Building low cost work lights and safety lights for theater

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Building Low Cost Work Lights and Safety Lights for Theater

by

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MA, University of Montana 2000

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Chairperson

Dean, Graduate School

3-88-2000

Date
Building a Low Cost Work or Safety Light for Your Theater

By Robert Louis Holter MA, University of Montana

Advisor:

Every theater needs work and safety lights that are inexpensive to operate. A work light operates on stage or in a shop to properly illuminate the area so rehearsals or building can go on. A safety light is designed to illuminate a set or stage with enough light so staff or visitors can negotiate their way around a dark theater without injury.

Two problems occur using standard theatrical lighting for work lights: the equipment is expensive and the lamps need to be dimmed rather than switched to keep the rated hours of life. What is needed is an inexpensive light source that is bright and can be switched on and off. The traditional theater safety light or “Ghost” light has several problems, but the main fault is that it burns constantly and is wasteful of energy. A better solution would control how and when the safety light is turned on.

This paper shows how to build a work light costing less than $45.00, which operates on a switched circuit. Modifying the work light with a motion sensor creates a simple safety light for under $60.00. Both units are made with commonly available parts. Any competent stage electrician can complete the unit in less than one hour including the addition of a motion sensor to modify the work light for use as a safety light.
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Part one - The Problems

Every theater needs good, inexpensive lights for rehearsals and construction work. There should also be a workable safety light for the hours when the staff is gone and others might need to negotiate around the sets and props on stage. A work light operates to sufficiently illuminate an area so rehearsal sessions or building can go on. A safety light (or ghost light) is designed to sufficiently illuminate a darkened theater so people can negotiate the space without getting hurt.

Getting proper illumination that is simple to operate and cheap to run is more difficult than it first appears. A “white light hang” of ‘regular instruments,’ such as scoops or Fresnels, is a common but flawed solution. This solution ties up valuable specialty lighting that cannot do its designated job for a production. If the work lights are plugged into the dimmer system, people must be trained to use the dimmers. Complications can arise if a breaker gets tripped, or anyone turns the system off.

An ideal work light should both bypass the dimmer system and work on a switched circuit cutting the need for a trained person and the use of the dimming system. To eliminate using stage instruments, which are fragile and very expensive, other equipment must be utilized. Quartz Porch Light fixtures rated at 500 watts make an excellent work or safety light. The lamp is designed to be switched on and off, not dimmed like most theatrical lamps, so the lamp life rating of 2,000 hours is accurate on a switched circuit. Motion sensor switches, with timed shut-off features can be added to the quartz light, and when the light is mounted, plugged into a hot circuit, and aimed
in the proper direction, the light automatically turns on when someone walks into the space. Hang the safety light with the rest of the stage lights and there is no more “ghost light” cord on the floor to trip anyone.

Following is a list of the parts needed and their approximate cost. Instructions follow which describe the work light / safety light assembly. Any competent stage electrician can assemble one in about an hour, even with the added motion sensor; however, anyone following the instructions should be able to construct the lights almost as quickly.

All the parts need to be UL listed or the light you build will be unsafe. All reputable manufacturers seek the UL listing to prove safety codes and ethical standards are met with their products.

Part two - The Part’s Needed

The work light will need the following items (shown in figure one):

1. A 500-Watt Quartz Porch light Fixture. The particular model shown is The Designers Edge Model # E164806, Catalogue number L-30. This unit has an adjustable reflector unit with “Zeus” lens clips. Any similar model will work well but the “Zeus” clips are easier when you have to re-lamp.

2. 1- steel Double Gang Box for the body of the light. The example uses a RACO box. Because this box becomes the body of the work light it must be a strong, steel box with rounded corners so that there will be no sharp edges to snag or cut anything.

3. A double gang cover plate. The example uses a double gang to single gang switch plate adapter so a motion sensor can be added. The switch plate is a standard single
gang face plate with a center knock out. Again RACO parts were used in the example. The faceplate combined with the single gang switch plate adapter sets the motion sensor approximately ½” out from the work light body. This gets the sensor away from the heat of the lamp, which can alter its function drastically and possibly destroy the motion unit. A standard solid plate double gang cover can be used when building just a work light, as the heat is not a problem if no motion sensor is used.

4. A ¾” threaded self-locking conduit nut to help secure the quartz light. The lamp comes with one conduit nut to secure it to a specialty box, making a second conduit nut necessary to secure the quartz light securely inside and out of the standard box.

5. A “C” clamp with bolt and washer. A “C” clamp can be purchased from any theatrical supply house. Order the clamp and the safety cables (item number 8) at the same time from the same supplier to save shipping expenses!

6. A 1½”x 5/8” fender washer to help secure the “C” clamp. Inasmuch as the “C” clamp comes with only one washer, you will need to have a second washer to help secure the clamp securely to both sides of the box.

