord)

A wrong assumption is sometimes made that if the tool does not have a 3-conductor plug then it will not be approved for use on a Construction Site per OSHA. If the tool is Double Insulated and properly rated and marked as such, the double insulated tool does not require a grounding wire.

OSHA 29CFR 1926.302(a)(1) Electric power operated tools shall either be of the approved double-insulated type or grounded in accordance with Subpart K of this part.

If a Tool has a Ground Wire, the Ground must remain intact i.e. one must not remove the ground prong on a 3-prong plug so it can plug into a 2-prong outlet. It can cause a safety issue because if the tool is not properly insulated or grounded the operator may be at risk for electric shock or electrocution.

Double Insulated type tools are designed with a second level of insulation inside the tool to reduce the risk of contact on an energized outer case of the tool if an electric short circuit or wire defect/damage happens inside the inner workings of the tool. The Double Insulated tools will be marked on the handle or data label with the words ‘Double Insulated’ or marked with a graphic symbol of a square box inside another square box.

The double insulated tools are limited to less than 150V to ground as clarified in this OSHA letter:

June 12, 2000

Hilti Entwicklung Elektrowerkzeuge GmbH
SEC-Zulassung
z. Hd. Axel Fischer
Hiltistrasse 6
D-86916 Kaufering

Dear Mr. Fischer:

This responds to your January 31, 2000, e-mail to the Occupational Safety and Health Administration (OSHA), in which you ask the following questions related to electrical power tools for construction. Please accept our apology for the delay in responding to this inquiry.

Question 1: Must electric power tools be either "double insulated" (class II, plug without grounding prong) or grounded?

Answer: Yes, but there are some limitations to choosing the double insulation option. 29 CFR 1926.404(f)(7)(iv) states that electric power tools must be grounded except when they are double insulated. The standard allows double insulation instead of grounding within certain limitations — double insulated tools are not to be used in a hazardous location and must not to be operated at over 150 volts to ground. Also, double insulated tools must be distinctively marked.

Note: Class designations in the standard for electric equipment refer to suitability for use in a hazardous location. Your e-mail indicates that your equipment is not intended to be used in a hazardous location.

Question 2: Must electrical power tools be approved by an Nationally Recognized Testing Laboratory?

Answer: Yes. Under §1926.403(a), all electrical conductors and equipment must be "approved." The standard defines approved as "acceptable." With regard to your equipment, acceptable means "accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a qualified testing laboratory capable of determining the suitability of materials and equipment for installation and use in accordance with this standard." See §1926.449.

Question 3: Must receptacles used for the connection of electric motors be limited to a maximum rating of 15-ampere per branch circuit?

Answer: Under §1926.404(b)(2)(iii), the rating of the receptacle that you would have to use is governed by two requirements: (1) the rating of a receptacle used for cord-and-plug connection of a motor to a branch circuit must not exceed 15-ampere at 125 volts or 10-ampere at 250 volts if individual overload protection is omitted; (2) even if individual motor overload protection is provided, the maximum rated receptacle that is permitted to be used on the circuit must conform to Table K-4 in §1926.404(b)(2)(iii) [see below]. Therefore, the answer depends first on whether individual motor overload protection is provided. If it is provided, then whether you can use a receptacle rated at more than 15-ampere will depend on the rating of the circuit (see Table K-4).

Where there is no individual motor overload protection, you are prohibited from using a receptacle with a rating over 15-ampere. However, where individual motor overload protection is provided, there are circumstances where a receptacle rated more than 15-ampere could be used. For example, (where individual motor overload protection is provided), a receptacle rated at 20 ampere could be used on a circuit rated at 20 ampere.

TABLE K-4 RECEPTACLE RATINGS FOR VARIOUS SIZE CIRCUITS	
Circuit rating ampere	*Receptacle rating ampere*
15.....	*Not over 15.*
20.....	*15 or 20.*
30.....	*30.*
40.....	*40 or 50.*
50.....	*50.*

Question 4: Can electric power tools with a 20 ampere "Twist Lock" Plug be used on a 15 ampere standard receptacle by the means of an adapter if the rated power of the electric power tool (when energized) does not exceed 15-ampere?

Answer: There would be several problems with using an adapter on a tool that draws 15-ampere. First, under §1926.403(a), all adapters/plugs must be approved by a Nationally Recognized Testing Laboratory (NRTL). We are not aware of any 20 ampere to 15 ampere adapters approved by a NRTL.

Second, your question raises a problem that goes beyond whether you could obtain an approved adapter. The more fundamental problem is that, in the United States, a tool rated at 15-ampere would overload most circuits equipped with 15-ampere receptacles — so use of such a tool on those circuits would violate §1926.404(b)(2). The only time a 15-ampere tool could be used on a 15-ampere receptacle would be if there was only one receptacle on the circuit, and if 15-ampere was the maximum load that could be imposed by the tool. Since most tools draw above their rated load at start-up, a tool rated at 15-ampere could even overload a circuit with only one 15 ampere receptacle.

If more than one 15 ampere receptacle is on the circuit, the maximum allowable load on the receptacle would be 12 ampere. Branch circuits used on construction sites supplying a single receptacle are rarely used. Since other receptacles on the circuit would be available for use by employees using other tools, the use of a 15-ampere tool would likely overload the circuit. Even a circuit with only two receptacles might be overloaded at some point if a tool of more than 12 ampere were permitted to be used because of the power required to start the tool.

In short, since your drill draws 15-ampere, the OSHA standard would require that it be used on a circuit with a capacity over 15-ampere. In the United States, this would mean using a circuit with a minimum capacity of 20 ampere.

Question 5: Can we use electric power tools rated 15 to 20 ampere on construction sites?

