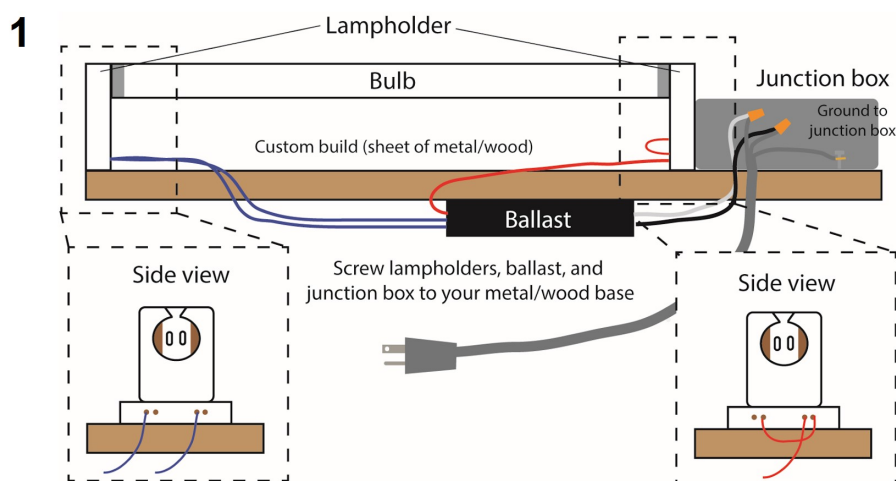


# Use existing UVGI bulbs and create a custom system to work with any set up

**Rationale:** This protocol is designed for building any size UV-C light, for multiple configurations depending on bulb size and available components. These fixtures can be wired to any cord end that works in a standard 15A outlet in the US or as locally appropriate (e.g., Type C/E in France or Type G in UK for 230V and 50Hz supply). In an ideal scenario, the bulb will be a standard size (2 ft or 4 ft) and fit fixtures that are readily available. However, in this protocol we show additional steps to alter a larger sized fixture to fit smaller bulbs. In the example images shown, we are using 3 ft bulbs that are commonly available in a biosafety cabinet (BSC) (Fig. 1). Remember, this setup can be adapted to locally available strip light fixtures, cords and plugs, wire nuts or terminal blocks, and other components. Wire colors noted here are not the same in all countries. Please follow the advice of local electrical component experts in your region.



**Safety Note:** UV exposure can cause skin and eye damage. The light assembly should not be turned on unless all occupants have adequate eye protection and there is no exposed skin. We recommend that personnel leave the room during the decontamination cycle. If this is not possible, occupants must always wear personal protective equipment (PPE) including UV safety goggles, UV face shields, tightly woven clothes, and gloves.

## **Important Factors to Consider Before Decontaminating:**

### **1) Higher UV required for higher humidity levels**

- Important when considering condition of the mask—each mask should be allowed to dry so water vapor from breathing is not left on mask at the time of decontamination.
- Decontamination should not be conducted in a particularly humid environment, otherwise mask irradiation should be adjusted accordingly. [1]

### **2) UVGI is less effective at decontaminating mask straps**

- Recommend additional decontamination using a disinfectant wipe on the straps, which is NOT an appropriate option for the filtering part of the mask. [2]

### **3) UVGI does not penetrate the interior of the mask [2]**

- The recommended doses will only provide surface decontamination. This still presents major benefits to HCWs to prevent further spread of the virus between patients, and to themselves, and other HCWs.
- Higher UVGI doses can allow for deeper penetration, but the stability of the mask materials can degrade and the number of decontamination cycles possible will be reduced.



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- 4) **US CDC, NIOSH, and FDA currently do not recommend N95 decontamination [3]**
  - a. Decontamination during this unprecedented pandemic should be done carefully with the understanding that UVGI has not been firmly tested to rigorous standards, but could help stop the spread of the virus caused from re-donning a contaminated mask.

