



Primary Mirror Handling Procedures

-
- Written by D. Blanco and G. Poczulp. Last Revised on 10/20/95 by DRB (dblanco@noao.edu)

Document number WODC 03-22

The following is a step by step procedure for removing the primary mirror from the telescope. Section II describes the installation.

The hardest part of this procedure is logistics. All activity must take place in a very limited space. Care must be taken to be sure the proper equipment is in the right place and that excess equipment is stored out of the way.

This procedure requires 6 people and can be done in 2 after completing the in-advance procedures.

In-advance procedures:

- Safety check of 5 ton hoist.
- Safety check of the lift cart (LC).
- Inspect primary transport box.
- Complete preparations of the 4m aluminizing chamber.
- Dry run of the primary handling procedure.
- Inspect Hydraset.

Equipment list.

- Primary mirror Cart.
- Lift Cart pump unit.
- Primary handling band.
- Primary spreader bars.
- Primary rigging straps.
- ____ ton Hydraset.
- Primary mirror removal tool set.

Procedure

1. The first step in removing the primary is to remove the tertiary mirror. This is done with the telescope horizon pointing, so it must be completed before any other part of the primary removal. See Tertiary Mirror Handling Procedures WODC 03- 21.
2. Stow the Thern floor crane back on the mezzanine.
3. You may want to remove the secondary mirror for realuminizing at the same time as the primary. In this case, you must replace the secondary mirror with the secondary dummy weight to keep the telescope safely balanced for the move from horizon pointing (for removal of the secondary and tertiary mirrors) to zenith pointing for primary removal. See Secondary Handling Procedures WODC 02- 20.
4. After removal of the tertiary, point the telescope north and to zenith.
5. Note: This places Hydra over the lift in a position it will be out of the way of the primary path. At this time we have not determined whether it is necessary to remove the IAS from the telescope. Clearances need to be reexamined prior to the next primary removal.
6. Install elevation stay bars (stowed in the southwest dome drive cabinet).
7. Uncable the primary mirror cell. Be sure all cables are properly labelled.
8. Install braces under the telescope skirt.
9. Install the building to pier brace on the mezzanine level.
10. Locate the safety railings (stored in the garage of the WIYN house) and bring them to the site.
11. Bring several pieces of 4x4x6' and 2x4x6' cribbing to the dome floor.
12. Bring the LC hydraulic unit to the dome floor.
13. Find two steel bridge inserts. Remove the wooden fillers from the ends of the rails and install the bridge inserts. Be sure the contact points are clean and the inserts seat properly.
14. There are three (?) sections of 7/8" square tubing that act as cart rail guides. Place

these in the west track. Arrange the pieces so that the tube section under the SE hydraulic leg can be removed (so it won't be crushed).

15. Open the main hatch - this lifts in two sections from rigging points in the dome floor. Use the 5 ton hoist. The hatch covers are NOT balanced about their rigging points, so don't be surprised when they pick up at an angle.
16. Stack the hatch covers atop each other between the stair well and the equipment lift hatch. Use cribbing do avoid damage to the dome floor.
17. Set the safety rails in place around the open hatch.
18. Rig the lift cart to the 5-ton hoist. Lift the cart and place it on the track with the hydraulic connectors pointing north (towards the telescope).
19. Remove all access panels to the primary mirror cell.
20. Push the cart under the telescope.
21. Remove the rail guide bar under the SE hydraulic leg.
22. Connect all hydraulic lines to the pump unit.
23. Start by lowering the cart all the way it will go. This raises the hydraulic legs and equalizes pressure in the four hydraulic circuits.
24. Raise the cart on power to within about 1 inch of the mirror cell.
25. Continue to raise the cart using the hand hydraulic pumps.
26. When the cart cups engage the mirror cell legs, continue pumping the lift until the pressure gauges on the cart read ____ psi. At this point the weight of the primary mirror cell has been transferred to the lift cart.
27. Using a ---- wrench and a cheater bar, loosen the primary mirror cell mounting bolts at the top of each of the flexion bars. This procedure takes two people - one to locate the wrench and spot, while the other pushes or pulls on the wrench. Take care with the inner bolts as they are very close to the glass.
28. Check the cart pressure from time to time during the removal. Adjust pressure with the hand pumps.

Removal of the WIYN primary mirror from the mirror cell.

-
- Last Revised on 10/20/95 by GP (poczulp@noao.edu)

The mirror and cell should be located on the handling cart with the top of the mirror exposed to allow the installation of the handling band. The tertiary mirror and cell have been removed. The primary mirror support forces, pressures, and LVDT positions should be brought to the nominal zenith pointing values after which the active optics control software and hardware must be turned off.

