Longwood University Theatre Program

Electrical Standards

Professor Campbell 2021

Forward

Electricity is an essential part of the high-tech, fast-paced, demanding life in modern theatre production. It is used all day, every day -- so much that we probably take it for granted and forget about the dangers associated with it.Thousands of people are injured or killed every year from the hazards of electricity in both the workplace and the home. It is our goal to make sure you have a safe workplace.

For you, a member of the Longwood theatre community, thinking like an inspector but acting as an educator will help to eliminate electrical hazards and at the same time raise the safety knowledge of our workforce. No matter how well understood our program's policies are, taking the time to make sure things are safe will only contribute to a stronger electrical safety program. Positive reinforcement will drive home the safety message and create an embraced culture of safety. Always make sure that you and your fellow students are following the expectations set forth by the Theatre program. Never hesitate to ask for clarification from the Technical Director.

Electrical safety accidents perpetually rank in the top 10 (and frequently the top five) of annual industrial fatalities. This is likely due to the large number of variables when working with electricity and energized systems. For this reason, organization, maintenance and communication are of the utmost importance to avoid contributing to these dire statistics.

Safety is everyone's #1 priority
Thank you,
Technical Director
Longwood University theatre program

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Ch. 1 National Electric Code

The NEC (National Electric Code) is a nationally adopted group of minimum safety standards for the completion of electrical work.

As technology grows, so does the NEC. The NEC is updated every three years.

The proper construction and use of cords is covered across a few articles in the NEC.

There is a specific section in the NEC for "Theatre, Audience Areas of Motion Picture and Television Studios", article 520.

- NEC Article 520.67 – "Multiple branch-circuit cable connectors, male and female, for flexible conductors shall be constructed so that the tension on the cord or cable is not transmitted to the connections."

What that means for you is that the outer jacket of the cable or cord must be encapsulated inside the plug so that the cord is not solely held in place by the electrical connections but by the clamping action on the exterior jacket. This is referred to as strain relief.

Another article that is relative to theater safety is "Flexible Cords and Cables," article 400.

- NEC Article 520. 68(A)(1) – "Flexible conductors, including cable extensions, used to supply portable stage equipment shall be listed extra-hard usage cords or cables."

NEC Table 400.4

Trade Name	Type Letter	Voltage	AWG or kemil	Number of Conductors	Insulation	Nominal Insulation Thickness			Braid on Each Conductor	Outer Covering	Use		
						AWG or kemil	mm	mils					
Hard Service Cord	SO	600	18-2	2 or more	Thermoset	18-16	0.76	30	None	Oil-resistant thermoset	Pendant or portable	Damp locations	Extra hard usage
	SOW	600										Damp and wet locations	
	SOO	600			Oil-resistant thermoset	14-10 8-2	1.14 1.52	45 60				Damp locations	
	SOOW	600										Damp and wet locations	
All thermoset parallel cord	SP-1	300	20-18	2 or 3	Thermoset	20-18	0.76	30	None	None	Pendant or portable	Damp locations	
	SP-2	300	18-16			18-16	1.14	45					
	SP-3	300	18-10			18-16 14 12 10	1.52 2.03 2.41 2.80	60 80 95 110			Refrigerators, room air conditioners		
All class	SPE-1	300	20-18	2 or 3	Thermoset	20-18	0.76	30	None	None	Pendant or portable	Damp	

Along with the above requirement is one that the cords must be labeled with the type designation(extra-hard usage), size, and number of conductors. NEC 400.6(A)

What this means for us is that we should inspect the cord and make sure that it is the correct type, extra-hard usage (Table 400.4).

Ch. 2: Theatre Specific Electrical Issues

1. Plug Types

Edison

Traditional 15A straight blade (parallel) and U-ground “Edison” plugs and connectors. These are used for extension cords and adapters.

PowerCON

Ideal for use with LED lighting and other loads such as multi-bank video monitors. They are color coded for input (blue and output (gray) to ease in proper wiring connection.

Twistlock Connector

This is the locking connector used with ETC Dimmer Doublers and the power for chain motors.

Stage Pin

These are the industry standard for traditional lighting fixtures and lighting cables.

2. Wire Sizes

A. Stage Cables 12/3

All stage pin cables are to be wired with 12 gauge three conductor SO cable. All powerCON connectors are to be wired with 12 gauge three conductor SJ cable. The maximum load on any stage cable is to be 20 amps.

Stage Pin Standard Cable Lengths
5', 10',15', 20', 25', 50', 75' and 100'

PowerCON Standard Cable Lengths
5', 10',15', 20', 25', 50', 75' and 100'

B. Two-fers

Two-fers at Longwood are used to plug two lights into one circuit or dimmer. All two-fers at Longwood are are commercially made. At no time should two-fers be built.

