B&B
FLASH BOX

PLEASE BE ADVISED

- ✓ **This guide is provided to the public as an educational training aid and to document the experience of creating the FlashBox for others.**

- ✓ **We make no guarantee nor assume liability for the information presented in this document or for any misunderstandings.**

TABLE OF CONTENTS

1. SCIENTIFIC OVERVIEW

During a crisis capacity, the CDC allows for limited re-use of facemasks, but this practice during responses to Ebola and SARS was associated with self-inoculation when not done carefully. After the 2009 H1N1 novel swine origin influenza, the Institute of Medicine prompted research in to determining the best options for mask sterilization in preparation for the next respiratory illness pandemic. They found that UVGI systems are relatively quick and easy to use, and do not leave chemical residues or risk exposing workers to toxic chemicals or degrade the masks like heat methods.

… The only important factor in inactivation of the virus is the dose of UVGI and the bulbs are relatively ubiquitous and inexpensive. …[This] large cabinet delivers 100-240 mJ/cm^2 the front of the masks and 30 mJ/cm^2 to the inside of the masks in 6 minutes. …

See ‘UVGI Informational Packet’ for more information:
Ultraviolet Germicidal Irradiation for Decontamination of Medical Facemasks, Lt Col Janelle L. Robertson

Ultraviolet Germicidal Irradiation for Decontamination of Medical Facemasks

Lt Col Janelle L. Robertson

HQ AETC, Randolph AFB

Introduction:

In light of likely future face mask shortages for providers, mitigations efforts are centering on safer mask reuse. Ultraviolet Germicidal Irradiation (UVGI) is the most promising method to sanitize masks of the multiple methods studied by the Institute of Medicine and others. The Biomedical Engineering Technician Instructors (BMETs) at AETC developed a large device that uses UGVI to decontaminate up to 20 masks at a time. The 71st Operational Medical Readiness Squadron at Vance AFB developed a small device that can decontaminate up to 8 masks at a time. These device can be made quickly from inexpensive materials (approximately $600 for large cabinet and $300 for small cabinet), will safely deliver an ideal range of UVGI exposure to destroy the COVID-19 virus while minimizing degradation of the masks, and markedly slowing the burn rates of PPE. This paper includes instructions on building the smaller devices, supplies required and prices, calculations, design considerations, and a protocol for device use. It also includes a "frequently asked questions on mask mitigation efforts" section for providers who are being asked to employ this practice. The step by step instructions on building the larger device is in an attached PDF.

Background:

During a crisis capacity, the CDC allows for limited re-use of facemasks, but this practice during responses to Ebola and SARS was associated with self-inoculation when not done carefully. After the 2009 H1N1 novel swine origin influenza, the Institute of Medicine prompted research in to determining the best options for mask sterilization in preparation for the next respiratory illness pandemic. They found that UVGI systems are relatively quick and easy to use, and do not leave chemical residues or risk exposing workers to toxic chemicals or degrade the masks like heat methods.

In the lab, UVGI has been successfully used to decontaminate N95 respirators exposed to the bacteriophage MS2, and influenza virus. Single stranded RNA viruses such as COVID-19 is destroyed at very small doses from 2-5 mJ/cm^2. The University of Nebraska uses a protocol for decontaminating N95s at a 60 mJ/cm^2 dose. This dose would allow for dozens of disinfection cycles without the UVGI affecting their filtering performance. The respirator itself would eventually degrade far before filtering capability would significantly decrease. A 30-60 mJ/cm^2

dose would also be several fold higher than that required to inactivate COVID-19, providing a wide margin of safety.

The University of Nebraska is currently using a UVGI protocol to sanitize N95 facemasks using a dose of 60 mJ/cm^2 administered by a UVGI whole room tower. Brooke Army Medical Center plans on using their Xenon UV room sanitation system for facemasks should supplies run low in a similar fashion. The systems that these centers are using are expensive, with even smaller systems that can deliver this dose projected to cost thousands of dollars. The only important factor in inactivation of the virus is the dose of UVGI and the bulbs are relatively ubiquitous and inexpensive.

The large cabinet delivers 100-240 mJ/cm^2 the front of the masks and 30 mJ/cm^2 to the inside of the masks in 6 minutes. The small cabinet delivers 40mJ/cm^2 to both sides in 1 minute.

Safety:

Prolonged exposure to UVC can cause eye or skin damage. Proper PPE, to include ANSI Z87.1 certified UV eye protection, should be worn whenever in the vicinity of this device.

Cleaning, changing, and maintenance of the UV bulbs should be based on manufacturers' recommendations.

Build Specifications and Information on UVGI Device that Can Decontaminate 8 Masks

1st Lt Mitchell Guerin
Vance AFB

Introduction/Background:

Due to uncertainty surrounding the COVID-19 pandemic and its duration, conservation of PPE such as N-95 respirators has been a key concern for medical facilities throughout the country. Under normal conditions, N-95s are single use—meant to be disposed of after being worn once.

When all methods to preserve N-95 filtering face-piece respirator supplies fail and there becomes a shortage, the decontamination of respirators may be the only viable option to ensure the safety of healthcare workers. The Center for Disease Prevention and Control (CDC) recommends, among other options, the use of ultraviolet germicidal irradiation (UVGI) for decontamination in a critical shortage. See https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/decontamination-reuse-respirators.html for a more detailed explanation of current PPE reuse guidelines.

Note: According to the Center for Disease Control (CDC) and National Institute for Occupational Safety and Health (NIOSH), decontamination of N-95 respirators should not be used as standard of care.

Safety:

This device includes electrical components and UV light emitters. Proper PPE, to include ANSI Z87.1 certified UV eye protection, should be worn whenever in the vicinity of this device.

Components & Prices:

In order to simplify the repeatability of our design, all components (with the exception of the UV lamps) were purchased at our local Wal-Mart. Any hardware store will likely have similar components. UV lamps can be found online or at some hardware/HVAC stores—note that the lamps need to operate at the appropriate wavelength (250-260 nm) in order to reliably inactivate pathogens. Look for packaging that indicates “germicidal” capabilities—these are most commonly used to treat air handlers in HVAC units.

Parts Listing

- Sterilite Modular Stacker Container ($16) – 39.76” x 21.5” x $17^{7/8}$”

- 2x Clean Comfort™ 36 Watt Dual Lamp Ultraviolet Coil Purifier ($135 each, price and model may differ based on availability)

- 1x Aluminum Foil ducting tape HVAC ($8.99)

- 1x Heavy Duty Aluminum Foil, 150 sq. ft. ($5.48)

- 2x replacement lamp cord ($3.77 each)

- 2x basic electrical switches ($2.94 each)

- 1x 2 gang switch box ($2.27)

- 2x UV Safety glasses ($10 each)

- GermAway UV-C Disinfection Visualizer Strips or UV monitor ($12.99-$150)

Total cost for complete system: **$349.15**

Calculations and Design Considerations:

IMPORTANT NOTE: There are various assumptions, estimations, and oversimplifications within these calculations. This is to prevent the calculations from being prohibitively complex, and to allow others to perform similar calculations with modified parameters (such as a different wattage UV lamp or different sized container). Various safety factors are included in the final calculations to account for inaccuracies, and these can be modified based on your confidence in the design of the device. That said, we recommend testing the efficacy of the completed device with a UV dose monitor before any clinical-related use of the device occurs.

Key Assumptions/Simplifications:

-Perfect reflection and conservation of energy→innacurate, assign uncertainty factor of 0.5

-All energy delivered to base of device from point source→innacurate, assign uncertainty factor of 0.5

-Even distribution of light dose along all masks→innacurate, assign uncertainty factor of 0.75

These uncertainty factors combine for a total safety factor of 0.1875

0.5 * 0.5 * 0.75 = 0.1875

To use this safety factor, multiply by the theoretical average dose obtained to yield an estimated “safe” dose.

For example, our calculated dose rate at the mask surface is 4.4 millijoules per square centimeter per second (mJ/cm^2s). With the safety factor of 0.1875, we can comfortably estimate that the minimum dose rate anywhere along the base of the device is at least 0.82 mJ/cm^2s (4.4 * 0.1875 = 0.82)

Design Requirements

- 30 mJ/cm^2 minimum total dose on each surface of N-95 at 260 nm wavelength (this is the dose required to ensure Covid-19 virus is inactivated)
- Able to treat multiple masks to ensure safety of re-use for up to 5 treatment cycles
- Portable and inexpensive

Calculation Rationale

UV lamps are typically designated by their wattage, or their electrical operating power. In order to make this information usable in the context of viral inactivation, we need to find the surface power density (milliwatts per square centimeter, mW/cm^2). At a basic level (refer to the assumptions above), this involves dividing the output power of the UV lamp by the irradiation surface area.

However, not all of the electrical energy entering the lamp is perfectly converted into light energy at the right wavelength—quite a bit of energy is lost as heat or emitted at a different wavelength. Based on similar models and conservative estimates, we used 30% efficiency for our calculations. Therefore, each of our 36W lamps is yielding roughly 10.8W of "useful" irradiation.

36 W * 0.3 = 10.8W 2 lamps, so total output→ 2 * 10.8W = <u>21.6 W</u>

So far, our units are still units of power, but dosage is energy, in this case Joules (J).

Thankfully, manipulation of the units in this case is simple→ 1 Watt = 1 Joule per second (J/s) = 1000 millijoules per second (mJ/s).

The surface area of our device base (the area where the N-95s are placed) is 4094 cm^2.

We can therefore calculate a surface power density of 21,600 mJ/s divided by 4094 cm^2.

This yields a theoretical average power density of 4.39 millijoules per square centimeter per second.

Due to the uncertainty and simplifications mentioned, with a safety factor of 0.1875 we can confidently say there is at least a surface power density of 0.82 mJ/cm^2 per second on all exposed areas of the N95.

To calculate the dose (in mJ/cm^2), simply multiply the surface power density by the time (in seconds) the device is used. For example, 60 seconds of treatment with our device yields a dose of 49.2 mJ/cm^2, which is more than the 30 mJ/cm^2 design requirement.

0.82 mJ/cm^{2}s * 60s = 49.2 mJ/cm^2

If confidence in your design is low or respirator users express concerns about effectiveness, simply increase the treatment time to increase the overall dose to an acceptable level. 3 minutes on each side is a commonly quoted treatment time that would be more than sufficient to inactivate any viruses.

Will UV light degrade my PPE?

Degradation of masks from UV light exposure is a common concern. Excessive exposure at high dose rates can degrade the materials in the filter and the elastic straps. Studies conducted through NIOSH[1] found that UV exposure compromised particle penetration, flow resistance, and respirator strap elasticity. However, the UV doses tested ranged from 120 to 950 joules per square centimeter. The doses our device produces (around 90 millijoules per square centimeter in a treatment cycle) are more than a thousand times lower than the tested levels.

We were able to perform a rough check of respirator degradation using a quantitative fit test. We performed a fit test on a new mask, then subjected it to numerous treatments before conducting another fit test. After 5, 10, and 20 treatment cycles (1 minute on each side) there was no decline in fit factor. Typically N-95s are recommended to be reused not more than 5 times

Other Considerations

We lined our device interior with heavy duty aluminum foil and HVAC ducting tape (including the lid) for several reasons. First, we wanted to reflect as much light as possible onto the masks, and aluminum is an excellent reflector of ultraviolet light. Second, UV light can degrade petroleum based products such as the plastic in our container, so the foil provided a layer of shielding.

Our device comfortably fits 8 N95 respirators, which might be insufficiently sized for a large clinic. A larger container could be used, but efforts should be made to ensure that light distribution is as even as possible, potentially by adding more UV lamps or making multiple devices. This prevents N95s directly under the lamp from being over-dosed and farther away N95s not getting enough dose.

N95s should be dry and unsoiled before treatment. If the respirator is visibly soiled, it should be thrown away—UV treatment will not be sufficient to sterilize it.

Take care to ensure nothing obstructs UV light rays from reaching all components of the mask.

UV devices should be tested for efficacy before being used in any healthcare settings. Ideally, a UVC monitoring device should be used. There are commercially available UVC germicidal test strips which change color after they receive a certain dose, but these may be “overkill”—they are designed for the doses needed to inactivate more resilient pathogens such as MRSA.

Design of the device and subsequent sterilization procedures should be a joint effort between your team, Public Health, and your Infection Control team to ensure all aspects of PPE sterilization are considered.

Basic Build Instructions

1. Line the entirety of storage crate and lid with heavy duty aluminum foil. Affix with HVAC ducting tape.

2. Assemble your UV lamps & mounts, and decide where to place your lamps in the storage crate. For our design, we positioned each lamp 11" from each side, measured from the base of the crate.

3. Mount lamps in storage container, spacing apart at equal distances based on how many lamps are used. We screwed our lamp bases into wooden blocks for added stability.

4. Based on the size of your lamp power cord, drill 2 holes in the storage crate and pass power cord through to exterior.

5. Wire each lamp power source to a single-pole switch and wall outlet power cord*. Cover any exposed wiring w/ electrical tape.

*Ensure your UV lamp is compatible with a 120V power source, or a transformer will be needed.

6. Utilize UV eye protection any time device has power, even when switches are off.

Note: This is not a comprehensive guide for use of the UV device; it is intended to help communicate design considerations for construction. Safety considerations, infection control procedures, PPE for the disinfection process, and more need to be developed in conjunction with your Infection Control and Public Health team to ensure usage is appropriate for your unique circumstances.

Study Source:

1. https://www.cdc.gov/niosh/nioshtic-2/20045956.html

Suggested Protocol for PPE Mitigation for Mask Decontamination and Reuse

- Healthcare professional retrieves a new N95 face mask. Prior to wearing it for the first time, label the FFR with the user's name, department/unit location, and date of first use.

- HCP dons the N95 mask per policy to ensure integrity of respirator and proper fit.

- Use during patient care for extended use without removal between patients.

- Ensure that hand are cleaned with soap and water or an alcohol-based hand sanitizer before and after touching or adjusting the Filtering Face Respirator (FFR).

- When the mask is to be removed (end of shift, break for meal, etc.), ensure that hands are cleaned as above.

- The mask should be carefully removed following appropriate doffing guidelines and placed into the cabinet. The elastic strap should be looped over the holding rod inside the UVGI cabinet. The outside of the mask should face the UV bulb.

- Be careful not to overload the cabinet with masks, placing at maximum 20 masks inside for the large cabinet and 8 masks in the small cabinet without overlap. Any areas that are "shadowed" would not be exposed to UV light and might retain organism.

- Once masks are loaded into the cabinet, ensure that the cabinet is completely closed as UV light can be a hazard to exposed eyes/skin.

- At the back of the large cabinet are a set of timers, select 6 minutes of decontamination time. For the small cabinet, turn on the device for 1 minute.

- Once the cabinet has been in operation for the appropriate amount of time and is off, it can be opened.

- A user with clean gloves can gather the masks from the cabinet.

- A marker can be used to make a tic mark on the mask to count number of times the mask has been decontaminated. The masks can then be placed them into paper bags.

- The mask can be stored in a clean paper bag with the users name/ work location/ and/or any pertinent information for retrieval when needed again.

- When the mask is needed again, use a pair of clean (non-sterile) gloves for retrieving the mask, when donning, and when performing a user seal check. Avoid touching the inside of the FFR.

- Visually inspect the FFR to determine if its integrity has been compromised.

- Check that components such as the straps, nose bridge, and nose foam material did not degrade, which can affect the quality of the fit, and seal.

- If the integrity of any part of the FFR is compromised, or if a successful user seal check cannot be performed, discard the FFR and try another FFR.

- Users should perform a user seal check immediately after they don each FFR and should not use a FFR on which they cannot perform a successful user seal check.

- Of note: Based on data regarding viral persistence in the environment and on mask materials for approximately 72 hours, the CDC suggests considering 5 separate masks on a rotating basis. This protocol could be used in conjunction with a 5 day rotating mask protocol or can be used with shorter protocols or with one mask, acknowledging that all significantly mitigate risk, with the 5 day combined protocol decreasing risk most. University of Nebraska continues to use the facemasks until the integrity of the mask is compromised, regardless of the number of decontamination cycles. Alternatively, 5 decontamination cycles is a reasonable number of cycles to expect continued facemask integrity.

- Additionally, this mask protocol can be modified to fit the needs of the facility as long as the central components of careful donning/doffing, appropriate checks to ensure continued integrity of the masks, UVGI use at the appropriate dose, and no sharing of masks between healthcare workers are continued.

FAQs for Face Mask Shortages and Mitigation Strategies

What are the CDC recommendations for face mask mitigation strategies?