Answer: As explained above, 15 ampere power tools can only be used on circuits rated 20 ampere. As a practical matter, many construction sites will only have 110 volt/15 ampere circuits. As discussed above, because of the power required to start a tool, you usually cannot use a 15 ampere tool on a 15 ampere circuit. Most circuits on construction sites have more than one receptacle, so in

that case you would be prohibited from using a 15 ampere tool because there would be an overload when other equipment was used in the other receptacles.

Question 6: Are there over-current tolerances?

Answer: No, the standard does not provide over-current tolerances.

Question 7: Are there States in which the branch circuits on construction sites must be rated 20 ampere (20 Ampere fuse) in order to be able to connect the 20 ampere "Twist-Lock" system?

Answer: We do not know whether there are any such State requirements.

If you need additional information, please contact us by fax at: U.S. Department of Labor, OSHA, Directorate of Construction, Office of Construction Standards and Guidance, fax # 202-693-1689. You can also contact us by mail at the above office, Room N3468, 200 Constitution Avenue, N.W., Washington, D.C. 20210, although there will be a delay in our receiving correspondence by mail.

Sincerely,

Russell B. Swanson, Director
Directorate of Construction

[Corrected 6/2/2005]

It is important to maintain the tools to be certain the insulation of the outer case of double insulated type tools is not compromised.

3. Regulatory and Controlling Authorities

NEMA, the US National Electrical Manufacturers Association, defines the plugs and receptacles to maintain consistency regardless of the manufacturer. For extension cords in our industry we deal with two basic categories: straight blades and Locking. The mating fits on the plugs and receptacles are strategically placed to match the voltage and current ratings on the plug. For example a typical household 120V U-Ground plug rated at 15 Amps can plug into a 20A receptacle but a 20A plug cannot plug into a 15A receptacle.

NRTL – National Recognized Testing Laboratory such as Underwriters Laboratories (UL), MET Laboratories, Inc. (MET), Intertek Group (Formerly ETL), Canadian Standards Association (CSA), or FM Approvals (FM). Over 50V must be approved by one of these Laboratories. All extension cords used in construction should bear the identifying mark from one of these Laboratories. Beware of counterfeit marked cords.

NFPA 70 NEC, National Electric Code (formally identified as ANSI/NFPA 70). It was first published in 1897 and is revised on a 3 year cycle. The National Fire Protection Association (NFPA) NEC is not a regulating code by itself, but is written such that it is frequently adopted by regulating bodies, be certain to note the revision that is formally adopted. The NEC makes a distinction between low voltage and high voltage (over or under 100 Volts) with different safety criteria. Presumably your skin will protect you to 100 volts but that might not be an entirely accurate assumption.

OSHA 29CFR frequently references the NEC. At OSHA's request, the NFPA created NFPA 70E which addresses safe electrical work practices to comply with OSHA 29CFR 1910 Subpart S and 1926 Subpart K.

OSHA 29CFR 1926 (mostly Subpart K – Electrical), is a key tool to OSHA's enforcement on construction jobsites for use of Extension cords.

IEC, The International Electrotechnical Commission publishes numerous international standards, including standards for plug and sockets, electrical power cords, weather protection on connections and electrical enclosures.

IEEE, (chartered as the Institute of Electrical and Electronics Engineers, but goes by IEEE), has many standards for electric insulation and testing.

NETA, InterNational Electrical Testing Association, has many published standards for testing.

International Codes, State Codes and Local Ordinances and Permit Requirements, governing the use of extension cords. Frequently they reference the NEC.

Manufacturer Requirements or Recommendations for proper use are also important to recognize. The instructions of acceptable use on the label of the cord must be followed.

4. Labels and Identifying Marks

OSHA 29CFR 1926.449 {Definitions}…..

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of a qualified testing laboratory which indicates compliance with appropriate standards or performance in a specified manner.

Listed. Equipment or materials included in a list published by a qualified testing laboratory whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

Listed and/or certified items (cords, adapters, boxes, plug ends, etc…) must be installed and used in accordance to the Labeling, listing or certification.

1926.403(b)(2)
Installation and use. Listed, labeled, or certified equipment shall be installed and used in accordance with instructions included in the listing, labeling, or certification.

1926.403(g)
Marking. Electrical equipment shall not be used unless the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified is placed on the equipment and unless other markings are provided giving voltage, current, wattage, or other ratings as necessary. The marking shall be of sufficient durability to withstand the environment involved.

Never use an ‘indoor only’ cord in an outside environment. The extension cord should be labelled such that you can identify it as a cord suitable for outside use.

Be aware of counterfeit cords that bear official markings as if they are properly listed, labeled or certified. The CPSC (Consumer Product Safety Commission), CSA and UL post recalls on their respective website including info on counterfeit marked cords. Use established vendors and legitimate distributors. Read labels carefully, the text should be grammatically correct and free of conflicting information.

> *OSHA 29CFR 1926.405(g)(2)(ii) Marking. Type SJ, SJO, SJT, SJTO, S, SO, ST, and STO cords shall not be used unless durably marked on the surface with the type designation, size, and number of conductors.*

It is important to note that individual components that make up an assembly can be marked by a NRTL, but that does not make the entire assembly approved by the NRTL. Here is a letter that is in the OSHA archives and is no longer an active policy:

> *NOTICE: This is an OSHA Archive Document, and may no longer represent OSHA Policy. It is presented here as historical content, for research and review purposes only.*
> *DATE: June 12, 1991*
>
> *MEMORANDUM FOR: AREA DIRECTORS*
> *DISTRICT SUPERVISORS*
>
> *FROM: LINDA R. ANKU*
> *REGIONAL ADMINISTRATOR*
>
> *SUBJECT: Extension Cords Acceptable for Use*
>
> *Only extension cords (cord sets) that are approved, as an assembly, by a Nationally Recognized Testing Laboratory (NRTL) such as UL are permitted to be used at places of employment. This limitation is based on the requirement that all equipment be approved as set forth in 29 CFR 1910.303(a) and 29 CFR 1926.403(a).*
>
> *There are a large number or extension cords purchased and used by employers that are not approved for use by a NRTL. This is particularly a problem on construction sites. There are extension cords used on these sites that are referred to by the manufacturer as contractor or handyman cords but they are not approved.*
>
> *Currently UL approves most extension cords. When UL approves equipment it is marked with the UL label and on that label will be the name of the equipment or the assembly that is approved. This is an important point because the presence of a UL label on a piece of equipment does not necessarily mean that the entire assembly the equipment is part of is approved. In many cases the UL label only means that one component of the assembly is approved; not that the entire assembly is approved. The cord, attachment cap (plug), or receptacle portion of the extension cord could be approved but the entire assembly that is the extension cord would not have a UL approval unless it was so marked. Therefore, such a cord would not be acceptable.*
>
> *The danger associated with the use of extension cords that are not approved is that such cords may not be constructed properly or they may not be appropriate for the environment in which they are being used.*

A listing or approval of equipment by a NRTL substantially reduces the possibility of such problems. Employers supplying unapproved cords for their employees use should be cited. A reasonably predictable injury for this type of a violation would be electrical shock.

If you have any questions regarding this matter, please contact John McFee at FTS 596-1201.

Extension cords should be marked about every foot on the cord with the service type, appropriate NRTL, the size and the number of conductors.

Inside the extension cord, each of the individual conductors are insulated and marked using a color code. The green conductor (sometimes bare wire but not in these type extension cords) is the Ground (earth Ground or grounding conductor), the white or grey conductor is the neutral (near ground potential, also referred to as the grounded conductor), and the Colored wires are the Hot conductors (also referred to as the ungrounded current carrying conductors), on single phase it is typically black but it can be red, orange or blue. On three phase systems, per *NEC Section 110.15 High-Leg Marking*, the High leg delta (aka Red Leg or Wild Leg) systems that have the midpoint of one phase grounded are required to have that phase conductor marked with orange.

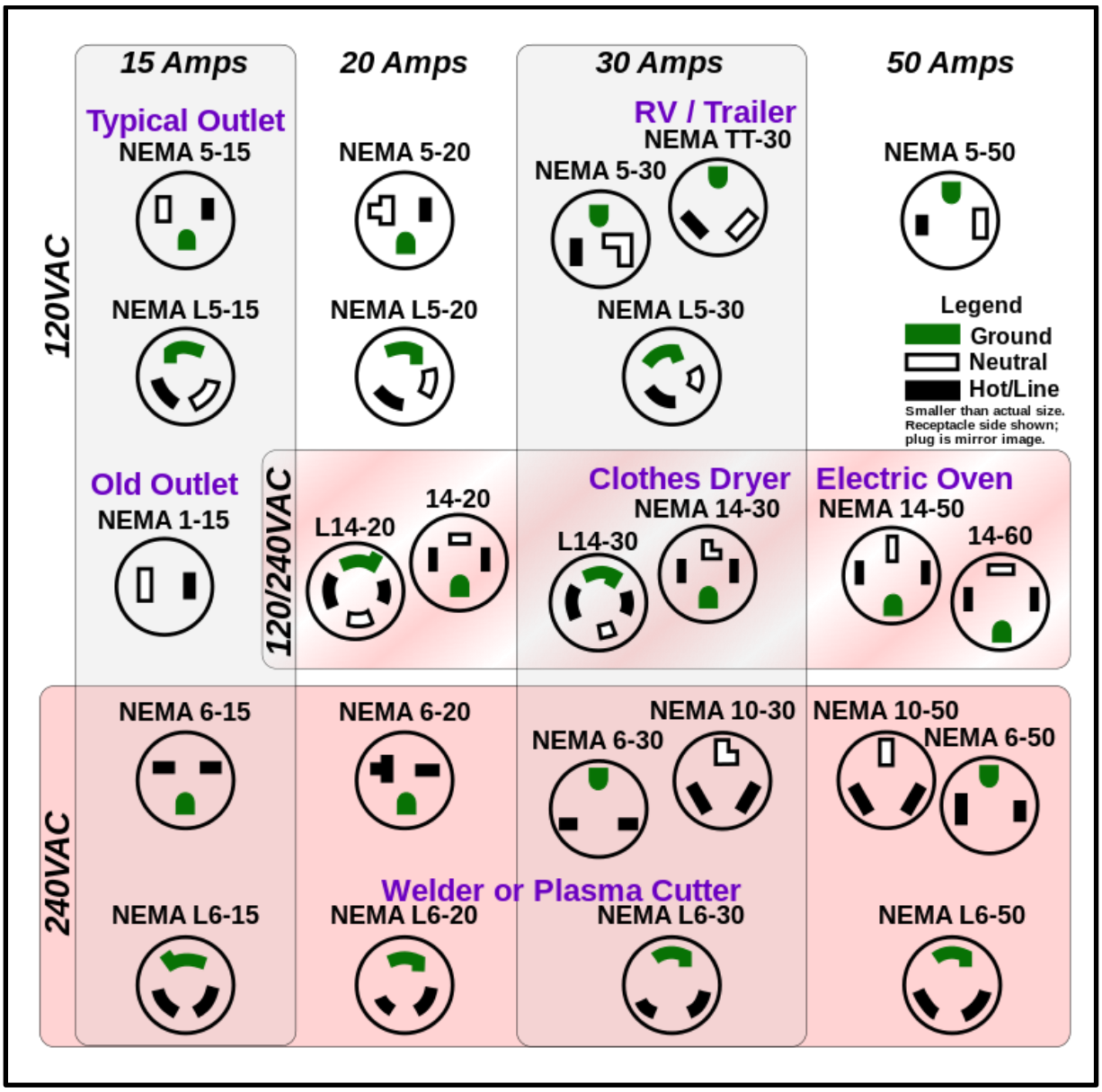
5. Connectors, Cord Ends and Strain Reliefs

Using the correct pin out for the voltage and current as defined by NEMA standards or a custom configuration specific to a unique piece of equipment provides a good means to be certain the correct connection is made to the appropriate voltage and current source.