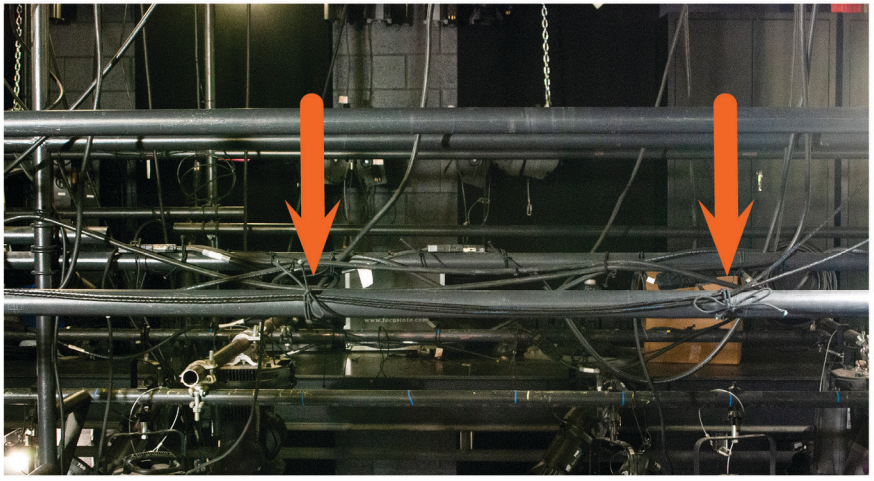
C. Extension Cords 14/3

Extension cords are made from 14 gauge wire. The maximum load on any extension chord is 15 amps. Any light gauge extension cords are to be removed from the theatre and given to the Technical Director. The type and gauge of cable can be found on the writing on the cable. If you are in doubt, please see the Technical Director.

3. Securing Cables

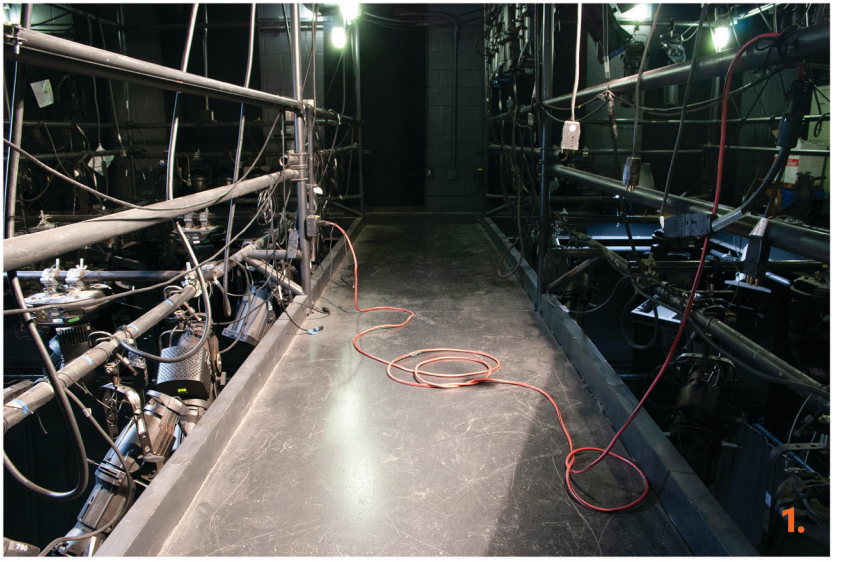
A. Tie Line

All stage cables are to be secured with black tie line no less that every 3′ using a clove hitch and a bow tie or half bow. Sections of tie line should be cut into 24″ lengths. Please see the Technical Director if you need additional tie line.