During crisis capacity the CDC allows for limited re-use of facemasks.

One HCP can use a mask for multiple encounters with different patients, removing it after each encounter. Care should be taken not to touch the outer surface of the mask during care, removal should be done carefully and deliberately. The mask should be folded so that the outer surface is held inward against itself to reduce contact with the outer surface during storage. It can be stored in a clean sealable paper bag or breathable container. If soiled, damaged, or hard to breathe through it cannot be reused. The facemasks that fasten by ties cannot be reused.

Given that the virus can persist on surfaces like the medical masks for up to 72 hours, the CDC has as an option issuing at least 5 masks per provider. The mask would be worn during the shift, taken off when no longer required and then stored in a paper bag. Rotation of the masks would allow for 4 days before a mask would be reused, allowing for natural degradation of the virus. They suggest decontamination by other means can be used during a crisis capacity and outline the most promising strategies of UV Germicidal Irradiation (UVGI), vaporous hydrogen peroxide (VHP), and moist heat.

When no masks are available, listed as lower preference to options such as let younger providers care for COVID patients and task providers who have recovered is the recommendation that HCPs might use homemade masks "as a last resort. However, homemade masks are not considered PPE since their capability to protect HCP is unknown".

https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/face-masks.html

Are there any safer ways to reuse a face mask?

UV Germicidal Irradiation is one of the most promising methods as they are relatively quick and easy to use, and do not leave chemical residues or risk exposing workers to toxic chemicals. University of Nebraska has a protocol for UVGI N95 sanitization and reuse already in practice.

CDC guidance released on 1 April 2020 notes that facemask decontamination and reuse would not be considered a usual care standard, but in crisis situations this process can be used to ensure continued availability. Their guidance also notes that UVGI does not appear to break down filtration or compromise the facemasks at doses that would be appropriate for inactivating the virus. They cite a 2015 study by Lindsley et al. that reports a reduction of the durability of materials of the FFRs for doses ranging from 120–950 J/cm^2 but these UVGI doses were markedly higher than those required for UVGI disinfection of RNA viruses. A 2007 study showed that single stranded RNA viruses, such as SARS-CoV-2, are inactivated by UVGI

exposures of 2-5 mJ/cm^2. This study prompted the University of Nebraska to select UV light for N95s disinfection at a dose of 60 mJ/cm^2, allowing for a wide margin of safety without damage to the masks and their protocol for disinfection is included for review.

In other lab studies that specifically looked at pathogen deactivation on N95 masks, UVGI has been successfully used to decontaminate N95 respirators exposed to the bacteriophage MS2, and influenza virus. Two studies of UVGI disinfection of respirators exposed to droplets and aerosols containing influenza virus found that a 1.8 J/cm^2 dose was sufficient to reduce the amount of viable influenza virus by a factor of >10^4 (>4-log reduction). This suggests that, for influenza virus, dozens of UVGI disinfection cycles could be performed on respirators without the UVGI affecting their performance. The respirator itself would eventually degrade before the filtering capability was significantly impacted.

Journal of Occupational and Environmental Hygiene. 2015; 12(8): 509–517
Journal of Occupational and Environmental Hygiene. 2007; 4(6): 400-405
American Journal of Infection Control 46 (2018) e49-e55
https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/decontamination-reuse-respirators.html

How effective are the different types of masks in blocking inhaled particles?

According to one 2014 study, N95 masks, as expected, block more than 95% of inhaled particles. Dental masks block 60% and surgical masks block 40% of inhaled particles. Cotton masks block 30% and cotton handkerchiefs block 2-13%. A 2010 study was similar in that t-shirt masks blocked 10% of particles, sweatshirt fabric blocked 20-40%, terry cloth blocked 40%, and scarves blocked 10-20%. However, a 2015 study of health care workers in Vietnam tested cotton masks and found they only blocked 3% of particles and likely increased the rate of infections in the wearers.

Aerosol and Air Quality Research, 2014; 14: 991–1002,
The Annals of Occupational Hygiene, 2010; 54 (7): 789-798
BMJ Open Access 2015; 5: e006577

Are homemade masks for HCWs an option?

No, they likely increase the infection risk to providers.

1607 hospital HCW in Vietnam were randomized to medical masks, cloth masks, or a control group (usual practice, which included mask wearing). Outcomes were clinical respiratory illness, ILI, and lab confirmed respiratory viral infection. Highest infection rates were in cloth

mask arm (RR=13). Penetration of cloth masks by particles was almost 97% compared to surgical masks at 44% and N95s at <0.01%. Because of the magnitude of the difference (esp. in light of the poorly filtering medical masks used), authors suggested that moisture retention, reuse, and poor filtration resulted in increased risk of infection. They recommend that they not be used, particularly in high risk situations.

BMJ Open Access 2015; 5: e006577

Should HCWs double mask or put cloth masks over their masks to "save" N95 masks?

No, this increases the risk of infection.

Observations during SARS suggested double-masking and other practices increased risk of infection because of moisture, liquid diffusion, and pathogen retention, similar to what can occur with the use of cloth masks in health care workers.

American Journal of Industrial Medicine 2006 Dec; 49(12): 1056-65

Are homemade masks for patients an option?

They do contain some exhaled particles but they are much less effective than surgical masks.

Twenty one healthy volunteers made face masks from cotton t-shirts, tested for fit. The number of microorganisms isolated from coughs through homemade masks, surgical masks, or no masks was compared using air-sampling techniques. The surgical mask was 3x more effective than homemade mask and these masks should only be used as a "last resort" but ultimately do not recommend them to protect against aerosols.

Disaster Med Public Health Preparedness. 2013;0:1–6

Is there a significant risk to doffing PPE?

Yes, we do it poorly!

Medical masks frequently have respiratory viruses on them and healthcare workers take off their PPE incorrectly 90% of the time. If healthcare providers take off PPE incorrectly and do not practice good hand hygiene, the benefits of mask decontamination would be negated.

BMC Infectious Diseases 2019 June 3; 19(1): 491
Journal of Occupational Hygiene 2019 Aug; 16(8):575-581

This link is to the WHO instructions for appropriately removing PPE:
https://www.who.int/csr/disease/ebola/remove_ppequipment.pdf

2880 Bergey Road, Ste. K
Hatfield, PA 19440
www.envservices.com
800 - 345 - 6094

Presents:

UV Intensity Report

Prepared for:

HQ AETC SG

Unit Tested:
UV DECON BOX

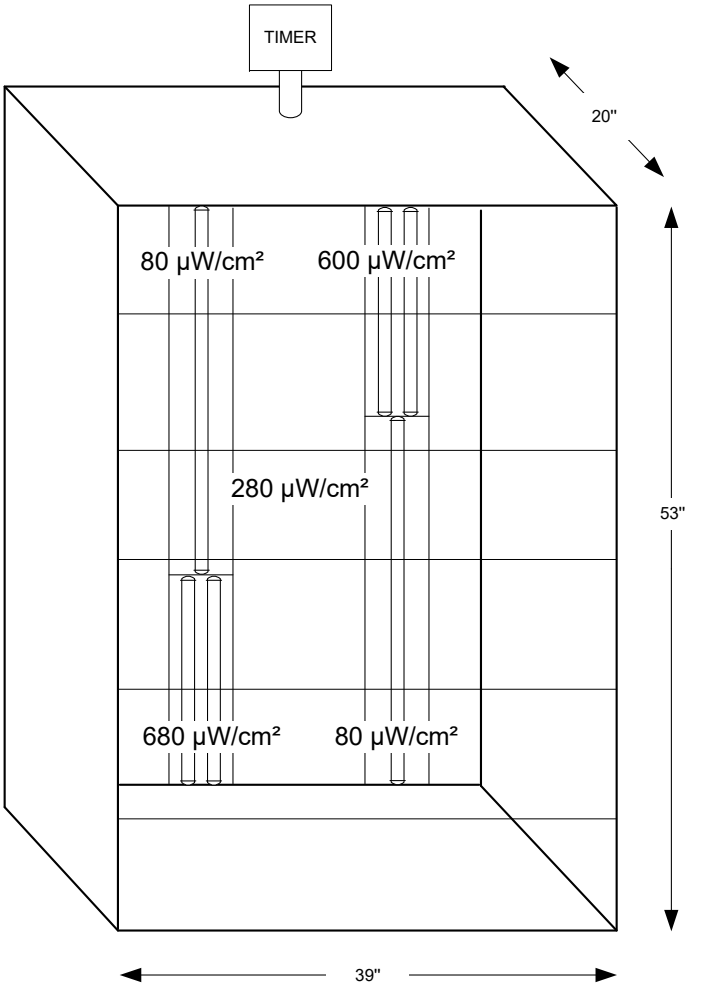
Date(s) Tested:

APRIL 2, 2020

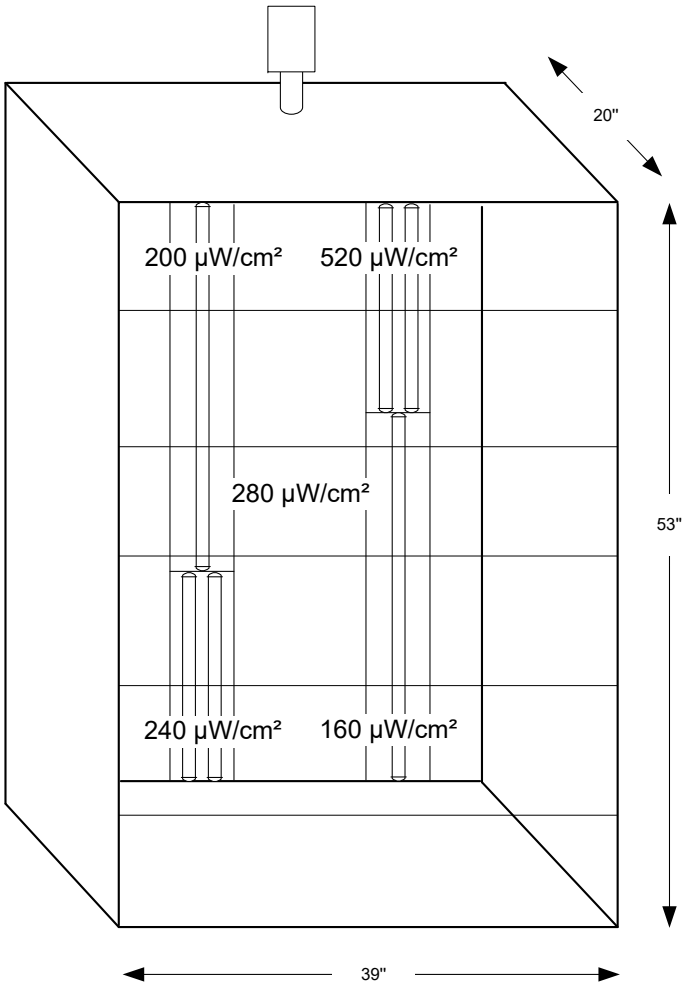
Field Service Technician(s):

JAMES KVAPIL, MICHAEL BURRAGE & JASON QUINN

UV LIGHT INTENSITY READINGS



All readings taken with sensor facing inside, towards UV lights



All readings taken with sensor facing inside, towards UV lights

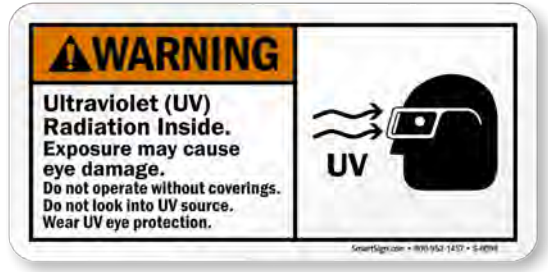
TEST EQUIPMENT

Equipment Name	Manufacturer	Model	Serial	Calibration Due Date
UV LIGHT METER	UVP	J225	45408	13 JAN 2021

Test equipment calibration certificates available upon request.

2. SAFETY PRECAUTIONS

- ✓ **Prolonged exposure to UVC can cause eye or skin damage.**
- ✓ **Proper PPE, to include ANSI Z87.1 certified UV eye protection, should be worn whenever in the vicinity of this device.**
- ✓ **Cleaning, changing, and maintenance of the UV bulbs should be based on manufacturers' recommendations.**



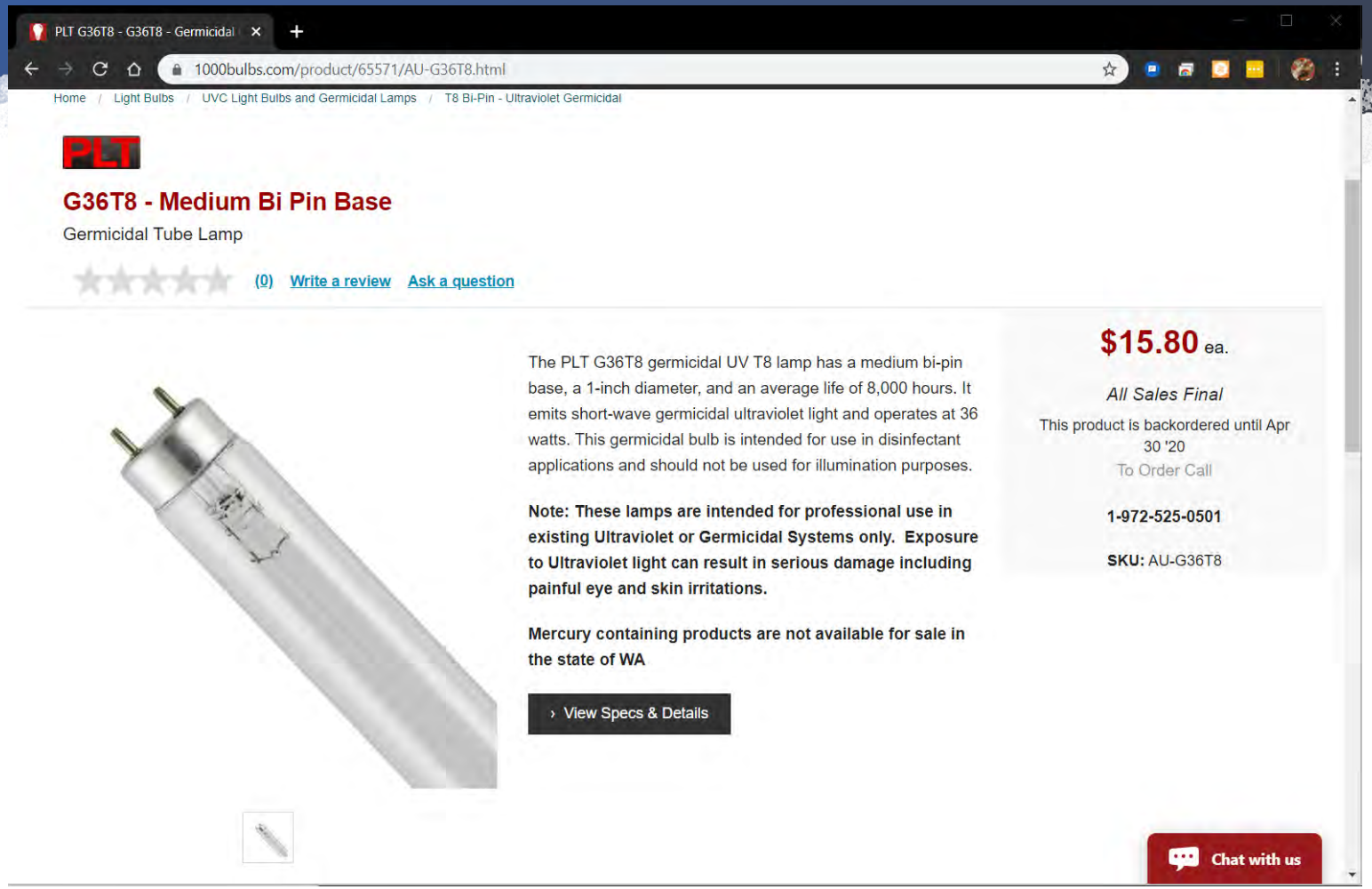
3. MAIN PARTS LISTING

Item	In Store Loc	Qty	Item Total
 Master Magnet 0.7 in. Neodymium Rare-Earth Magnet Discs (3 per Pack) Model #07047HD	Aisle 04 Bay 001	5	$24.85
 HDX 150 ft. 16/3 Extension Cord Storage Reel Model #HD-130PDQ	Aisle 35 Bay 005	1	$8.77
 Master Magnet 1/2 in. Neodymium Rare-Earth Magnet Discs (6 per Pack) Model #07046HD	Aisle 04 Bay 001	3	$14.91
 HDX 100 ft. 16/3 Indoor/Outdoor Extension Cord, Orange Model #HD#277-525	Aisle 35 Bay 003	1	$17.97
 BELL 1-Gang Weatherproof Deep Gray Box with Three 1/2 in. Threaded Outlets Model #5385-0B	Aisle 37 Bay 016	1	$9.51
 Gardner Bender 304-Piece Electrical Project Kit, Includes Tools, Tester, Wire Nuts, Cable Ties, Staples and Tape in Reusable Canister Model #EVK-003	Aisle Bay	1	$19.30
 Halex 1/2 in. ACC Non-Metallic Strain Relief Cord Connector Model #27693	Aisle 36 Bay 005	12	$24.48
 Dura Corp 3/4 in. Schedule 40 PVC Cross Model #C420-007	Aisle 10 Bay 001	2	$5.34
 3M Scotch 3/4 in. x 15 ft. 2242 Electrical Splicing Tape Model #6165-BA-10	Aisle 31 Bay SC2	1	$4.95
 Metalux 32-Watt 2-Light White 4 ft. Fluorescent Strip Light Model #SSF232R	Aisle 34 Bay 006	4	$99.88
 JM eagle 3/4 in. x 10 ft. 480-PSI Schedule 40 PVC Plain End Pipe Model #57471	Aisle 20 Bay 002	10	$1.95

