

# 120 INCH TELESCOPE PRIMARY ALUMINIZING PROCEDURE

Corrected Copy 2-7-06

## FIRST DAY

CREW: 9 - 9 hours

\*Do in advance if possible.

- \*1. Remove Cassegrain spectrograph and store by main console. (1)
- \*2. Move coude third mirror or stand onto west mezzanine. (5-8)
- \*3. Disconnect 5 ton hook (9-12), and hook up 15-ton hook. (13-16) (Do not rereave bridge crane.)
- \*4. Install 3 support arms to lock telescope in position. Make sure telescope is perfectly located at zenith. (2-4) Hook declination bar to telescope first then to fork.
5. Remove east mezzanine hand rail.
6. Remove trim weights and store on east curb.
7. Remove dial indicators until tub and counterweights have been removed. Record readings. (17)

NE	NW	S

8. Install mirror handling platform extensions: north-1, south-2. (18-20)
9. Remove cable take-up turning block - tie up to north side of telescope. (21-22) (Do not remove cable trough.)
10. Attach tub fixture to mirror platform and drive under tub. Bolt tub to fixture.
11. Unbolt tub using 1 $\frac{1}{8}$  inch ratcheting box wrench. Remove tub with standard rigging and store on east mezzanine - (lifting bar, NNE-SSW). NOTE: Use tub fixture and leave electronic chassis and TV in place. (23-27) Use locating fixture for re-installation of tub.

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12. Remove telescope counterweight assemblies with mirror handling platform and store on east mezzanine. Block E and W with 2x4's. (**Remove N-E-W first.**) (28-32). Use  $1\frac{7}{8}$  and 2 inch sockets.

13. Reinstall dial indicators and jack mirror .100 inches. Remove indicators. (17 and 33) Make sure to have one person on each indicator for verification of travel.

14. Remove flooring on mirror handling platform and install  $\frac{3}{8}$  shim on east track. (34) This is a tapered shim.

15. Position platform under cell. (34-36)

16. Remove micrometers and hold down springs. **CAUTION: RECORD READINGS: DO NOT CHANGE SETTINGS.** Lift on counterweights to install allen wrench. (37)

NE	NW	S

17. Bolt cell to platform using 8 -  $\frac{3}{4}$  inch x 2 inch bolts and nuts. Use  $\frac{5}{8}$  inch bolts where required. Use  $1\frac{1}{4}$  inch wrench for  $\frac{3}{4}$  bolts. Use  $15/16$  inch wrench for  $\frac{5}{8}$  bolts.

18. Remove 16 bolts and nuts attaching cell to telescope. (38-39) (nut size -  $2\text{-}3/16$  inch and bolt -  $2\frac{1}{4}$  inch, due to clearance problems on the east and west sides we need to use a ratcheting extension and 1 inch drive breaker bar with a  $2\frac{1}{4}$  inch socket and a  $2\text{-}3/16$  inch slugger wrench.)

18a. Remove north Thermister (41)

19. Lower cell to down limit. (41)

20. Check that balls on jacks are centered.

21. Move platform to north limit.

22. Start testing mirror at this point, prepare area and chemicals and remove cardboard, tape, and foil. (50-51)

23. PREPARE to remove support assemblies. Leave defining units in place. (42)

24. Install support arms for mirror spreader bar on south end of mirror handling platform while work on mirror continues. (43)

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- 25a. Locate 3 - ¼ inch slotted fillister head screws. Screw in by **hand** until they touch the crown.
25. Remove 2 aluminum clips from under 2 each ½ inch socket head spring-loaded guide pins. (45-a) If the heads do not bottom out, take hold of 2 or 3 rectangular shaped counterweights and push up on one while rattling the other back and forth until bolts drop in place. (46-e)
26. Install split PVC keepers (screws down) around 1 inch shaft supporting large 70 pound counterweight and push up into place. (49-a)
27. Remove 3 round counterweights from each support with ⅞ inch open end wrench at the cast iron lever arm bracket (Don't move weight on shaft). They are all match marked. (44-c) Keep counterweights in sets and in sequence.
28. Loosen 2 of the 4 radial set screws on large circular flange (THOSE **NOT** PAINTED RED). Use "L" shaped ¼ inch allen wrench. Don't touch radial centering screws in triangular grey casting. (46-a)
29. Remove all socket head cap screws holding large round flange **except** the second one 3 clockwise of the triangular point of the center plate, (45-b). Three of the cap screws are hidden above the rectangular weights. Remove with a standard allen wrench.
30. Remove 3 socket head cap Screws, one from each point of the triangle shaped plate supporting the counterweight. (45-e)
31. Install 3 short hex-shaped and relieved extension screws and triangular push plate for jack. Use 3 holes in triangle casting. (46-b)
32. Install 3 long ½ inch rods in first hole clockwise of triangular plate. NOTE: Center support has no triangle plate. (48-d)
33. Install jack and align screw push plate by adjusting 3 nuts supporting jack. Screw pilot and bearing to engagement with push plate. (48-b and c)
34. Remove 3 remaining cap screws from counterweight assembly flange. (47-a)
35. Wiggle jack gently while removing counterweight assembly until flange and radial set screws are no longer engaged.
36. Lower flange down 2 inches below mirror cell and install 3 clamps with slotted studs hanging down through 3 easily accessible holes and add bent bracket and nut. Note: center support hole uses 3 special clamps.
37. Raise flange till flush with mirror cell; using screwdriver rotate slotted studs (3) to engage clamps with outer diameter of hole and tighten with 15/16 inch open end wrench. (47-b)