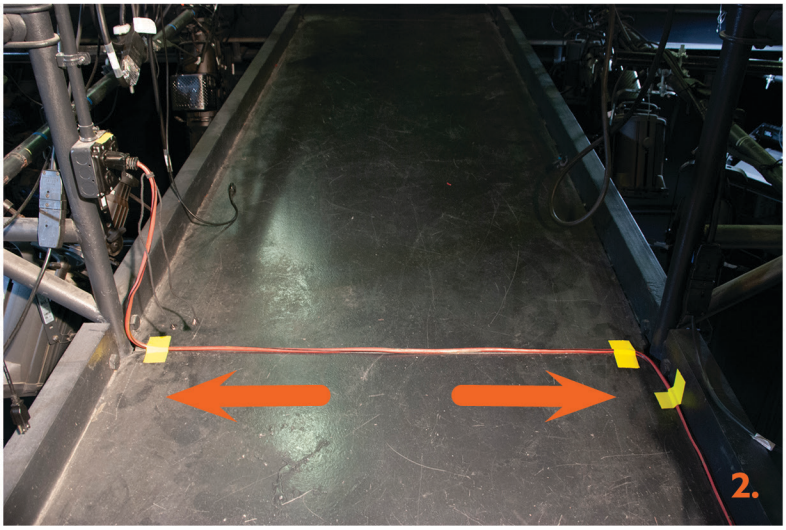


B. Taping Down

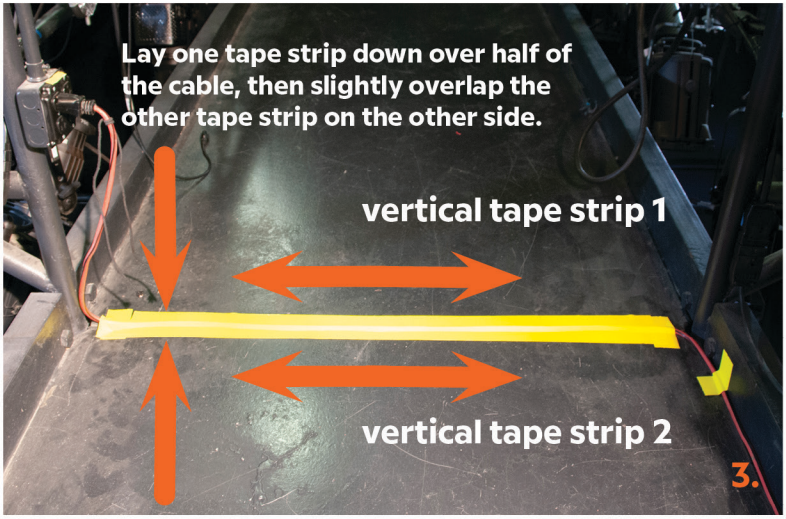
Any cable that is to be run on the floor needs to be taped to the floor with gaffer's tape. If it is able to be seen by the audience, it needs to be put down with black gaffer's tape. If it is back stage, on the mezzanine or the catwalk, it needs to be taped down with yellow gaffer's tape. Please see the Technical Director if you need gaffer's tape.



1. Assess the area where you will be taping down the cable. Fix any tangles before you start taping.



2. Pull on the opposite ends of the cable tightly to secure a straight line. Add strips of tape to secure those spots.

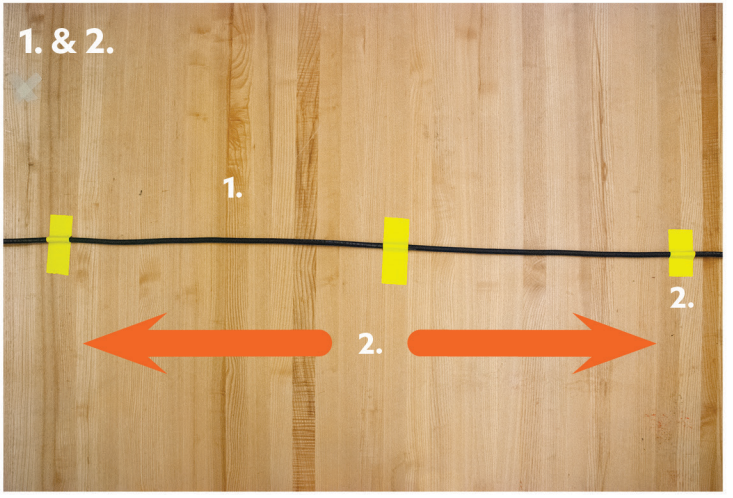


3. Add long vertical tape strips that cover half of the cable on one side, and half on the other side.

At no time are any cables to be secured to any sprinkler pipes or electrical conduit. If you need help identifying the sprinkler pipes and conduit please see the Technical Director.

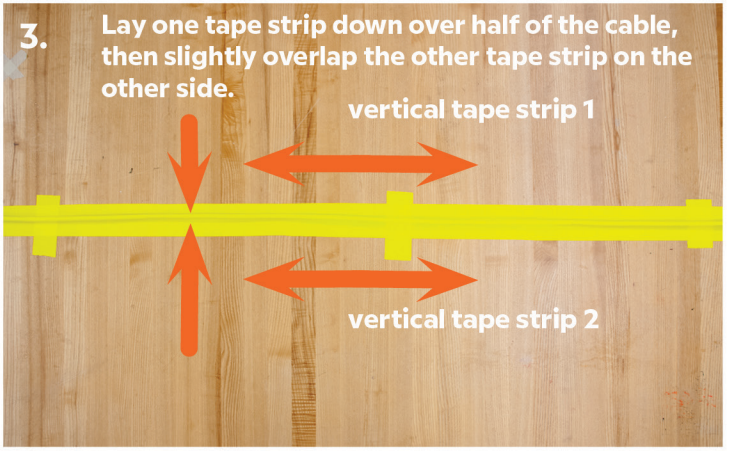
C. Carpet

At times, cables that are run on the floor can be covered in carpet. When you do this, you must make sure that the carpet is secured to the floor with gaffer's tape on all sides. Please see the Technical Director if you need gaffer's tape.