	Dura Corp 3/4 in. x 1/2 in. Schedule 40 PVC Reducer Bushing Model# C438-101	Aisle 10 Bay 001	1	$0.78
	OOK 25 ft. 55 lb. 16-Gauge Galvanized Steel Wire Model #50130	Aisle 04 Bay 028	1	$2.28
	Charlotte Pipe 3/4 in. PVC Sch. 40 S x S Tee Model #PVC024000800HD	Aisle 20 Bay 001	12	$6.84
	Twist and Seal Cord Protect Outdoor Extension Cord Cover and Plug Protection, Green Model #TSCP-G-1000	Aisle 37 Bay 015	1	$4.97
	Husky 2 in. Ratcheting PVC Cutter Model #16PL0805	Aisle 20 Bay 019	1	$24.98
	Carlon 3/4 in. Schedule 40 and 80 PVC Type-LB Conduit Body Model #E986E-CTN	Aisle 44 Bay 003	1	$3.96
	BELL 1-Gang Horizontal or Vertical Mount Weatherproof Flip Lid Device Cover Model #MX1050SB	Aisle 44 Bay 005	1	$3.67
	Charlotte Pipe 3/4 in. Side Outlet 90-Degree Socket x Socket x Socket Elbow Model #PVC025100800HD	Aisle 10 Bay 001	18	$35.64
	HDX 15 ft. 16/3 Indoor/Outdoor Workshop Extension Cord, Black Model #SJTW16315BL	Aisle 35 Bay 001	1	$9.98
	Husky 15 Amp In-Line GFCI with Power Block Model #04-00105	Aisle 35 Bay 001	1	$33.97
	Dura Corp 3/4 in. Schedule 40 PVC Coupling Model #C429-007	Aisle 10 Bay 001	4	$1.84

	Shurtape 2.5 in. x 60 yds. Aluminum Foil Repair Tape Model #242807	Aisle Bay	1	$16.57
	Husky Screwdriver Set (2-Piece) Model #246340020	Aisle 02 Bay 008	1	$3.97
	Defiant 15 Amp 4-Hour In-Wall Push Button Countdown Timer Switch with Screw Terminals, White Model #30469	Aisle 35 Bay 013	1	$24.98
	Everbilt 48 in. x 25 ft. Double Reflective Insulation Model #ADD04 1220x7.5	Aisle BW Bay 001	2	$86.42
	HDX 16 oz. Rubber Mallet Model #31030	Aisle 02 Bay 010	1	$5.47
	3 in. Square Black Indoor Station With Digital Countdown Timer And Stopwatch Model #38.2013.01	Aisle Bay	1	$14.99

UV-C GERMICIDAL BULBS



UV-C LIGHT METER

GENERAL Ultra Violet Light Mete ×

grainger.com/product/GENERAL-Ultra-Violet-Light-Meter-3GZX4

GENERAL

Ultra Violet Light Meter, UV C

Item # **3GZX4** Mfr. Model # **UV512C** Catalog Page # **N/A** UNSPSC # **41115308**

Web Price

$637.00 / each

1 **Add to Cart**

+ Add to List |

Shipping Pickup

Backordered, expected to arrive between **Tue. Apr 21 - Tue. May 05.**

Ship To **75201** (Change)

Shipping Weight **2.21 lbs.**

Country of Origin **Taiwan** | *Country of Origin is subject to change.*

Note: Product availability is real-time updated and adjusted continuously. The product will be reserved for you when you complete your order.
More

How can we improve our Product Images?

Compare

Technical Specs

Item	**Ultra Violet Light Meter**	Memory	**20 Point**
Lighting Types	**UV C (220 to 270 nM)**	Battery Type	**9V**
Measuring Range	**1 to 1999 uW/cm2, 0.01 to 40 mW/cm2**	Cord Length	**46"**
Accuracy	**+/-4% +/-1 Digit**	Calibration Certificate	**NIST**
Display	**Backlit 4 Digit LCD**	Includes	**Sensor, Battery and Instructions**

4.TOOLS

- ❑ Rubber mallet
- ❑ Side Cutters
- ❑ Philips head screwdriver
- ❑ Flat head screwdriver
- ❑ Needle-nose Pliers
- ❑ Dry erase marker
- ❑ 2” Ratcheting PVC cutter
- ❑ 8” Zip ties
- ❑ Tape measure
- ❑ Powered screwdriver (optional)
- ❑ Adjustable wrench (optional)

5. PPE

EDGE EYEWEAR

Dakura Scratch-Resistant Polarized Safety Glasses , Aqua Precision Blue Mirror Lens Color

Item # 4NXX7 Mfr. Model # TSMAP218 Catalog Page # N/A Catalog Group # H1159 UNSPSC # 46181802

Web Price

$38.25 / each

1 Add to Cart

+ Add to List |

Confirm ZIP Code to determine availability.

75201 Save

Shipping Weight 0.07 lbs.

Country of Origin Taiwan | *Country of Origin is subject to change.*

Note: Product availability is real-time updated and adjusted continuously. The product will be reserved for you when you complete your order.
More

How can we improve our Product Images?

Compare

Product Details

Edge Eyewear® Dakura polarized safety glasses feature a traditional, wraparound frame style perfect for those wanting tighter eyewear that looks great
View More

Technical Specs

Item	Polarized Safety Glasses	Frame Material	Nylon
Series	Dakura	Lens Material	Polycarbonate
Gender	Unisex	Temple Color	Black
Lens Color	Aqua Precision Blue Mirror	Temple Style	Straight
Polarized Lens	Yes	Photochromatic Lens	No
Lens Coating	Scratch-Resistant	Metal Detectable	No
Foam Lined	No	X-Ray Detectable	No
Eyewear Frame Design	Wraparound	UV Protection	99.99% UVA/UVB/UVC

6. ASSEMBLY

- ✓ **Please keep in mind that this project involves 120VAC power which can be dangerous and deadly if not used safely. Only trained personnel should attempt to build, maintain or repair equipment such as this FlashBox.**

- ✓ **Also be aware of sharp tools, edges flying debris as this can lead to injury to life and limb.**

ASSEMBLY PART 1

Step one	**Cut 8 PVC pipes at 49 inches long each. These will be the side pieces going from bottom to top (height)**
Step two	**Cut 8 PVC pipes at 8 ¼ inches long. These pieces will be used to assemble the top and bottom sections in-between the light fixtures on the rear (length) of the unit.**
Step three	**Cut 8 PVC pipes at 16 ½ inches long. These pieces will be used as the bottom and top sides (width).**
Step four	**Cut 8 more PVC pipes at 16 ½ inches long. These pieces will be used for the bottom and top front spacing (front length).**

ASSEMBLY PART 2

Step five	**Cut 8 PVC pipes at 6 ½ inches long. These pieces will be used to assemble the top and bottom in-between the light fixtures on the rear (length) of the unit.**
Step six	**Cut a piece of insulation using the full width of 48 inches by a length of 25 inches long. (48”x 25”). This will be the bottom panel.**
Step seven	**Cut a piece of insulation using the full width of 48 inches by a length of 30 inches long. (48”x 30”). This will be the top panel.**
Step eight	**Cut a piece of insulation using the full width of 48 inches by a length of 91 inches long. (48”x 91”). This will become the wrap from the front around the sides and back all the way to the front again.** **Cut last piece of insulation 12 feet x 24 ½ inches (12’x25.5”)**

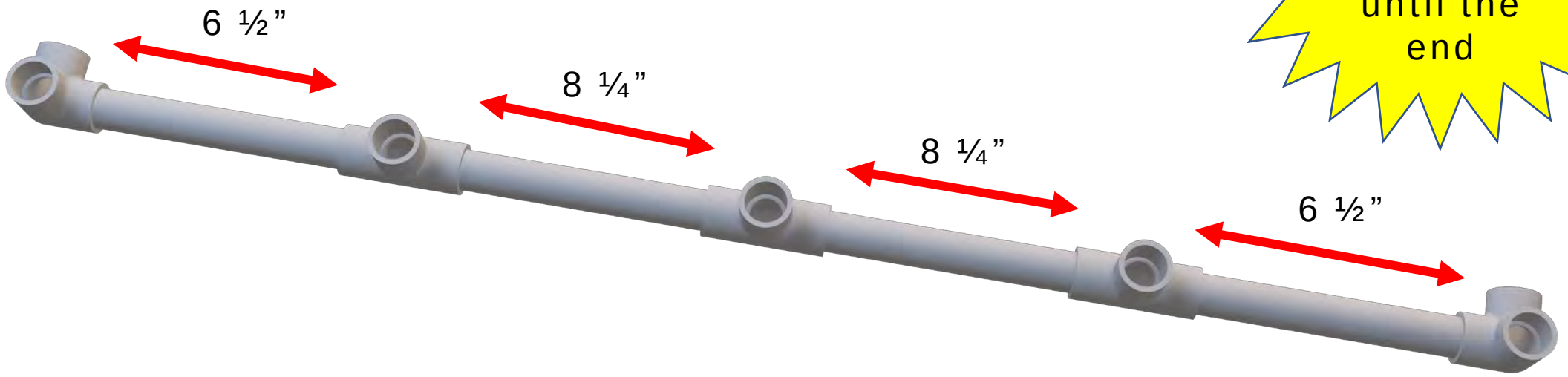
ASSEMBLY PART 3

Step nine	**Cut Black extension cord in half which should be roughly 43 inches.**
Step ten	**Cut orange extension cord receptacle end off (Female end). Starting from the cut end measure and cut off two 56 inch pieces. Cut another 2 pieces measuring 35 inches. The four pieces will be used to wire the light fixtures. The rest of the cord will be to connect 120VAC to the power / timer switch.**

ASSEMBLY PART 4

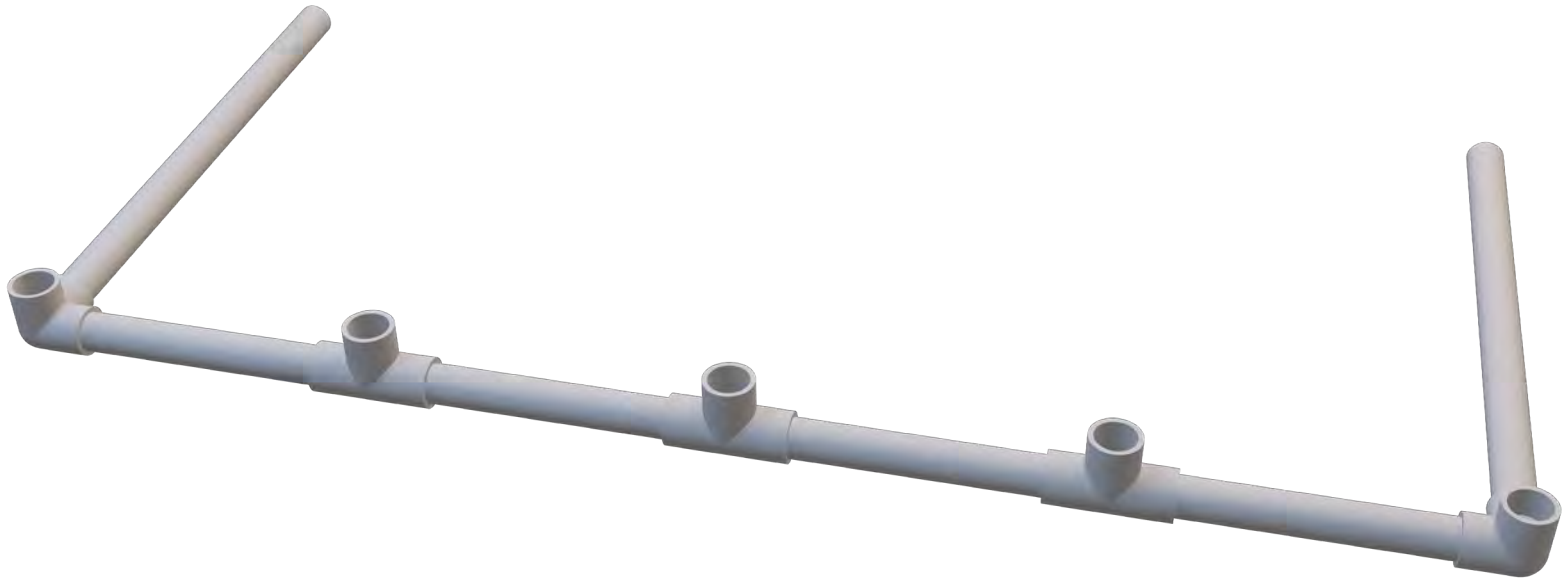
- Combine two PVC 3-way elbows, two 8 ¼ inch pipes, two 6 ½ and three tees *example below.
- Make two of these segments.

Pro Tip! Keep fittings loose until the end



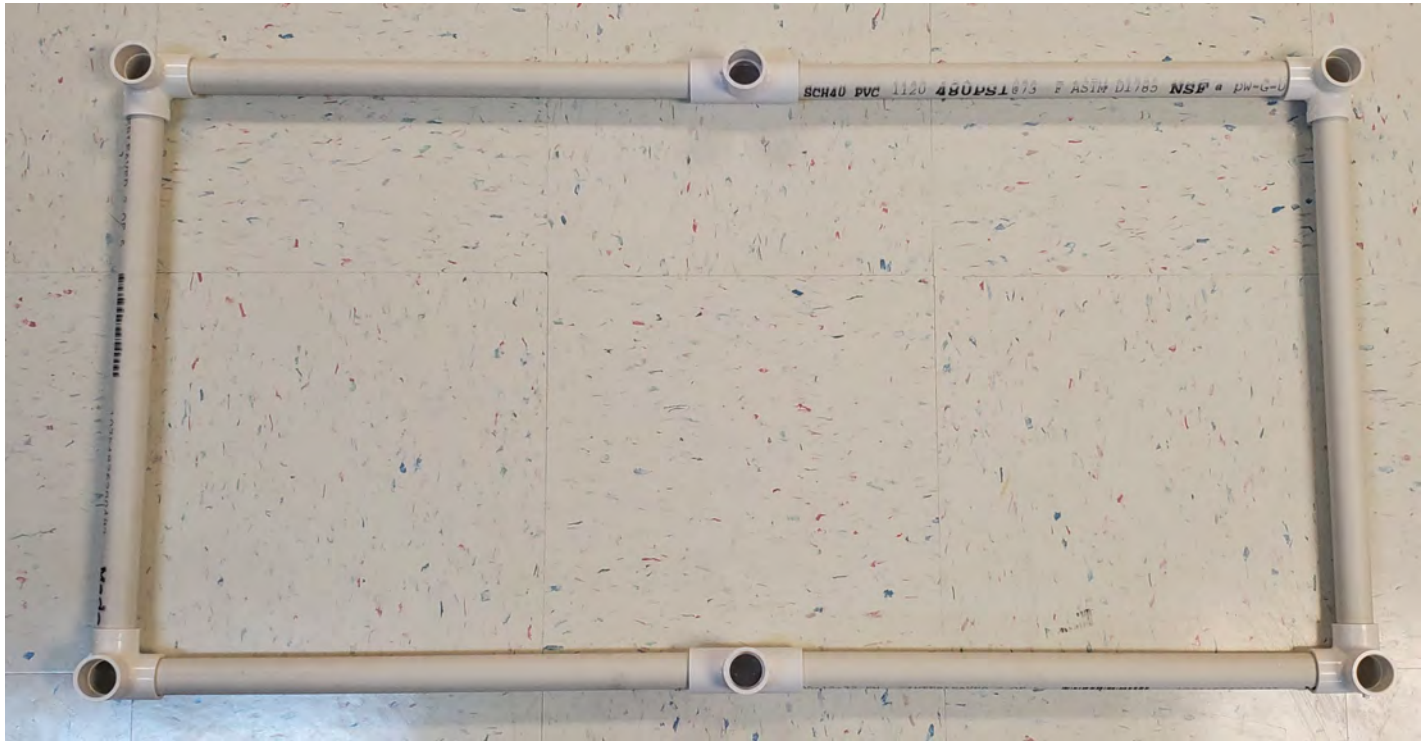
ASSEMBLY PART 5

- Connect the two 16 ½ inch PVC pipes to make the (length) sides for the bottom and top of the units.