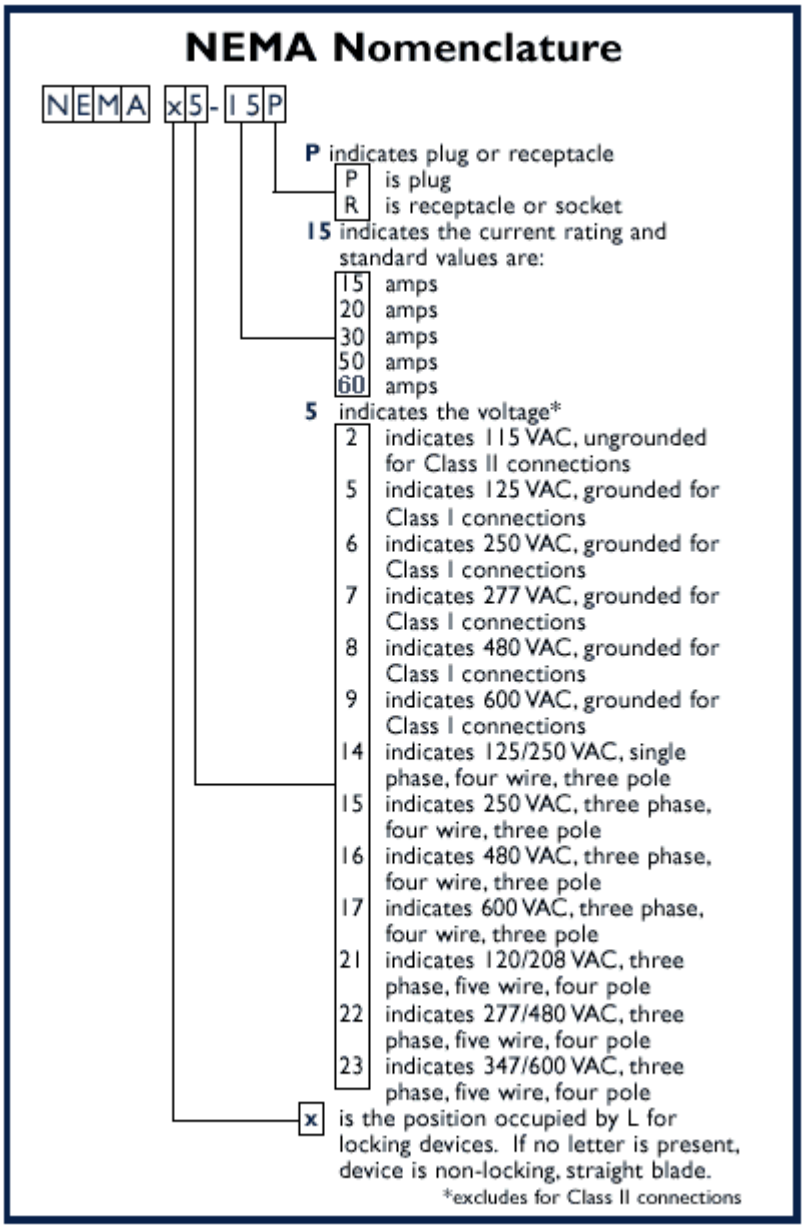
Cable protection from physical damage like a wrap or sleeve is available but putting additional thermal barriers on a cable may cause it to get hot and may exceed the ratings of the cord during normal use. It is better to protect the surfaces the cord where it will be dragged across to minimize any damage to the cord and to extend the useful service life of the extension cord.

It is important to use strain reliefs or molded connectors to prevent pull being transmitted directly to the terminal screws.

OSHA 29CFR 1926.405(g)(2)(iv) Strain relief. Flexible cords shall be connected to devices and fittings so that strain relief is provided which will prevent pull from being directly transmitted to joints or terminal screws.



https://commons.wikimedia.org/wiki/File:NEMA_simplified_pins.svg#filelinks



6. Proper Sizing of Extension Cords

At a very basic level, extension cords need to be sized appropriately for the wire size (Ampacity). The essential function of the extension cord is to carry electrical current to the equipment being operated. The longer the length of the cord equates to higher resistance which creates a larger voltage drop. Per ANSI/NEMA MG 1-2011, electrical motors are allowed +/-10% of nameplate voltage, so the practical limitation of the length and AWG wire size is dependent on the allowable voltage drop.

Estimate AWG Cord Size			
Amps	0 - 50 FT	51 - 100 FT	101 - 150 FT
1-11	18	16	14
12-18	16	12	10
19-25	12	10	8
26-35	10	8	6
36-40	8	6	4
41-50	6	4	2
51-60	4	2	2

It is important to identify the influences of real world de-rate factors such as heavy inductive loads, (induction – power factor), increased resistance with elevated temperatures in the heated copper conductors, heat generated by a high number of motor starts, local Resistance Points (loose lugs, connections, arc burned contact points), variable speed motors running with reduced cooling fan speeds, lower supply voltage (208 vs 230), unbalanced legs on a 3phase circuit, etc…

Voltage is an across variable meaning it is measured as a different potential between two points (usually from hot to earth ground). For example on a 240V single phase cord there will be two hots (NEC refers to as the Ungrounded current carrying conductors) and one Ground and sometimes the cord might carry a forth conductor (4-pole) which would be a Neutral (the NEC refers to the Neutral as a grounded conductor) in addition to the earth ground (the NEC refers to as a grounding conductor). The voltage between the two hots is supposed to be 240V and the voltage between one of the hot conductors and the Ground should be 120V.