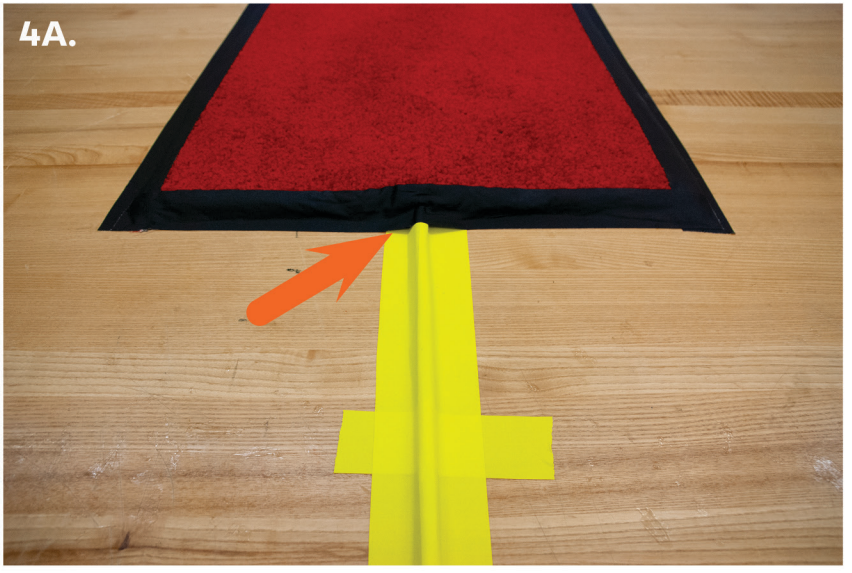


1. Assess the area where you will be taping down the cable. Fix any tangles before you start taping.

2. Pull on the opposite ends of the cable tightly to secure a straight line. Add strips of tape to secure those spots.



3. Add two long vertical tape strips that cover half of the cable on one side, and half on the other side. The second tape strip should overlap the other tape strip slightly.

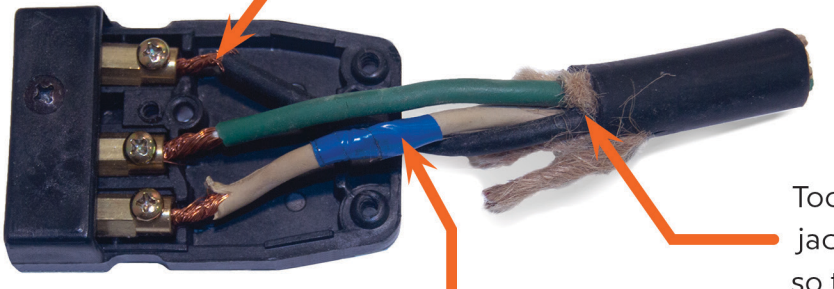


4. Place the carpet over the taped down cable. Make sure the carpet is free of any bumps and is as flat as possible. Use 4 long strips of black gaff tape to secure the carpet to the ground. Half of each tape strip needs to cover the carpet, and the other half is secured to the ground. Leave clean corners where all the tape ends meet.

As you lay down the tape, make sure there are no folds or bumps in the tape. Gently smooth them out with your hand as you go. Make sure that the black tape is snuggly fit around the areas where it overlaps the cable.