ASSEMBLY PART 6

- Combine two 16 ½ inch, PVC pipes and one 3/4 inch Tee, to complete the BOTTOM of the unit.



ASSEMBLY PART 7

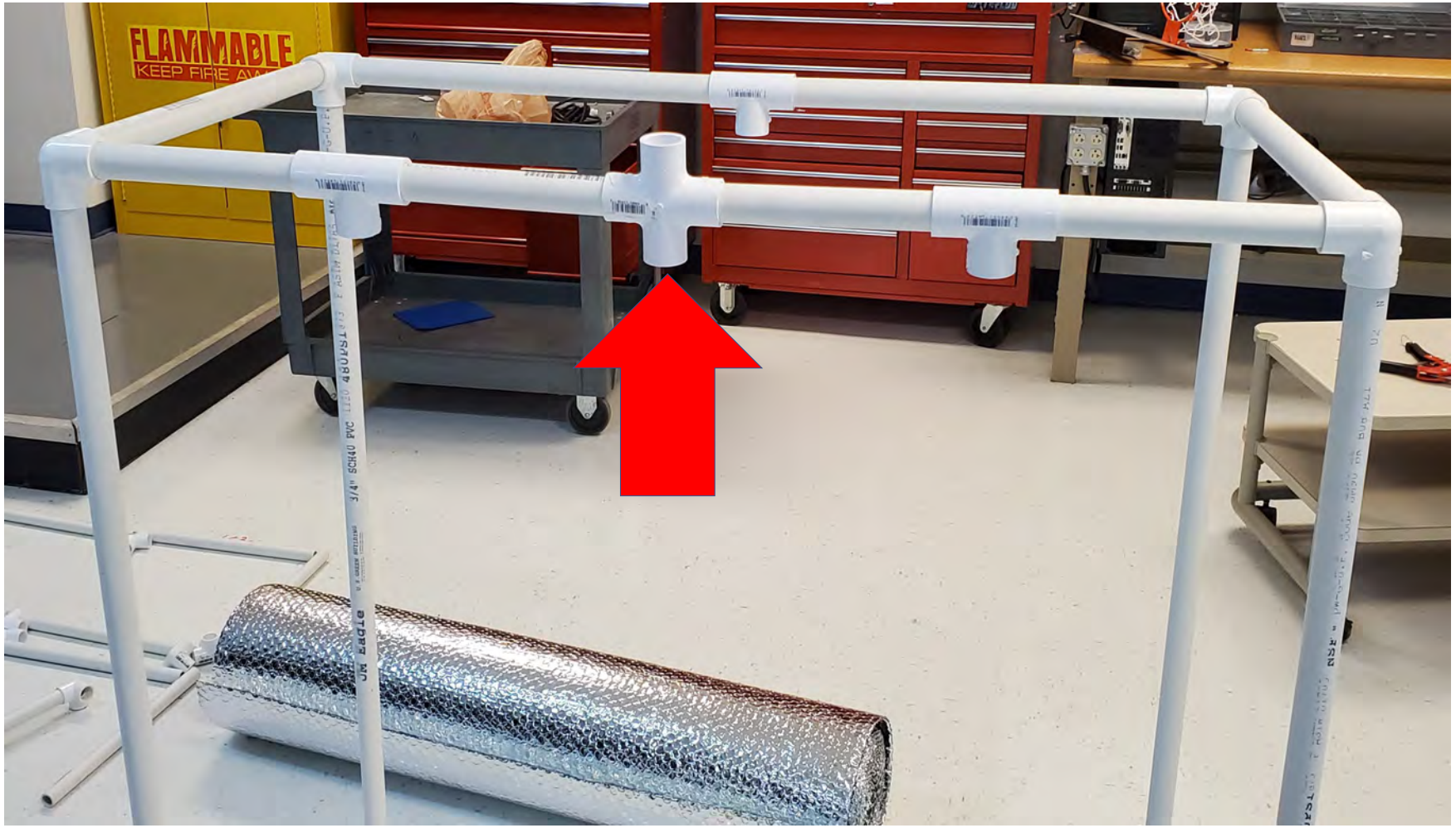
- Take the precut 25-inch-long piece of insulation and lay it over the bottom evenly across all sides. Cut a small ‘X’ over the open holes and push the insulation down through the bottom of the hole.

ASSEMBLY PART 8

- Insert the vertical 49-inch PVC pipe into the four corners.

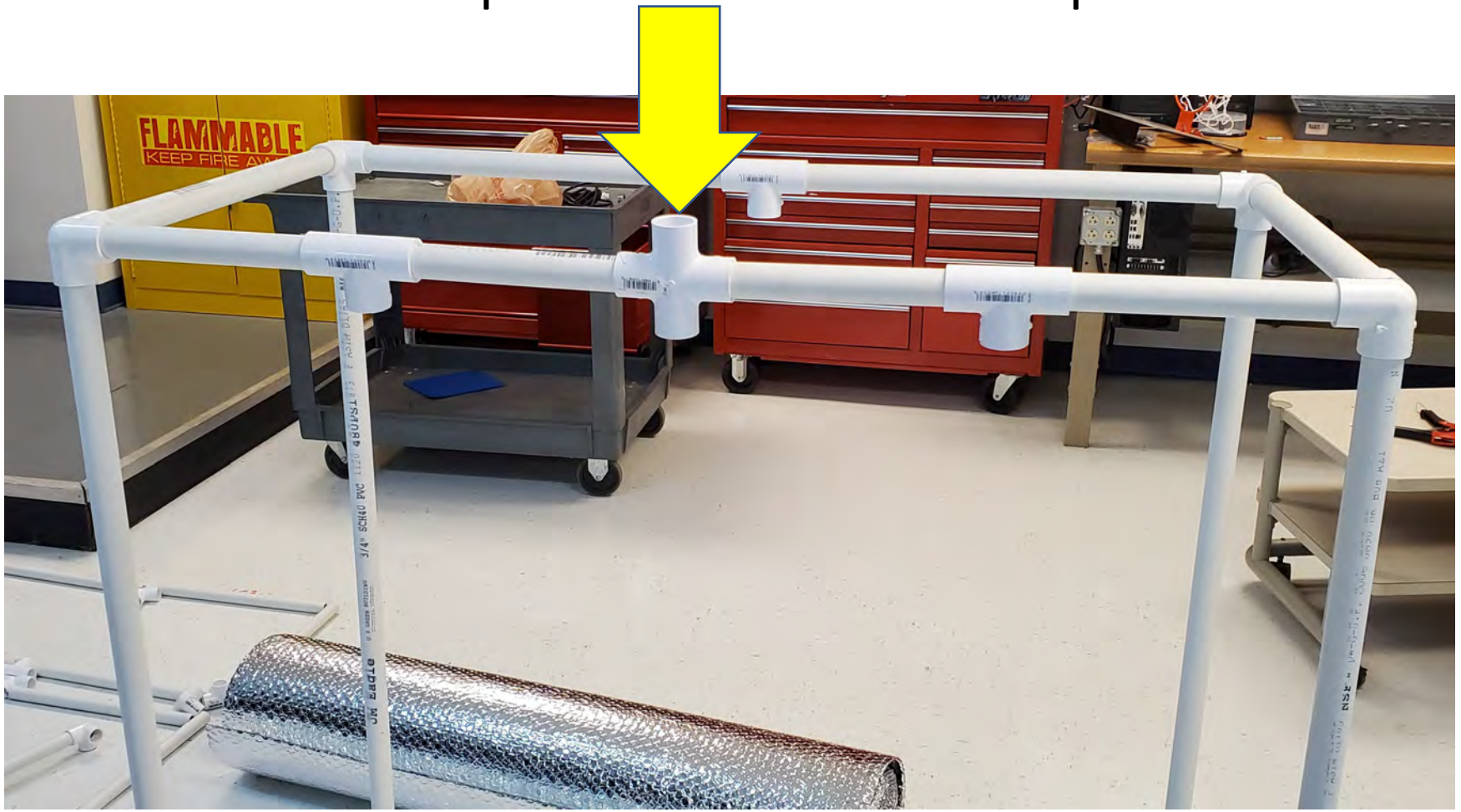
ASSEMBLY PART 9

- The top is assembled the same way as the bottom with one exception. The middle tee is replaced with a ¾” cross.



ASSEMBLY PART 10

- Cover top with 30” insulation with 5” extending out over the front and back. Cut X over top hole of the cross and push down.

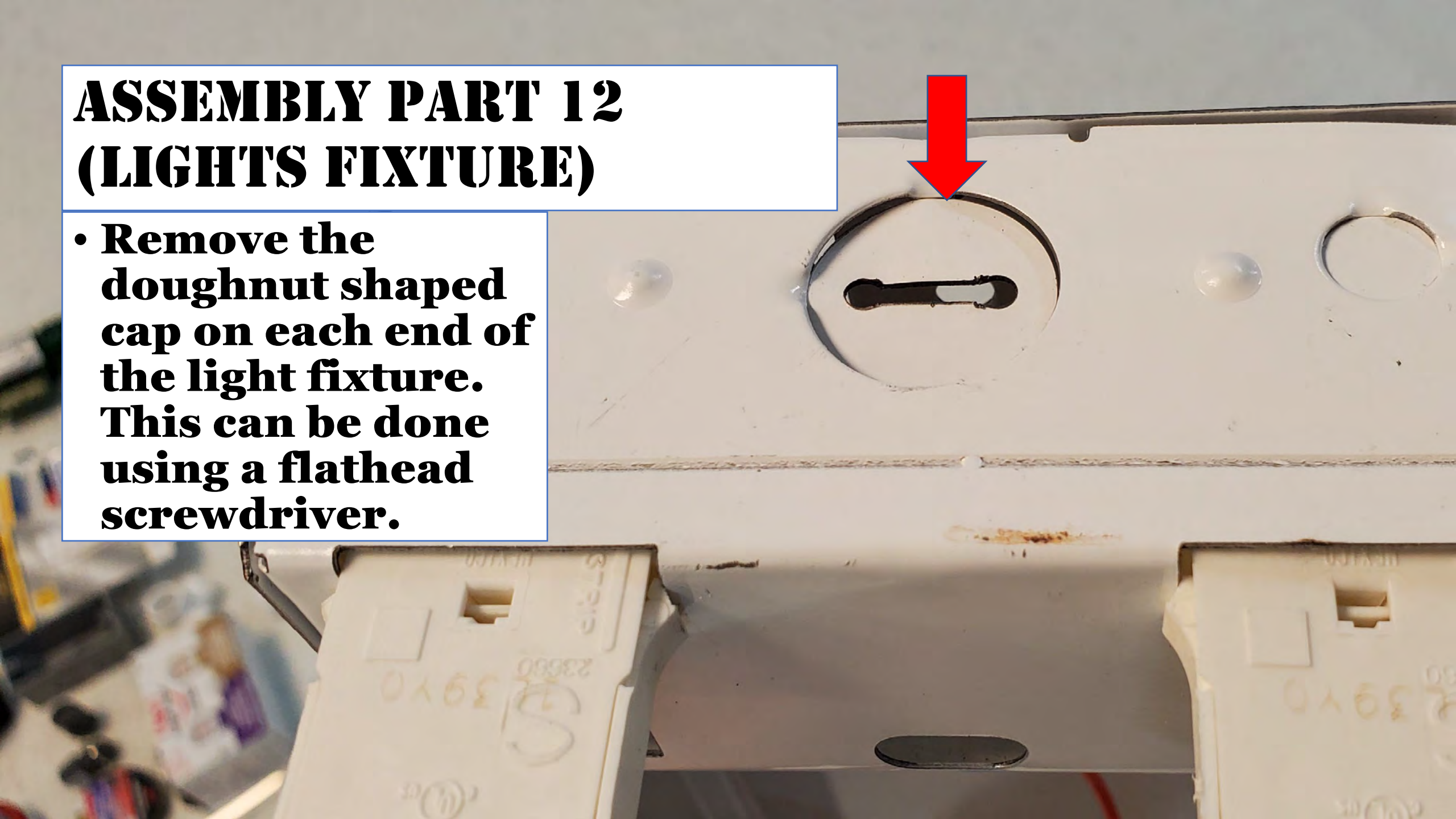


ASSEMBLY PART 11 (LIGHTS FIXTURE)

- **Overview-The light fixture can hold any T8 bulb up to 48 inches. For the booth we built, we could only find 17” UV-C bulbs from Grainger. Remove screws from the end piece. It is easy to move the end piece up and down the frame by pinching or pushing in the tabs on both sides of the <u>one</u> end piece and sliding the entire end piece down the frame.**

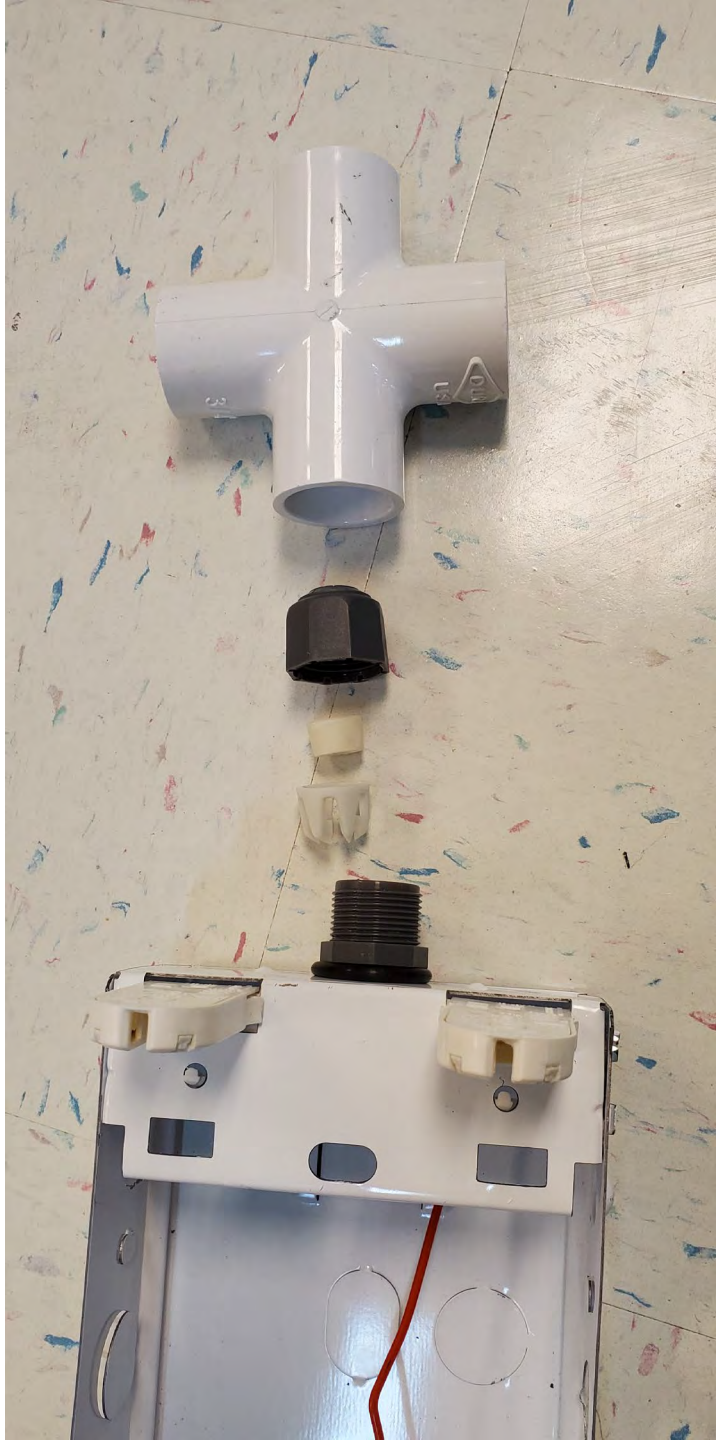
ASSEMBLY PART 12 (LIGHTS FIXTURE)