## **Materials used:**

1. 6 ft. 16/3 SPT-3 Appliance Replacement Cord, Grey (Home Depot, Internet # 100672804, Store SKU # 588547, [Appliance Replacement Cord](#)) \*Plug Type varies by country
2. 3/8 in. Flexible Metal Conduit (FMC) Combination Clamp Connector (5-pack) (Home Depot, Internet # 100186543, Store SKU # 604070, [FMC Clamp Connector](#))
3. 14 in. UV cable tie – Black (100-pack) (Home Depot, Internet # 203531913, Store SKU # 295875, [UV Cable Tie](#))
4. Temflex 3/4 in. x 60 ft. 1700 Electrical Tape – Black (Home Depot, Internet # 310698741, Store SKU # 1004658377, [Electrical Tape](#))
5. 73B Orange WIRE-NUT Wire Connectors (100-pack) (Home Depot, Internet # 202894270, Store SKU # 621228, [Wire Nut](#)) \*Terminal blocks used in some countries
6. UV Bulb(s) (Bulb obtained from local research institution or online store)
7. Conduit box (Home Depot, Internet # 100560024, Store SKU# 299839, [Handy Box](#))
8. Conduit box cover (Home Depot, Internet # 202056194, Store SKU# 744425, [Handy Box Cover](#))
9. 660W Medium G13 Base Bi-Pin Low Profile Slide-On Turn-Type Linear Fluorescent Lampholder, White (Home Depot, Internet # 301667481, [Tombstones](#))
10. #8 - 5/8" Length Wood Screws (Home Depot, Internet # 204587445, Store SKU# 960033, [#8 Screws](#))
11. Needle-Nose Pliers
12. Phillips-Head Screwdriver
13. Wire cutter/stripper
14. Metallic or Plastic Washers for #8 Screws
15. Wooden backing board or another UV-C compliant material or fixture to attach components of the lighting assembly

## **Protocol:**

**NOTICE: After construction of the UVGI lamp assembly, UV-C output must be measured with the appropriate UV-C meter (attenuation  $\lambda=254\text{nm}$ ) in order to determine the required decontamination/irradiation times. UV-C output should be measured at essential points in the mask decontamination area. Please refer to our website (<https://gleghornlab.com/uvgi-decontamination>) for specific details. Further questions or feedback can be submitted via query in our webform (<https://forms.gle/qmhKNax5eR15hMuC8>)**

**Step 1:** This fixture can be assembled using the outlined materials above to build a completely custom light fixture to house a UV bulb (Fig. 2a). First, lay the wooden backing board, or other UV-C compliant material, on a flat surface and place the tombstones on the wood so that the slots



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for the UV bulb pins are perpendicular to the board and facing up (Fig. 2b-d). Slide the bulb into both tombstones to allow the tombstones to hold the bulb securely without too much pressure on the bulb (Fig. 2d). Station the tombstones and bulb in the desired final mounting position and use a pencil or marker to mark the tombstone locations on the backing board (Fig. 2e-2f). Mark both tombstones, making the marks clear and obvious to identify the exact spot of the tombstone (Fig. 2e-2f). Remove the bulb and line the tombstones up with the markings (Fig. 2f). In the notch of the tombstone, tighten a #8 – 5/8" length wood screw into the board (Fig. 2g). Repeat and secure second tombstone to the board (Fig. 2h).

**Step 2:** Take the conduit box and remove one of the knockouts from the side of the box (Fig. 3a-3b). On the long side of the box, knockout the metal circle in the middle by pushing the metal circle into the conduit box (Fig. 3a-3b). The edges will be sharp so take care not to cut yourself while knocking out the circular piece of metal. The conduit box should be secured to the backing board by placing at least 2 screws through the screw holes that are flush with the bottom of the conduit box (Fig. 3c). The conduit box can be placed anywhere on the backing board that works for your specific set-up; in this example assembly, we have placed it just below the tombstone on the backing board where extra wood was available. In a North American setup, partially screw in a grounding screw onto the raised portion of the conduit box (Fig. 3d). **Note: 2-prong plugs would connect to the fixture by terminal blocks rather than a GRND screw. Wire colors in the cord/fixture may be different in your country.**

**Step 3:** Remove the nut from the conduit clamp and insert the clamp into the conduit box (Fig. 4a-4b). Make sure the side with the screws and clamp are facing the outside of the box while the side the nut was removed from faces inside the conduit box (Fig. 4c). Tighten the conduit clamp nut around the conduit clamp using pliers to secure the clamp to the conduit box (Fig. 4d). Take the appliance replacement cable and insert the end with the three wires into the conduit box through the conduit clamp (Fig. 5a-5c). The other end of the power cable should be outside of the conduit box. A portion of copper on the wires will already be exposed, however more of the wire may need to be stripped to expose more of the copper wire. This can be done using wire cutters or strippers (Fig. 5d). From the three wires now inside the conduit box, take the 'ground' wire which will typically be green or bare copper without shielding, and attach it to the grounding screw in the conduit box (Fig. 5d). In our example, the ground wire is green and was attached to the grounding screw on the raised portion of the conduit box (Fig. 5d). Tighten the grounding screw to secure the wire.