Ch. 3: Common Issues with Cables

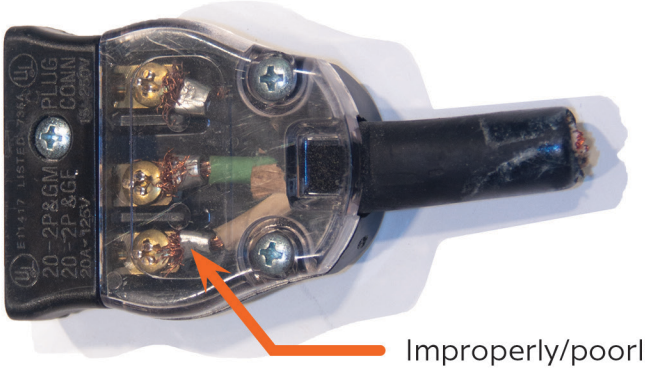
1. Poor Terminations



Improperly terminated wires.
Too much insulation has been stripped

Too much of the outer jacket has been removed so there is no strain relief

This wire was cut and then covered with tape

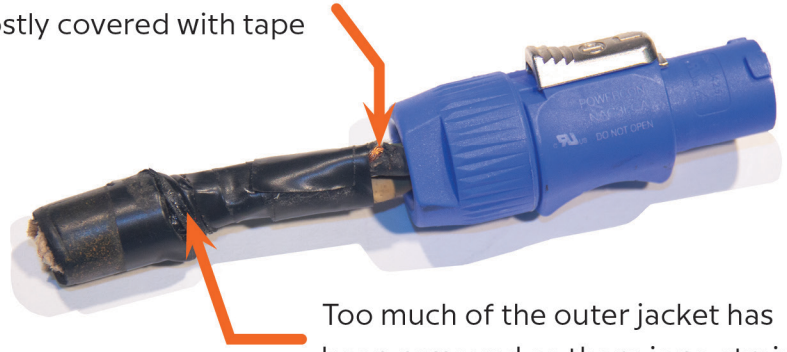


Improperly/poorly applied crimps

2. Lack of Strain Relief

This is SO cable which is too thick to be used with the PowerCON connectors. Now the connector is applying strain relief to the conductors rather than the outer jacket as required

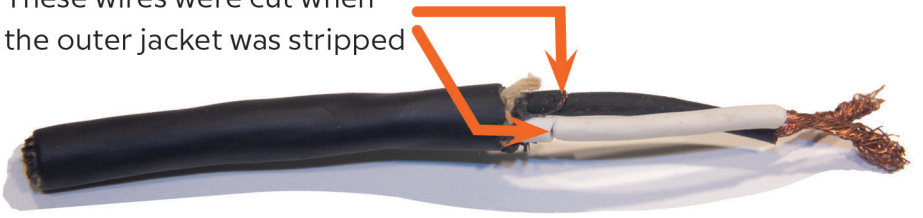
This wire was cut and then mostly covered with tape



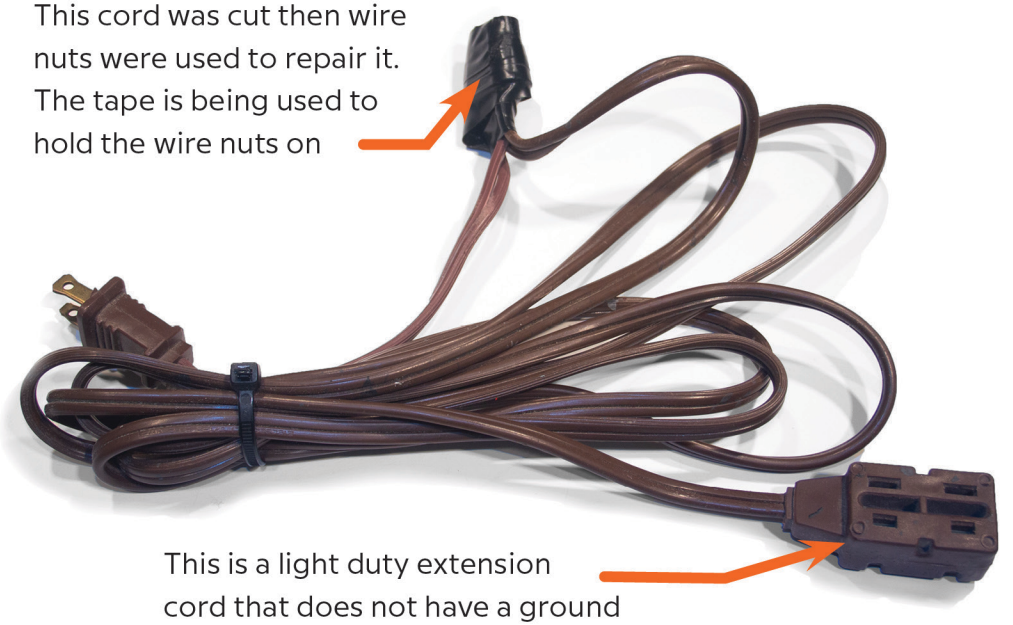
Too much of the outer jacket has been removed so there is no strain relief