- **Remove the doughnut shaped cap on each end of the light fixture. This can be done using a flathead screwdriver.**



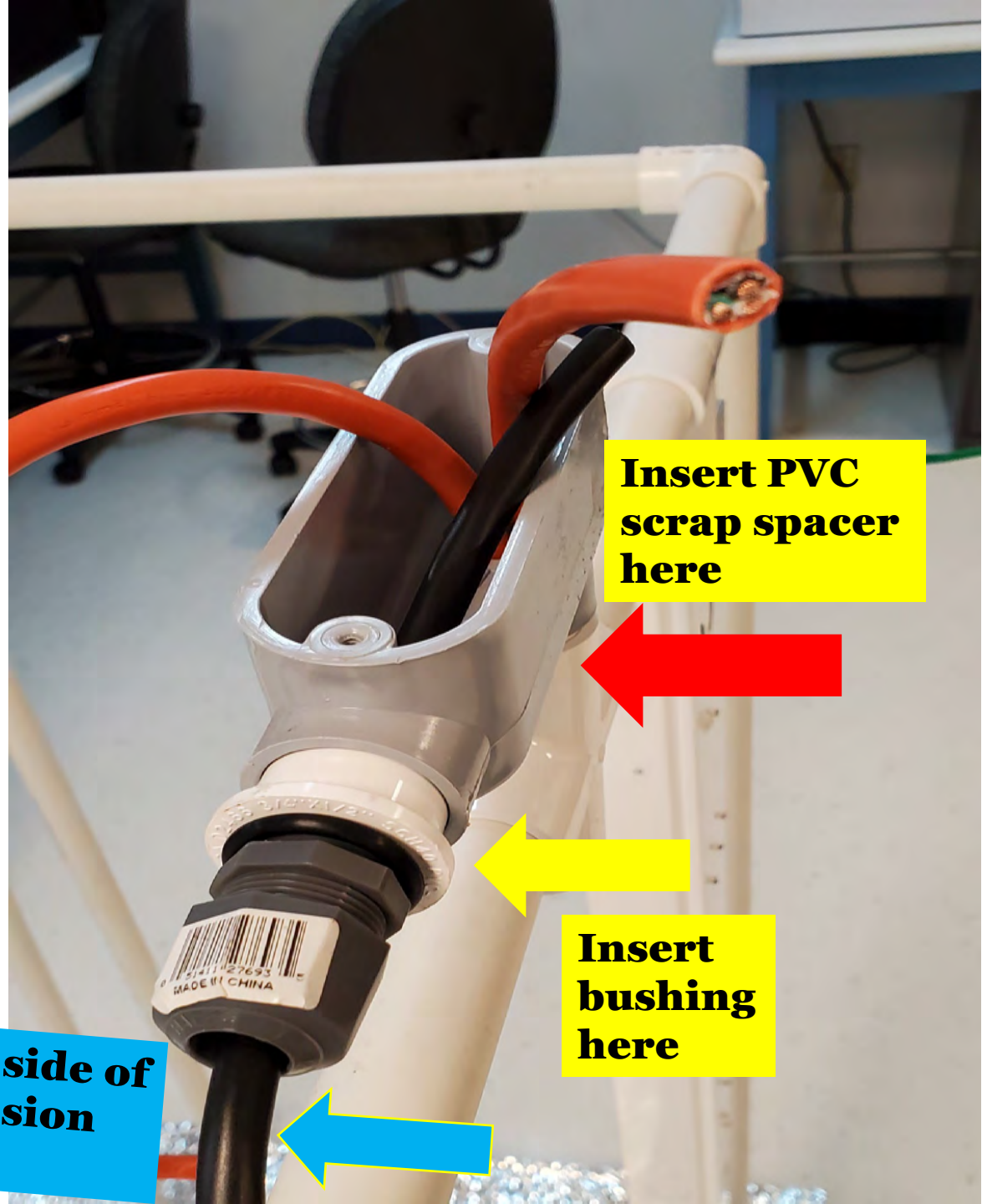
ASSEMBLY PART 13 (LIGHTS FIXTURE)

- **Unscrew the metal ring on the strain relief. Screw the strain relief through each end of the light fixture where you just removed the metal cap.**



ASSEMBLY PART 14

- **Insert Grey ‘L shaped’ electrical box by using a small piece of PVC scrap (about 1”-2”) connecting to the cross on top of the frame. Insert ¾” bushing into the box. Insert the strain relief into the bushing. Take the end of the strain relief and push the black extension cord through. Make sure to use the piece of cord that has the prongs and not the receptacle. Pull enough cord through the electrical box as show. Push orange cord through PVC frame down through the strain relief through the light fixture. See next picture.**



ASSEMBLY PART 15

- **Add a ¾” coupler between the PVC and the strain relief to make a tighter fit. Pull the orange electrical cord down through the strain relief to the inside of the light fixture**

ASSEMBLY PART 16 (WIRING)

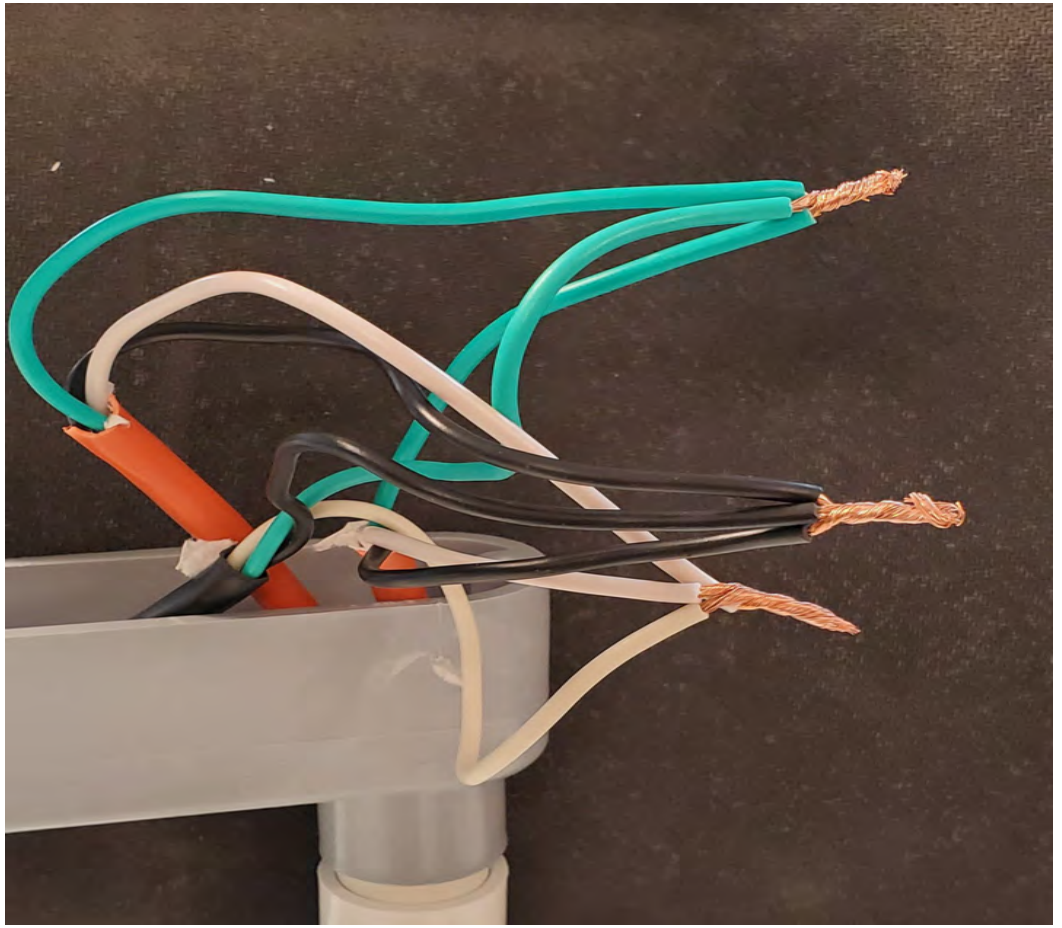
- **Strip off orange shield on both ends of the cord exposing about 1 ½” of the three wires (black, white, and green)**

ASSEMBLY PART 17 (WIRING)

- **Strip green, white, and black wires exposing the copper core.**

ASSEMBLY PART 18 (WIRING)

- **Twist like colors together. Top with wire nut (pictured on bottom left). We used waterproof wire nuts but if your unit is not going outside use cheaper versions.**



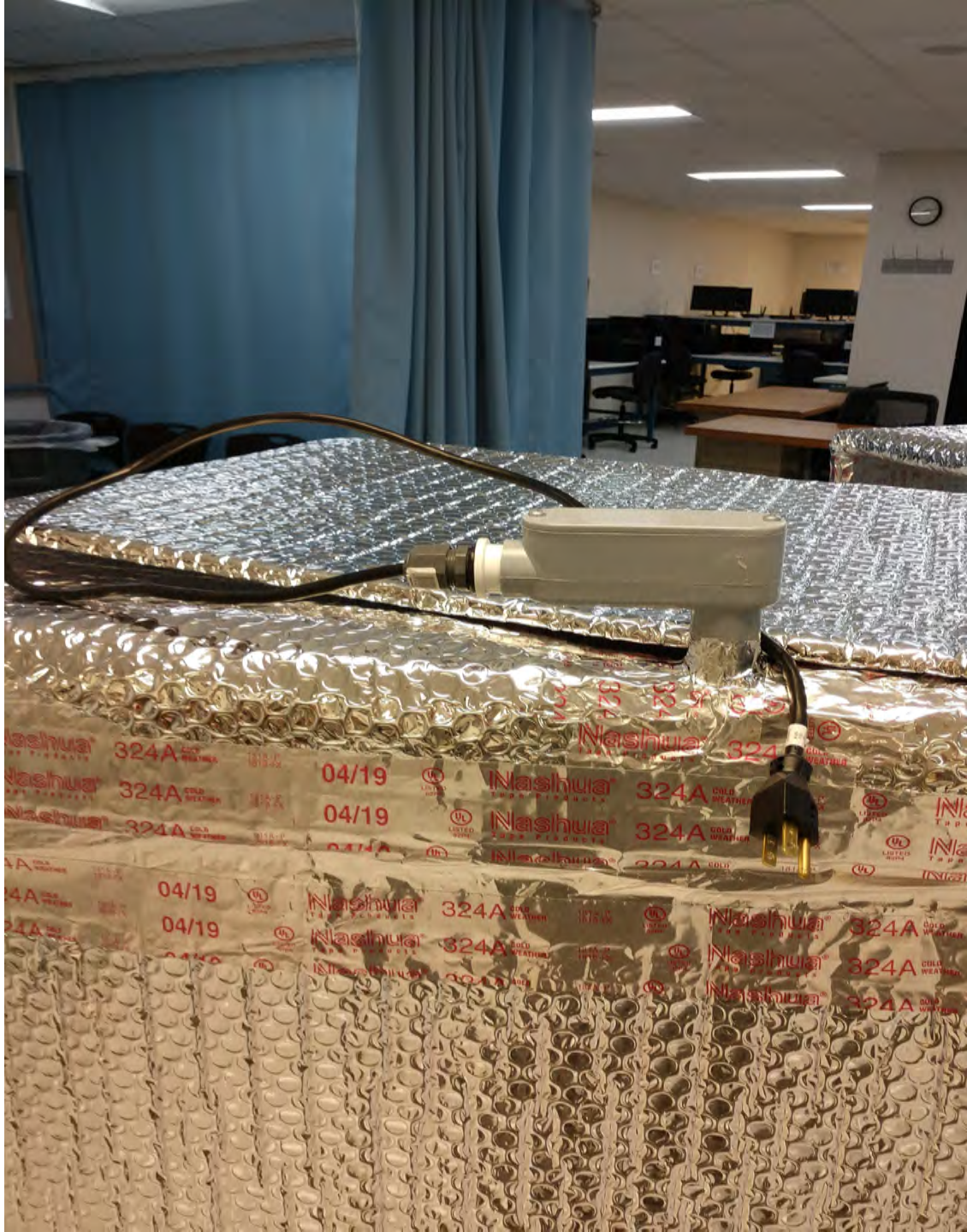
ASSEMBLY PART 19 (WIRING)

- **Twist together the white and black wires of the electrical ballast (black box) in the light fixture to the white and black wires of the orange cord. Top with a wire nut. The green wire can be screwed down to the frame of the light fixture using any open hole. The light fixture has a bag of screws. Use the green screw.**

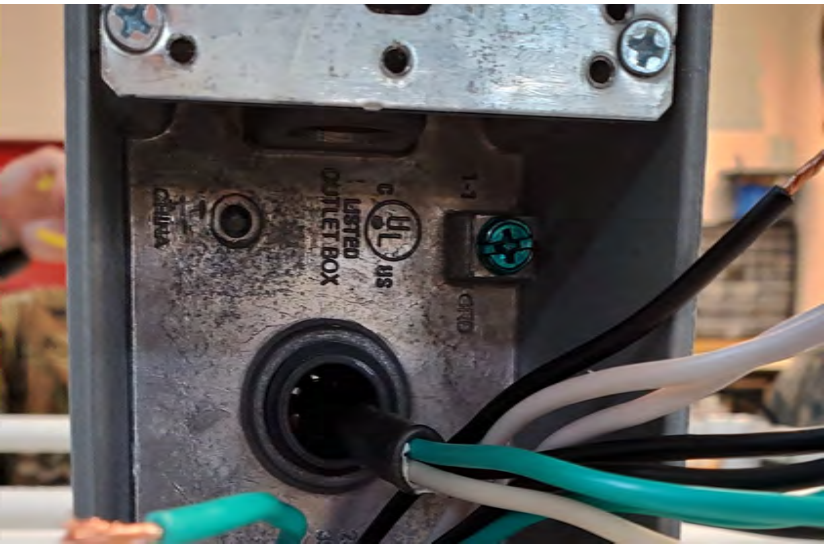
ASSEMBLY PART 20 (WIRING)

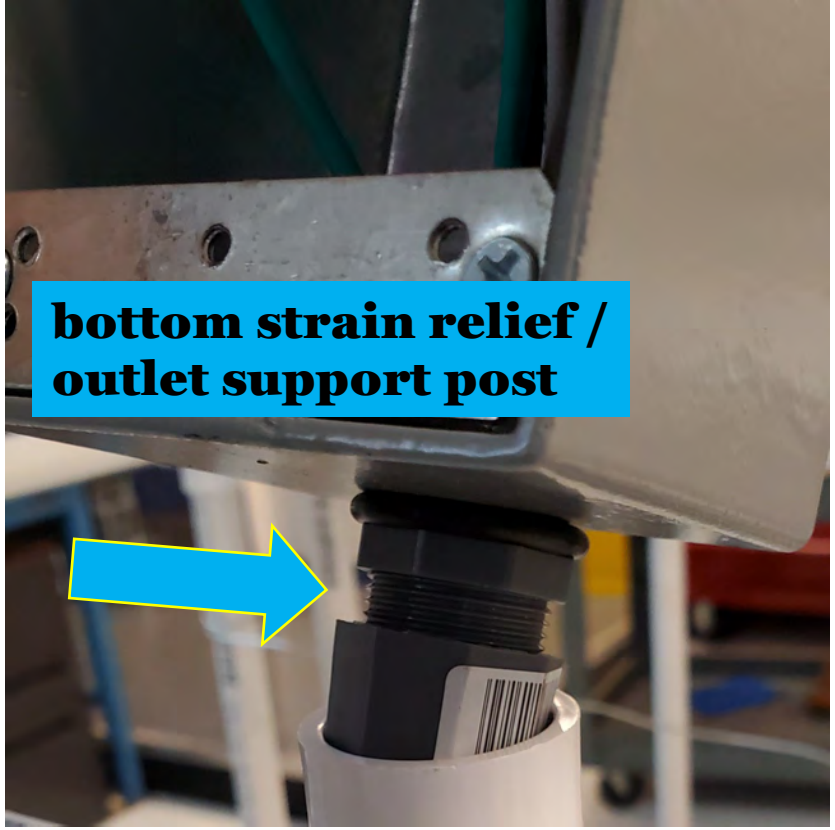
- **Replace the screws into the top lid of the Grey ‘L shaped’ electrical box**