7. A ¼” x 2” eye bolt with two nuts. The example used an H.B. Ives ¼”X ½” eyebolt part #56-3040 with a safe working load of 160 lb. and standard ¼” nuts rated for the same weight. The safety wire attaches to the eyebolt.

8. A safety cable. The safety cable is not an option. If your other stage instruments do not have a safety cable, order enough for each piece of equipment! OSHA (and good sense) requires that any hanging instrument be safety cabled!
9. 3 feet of 12/3 SO rubber jacketed electrical cable for the power cord. 12/3 SO stands for 3 number 12 gage stranded conductors, with cotton or other fiber strain relief woven between the conductors and an oil resistant rubber casing. The shortened description SO is standard for this type of cable. The cable used to build the example was standard 12/3 SO American Wire Products portable extension cable.

10. Two #12 hard body wire nuts are available at any hardware store. The wire nuts attach the wires of the power cord to the Quartz light fixture wires.

11. A cord grip connector. The National Electric Code is very clear that a specialty chord grip connector must be used to attach SO chord to any portable unit. One important note – standard “Romex” connectors are not legal for attaching SO chords to temporary fixtures, “Romex” connectors will come loose allowing the wire to be pulled and twisted apart causing a short circuit.

12. A male connector that matches your switched circuit. Because your switched work circuit may be a female receptacle of different manufacture, check the outlet and match the male connector.

13. A small bottle of thread locking compound. There are several on the market, LockTite® was used on the example.

14. A motion sensor that automatically turns on the light if you make a safety light. The example is a Regent Model #MS401 from Wal Mart. The prices vary as the functions get more elaborate or the units becomes more sensitive. The differences between a $12.50 unit and a $45 00 unit could include sensitivity, the size of the
zone the sensor will cover, the wattage, and the name of the manufacturer. All of the parts, except the fender washers for the “C” clamp and a motion sensor, are shown below in figure one. The numbers on the photograph below are referenced to the descriptions above.

Figure One

The cost of the parts is broken down in table number 1, which follows. The prices are based on standard retail prices. Wait until these fixtures are on sale and the cost of your light might be a bit less.
### Cost breakdown of parts

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
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<tbody>
<tr>
<td>Quartz Light Fixture</td>
<td>$14.95</td>
</tr>
<tr>
<td>Double-gang steel box</td>
<td>$1.39</td>
</tr>
<tr>
<td>Double-gang to single gang adapter</td>
<td>$ .75</td>
</tr>
<tr>
<td>Face plate cover with knock-out</td>
<td>$ .57</td>
</tr>
<tr>
<td>¾” threaded conduit nut</td>
<td>$ .35</td>
</tr>
<tr>
<td>“C”-clamp</td>
<td>$ 9.00</td>
</tr>
<tr>
<td>1 ½” fender washer</td>
<td>$ .35</td>
</tr>
<tr>
<td>Safety Cable</td>
<td>$ 2.95</td>
</tr>
<tr>
<td>3 feet of 12/3 SO rubber jacketed electrical cable @$ .60 per foot</td>
<td>$ 1.80</td>
</tr>
<tr>
<td>2 - #12 hard body wire nuts</td>
<td>$ .45</td>
</tr>
<tr>
<td>Cord grip connector</td>
<td>$ 2.49</td>
</tr>
<tr>
<td>Edison connector</td>
<td>$ 4.95</td>
</tr>
<tr>
<td>¼”X ½” eye bolt and extra ¼” nut</td>
<td>$ .95</td>
</tr>
<tr>
<td>.08 FL. OZ. bottle of thread locking compound</td>
<td>$ 2.50</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$43.44</td>
</tr>
<tr>
<td>Motion sensor</td>
<td>$14.25</td>
</tr>
<tr>
<td>Cost to make motion sensing safety light in this paper</td>
<td>$57.69</td>
</tr>
</tbody>
</table>
**Part three - building the work or safety light**

To assemble a safety light, start with the steel double-gang box. The box will become the physical body of the unit, and will contain the wiring junctions for the SO chord and quartz lamp housing. In any standard steel box there are three knock-outs for each side, and five knock-outs and two $\frac{3}{4}''$ holes on the back of each unit. Decide which sides will become the top and bottom of the box and mark them accordingly with a marker. Remove the center knock-outs from top and bottom. Next decide which side you want your power cord, and remove the center knock-out on that side. See figure two.

**Figure two**

![Diagram of steel box knock-out plan]

- **Use top $\frac{3}{4}''$ hole to attach the eye bolt for the safety cable**
- **The knock-out plan for the steel box**
- **Choose which side you want your power cord to enter and remove the center knock-out**
- **Choose which will be top and bottom and mark it on the box- remove the center knock-out top and bottom.**
In the top hole secure the “C” clamp with the clamp bolt and washers. Cinch the bolt so the washers bind onto the body to keep the clamp from moving.

