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**COC Ergo-Arm Procedure for lifting large optics**

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## 1. Introduction

The purpose of this document is to provide a procedure for lifting and moving large optics with the Ergo-Arm. This procedure uses information from Mike Gerfun's User Manual as well as notes and observations from several people during the use of this instrument, compiled into a procedure format.

## 2. Preparing a lab area for Ergo-Arm use

This section explains what COC considers "good policy" for working with the Ergo-Arm and large optics. It is a short list of practices learned from lab experience that keeps the optic and work area cleaner and reduces the frequency of accidents.

1. Clean workspace of unnecessary clutter, tools, etc
2. Use 3 man system when operating the ergo-arm, one to orient the optic, one to operate the arm, and one to take the role of "spotter". The spotter should watch the pressure gauge, keep an eye on the arm/optic interface, and watch for mistakes the other two people may be making. This role has proven to be very valuable in practice.
3. When working with a real optic, wear gloves at all times
4. Wipe down dirty tools with IPA
5. Remove all pens from pockets
6. Put glasses on a lanyard
7. Remove or cover all jewelry
8. Wear gloves, hairnet and a facemask when around unprotected optics. Gown optional
9. If the optic is coming out of its metal container, wipe down the outside of its container with IPA before opening it
10. Wipe down inspection fixture with IPA
11. Wipe down any o-rings that will be touching the optic with spectroscopic grade isopropanol only (preferably in glass dropping bottles)
12. Now you are ready to begin using the ergo-arm

## 3. Lifting an Optic

First decide who is the spotter, the ergo-arm operator, and the optic handler. Next, note with version of the ergo-arm you are using. There are two versions; the first version does not have a vacuum tank, pressure alarm, or a locking mechanism for the forward/back motion of the arm. The second version does have all of these. It is important to note the difference between the two, especially if you begin to lose vacuum. The ergo-arm with no vacuum tank will lose vacuum much quicker, leaving the operator less time to react. The lack of pressure sensor and alarm (there is a pressure gauge) also means you have to pay more attention by eye to what is going on. The steps below that are specific to each ergo-arm are noted by (v1) or (v2). Going through the whole procedure first with a dummy optic is always a good idea if the operator has not used the ergo-arm before.

1. Check that the suction plate is the correct type for the kind of optic you are lifting (ie the Test Mass suction plate has flats that need to line up with the Test Mass that is being lifted)
2. Check that the crash mat is situated on the ergo-arm legs. (pic)
3. If you are lifting an optic out of its optic container, place the container on the crashmat. This will allow the container to tilt, making it easier to make full contact with the o-ring, and is the easiest and safest way to lift it.
4. Adjust position of suction head until it approximately lines up with the optic's face. Use hand crank(1), vertical/horizontal plate tilt (5), right/left slide(7) or plate rotation(10) to position. Remember to re-tighten each knob after you are done positioning.
5. Make sure vacuum plate evacuating valve(14) is **closed (V2 only)**
6. Make sure pump down/air vent valve(13) is **open (V2 only)** \* Alternatively, you can first evacuate the large tank, then the plate using only the tank if you choose.
7. Plug in and turn on vacuum gage wireless receiver(16) (V2 only) It should read "0.0" representing atmospheric pressure in "inches of mercury" (in/Hg.)
8. Hold the hose of the pump(18) with the fitting facing you, and turn the cap ½ turn counter clock wise, to insure it is loose
9. Place the fitting over the evacuating valve nipple(14) and turn the fitting counter clock wise (viewed from above ) to finger tight. The valve is sealed by an o-ring so don't worry about it being overly tight.
10. Turn the pump(18) on. It will take about 4-5 minutes to pump down to 27 in/Hg. If the gauge(16) does not respond within 10 seconds, something is wrong. Usually this is because the o-ring is not close enough to the optic to pull vacuum, check that the o-ring is touching the optic on all sides. Also check the hose and valve for leaks.
11. After it has reached ~27in/Hg pressure, close the vent valve(13)
12. THEN shut off the pump, unscrew the fitting 1/2 turn, and remove the hose. Make sure steps 11 and 12 are done in the right order. The tank is now full of nothing.
13. Unscrew the vacuum fitting on the hose 1/2 turn, and remove from valve.
14. Watch the vacuum gauge very closely to make sure it does not lose vacuum. Do this for at least 2 minutes. Do not continue lifting if it loses vacuum. If the alarm(v2) sounds when you are lifting, crank down the optic until it is resting safely on a flat surface. Typically, the ergo-arm will not drop an optic until it gets down to 2-5 in/Hg so you have enough time to crank it back down.

#### 4. Lowering an Optic

15. Position optic, using two people to actually move the ergo-arm. Once you touch the optic down don't keep pushing on it, otherwise unnecessary force is put on the optic by the ergo-arm.
16. Check that the optic is resting fully on the surface.
17. Slowly loosen the vacuum release valve.
18. Back the arm off the optic.

## 5. Quick Checklist

For people that are already accustomed to using the ergo-arm, this is a quick checklist when using the ergo-arm.

### 5.1 Lifting a Large Optic

- Clean work area
- Wear Gloves, hairnet and facemask
- 3 people: one operator, one optic handler, and one spotter
- wipe down dirty tools or optics containers w/isopropyl
- Glasses on lanyard, jewelry off or under clothing/gloves
- Note which version of ergo-arm is being used(version 2 has a tank and digital pressure receiver)
- Locate crashpad
- Right vacuum plate for optic (test mass plate has flats)
- Maneuver ergo arm so that the vacuum plate is roughly parallel and centered on the optic's face. Remember:
  1. CW on handle raises arm
  2. CWW on handle lowers arm
  3. Each knob on plate gives a different degree of freedom
- Vacuum pump pumps and holds vacuum
- Tighten all "guideblocks" on ergo-arm head before lifting optic so that it does not swing around when it is lifted
- Watch pressure gauge when lifting

### 5.2 Lowering optic

- Still watch pressure
- Stop as soon as optic sets down to avoid pressing on it with the ergo-arm
- Verify the optic is resting fully on the surface
- release vacuum slowly

- Keep vacuum plate and vacuum pump nozzle covered with foil when not in use

## 6. Referenced Pictures

Numbered components in pictures:

- 1) Vertical Hand Crank
- 2) Vertical Hand Crank Brake
- 3) Horizontal positioning Wheel
- 4) Horizontal positioning Brake
- 5) Vertical/Horizontal tilt wheel
- 6) Right/Left guide block
- 7) Right/Left guide block Brakes
- 8) Right/Left swivel Brakes
- 9) Vacuum plate
- 10) Rotation Brake
- 11) Upper Vacuum hose
- 12) Lower vacuum hose
- 13) Pump down/air vent valve
- 14) vacuum plate evacuating valve
- 15) wireless vacuum gauge transmitter