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38. Remove all jack equipment and proceed to next support assembly until completed.
39. Have team strip and clean mirror this night. Remove temperature sensor from the front of the mirror.
40. Test mirror surface with reflectometer. (52-53)
41. Prepare mirror for stripping and cleaning:
  - A. Apply 1 wrap of single face 2 inch masking tape in place of cardboard
  - B. Apply 1 wrap of double face 2 inch masking tape over above
  - C. Apply 1 wrap of 48 inch wide vinyl sheeting draped over edge of cell
  - D. Apply 2 wraps of single face 2 inch masking tape
  - E. Build a dam around the mirror by folding 2 inch duct tape  $\frac{1}{2}$  inch
42. Tie balls of cotton on end of PVC tubing and Lucite rods 2 feet long. (59)
43. Install PVC drain plug in center of mirror from bottom and inflate inner tube and connect 3 hangers. (57-58) Make sure top of inner tube is approximately 1 inch below mirror surface.
44. Optician and 2 technicians proceed with stripping. Follow "Lick Observatory" procedure. (60-62)
45. Carefully cover with strips of cellophane and tape to side of glass. (64) Stow under telescope.

## SECOND DAY

1. Idle technicians remove floor covers over aluminizing tank. (63)
2. Remove draping and all tape.
3. Match mark mirror to cell with masking tape (2 places - NE and NW). (65)
4. Slip sling around mirror. (66)
5. With use of bridge crane, install 2 edge arcs on mirror cell (NE-NW) and bolt down. (67) Install aluminum sling supports (68) and block up hook end so sling is parallel.
6. Use long 2-inch cable stinger to install lifting bar. (69-70)
7. Install ball screw jacks and attach to sling (71) (#1 in west).
8. Install top U-shaped safety bracket on spreader bar (marked) and 2 safety brackets on sling. (72) Make sure that top bracket does not touch aluminum dial indicator push rod.

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9. Install trim weights on north end of platform (40 weights).
10. Remove defining units after completing steps A and B; (NOTE settings). (42)
  - A. Turn (4, two on each unit) socket head graduated screws counter-clockwise on the N and S defining units 36 turns to release the crowns. (**CAUTION: Turn 2 EW screws 20 turns only**) (73-a) **Note: Orange match marks**)
  - B. Remove 6 flat head screws and install 2 - ½ inch jack screws to push out assembly (73-b and c)
11. Take up sling ball screw jacks until mirror starts to move. (74) Tilt a little first. Record dimension from stop to top of ball nut.
12. Attach a rope to either side of sling. (76)
13. Open aluminizing tank and remove all small mirror brackets from inside the tank.
14. Install Tuggit hoist from bottom of platform to frame for safety. (74)
15. **Remove: North Platform Extension**
16. As platform is tilted, keep bridge crane hook snug on lifting bar and back off Tuggit hoist. (75)
17. After mirror is in vertical position, lift mirror with hook ¾ inch off edge arcs so that lifting bar clears support arms. (76)
18. Roll platform south away from mirror to just clear telescope.
19. Disconnect power cable to mirror handling platform and store on floor. (77-a, 76)
20. Rotate dome and position mirror over tank. (77)
21. Position 2 technicians on tank to guide mirror sling into position. Remove temperature sensor from bottom of mirror.
22. Lower mirror enough to clear support arms and slide west into position; place weight on tank supports. (78-79)
23. Do not slack lifting screws until top center support has been bolted to tank. (80)
24. Slack lifting screws and disconnect from sling; stow bar above floor opening. (79)
25. Remove 2 safety brackets and connect 2 bottom safety straps between sling and tank. (80-b)

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26. Remove all cellophane and allow coating technician to do final cleaning and inspection of mirror.
27. Close tank and start roughing pump.
28. Rope off observing floor opening for safety.
29. Thoroughly inspect all crowns for damage; clean supports and cell as required. (82)
30. Bring 3 - ¼ inch push screws just into contact with crowns. This keeps them straight during reinstallation of mirror supports. (44a)
31. Vacuum coat the mirror.

## THIRD DAY

CREW: Same - 8 hours

1. Open tank, inspect mirror, test and cover surface of mirror with cellophane. (81)
2. Lower spreader bar and jacks over mirror and connect to sling. (79)
3. Disconnect 2 safety brackets at bottom of sling. (80-b) Also remove (A). Do not unbolt from tank until upper safety bracket is attached to spreader bar.
4. Take up jacks equally about one turn (do not rotate mirror); lift mirror about 3 inches and outhaul to disengagement of tank supports.
5. Install temperature sensors on front and back of mirror.
6. Inspect 18 Invar bearing races inside mirror support pockets for loose "O" rings and set screws.
7. Lift straight up while guiding with 2 attached ropes at bottom of sling and 2 technicians on tank. (83)
8. Rotate dome and center mirror in North; connect platform power.
9. Drive platform north and carefully guide mirror past edge arcs (84).
10. Make sure mirror cell is parallel to back side of mirror; override limits if necessary. (85)
11. Check rotation and center line of mirror with cell. Make adjustments with jacks after lifting bar is resting on supports.