It is important to note that the correct way to measure voltage drop is when tool is loaded. The voltage at the end of the cord may appear to be within the +/-10% NEMA nameplate voltage band but once the tool is running, the voltage drop might be significant.

Current is a thru variable so it is measured under full load. Typically, one conductor is isolated and a clamp-on ammeter is used to measure the current flow but a better explanation is with a mounted ammeter that is placed in the path of the conductor.

As a rule of thumb, Amps is watts divided by Volts (or Watts = volts times amps). So for example, if a tool draws 20A at 120V, the equivalent tool at 240V would only draw 10A. This is a useful rule of thumb for determining the amp draw on a cord if the tool is rated on the nameplate in watts. It is only a rule of thumb because it doesn't take into effect power factors on inductive loads and motor startup current draw that is not identified on the motor nameplate like the running FLA (full load amps).

Cords that are hot to touch might be an overloaded situation and may require further investigation. Look for other important ratings on the extension cords like outdoor rated cords suitable for wet areas and sustained sunlight. The O or OO for use around petroleum products like oils. The heavy Jacket can make the cord more crush Resistance and abrasion resistant. The voltage rating is important also for 300V SJ or 600V S cords if the equipment is running on 480V. Also, the electrical insulation usually means more thermal insulation so sometimes heavy jacket cords don't dissipate heat as effectively. Finally the overall weight of the extension cord can be a factor on some jobs that require manually hauling the cords and equipment to remote locations or elevations.

7. Proper Care for Extension Cords

Cover and protect cords so they are not walked on or driven over. Hand trucks and push carts can also damage the inner insulation of the extension cords because the high concentration of forces on a smaller tire.

Flexible cords and cables shall be protected from damage. Sharp corners and projections shall be avoided. Flexible cords and cables may pass through doorways or other pinch points, if protection is provided to avoid damage.

> *OSHA 29CFR 1926.405(a)(2)(ii)(I) Flexible cords and cables shall be protected from damage. Sharp corners and projections shall be avoided. Flexible cords and cables may pass through doorways or other pinch points, if protection is provided to avoid damage.*

When not in use, unplug the cord, coil it up with a generous loop larger than the practical bend radius of the flexible cord, and store in a cool place not in direct sunlight (UV may damage the outer jacket).

Inspect the extension cords before use and take out of service if it is damaged. Be certain all the contact pins are intact and that the electrical insulation is not compromised. Check for visual signs that the cord was crushed and might need additional analysis to determine if any internal damage to the cord inside the outer jacket.

> *OSHA 29CFR 1926.21(b)(2) The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury.*

8. Polarity and Electrical Flow

On single phase 120V circuits there is a polarity established between hot and the Neutral that must be preserved to keep the hot as the hot and the neutral at near ground potential. If the polarity is reversed it can have deadly consequences. Many switches are SPST (Single-pole Single-Throw) and effectively only break the hot side of the circuit leaving the neutral intact. With reversed polarity the switch will break the neutral (and without a continuous circuit, it will shut off the equipment) but it will leave the hot energized and the potential on the equipment to earth ground can be the full 120V.

Some switches are DPST and effectively break both the hot and the neutral leaving the Ground intact (as required by OSHA).

It is important that cords are wired to the correct polarity and tested before putting them into service.

To reduce the incidences of having a reversed polarity situation, many plugs and receptacles have larger blades and receivers for the neutral side so they can't get inserted incorrectly. Never modify the size of the blade to fit into an outlet to defeat this important safety design feature. They also color code the terminals such that the hot terminals are bright shiny brass colored and the neutral terminals are silver (the ground is green).

On 240V circuits, the potential is split between two 120V hot conductors with a 240V potential difference between them. If equipment uses both 120V and 220V circuits, the extension cord needs to be 4 conductors to carry a neutral for the 120V circuit side.

On 3 phase circuits the rotations of the motor can be established by switching any two of the three hot conductors.

9. GFCI, Circuit Breakers and Fuses

Surge arrestors (also known as lightening arrestors) are designed to protect the equipment from sudden excessive electrical surges in the power line. Fuses and circuit breakers are designed to protect the circuit from excessive current (unlike a fuse, the Circuit Breakers can be reset). Thermal overloads are designed to protect the motor from overheating (may have manual or automatic reset), AFCI (Arc Fault Circuit Interrupter) is a circuit breaker designed to detect a non-working electrical arc to prevent fires, and GFCI are designed to protect the operator from electrocution by detecting current balance from hot to ground.

Some equipment or power tools are designed with built in GFCI protection and some extension cords also have built in GFCI protection.

Some nuisance tripping of the circuit breakers or fuses can be caused by excessive motor starts in a short duration of time.

GFCI protection can have nuisance tripping in damp conditions where electricity can leak across moist surfaces.

For safety reasons, it is important that the path to ground must permanent and continuous.

OSHA 29CFR 1926.404(b)(1) Ground-fault protection –

OSHA 29CFR 1926.404(b)(1)(i) General. The employer shall use either ground fault circuit interrupters as specified in paragraph (b)(1)(ii) of this section or an assured equipment grounding conductor program as specified in paragraph (b)(1)(iii) of this section to protect employees on construction sites. These requirements are in addition to any other requirements for equipment grounding conductors.

OSHA 29CFR 1926.404(b)(1)(ii) Ground-fault circuit interrupters. All 120-volt, single-phase 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground-fault circuit interrupters for personnel protection. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with ground-fault circuit interrupters.

OSHA 29CFR 1926.404(b)(1)(iii) Assured equipment grounding conductor program. The employer shall establish and implement an assured equipment grounding conductor program on construction sites covering all cord sets, receptacles which are not a part of the building or structure, and equipment connected by cord and plug which are available for use or used by employees. This program shall comply with the following minimum requirements:

OSHA 29CFR 1926.404(b)(1)(iii)(A) A written description of the program, including the specific procedures adopted by the employer, shall be available at the jobsite for inspection and copying by the Assistant Secretary and any affected employee.