- **This completes the wiring for this side.**



ASSEMBLY PART 21 (WIRING)

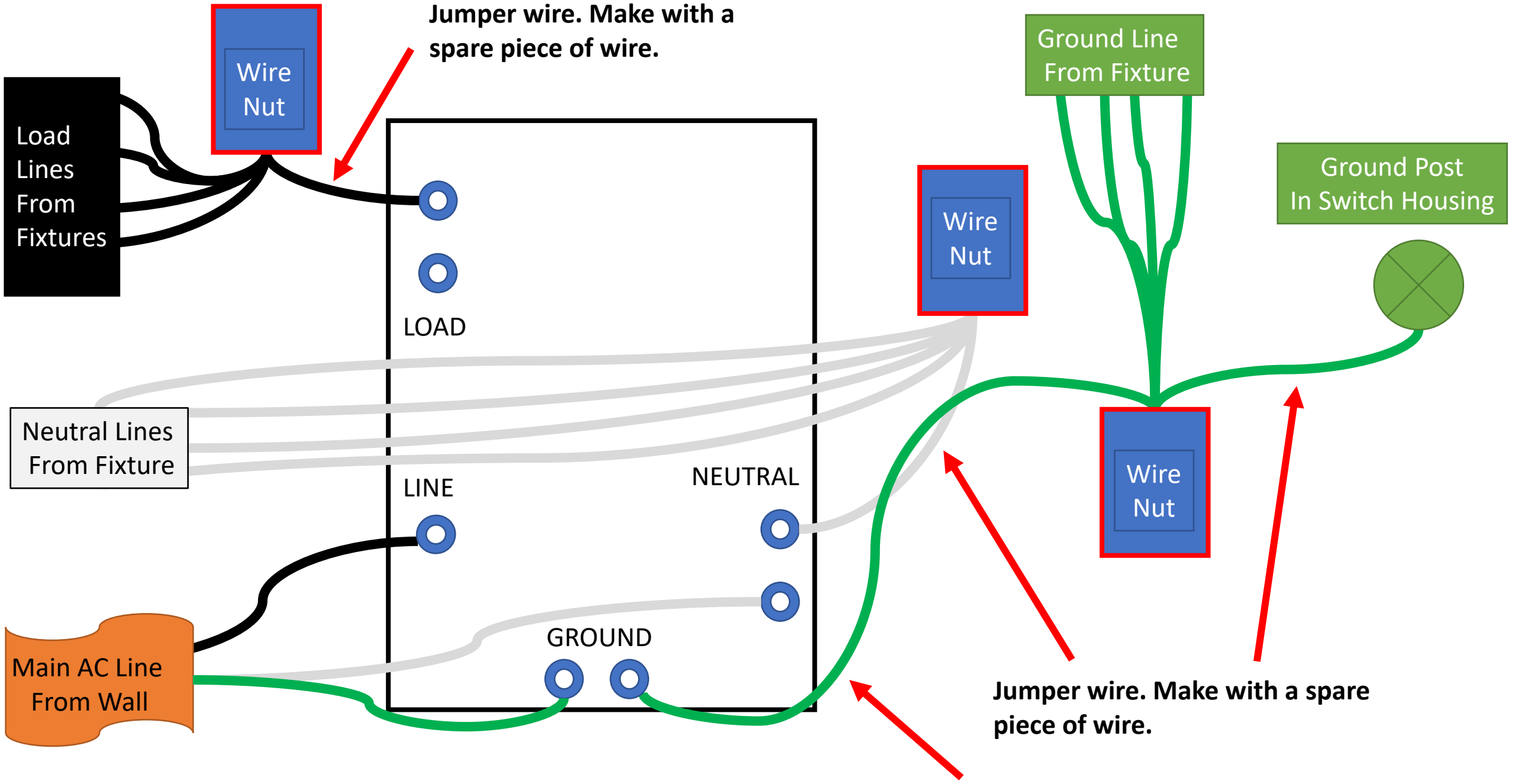




- To connect the timer / power switch to the previously built half, use the 2nd half of the previously cut black extension cord through the top strain relief and the orange power cord through the rear strain relief. Next, run the lower light fixture power wires through the bottom strain relief / outlet support post. This will be supported using the top ¾ PVC 4 way connector.

ASSEMBLY PART 22 (WIRING)

See Wiring diagram on the next slide


Wire Nut
Jumper wire. Make with a spare piece of wire.
Load Lines From Fixtures
LOAD
Neutral Lines From Fixture
LINE
NEUTRAL
GROUND
Main AC Line From Wall
Wire Nut
Ground Line From Fixture
Ground Post In Switch Housing
Wire Nut
Jumper wire. Make with a spare piece of wire.

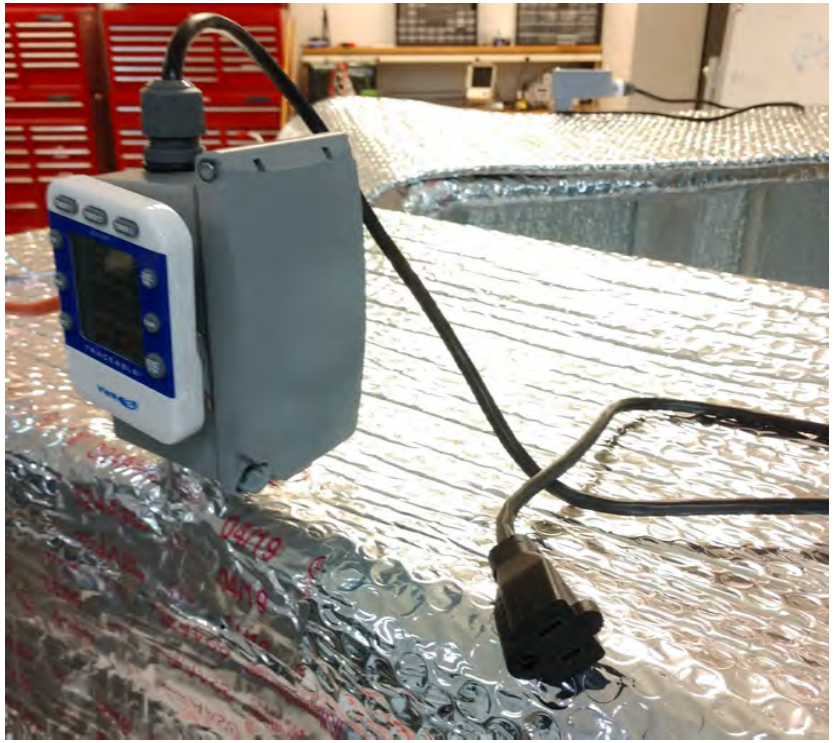
ASSEMBLY PART 23 (WIRING)

Finish the outlet by screwing in the outlet to the electrical box and then the cover to the outlet.

ASSEMBLY PART 24 (WIRING)

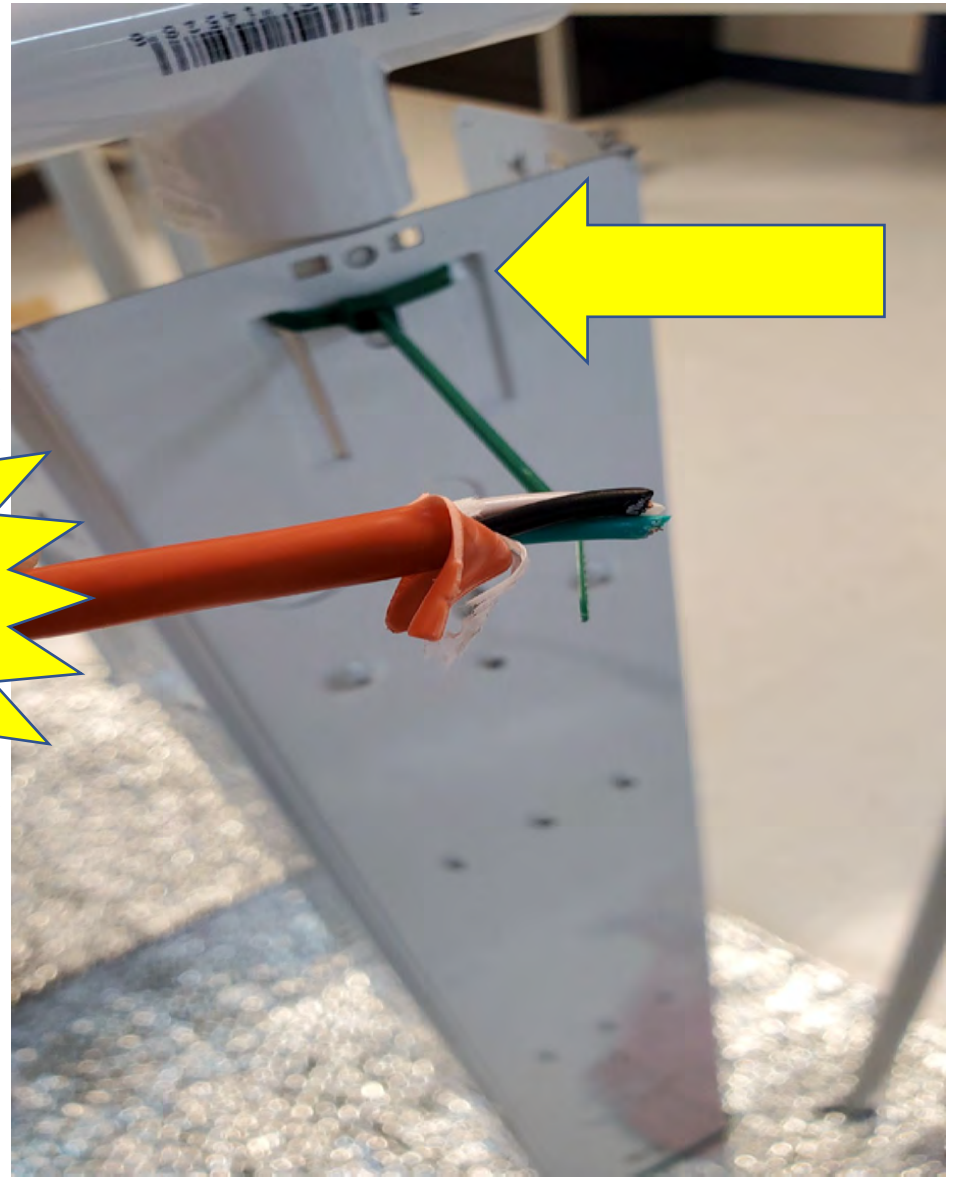
- The cable that goes into the rear strain relief is the remainder of the orange power cord with the prongs.

- Here is what the completed section should look like.



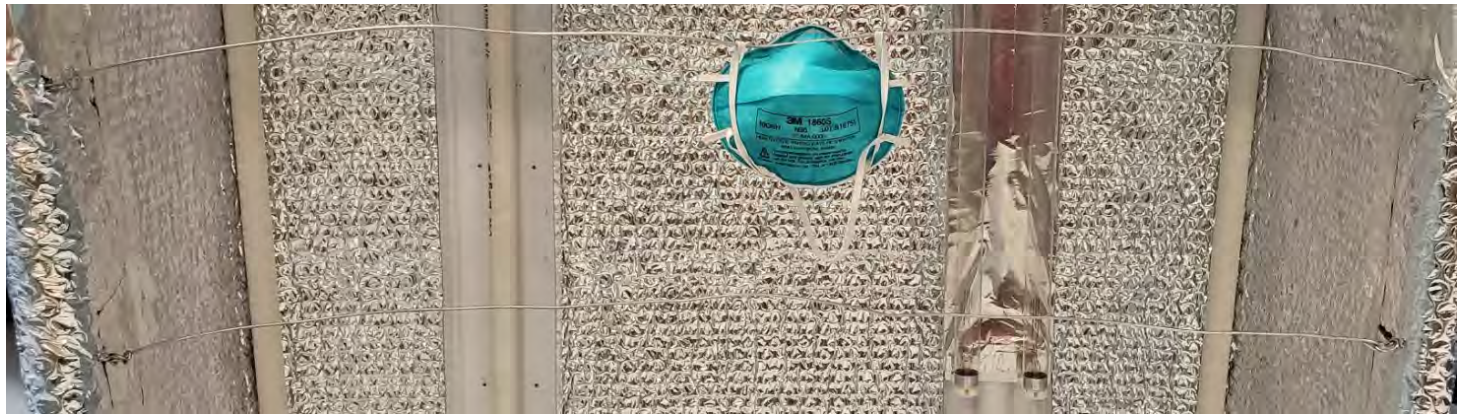
ASSEMBLY PART 25

Check bulb fitment before securing everything!!!



- **Finish securing light fixtures to frame with zip ties as shown on top on bottom of the frame. Finally, push the all PVC pieces tight together with the rubber mallet or by hand.**

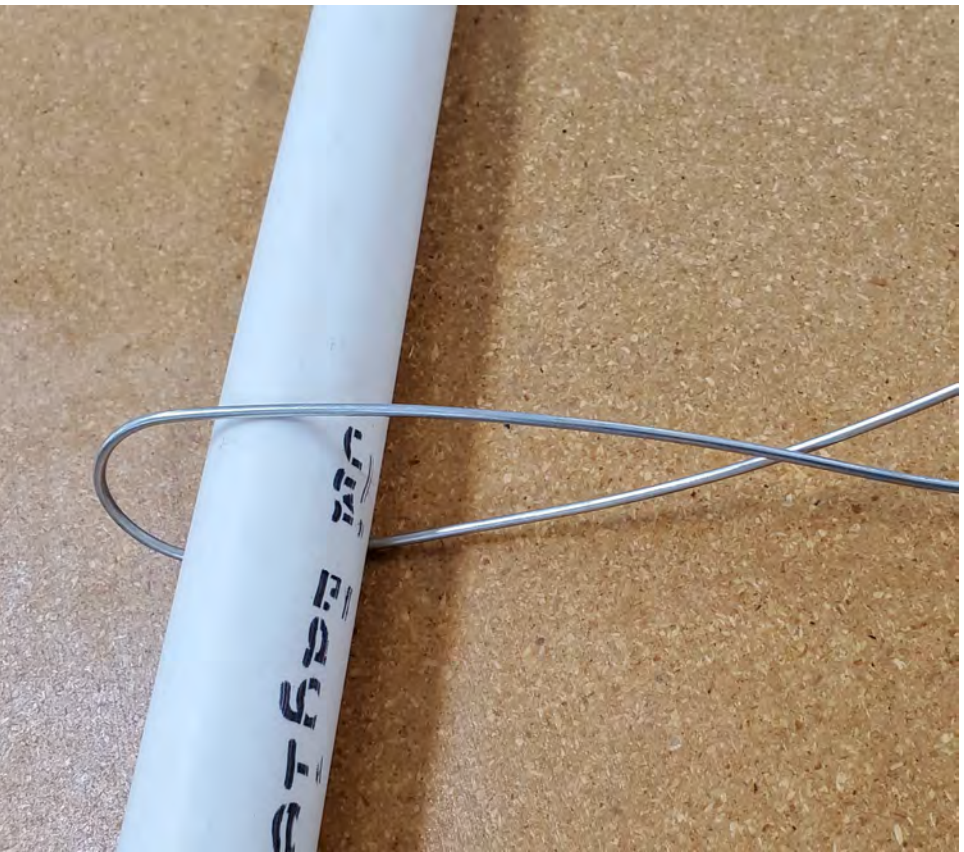
ASSEMBLY PART 26 - 29



- The next 3 steps involve creating the mounting lines for the masks. We chose to wrap the wire around the PVC vertical pipes on the Main Control half of the Flashbox to make small hook rings then we cut five wires that were long enough to run across the middle and hook onto the other side.