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12. Slack crane hook just a bit and start tilting platform down. Follow with hook and tuggit.
13. Level platform with machinist level on cell flange.
14. Remove trim weights.
15. DO NOT move platform until 3 mirror supports have been installed (center, east, and west).
16. Remove lifting bar and brackets only after #15 is completed.
17. Install north platform extension.
18. Remove edge arcs.
19. Remove mirror sling. (68 and 86)
20. Close aluminizing tank and floor over tank while mirror supports are being installed.
21. Install all mirror supports:

## **IMPORTANT TO DO THE FOLLOWING STEPS IN SEQUENCE**

- A.** Carefully jack supports until crowns are engaged. Rattle large round weights. (48)
  - B.** Lightly screw in radial set screws (2 unpainted set screws). (45f)
  - C.** Lightly tighten 3 cap screws and remove jacks. (45-b)
  - D.** Loosen 3 - ¼ inch slotted fillister head screws 6 turns counter clockwise (crown supports). (44-a)
  - E.** Finish installing cap screws on large flange and tighten radial set screws (2 unpainted set screws). (45-b)
  - F.** Install 2 aluminum clips on guide pins (insert pull wire in hole in screw head). (45-a)
  - G.** Reinstall 3 radial weights (49-c)
  - H.** Remove split PVC blocks. (49-a)
22. Install both defining units: (42)
    - A.** Turn graduated screws clockwise on NS (36) turns to previous setting; on EW 20 turns only. (73-a) (One of the N-S screws may only turn 35½ turns.)
  23. Drive mirror handling platform under telescope.

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## FOURTH DAY

CREW: Same - 8 hours

1. Carefully remove cellophane from mirror surface.
2. Insulate mirror blank:
  - A. Install 1 inch black masking tape to  $\frac{1}{4}$  inch inside mirror surface of radius edge.
  - B. One wrap of single face 2 inch masking tape.
  - C. One wrap of double face 2 inch masking tape.
  - D. One wrap of 3 inch corrugated cardboard.
  - E. One wrap of double face 2 inch masking tape.
  - F. One wrap of 3 inch corrugated cardboard
  - G. One wrap of double face 2 inch masking tape.
  - H. One wrap of 18 inch wide aluminum foil.
  - I. Install top hat light shield in 8 inch center hole.
3. Install 6 washer spacers at W-S-E bolt pattern on cell and raise mirror.
4. Install cap screws in down position (nuts down).
5. Remove most of cell/platform bolts if necessary for alignment.
6. Install 4 bolts at N-S-E-W position and torque with 2 man power. Use tubing extension on flex handle (38). (Nut size 2-3/16 inch, bolt size  $2\frac{1}{4}$  inch. Due to clearance problems on east and west sides, we need to use a ratcheting extension and 1 inch drive breaker bar with a  $2\frac{1}{4}$  inch socket and a 2-3/16 inch slugger wrench.)
7. Remove 8 tie-down bolts between platform and cell. Use  $1\frac{1}{4}$  inch end wrenches for  $\frac{3}{4}$  inch bolts and  $15/16$  inch end wrenches for  $\frac{5}{8}$  bolts.
8. Lower platform.
9. Lower mirror jacks to their stops.
10. Stow platform in north and replace wood flooring. Remove ramp and shim from east track.
11. Install 3 micrometers and check readings: install springs between counterweights and brackets. (37)
12. Check to make certain round counterweights are level; adjust by turning turnbuckles; counter-clockwise raises weights.
13. Check that all counterweights are free and floating.

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14. Install 4 counterweights on telescope with platform. South first; then E, N, W together. Support E, W on 2x4s.
15. Position tub on platform and center under telescope. (26-24)
16. Lift carefully aligning taper guide pins
17. Bolt tub to cell: (23)
  - A. Screw in and torque 12 insulated hex head screws (1 $\frac{1}{8}$  inch ratcheting box wrench).
  - B. Position and bolt on cable turning block assemblies.
18. Install dial indicators and reset, if required, by rotating turnbuckles above micrometers. Do not change 0-settings on dial gauges. (17)
19. Unbolt tub fixture from the tub, lower platform and travel to north limit.
20. Remove 2 south platform extensions and tub fixture.
21. Replace trim weights per balance specifications.
22. Remove 3 support bars from fork and store in north mezzanine. **Remove: 2 south hand-rails from mirror handling platform.**
23. Test telescope controls for proper operation.
24. Collimate primary mirror (if asked for) using:
  - A. Prime focus and Direct Camera
  - B. Collimate by adjusting micrometers.