OSHA 29CFR 1926.404(b)(1)(iii)(B) The employer shall designate one or more competent persons (as defined in 1926.32(f)) to implement the program.

10. Repairing Damaged Extension Cords

Tag damaged equipment and remove from service.
Flexible cords have many strands to pulling and bending can loosen the terminal connection.

OSHA requirements are set by statute, standards and regulations. Our interpretation letters explain these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA's interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. Also, from time to time we update our guidance in response to new information. To keep apprised of such developments, you can consult OSHA's website at http://www.osha.gov.

DATE: March 3, 1992	*CHARLES CULVER, Director*
MEMORANDUM FOR:	*Directorate of Compliance Programs*
THROUGH:	*LEO CAREY, Director*
	Directorate of Compliance Programs
FROM:	*PATRICIA K. CLARK, Director*
	Directorate of Compliance Programs
SUBJECT:	*Contractor shop-made extension cords.*

This is in response to your November 13 memorandum requesting an interpretation of OSHA requirements pertaining to shop-made extension cords. I apologize for the delay in responding to you.

Normally, equipment must be approved as an assembly by a nationally recognized testing laboratory before it would be acceptable under the General Industry or Construction Electrical Standards (Part 1910, Subpart S and Part 1926, Subpart K, respectively). In the case of cord sets used in construction, it is common for them to be assembled in the field by electrical contractors. It should be noted that OSHA interprets cord sets as being temporary wiring extensions of the branch circuit. As such, temporary electrical power and lighting wiring methods, as specifically modified in 1926.405(a)(2) and 1910.305(a)(2), may be of a class less than that required for a permanent installation. Thus, temporary electrical power and lighting installations are permitted during the period of construction, remodeling, maintenance, repair or demolition of buildings, structures, equipment, or similar activities. In addition, temporary wiring must be removed immediately upon completion of construction or purpose for which the wiring was installed.

When the temporary wiring consists of shop-made cord sets, self-fabricated lighting installations, emergency or experimental wiring etc., as permitted by 1926.405(a)(2) and 1910.305(a)(2) to be assembled and installed at the work site using approved parts, the requirement for listing by a nationally recognized test laboratory does not apply. If a factory-manufactured temporary wiring assembly, such as ready-made extension cords, temporary lighting strings (UL-1088), "on-the-spot" emergency lighting, etc., is desired, then the prefabricated temporary wiring assembly to be installed must be of a type that a nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe.

In regard to electrical contractors assembling cord sets at construction sites, the practice is acceptable, provided the assembled cord sets are constructed in a manner equivalent to those that are factory-assembled and approved. (The same approach applies to the General Industry Electrical Standards. However, your question pertained to construction, so the remaining references are to Subpart K of Part 1926.) Criteria for determining whether shop-made cord sets meet existing electrical standards include:

1. All components must be approved for the purpose by a nationally recognized testing laboratory (1926.403(a)). Individual components must be compatible for use with the other components of the completed assembly.
2. The cord set must meet all applicable requirements of Subpart K. For example, the assembly must be marked appropriately (1926.403(g)); boxes intended for use in a permanent installation may not be used (1926.403(b)(1)(i)); cords must be connected to devices and fittings so as to provide strain relief (1926.405(g)(2)(iv)); cords passing through holes in enclosures must be protected by bushings or fittings designed for the purpose (1926.405(g)(2)(v) – fittings designed to fasten cables to metal boxes are not acceptable); and no grounded conductor shall be attached to any terminal or lead so as to reverse designated polarity (1926.404(a)(2)).
3. The cord set must be assembled by a qualified person.
4. The wiring of the completed assembly must be checked before the cord set is first used. For example, the following, or equivalent, tests should be performed:
(a) All equipment grounding conductors shall be tested for continuity and shall be electrically continuous.
(b) Each receptacle and attachment plug shall be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor shall be connected to its proper terminal.

[Corrected January 22, 2008]

Be certain to repair the cord with the correct connector, if the cord is rated for outdoor use than a water resistant plug and receptacle equivalent to the manufacturers originally listed cord.

The out jacket can get scuffed from dragging on abrasive surfaces of pulling around sharp corners/edges, so carefully inspect the entire length of the cord and replace if the electrical insulation is compromised.

Worn, frayed or damaged cords must not be used.

OSHA 29CFR 1926.416(e)(1) Worn or frayed electric cords or cables shall not be used.

OSHA Letter#20070926-7973 (04-April2010) Splice Repair of cords:

OSHA requirements are set by statute, standards and regulations. Our interpretation letters explain these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA's interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. Also, from time to time we update our guidance in response to new information. To keep apprised of such developments, you can consult OSHA's website at http://www.osha.gov.

June 17, 1992

MEMORANDUM FOR: LINDA R. ANKU
Regional Administrator
FROM: PATRICIA K. CLARK, Director
Directorate of Compliance Programs
SUBJECT: Acceptable Job-Made Extension Cords.

This is in reference to your memorandum of June 12, 1991 to your area directors and district supervisors on the subject of extension cords acceptable for use (copy attached). We believe your interpretation is unduly restrictive and that it does not accurately reflect the requirements of the applicable standards. We have prepared the following analysis, which indicates that shop-made extension cords and other temporary wiring is acceptable in certain circumstances. It is not required in all circumstances that an extension cord be approved as an assembly.

Analysis

Normally, electrical equipment must be approved as an assembly by a nationally-recognized testing laboratory to be acceptable under the General Industry or Construction Electrical Standards (Part 1910, Subpart S and Part 1926, Subpart K, respectively).