- There are various ways to hold the the mounting lines to the vertical pipes. Even zip ties can be used to hold up the mounting lines as seen on Assembly Part 29

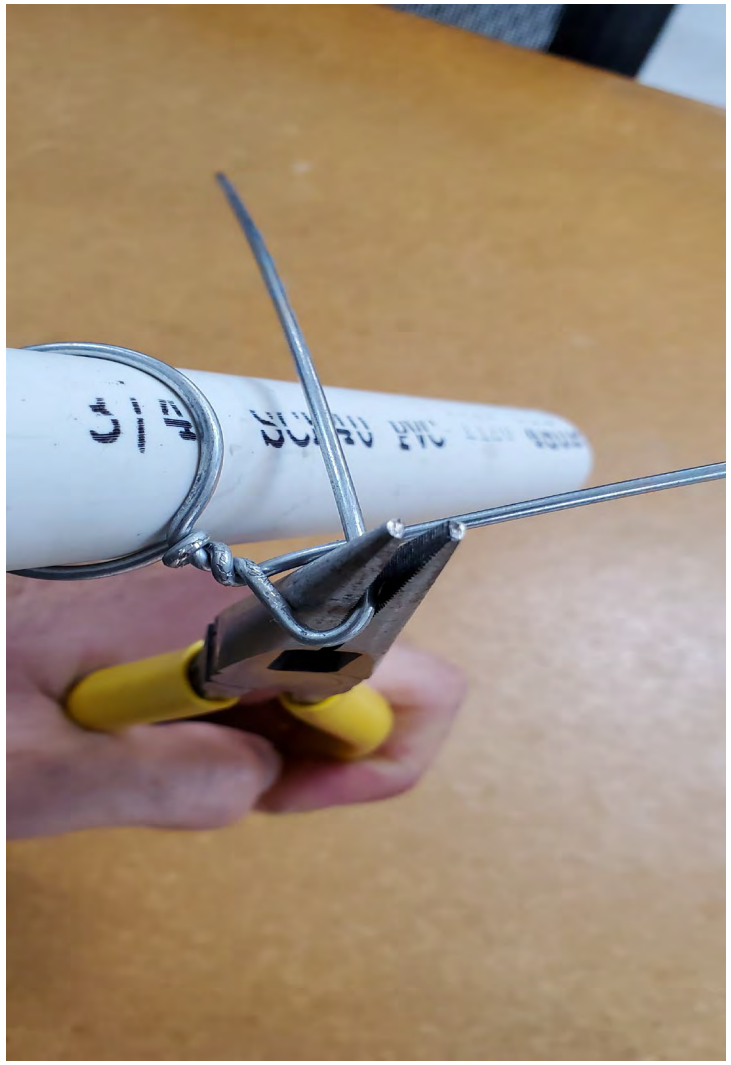
ASSEMBLY PART 26



- Using the 16-gauge steel wire tie a loop on the frame starting from the top and spacing down the frame every 10-12”. Once done on both sides run a wire into a loop on both sides and tighten. Secure with Zip ties under loop. See next slide for completed loop.

ASSEMBLY PART 27

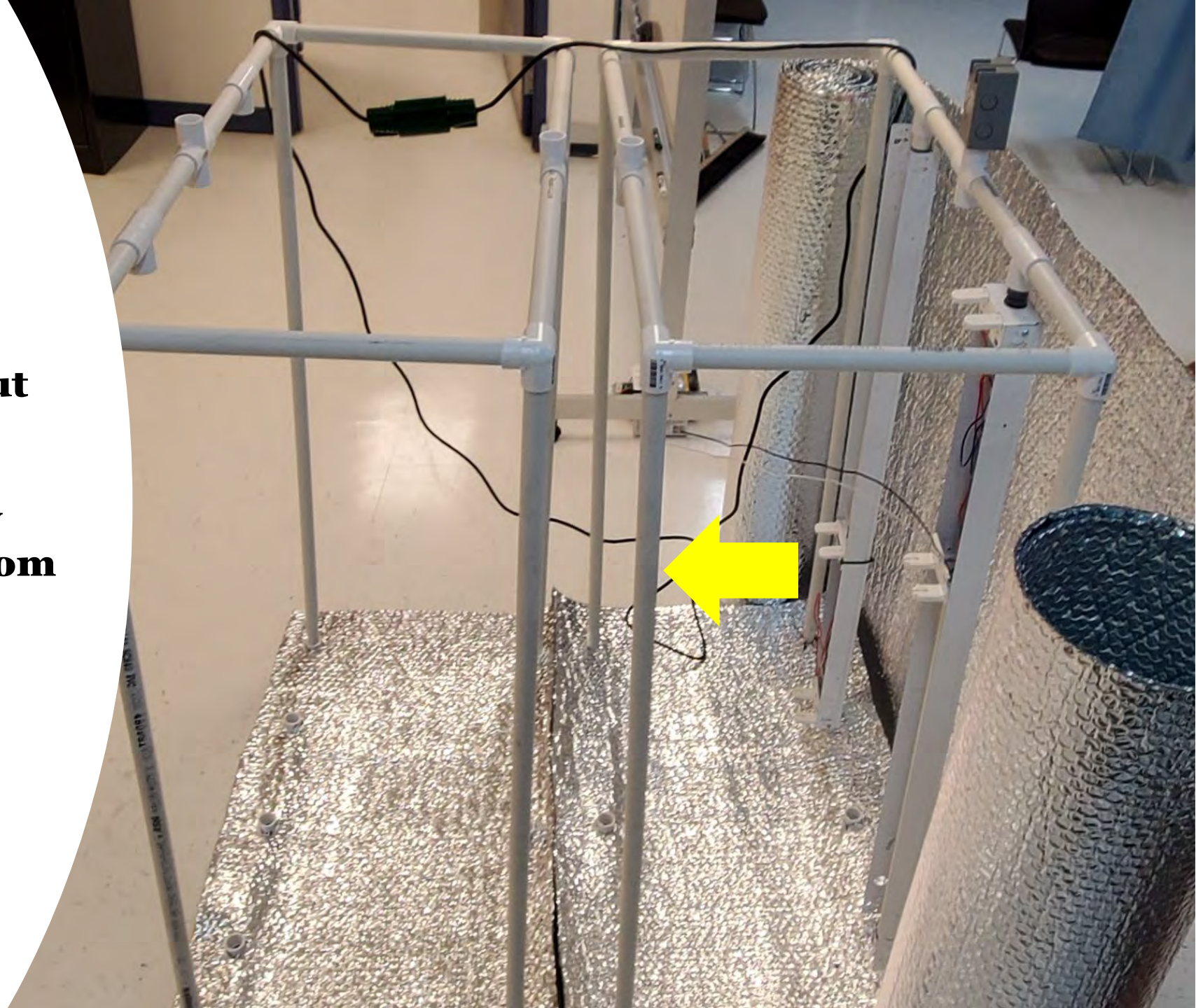
ASSEMBLY PART 28



ASSEMBLY PART 29

ASSEMBLY PART 30

- **Unroll the previously cut 91” sheet of insulation**
- **Wrap evenly all the way around the FlashBox from one side to the other.**
- **Yellow arrow indicates front post of one side.**



ASSEMBLY PART 31

- **Secure the insulation with the ‘cold weather foil tape’ starting at one of the front corners and work your way around to the other front corner.**

- **You will have to cut slits on the side with the wire to let your wire hooks sit flush between your insulation.**

ASSEMBLY PART 32

- Next, we will start cutting and taping the bottom of the unit.

- Your bottom overhang should look something like this to start with

ASSEMBLY PART 33

- **Make a straight cut and a vertical cut that lines up with each corner of the front of each unit.**

ASSEMBLY PART 34

- **Cut the rear corners with vertically as shown. Fold up the piece and tape as shown.**

ASSEMBLY PART 35

- **Fold up sides and front and tape as shown.**

- **The front hanging insulation will not be taped.**

ASSEMBLY PART 36

Shown here is the bottom and sides taped. This is the side of the booth without the wires.

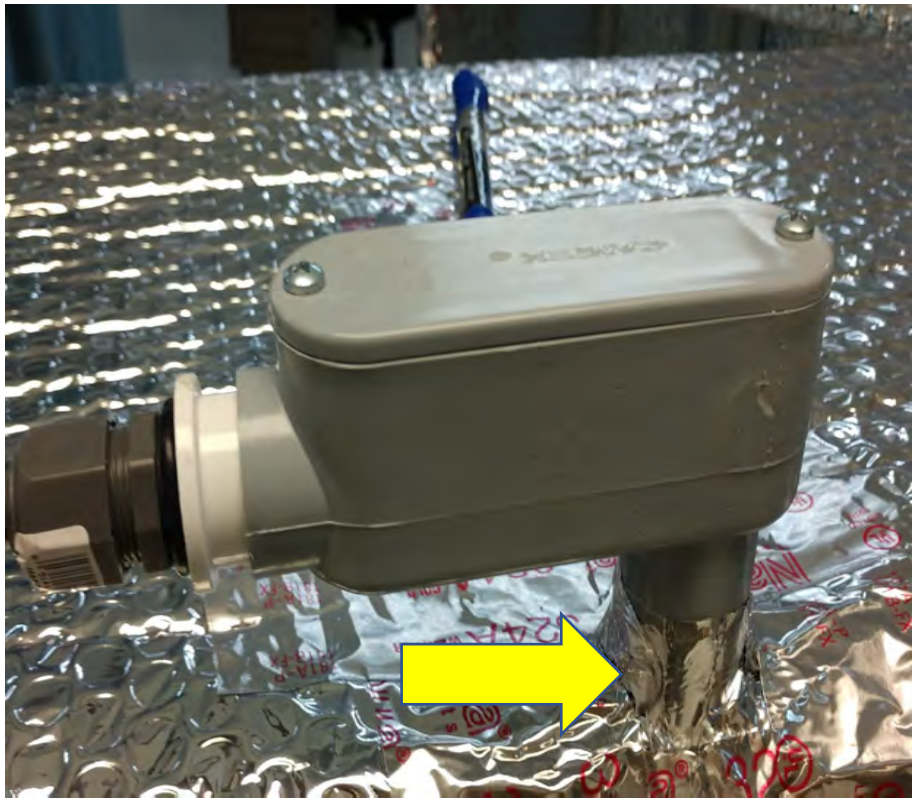
ASSEMBLY PART 37

- **Shown here is sides taped with the steel wires exposed on the opposite booth.**

ASSEMBLY PART 38

- **Cut the top insulation corners and front flap the same way as the bottom.**
- **Fold front flap over the top PVC pipe and tape to the inside. Fold top sides down and tape.**

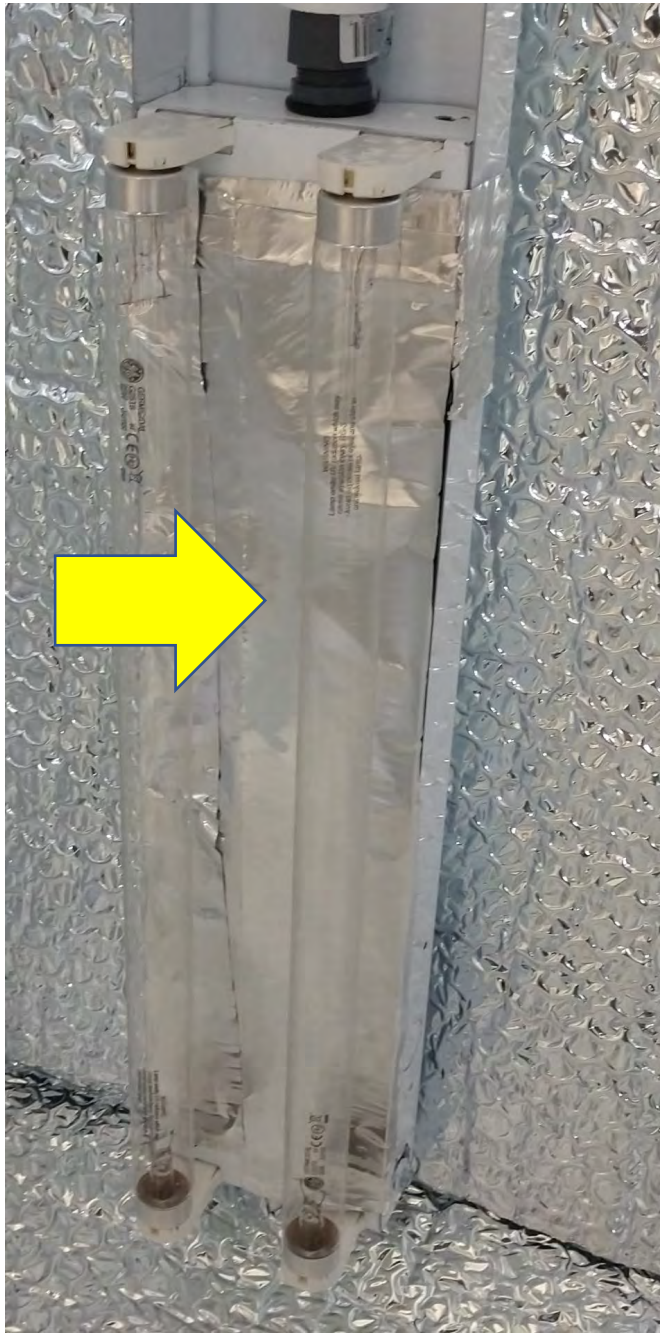
ASSEMBLY PART 39



- **Tape around both electrical boxes to seal any holes.**

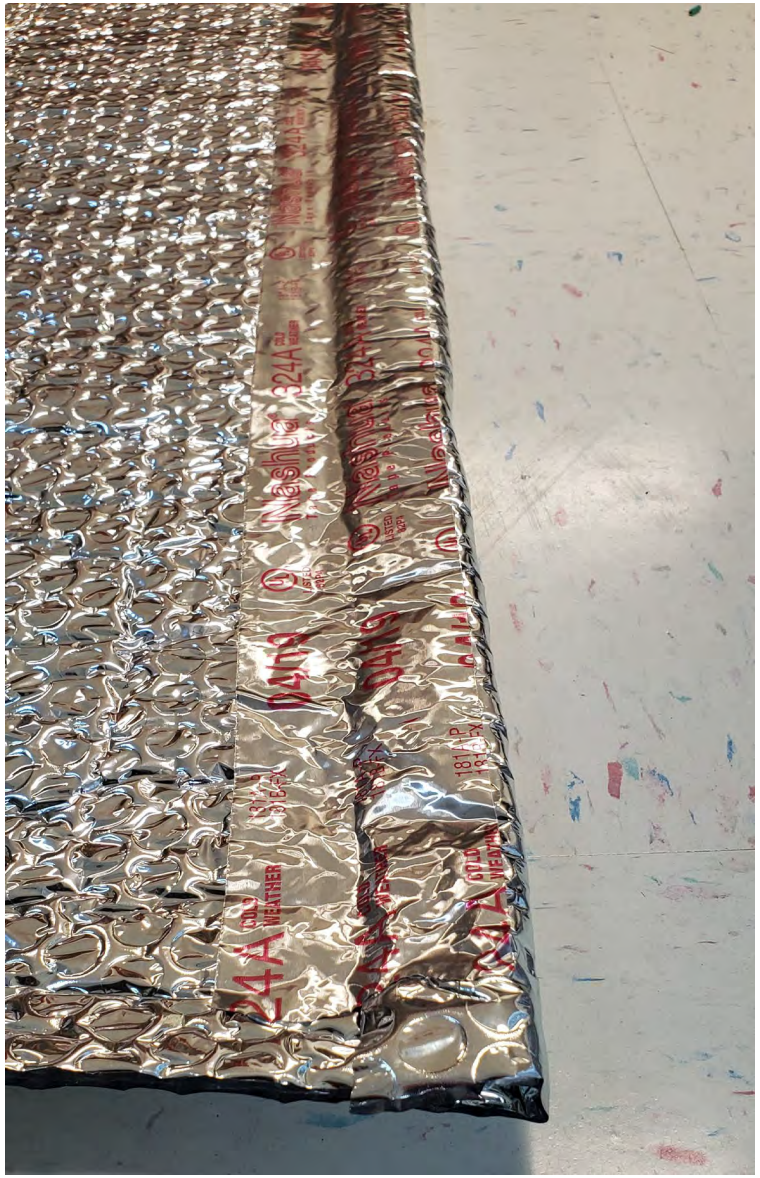
ASSEMBLY PART 40

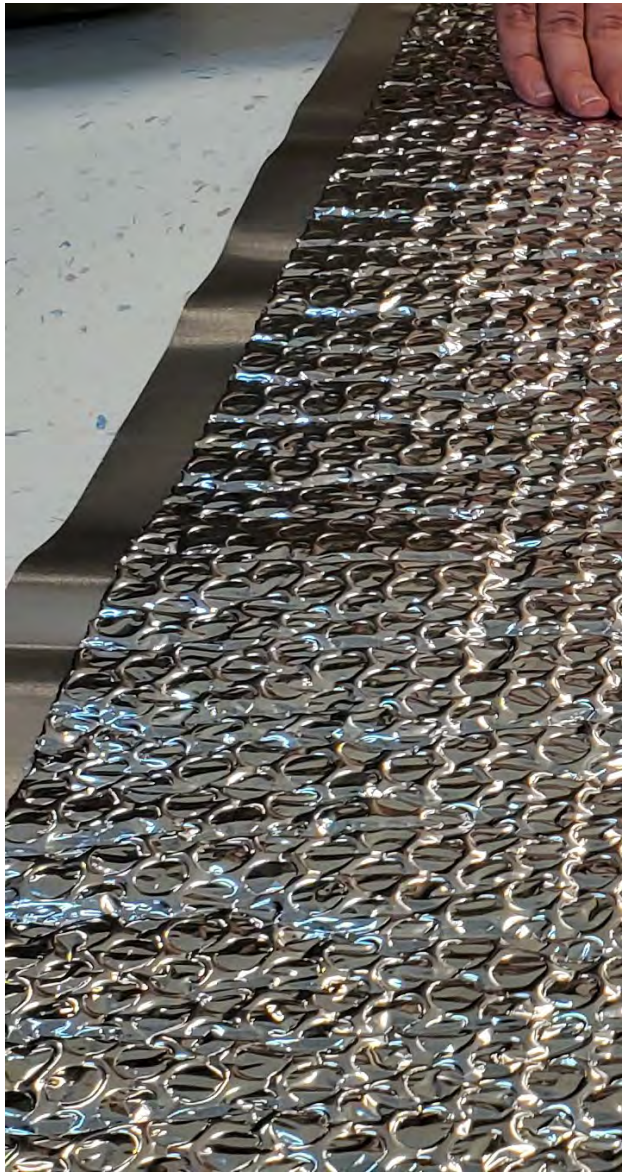
- **Tape over light fixtures to cover wiring and electrical ballast.**