3. Cut or Damaged Insulation/Cables

These wires were cut when
the outer jacket was stripped

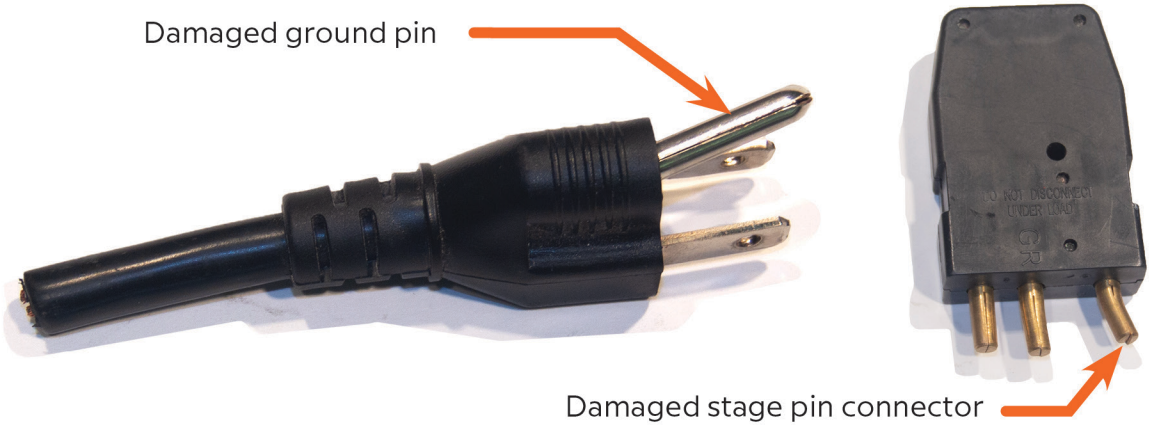


This cord was cut then wire
nuts were used to repair it.
The tape is being used to
hold the wire nuts on