**Step 4:** Next, the ballast will be secured to the back of the backing board so that it is an equal distance between the two tombstones but will not interfere with the bulb. Use two wood screws and metal or plastic washers to secure the ballast to the backing board (Fig. 6a-6b). The washer should be between the head of the screw and the ballast notch (Fig. 6b). Coming out of the ballast will be 2 blue wires and a red wire (Fig. 6b). Attach the two blue ballast wires to one of the tombstones by pushing the bare wire ends into the wire slots in the tombstone (Fig. 6c). When looking at the tombstone, there will be an opening to either side of the screw. Each opening has 2 slots that can hold a wire end. A blue wire should be pushed into slot 1, the slot furthest to the left, and the remaining blue wire pushed into slot 3, the slot to the right of the screw (Fig. 6c).



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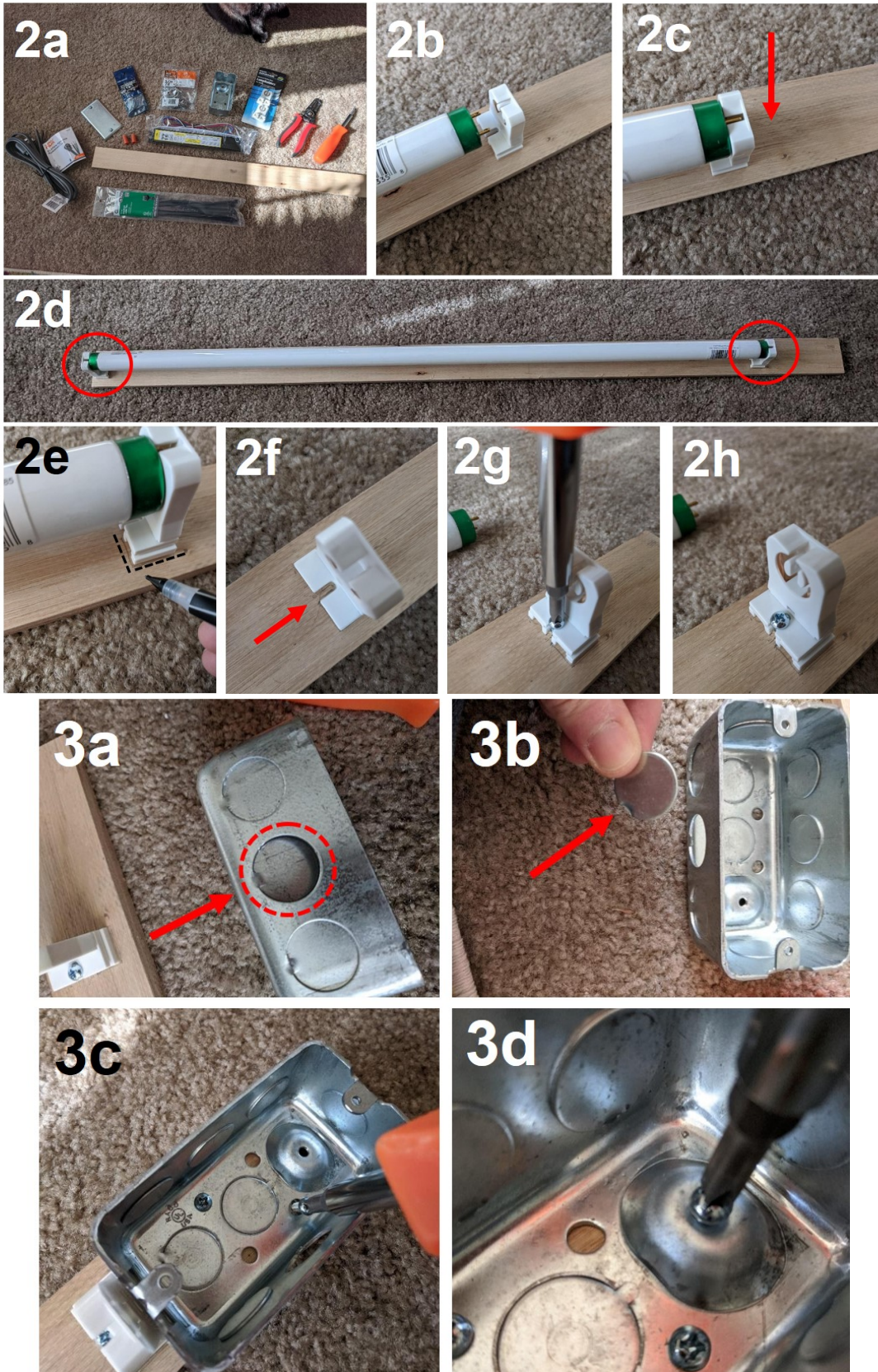
Ensure the wires are secure by gently tugging on the wire. If they easily slip out, fully remove the wires, ensure that enough of the shielding on the wire is removed and the metal is exposed, and push the wire back into the slots. On the second tombstone, a jumper wire will be needed. Create a jumper wire by cutting a small section of red wire and removing the plastic shielding on either end to expose the copper wire (Fig. 6d). The red wire that is directly connected to the ballast should be inserted into slot 3 in the tombstone. As a reminder, this is the slot to the right of the securing screw on the side closest to it (Fig. 6d). Insert the jumper wire into slots 2 and 4 (Fig. 6d). Check to make sure the red wires have been secured in the tombstones by gently tugging on them. Once the wires are secure, the tombstones have been successfully connected to the ballast.