ASSEMBLY PART 41

- **The final 12’ x 24½” piece of insulation will be the covering across the middle of both boxes when put together.**
- **Roll all edges; top, back, and sides roughly 2 inches over and secure tape down.**

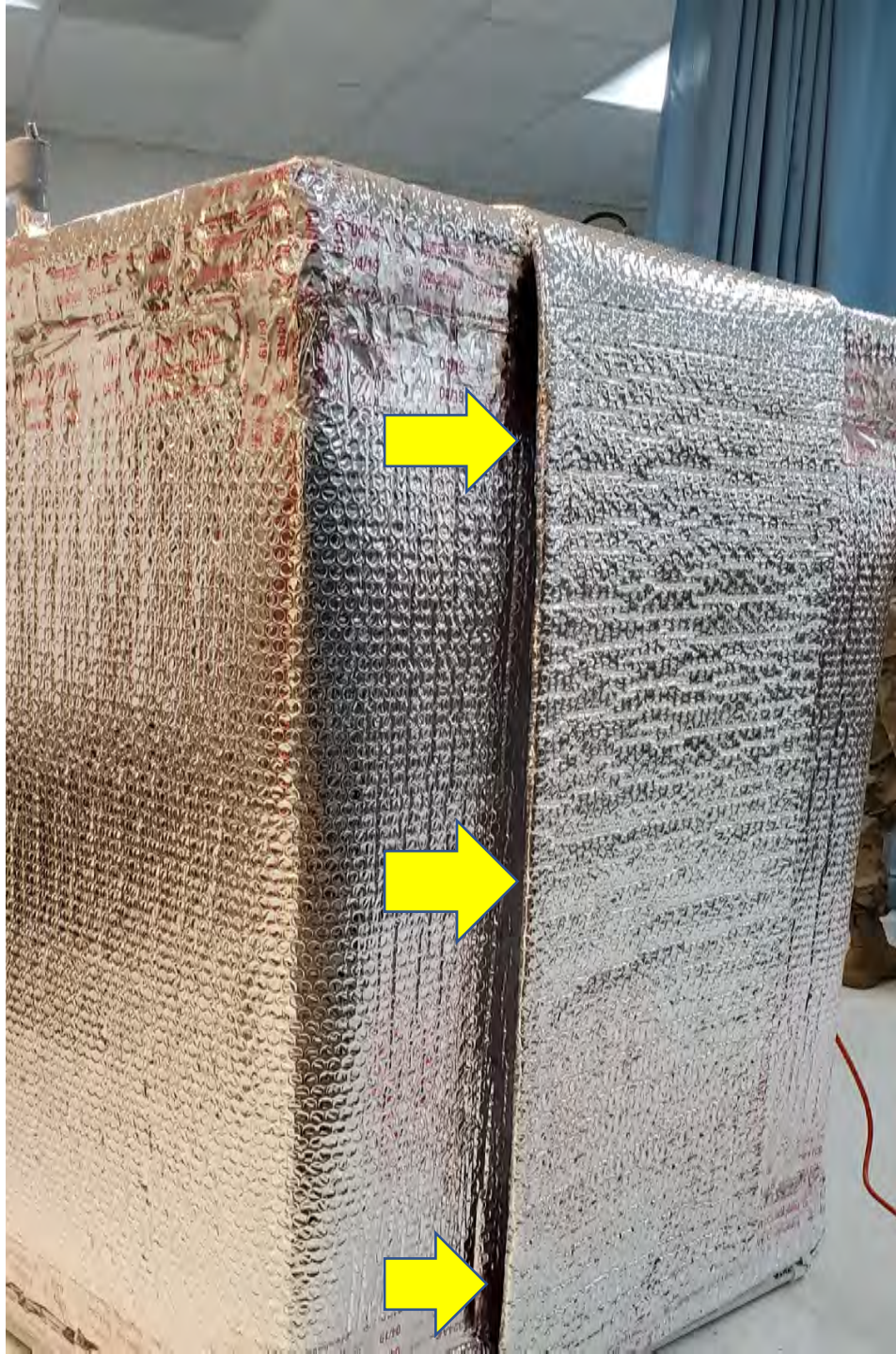




ASSEMBLY PART 42

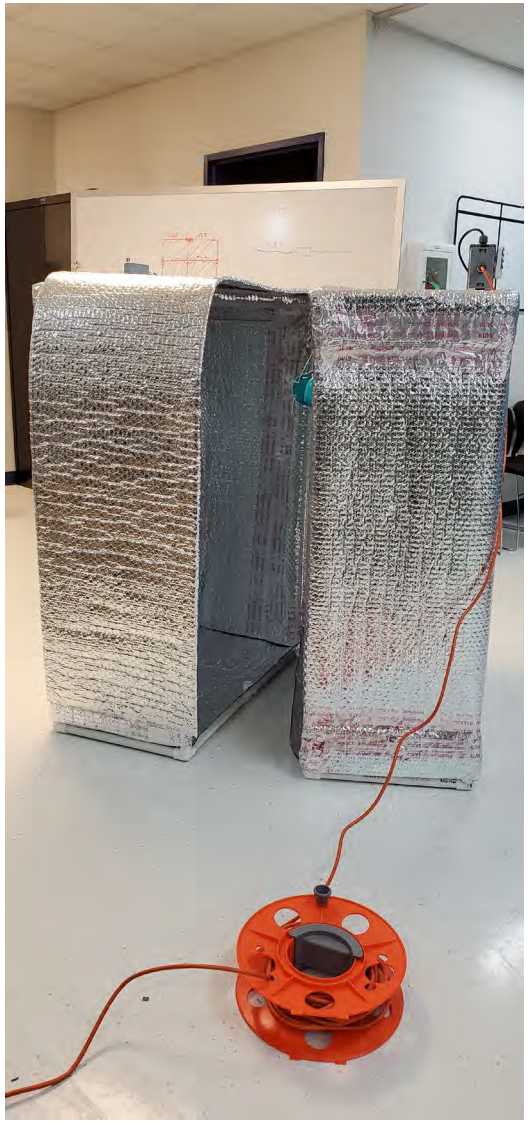
- **Tape magnets to the inside of the cover on each corner of each side and top.**
- **Tape magnet to shell directly opposite of cover magnet.**
- **Apply more magnets where light may shine through.**

*** Arrows indicate suggested placement.**



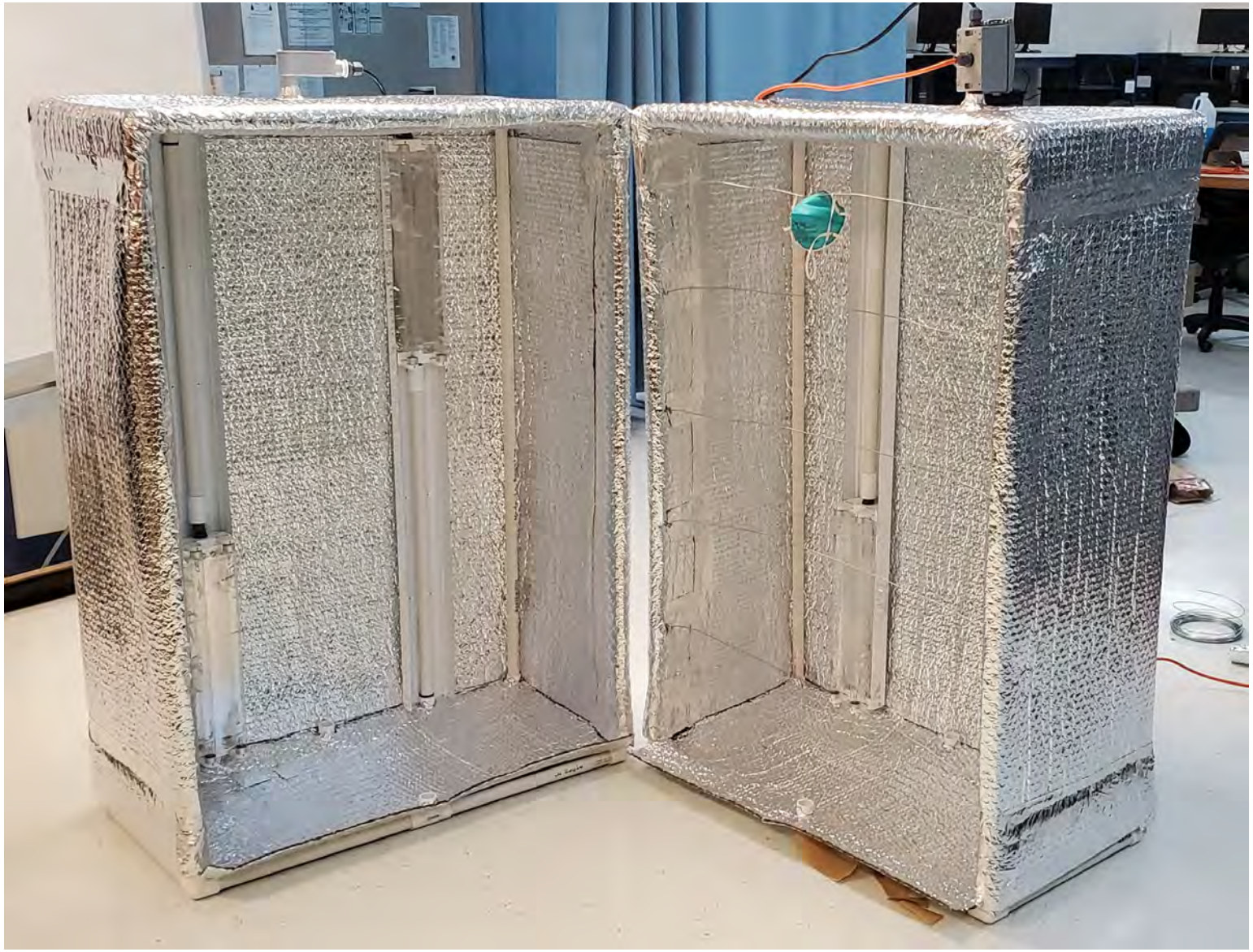
ASSEMBLY PART 43

- **Install bulbs**
- **Plug in all connections**
- **Put on PPE and ensure the area is clear / safe.**
- **Power on**

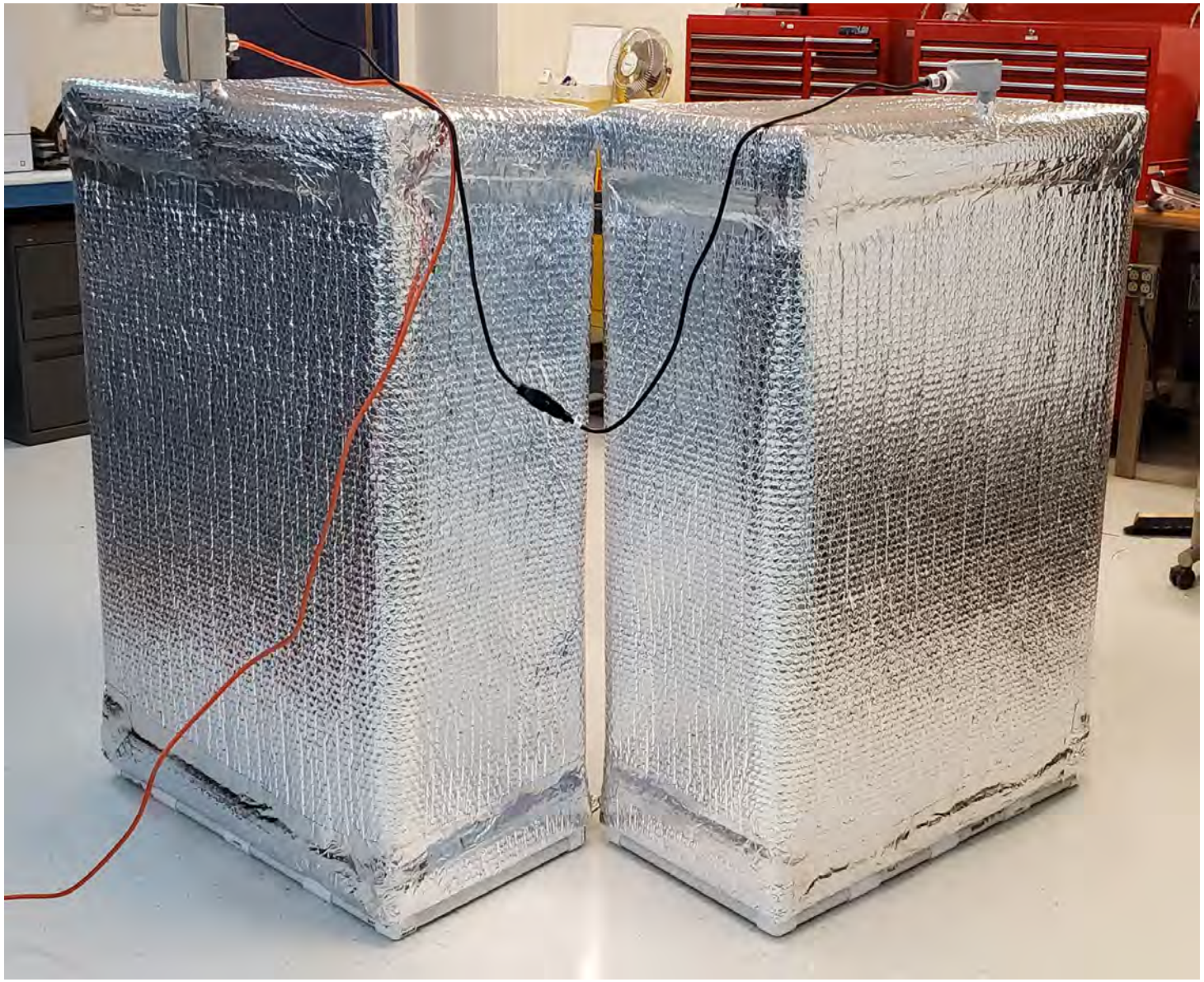


FINAL BUILD PHOTOS

FINAL BUILD PHOTOS



FINAL BUILD PHOTOS



8. TEAM OVERVIEW

- SOLUTIONS ARCHITECT, MAIN DESIGN / BUILD GUIDE AUTHOR
  TIMOTHY BILBREY
- SOLUTIONS ARCHITECT, MEDICAL ADVISOR
  JANELLE ROBERTSON
- SOLUTIONS ARCHITECT, MATERIAL MANAGEMENT / REVISION / ELECTRONICS LEAD
  CHRISTIAN BOND
- SOLUTIONS ARCHITECT, MATERIAL MANAGEMENT / LOGISTICAL LEAD
  REWA PRICE
- SOLUTIONS ARCHITECT, MORAL AND SAFETY LEAD
  JOE RUISI
- ELECTRICIAN, CONSTRUCTION GUIDANCE
  WILLIAM ROBERTS

** A SPECIAL THANKS TO

ENV SERVICES

For helping us capture our UV-C band measurments

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