To begin the installation of the Quartz light fixture, first thread the purchased conduit nut “cup up” onto the shaft.

**Figure three**

(self-locking conduit nuts placed “cup up” on shaft of the quartz light)

(Bolt with extra washer)

(Quartz light shaft secured through bottom hole of box)

(Double Gang Box with knock-outs removed)

(“C” Clamp with washer secured through top hole of box)

Through the top knock-out hole secure the “C” clamp by bolting it with a washer on either side of the double gang box. Secure the Quartz light fixture in the bottom of the box using the threaded self locking conduit nuts.

Insert the quartz light fixture into the double gang box by threading the wires and shaft through the bottom hole. Secure the shaft inside the box with the nut supplied by the manufacturer (figure three). Tighten the nuts and bolts as tightly as possible using pliers or wrenches as needed.

Now attach the ¼” x 2” eye bolt through one of the standard ¼” holes found in the back of the box (see figure 4). Thread one nut approximately ⅜” up the shaft of the eyebolt. Insert the shaft through the hole and affix it with the second nut. Secure the
nuts for the eyebolt on both sides of the box with thread locking compound. The basic unit is now ready for wiring.

**Figure four**

The unit with eye bolt for safety wire – side view

Eyebolt attached to the back of the steel box with a nut on each side secured with LocTite®

To start the wiring, first assemble the power cord. SO chord is made up of three layers, the rubber casing and protective packing, insulators for the individual wires and the conductors or wires (see figure five).

**Figure Five**

SO power chord casing removed and individual wires stripped to show conductors

Individual insulated wires

Heavy rubber casing and protective packaging

Conductors

Prepare both ends of your 3'-0" chord. Begin by removing the heavy rubber casing of the SO cord with a sharp knife to expose the individual insulated wires. The box
end of the power cord will need the casing stripped back to show approximately 5” of insulated wire for attaching to the quartz light. The other end of the SO cord which will have a male plug should be stripped back as the manufacturer instructions state (usually about leaving 1 ¼” of insulated wire). Check the insulation after stripping the casing. Make sure it is intact and not cut into by the knife when removing the casing.

Follow the manufacturer instructions to expose the proper amount of bare wire on the connector side (usually approximately 3/4”). On the end to be connected to the quartz light strip off insulation to show 1” of bare wire.

Next attach the male connector following common wiring practices and the connector manufacturer instructions.

After attaching the male connector, thread the other end of the cable into the box through the cord grip connector at the side knock out. Tighten the chord grip connector to secure the cable to the box. Once the chord is secured to the box connect the proper matching wires from the supply chord to the Quartz light fixture wires. Screw on the wire nuts so that the matching wires are secured tightly.

The work light is now wired. Attach the cover plate. Attach the safety wire to the eyebolt. You are now ready to lamp the quartz light. As with any instrument, make sure that the unit is unplugged and that the pan and tilt adjustments are secure. Take time to clean the lens and reflector if they need it. In lamping a Quartz fixture be sure not to touch the bulb because the oily fingerprints will cause the Quartz glass to overheat and fail during operation. If you do touch the glass wipe it off with a clean rag moistened with rubbing alcohol. Figure six shows the finished work light ready to hang
– note the knock out hole in the center of the cover plate which will be needed for future addition of a motion sensor.

**Figure six**

If you are going to add a motion sensor to the light to make it a safety light, remove the faceplate and knock out the hole. Install the motion sensor through the hole utilizing the conduit nut supplied with the motion unit (see figure seven).

**Figure Seven**

- Attach sensor through faceplate with the locking conduit nut and secure faceplate to box with supplied screws – wire as per manufacturer instructions.
Attach the wires of the motion switch following the manufacturer’s supplied wiring diagram. Each manufacturer’s design varies slightly so follow wiring instructions carefully. The sensor unit comes with instructions as to how and where the motion sensor will work best. Read these and place the safety light accordingly. The sensitivity and delay functions work differently for each model. Select the device settings and try out the safety light in its place to be sure that the light works as required. Figure eight shows a completed safety light.

**Figure eight**

![Figure eight](image_url)

**Part four - Final Thoughts**

The combination work and safety light should be plugged into a switched circuit for the most trouble-free operation. However, with any new light, innovative ways to use these instruments will be found. The lights are small enough to hang among the other instruments in show plots and remain rehearsal lights. The work lights can double as
portable video lights or lights for displays. Or they can be moved about any location to illuminate a dark corner providing light for painters, and carpenters. The units are inexpensive to build and maintain and will stand quite a bit of knocking around, making them ideal additions to any lighting inventory.