**Step 5:** Next, the ballast needs to be connected to the appliance cable that is in the conduit box (Fig. 7a). Take the black and white wires from the ballast and insert them through the conduit clamp on the conduit box (Fig. 7b). Take one of the 2 remaining wires from the appliance cord and hold together with the white wire from the ballast box so that the ends of the cables are facing the same direction and are brought together (Fig. 7b). Place a wire nut onto the two wires and twist together in a clockwise direction until tight (Fig. 7c). Take the remaining appliance wire and repeat with the black ballast wire (Fig. 7d). Wrap the base of both wire nuts with electrical tape so that there are no gaps between the wire nut and the exposed wire within it. Using a Phillips-head screwdriver, secure the conduit cover on top of the conduit box using the screws present in the cover to secure the cover to the box (Fig. 7e-7f). The custom-made light fixture is now assembled and ready for a UV-C bulb.

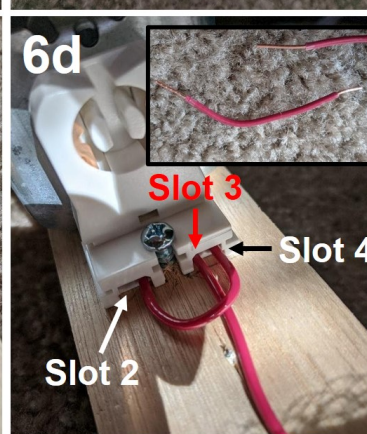
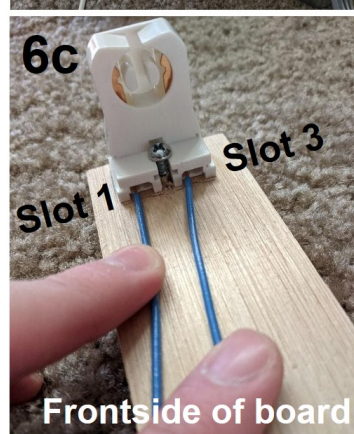
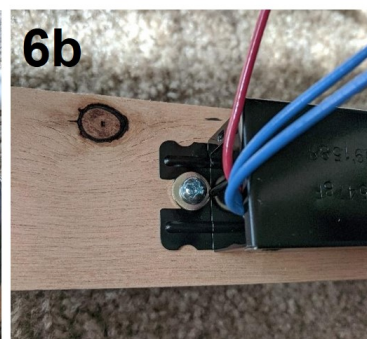
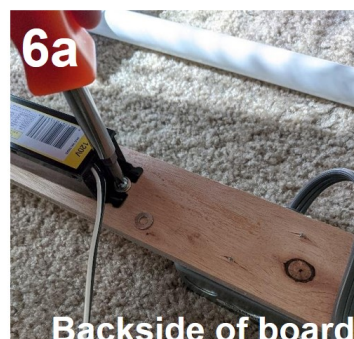
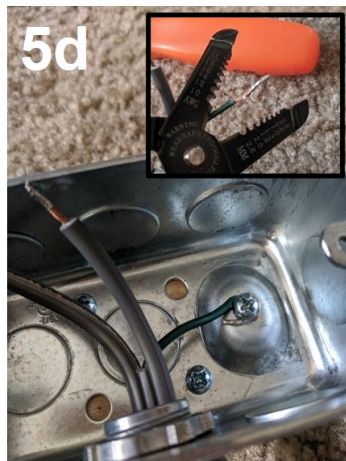
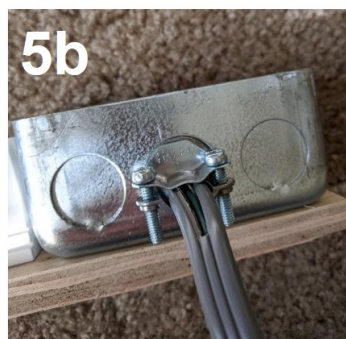
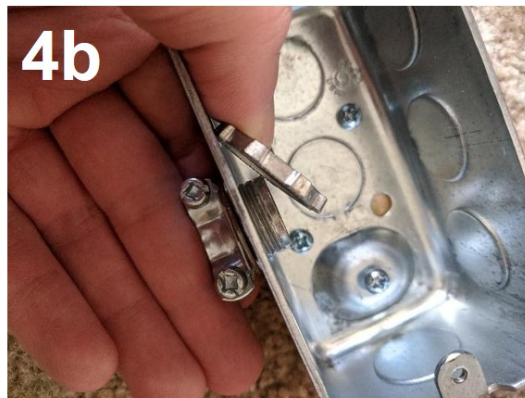
**Step 6:** Place a UV-C bulb into the tombstones by placing the pins into the connector and rotating the bulbs 90 degrees until the tombstones click and the bulb is locked in place (Fig. 8a-8b). Clean the UV bulb with a cloth to ensure it is free of any dust that might affect the UV output. Using zip ties, secure any loose wires from the ballast box to the fixture. This custom constructed fixture can be secured in the room where decontamination will be performed using zip ties. The finished product can then be plugged in and tested for UV-C output using a UV-C meter ( $\lambda=254\text{nm}$ ). Be sure to use UV-C safety while using this assembly to prevent unwanted UV exposure to personnel (Fig. 8c).