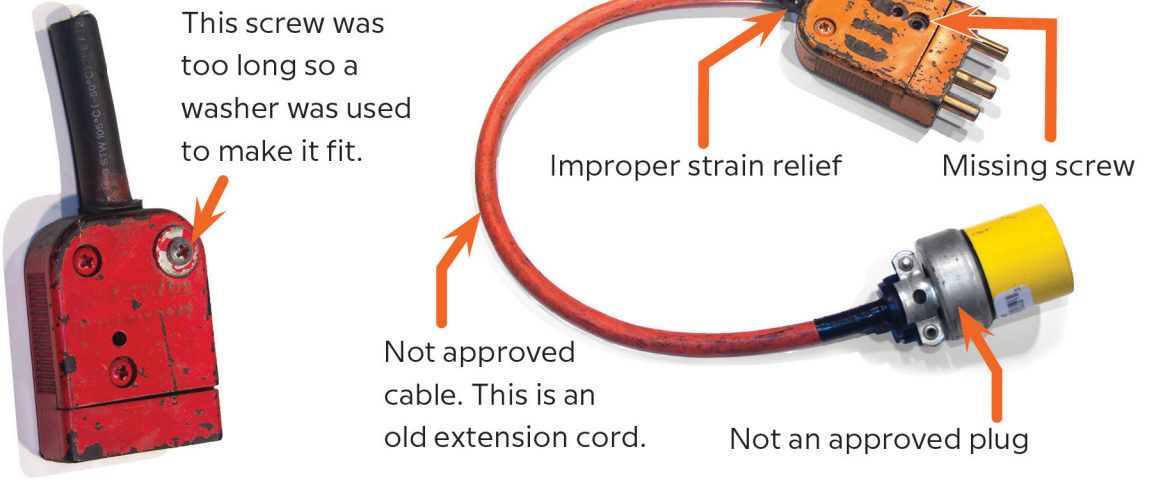


This is a light duty extension
cord that does not have a ground

4. Damaged Pins



5. Non-standard Parts



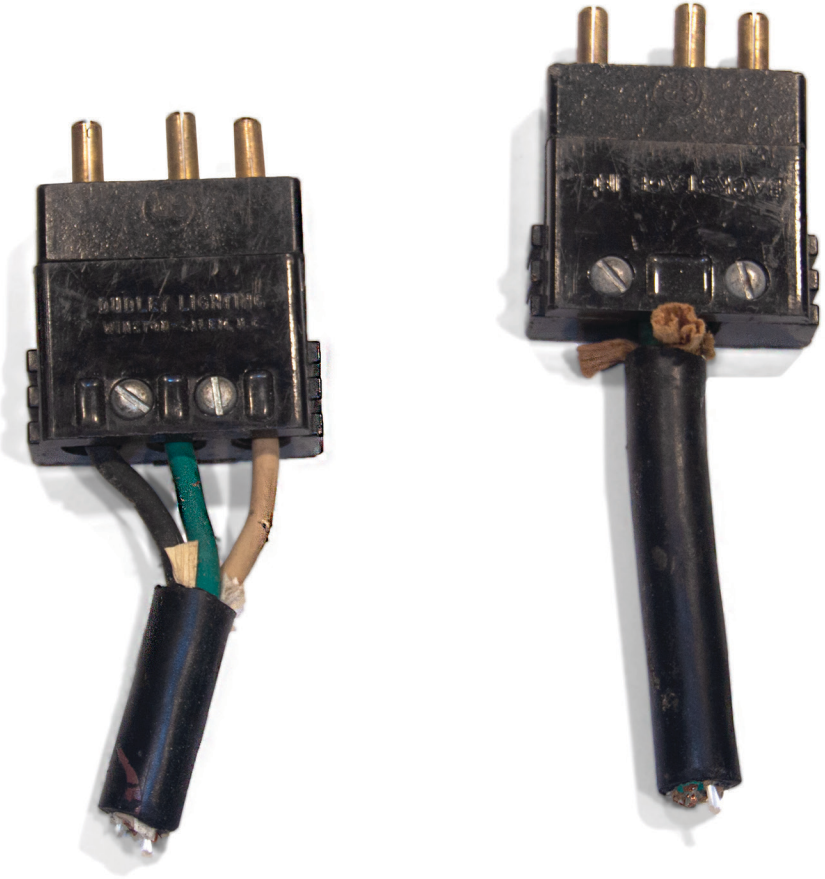
Ch. 4: Unacceptable Plugs

1. Low Quality Plastic and Metal Plugs

The following plugs may not be used in any theatre, scene shop or work space due to low quality or lack of proper strain relief. If you encounter any of these plug styles, immediately remove the cable and bring it to the Technical Director.

2. Old Square Union Plugs (Stage Pin Connectors)

These are very old plugs that are difficult to wire because of a lack of interior space and do not have proper strain relief.

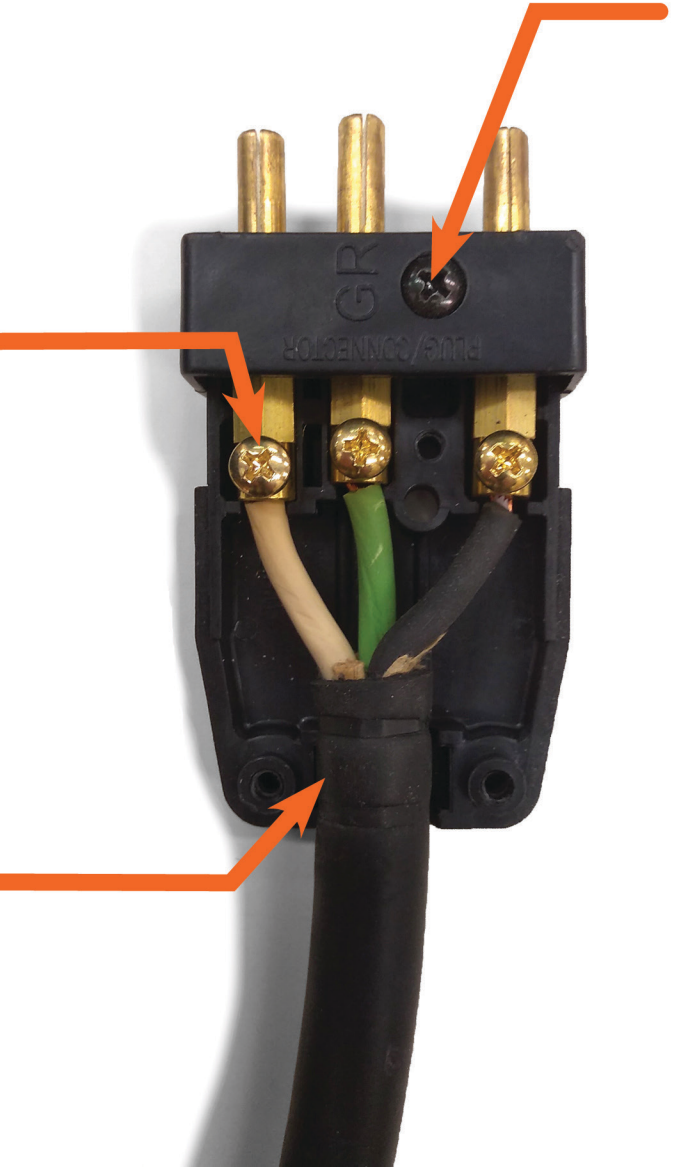


Ch. 5: Properly Wired Stage Pin Connectors

Stage Pin

Properly terminated wires with each wire going to the correct terminal. Little to no copper is showing and the terminal screws are tight.

The outer jacket extends into the plug so that proper strain relief can be achieved.



Please never remove this screw on any stage pin plug.