1. Remove the three thermocouple sensors that are attached to the O.D. of the front faceplate by unplugging at the connectors and removing the insulating tape.
2. Remove the twelve earthquake clips and the two bolts that hold each in place to the mounting blocks using a 3/8" allen wrench. Be particularly careful of the thin glass side wall of the mirror when using the wrench. Remove one or two of the short PVC ventilation tubes near the lateral constraint devices to allow better access. It will be difficult or impossible to remove these tubes after the handling band is in place.
3. Gently compress the lateral LVDT unit and remove the connecting rod that is held in place between the two detents. Place the rod in a safe place until reassembly.
4. Begin installation of the four handling band sections, note that the turnbuckles should not be attached when the sections are lowered into place. Each section weighs about 200 lbs. and the orientation and positioning of the sections is important. The bottom of the handling band sections set on the earthquake clip mounting blocks. The orientation of the handling band is determined by the vertical lines on the outer sidewall of the mirror.
5. When the four handling band sections are in place, install the eight turnbuckles and begin to tighten by hand. It is helpful to install all of the turnbuckles in the same sense, so that they are all turned the same direction when tightening. Check that the gaps between the handling band sections are uniform (~3 1/4") when the turnbuckles are hand tight. Check that the rubber lining on the handling band engages mirror

uniformly and the handling band extends above and below the mirror by ~0.20". On the overhead crane, rig the 10K lb. Hydraset with four 9' 6" long by 3" wide straps. Check the straps for any sign of damage. Extend the Hydraset hand controls.

6. On the floor, assemble the two spreader bars and the four vertical hangers, noting that two of the hangers are of different length. The spreader bar with the two short hangers is assembled with two 3/4" clevises on each side, while the spreader bar with the long hangers uses only one 7/8" clevice per side. Attach the ends of the four straps to the clevises on the hangers and lift the spreader bars. When the straps are rigged to the crane, the top ends of the straps should be arranged in an alternating arrangement rather than an opposing one. When the spreader bars are positioned to form an "X" there should be a small (~3/8" or less) gap between the bars and the bottom of the hangers should be at the same level. Install two small pieces of rubber between the long hangers on the top spreader bar and the straps to prevent chaffing.
7. Lower the spreader bars and hangers over the mirror and handling band, being especially careful with the ends of the hangers as they approach the front surface of the mirror. It is REQUIRED that one person be positioned at each hanger during this operation to assure that the hangers do not contact the glass. (Larry Goble suggests some removable rubber boots to fit over the ends of the hangers as added protection.)
8. Attach the four hangers to the trunions on the handling band and secure the cover plate by lightly tightening the single bolt. Do not over tighten.
9. After checking that the crane is centered over the mirror, pump up the Hydraset to 5000 lbs. using the hand control only. Allow some time for the straps to stretch.
10. Remove the single bolt that attaches each of two lateral constraint devices to the Invar brackets at the top and bottom of the mirror using a short 3/16" allen wrench. If, for some reason, the bolt is very tight, CAREFULLY use a 1" open end wrench on the hexagonal section of the lateral constraint (just to the right of the flexure) to react against while turning the bolt. It is not necessary to remove the entire lateral constraint assembly, but exercise caution when working near them. Place the hardware in a safe place until reassembled.
11. Disconnect the past zenith mechanism at the bottom of the cell using a 7/16" open end wrench, noting that the preload will be set at reassembly by adjusting the average distance between the washers and the posts that compresses the two springs to 1.64". The connection rods should be taped to the backplate of the mirror until they can be removed later. When the mirror is lifted clear of the ventilation tubes,

push in on the rods to drop the mechanism locators to the top of the cell. Place the hardware in a safe place until reassembly.

12. Under the cell, locate the three hardpoint mechanisms and loosen the 1/8" allen setscrews that are positioned opposite the index markers. Raise the three hardpoints into contact with the backplate of the mirror by rotating each of the 7/8" hex head screws, using a socket with a long extension, one turn COUNTERCLOCKWISE. This is opposite the expected sense because the hardpoint mechanism incorporates a differential screw, and one turn corresponds to 0.040". Note the arrow used as an index marker on the flange.
13. Detach the 66 axial support rods from the backplate of the mirror. This is done by using a 9/16" open end wrench to loosen the locknut while reacting the torque against a 1/2" open end wrench on the support rod bracket. This prevents any twisting on the load cell, which is attached to the support rod bracket.
14. Turn the locknut up to the small diameter on the support rod so that the locknut is completely loose. Loosen the support rod from the puck on the backplate of the mirror by turning the knob (with spanner holes) attached to the support rod. It should turn by hand, but a SHORT handled spanner (allen wrench) can be used if necessary. Unscrew the support rod until it drops free from the mirror and rests in the support rod bracket.
15. After all 66 axial support rods have been detached it is required that a visual check is performed by looking under the mirror at the support pucks and verifying that all support rods have been disconnected. It is also possible to perform a check by turning on the active optics system and reading out the values of the load cells.
16. Lift the mirror slowly, USING ONLY THE HYDRASET HAND PUMP CONTROL, to assure that the mirror is not hung up in any way. The load on the Hydraset must not exceed the mirror and handling band dead weight of 5400 lbs. by more than 100 lbs. It will be necessary to pay particularly close attention to the lateral supports until they are clear of the backplate of the mirror. The three axial LVDTs are spring loaded and do not need to be removed. When lifting the mirror check that the lip on the I.D. of the central hole in the primary does not catch the lip on the center tertiary mirror support. When it is CERTAIN that the mirror is free of the cell, the slow speed on the crane may be used.