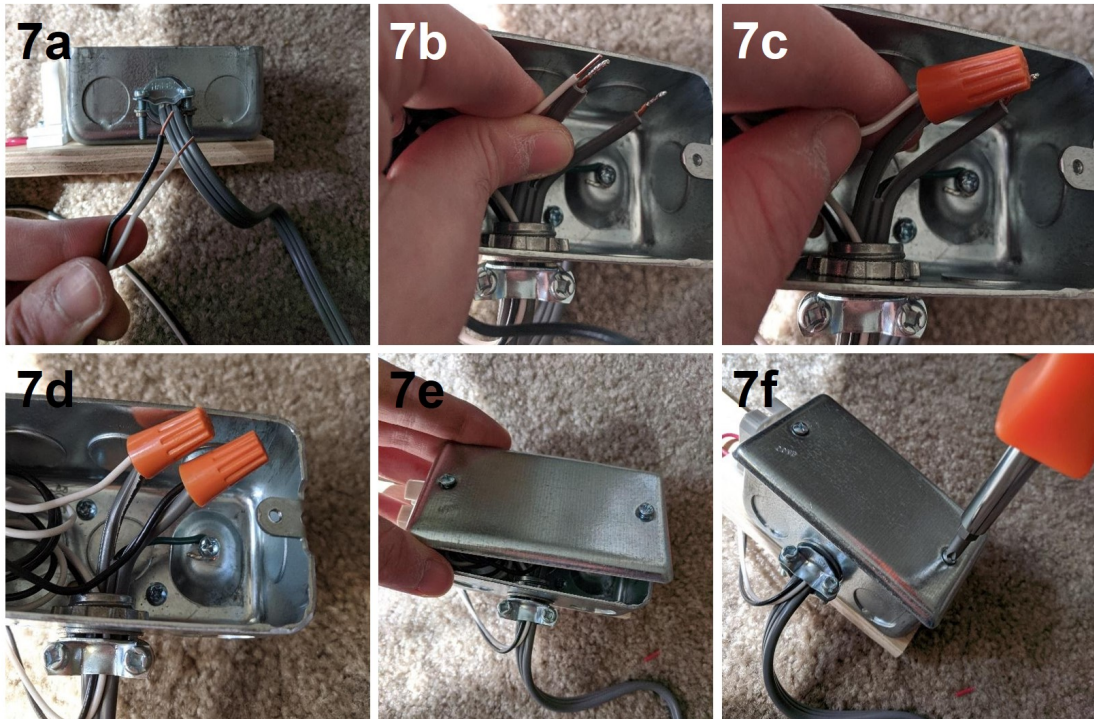
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*\*In this example set-up, a non-UV fluorescent bulb was used for demonstration.*