However, it is also true that cord sets, assembled in the field by qualified persons, are appropriately used in both general industry and in the construction industry, under limited circumstances. Such cord sets are considered to be temporary wiring extensions of the branch circuit.

Temporary electrical power and lighting wiring methods, as specified in 1910.305(a)(2) and 1926.405(a)(2), may be of a class less than that required for a permanent installation. Thus, temporary electrical power and lighting installations are permitted during the period of construction; remodeling; maintenance; repair or demolition of buildings, structures and equipment; or similar activities. Such temporary wiring must be removed immediately upon completion of the work for which the wiring was installed.

When the temporary wiring consists of shop-made cord sets, etc., using approved parts, as permitted by 1910.305(a)(2) and 1926.405(a)(2), the requirements for listing by a nationally-recognized testing laboratory do not apply.

The practice of assembling electrical extension cords is considered to be in compliance with OSHA standards, provided the assembled cord sets are assembled in a manner equivalent to those that are factory-assembled and approved. Criteria for determining whether shop-made cord sets meet existing electrical standards include:

1. All components must be approved for the purpose by a nationally-recognized testing laboratory (1910.303(a)) and (1926.403(a)). Individual components must be compatible for use with the other components of the completed assembly.

2. The cord set must meet all applicable requirements of 1910 Subpart S and 1926 Subpart K. For example, the assembly must be marked appropriately (1910.303(e)) and (1926.405(g)(2)(iv)); boxing intended for use in a permanent installation may not be used (1910.303(b)(1)(i) and 1926.403(b)(1)(i)); cords must be connected to devices and fittings so as to provide strain relief (1910.305(g)(2) (iii) and 1926.405(g)(2)(iv)); cords passing through holes in enclosures must be protected by bushings or fittings designed for the purpose (1926.405(g)(2)(v) – fittings designed to fasten cables to metal boxes are not acceptable); and no grounded conductor shall be attached to any terminal or lead so as to reverse designated polarity (1910.304(a)(2)) and (1926.404(a)(2)).

3. The cord set must be assembled by a qualified person.

4. The wiring of the completed assembly must be inspected by a qualified person before the cord set is used initially. For example, the following checks and tests, or equivalent, should be performed:

- *a. Determine that all equipment grounding conductors are electrically continuous.*
- *b. Test all equipment grounding conductors for electrical continuity.*
- *c. Determine that each equipment grounding conductor is connected to its proper terminal.*
- *d. Test each receptacle and attachment plug to ensure correct attachment of the equipment grounding conductor.*

If you have further questions on this matter, please contact the [Office of General Industry Enforcement at (202) 693-1850].

[Corrected 4/21/2009]

Cords can be spliced or have major repairs if 12AWG to 2AWG provided the repair meets the same insulating properties and usage characteristics as spelled out in OSHA 1926:

OSHA 29CFR 1926.405(g)(2)(iii) Splices. Flexible cords shall be used only in continuous lengths without splice or tap. Hard service flexible cords No. 12 or larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.

Taping electrical tape on the outer jacket of an electrical cord is ok on superficial nicks on outer Jacket but not recommended. The tape hides the damage from inspection. Damage might be more than a quick visual inspection might yield at first blush. The tape may also loose flexibility of the cord. If it is bad enough to tape, it might have more damage than would permit it to be taped.

December 16, 1998

Mr. Dennis Vance
Safety Specialist
711 Low Gap Road
Princeton, WV 24740

Re: 1926.403(e); 1926.405(g)(2)(iii); 1926.416(e)(1).

Dear Mr. Vance:

This is in response to your letter of March 20, and your follow-up letter of October 9, concerning the use of electrical tape to repair minor damage (abrasions and cuts of limited depth) on the outer jacket of an extension cord. We apologize for the lateness of this reply.

Generally, electrical tape may be used to cover superficial damage to cord jackets

You ask whether there is any prohibition against putting electrical tape over these kinds of abrasions and nicks when there is no damage beyond the jacket — the conductors have not been scraped or exposed and the insulation inside the jacket has not been displaced or compressed.

Section 1926.416(e)(1) provides that "worn or frayed electrical cords or cables shall not be used." Superficial nicks or abrasions — those that only slightly penetrate the outer jacket of a flexible cord, and do not permit the cord to bend more in that area than in the rest of the cord — do not normally render a cord "worn or frayed." Therefore, there is no need to repair or replace such a cord.

Recommendation against taping

While taping these incidental abrasions and cuts does not necessarily violate any OSHA standard, we recommend that employers not tape this type of damage for two reasons. First, Section 1926.403(a) requires that "all electrical conductors and equipment shall be approved." This standard precludes the use of approved electrical conductors and equipment if their characteristics are significantly altered. Applying electrical tape that is too thick or applying too much of it could change the cord's original flexibility and lead to internal damage. Second, the depth of the abrasions and cuts cannot be monitored to see if they get worse without removing the tape.

It should also be kept in mind that the heavy-duty extension cords commonly used on construction sites are designed to withstand a hostile environment. Damage to an extension cord that is bad enough to consider taping may have caused damage beyond the jacket.

Tape may not be used to repair significant damage to cord jackets

Repair or replacement of a flexible cord (depending on its gauge) is required when the outer jacket is deeply penetrated (enough to cause that part of the cord to bend more than the undamaged part) or penetrated completely, or when the conductors or their insulation inside are damaged. Two provisions of the standard prohibit the repair of the jacket of a worn or frayed flexible cord with electrical tape. Section 1926.403(a) requires that the cord be approved. The original approval of the cord was based on the types of materials and construction used. As noted above, taping the cord can change the flexibility characteristics of the cord, which in turn can affect the amount of stress in the adjacent areas. This is of particular concern with respect to the grounding wire. Also, the jacket is designed both to prevent damage to the conductors and insulators inside and to further insulate the conductors. Taped repairs usually will not duplicate the cord's original characteristics; in most cases neither the jacket's strength nor flexibility characteristics will be restored. Therefore, tape repairs of the jacket may not be used to bring a worn or frayed flexible cord into compliance.