Ch. 6: Procedures for Repairing Cables

1. Testing Cables with the GAMChek

All students who need to repair any electrical cable or install a plug need to have been given their instruction from the Technical Director or the University's electricians. If you have not received instruction in your THEA 240 class, please see the Technical Director for a training session.

If you encounter a cable or lighting unit that need to be repaired, please bring it to the Technical Director. If you have received training, you may repair the cable. All repairs must take place in the scene shop and be inspected by the Technical Director prior to use. Additionally, each repaired or built cable must be first checked with the GamChek prior to use.

If you have received training in the past and need a refresher, please see the Technical Director.

GAMChek

Lamp Check

1. Move selector switch to ‘Lamp’ symbol setting.
2. Plug the fixture or light into the female end of GamChek™. If the lamp and wiring are good, an audio signal will sound and the amber LED will light.

Cable Check

1. Move selector switch to ‘Cable’ setting.
2. Plug both ends of the cable into corresponding ends of GamChek™.
3. Depress each button (H, G, N) individually.

Each LED should light individually in correspondence with its button.

Button lights a non-corresponding LED: mis-wired cable.

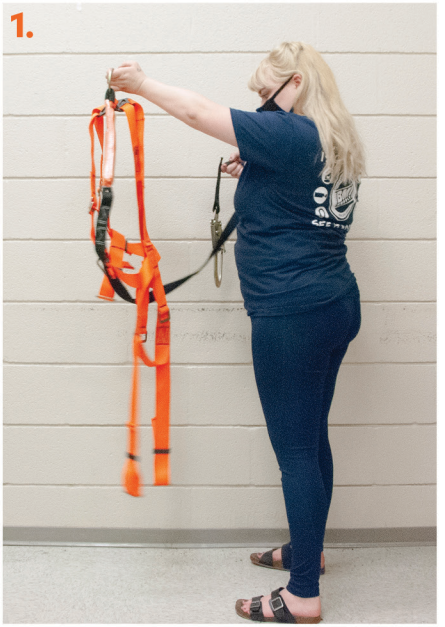
Two LEDs light together: electrical short. No LEDs light: no continuity in the line.

1. Move selector switch to ‘Cable’ setting
2. Plug GamChek™ into power receptacle

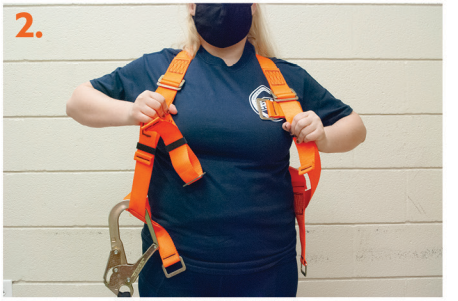
If no LED lights: no power. If LED lights: match the LED configuration with the label to determine power status.

Replacing or installing battery needs to be done by the Technical Director.

Ch. 7 Putting on Fall Arrest



1. Be sure to inspect your harness before using it. If your harness has missing parts or is tangled, it could result in injury.



2. Put your arms through the harness and adjust it to properly fit on your shoulders.

3. & 3A. Clip and tighten chest strap. The harness should sit against your body without being loose.

Be sure to tighten ALL straps completely.

4. & 5. Clip and tighten both leg straps by reaching through legs. Insert one part of the clip into the other one part.

6. & 6A. Make sure to check for twists in the harness and to fix them.

7. & 7A. This is what the harness should look like when it is properly put on and adjusted.

8. Have a buddy check your harness to ensure that it is on properly, then you are all set.

Ch. 8 Procedures for Using Scaffold Clip

1. Hold the clip in your hand. The clip is attached to a harness which will protect you while you wear it on the catwalk.

2. Use your thumb to release the latch with your fingers. Squeeze your fingers to open the latch.

3. Latch the clip onto a pipe that is safe.

4. Release your grip on the clip once you are securely attached to the pipe.

Ch. 9 Where to Attach Fall Arrest on Catwalk

Always clip yourself in higher than where you are working, so if you fall, your body will absorb less of an impact and will have less chance of getting injured.

NEVER use the bottom pipe. It is not rated for falls.

If you attach the clip to the vertical pole, do not clamp down onto any wires because you could cause damage to them.

Use the middle bar if you are working in a position such as this.

Ch. 10 Longwood Theatre's Electrical Certification Program

To be certified, a student must pass a written and practical exam with 100% of the questions answered correctly. The exam may be taken after the student has read this standards manual and has received instruction from the Technical Director or one of Longwood's electricians.

Once certified, a student after notifying the Technical Director may repair a damaged cable.

This certification is good for one year.

Additional Resources

esta.org
USITT.org

design by

spring 2021


TREACHERY
CORRUPTION
ADULTERY