In addition, Section 1926.405(g)(2)(iii) states that "flexible cords shall be used only in continuous lengths without splice or tap. Hard service flexible cords No. 12 or larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced." This standard precludes the repair of flexible cords smaller than No. 12.

MSHA has a different standard governing the repair of flexible cords

You point out in your letter that U.S. Department of Labor's Mine Safety and Health Administration (MSHA) permits the taping of damaged flexible cords in mines, which are, in many cases, very hazardous environments. The standard that applies in mines is different from the OSHA standard. The MSHA standard, located in volume 30 of the Code of Federal Regulations, Section 75.517, provides that "power wires and cables...shall be insulated adequately and fully protected."

A mine employer complies with this standard by "insulating adequately and fully protect[ing]" the cord. By its terms, this permits the use of cords as long as they are properly insulated and protected. Where that can be accomplished by the proper application of suitable electrical tape, the requirements of that standard are met. In contrast, the OSHA standard, which is based in large part on the National Electric Code, requires that the cords be "approved," and prohibits the repair of cords smaller than No. 12. Consequently, the use of tape to repair a worn or frayed cord is permitted under the MSHA standard but not under the OSHA standard.

if you require any further assistance, please do not hesitate to contact us [by fax at: U.S. Department of Labor, OSHA, Directorate of Construction, Office of Construction Standards and Guidance, fax # 202-693-1689. You can also contact us by mail at the above office, Room N3468, 200 Constitution Avenue, N.W., Washington, D.C. 20210, although there will be a delay in our receiving correspondence by mail.]

Sincerely,

Russell B. Swanson, Director

[Corrected 6/22/2007]

Look for deformed or missing pins, missing grounding pin, damage to outer jacket or insulation, Loose plug or receptacle end, pinched or crushed outer jacket, cracked plug end, use of duct tape or electrical tape.

April 12, 2010

Letter # 20090606-9144

Re: Whether an employer can repair an extension cord under 29 CFR 1926, Subpart K.

Question: Under what circumstances may an employer located in Minnesota repair a damaged extension cord under 29 CFR 1926, Subpart K?

Answer: Paragraph 1926.405(g)(2)(iii) provides:
Flexible cords shall be used only in continuous lengths without splice or tap. Hard service flexible cords No. 12 or larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.
This standard permits you to repair an extension cord, under the conditions set forth, provided the cord is a flexible cord that is No. 12 or larger.

Additionally, 1926.403(a) requires all electrical conductors used by employers on a construction site to be "approved." Section 1926.449 defines "approved" as:

Acceptable to the authority enforcing this subpart. The authority enforcing this subpart is the Assistant Secretary of Labor for the Occupational Safety and Health. The definition of "acceptable" indicates what is acceptable to the Assistant Secretary of Labor, and therefore approved within the meaning of this subpart.

Section 1926.449 defines "acceptable" as:

An installation or equipment is acceptable to the Assistant Secretary of Labor, and approved within the meaning of this subpart K:
(a) If it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a qualified testing laboratory capable of determining the suitability of materials and equipment for installation and use in accordance with this standard; or
(b) With respect to an installation or equipment of a kind which no qualified testing laboratory accepts, certifies, lists, labels, or determines to be safe, if it is inspected or tested by another Federal agency, or by a State, municipal, or other local authority responsible for enforcing occupational safety provisions of the National Electrical Code, and found in compliance with those provisions; or
(c) With respect to custom-made equipment or related installations which are designed, fabricated for, and intended for use by a particular customer, if it is determined to be safe for its intended use by its manufacturer on the basis of test data which the employer keeps and makes available for inspection to the Assistant Secretary and his authorized representatives.

Assuming the extension cord you are repairing was initially "acceptable," §1926.403(a) precludes you from using a repaired cord if the cord is significantly altered as a result of the repair. For example, you are precluded from using a repaired cord if the repair changes the cord's original flexibility.[1] As you may be aware, the State of Minnesota operates its own occupational safety and health program under a plan approved by Federal OSHA. Under this plan, the Minnesota Department of Labor promulgates and enforces occupational safety and health standards under authority of State law, and posts them on its website at http://www.dli.mn.gov/mnosha.asp. Although some of Minnesota's standards are different, both its standards and interpretations must be at least as effective as Federal OSHA's. For information on Minnesota's Electrical standard and its enforcement, we suggest that you contact:

James Krueger, Compliance Director
443 Lafayette Road North
St. Paul, Minnesota 55155-4307
PH: (651) 284-5050
TOLL FREE: (877) 470-6742
FAX: (651) 284-5741
Sincerely,

Bill Parsons, Acting Director
Directorate of Construction

It is important to note a relax in restrictions from OSHA in that extension cords are to be used for temporary electrical power, so OSHA 29CFR 1926.405(a)(2) may be less than on a permanent installation. The full requirements of NRTL do not apply. As long as they are equivalent to factory assembled cords. Assemblies marked appropriately 1926.405(g)(2)(iv) and 1926.403(b)(1)(i) with the appropriate strain Reliefs, and the assemblies were made by qualified person, and that the grounding conductor remain intact.

Repairs 1926.404(b)(1)(iii)(C) but need to be compliant with 1926.403(a)

> *OSHA 29CFR 1926.404(b)(1)(iii)(C) Each cord set, attachment cap, plug and receptacle of cord sets, and any equipment connected by cord and plug, except cord sets and receptacles which are fixed and not exposed to damage, shall be visually inspected before each day's use for external defects, such as deformed or missing pins or insulation damage, and for indications of possible internal damage. Equipment found damaged or defective shall not be used until repaired.*