Title: Primary Mirror Cart Design Requirements for the WIYN 3.5 Meter Telescope

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1. Purpose & Scope

This document defines the design requirements for the Primary Mirror Cart (PMC). The PMC is an auxiliary piece of equipment that is used for removing the primary mirror in its cell from the telescope.

2. General Description

The WIYN Telescope is an altitude-over-azimuth configuration with a 3.5 m diameter primary mirror. On a yearly or bi-yearly basis the primary mirror will be removed from the telescope, stripped of its aluminum surface coating, and recoated with a fresh layer of vacuum deposited aluminum. The cart will facilitate the mirror removal process.

Mirror cell removal involves supporting the mirror and its cell (combined weight about 15,000 pounds) with the cart, detaching the cell from the telescope, lowering the cell about 12" by means of elevator jack screws on the cart, and rolling the mirror and cell onto the dome floor where the mirror can be prepared and removed from the cell using the overhead dome hoist.

The cart will provide an elevator mechanism for raising and lowering the mirror and cell. It will roll on two rails which bridge the transition between the dome floor and the telescope azimuth platform. One rail will be vee shaped to engage the grooved wheels on the cart; the other rail will be flat. This arrangement provides registration without over-constraint which could bind the cart movement.

2.1 Mirror Removal Procedure

A brief description of the necessary steps involved follows. This is not meant to be complete or definitive but does provide an outline of the procedure:

1) Lock the telescope elevation structure from moving with the telescope zenith-pointing.

2) Install tracks on the dome floor bridging the gap between the dome floor and telescope azimuth platform.

3) Lift the mirror cart from a delivery truck using the dome hoist and position it on the rails.

4) Roll the cart into position under the mirror cell.

5) Engage the cart to the cell by raising and positioning the cart jack screws.

6) Detach the mirror from the telescope center section (ring beam).

7) Lower the mirror and cell using the cart jack screws.

8) Roll the cart onto the dome floor. Hand or electric powered winches may be used for moving the cart.

9) Disengage the mirror supports and defining units from the mirror. This will involve access under neath the primary mirror cell on an automotive "creeper" dolly.

10) Remove the mirror edge ring and preventers from around the primary.

11) Install the mirror lift band.

12) Lift the primary mirror from its cell using the overhead hoist.

Additional steps and safety checks will be determined. The procedure is reversed for installation.

3. Requirements

3.1 Safety

The primary mirror is basically irreplaceable. All prudent steps will be taken to make every aspect of mirror handling as safe as possible. All mechanisms will be designed with safety factors of six or higher.

3.2 Jacking mechanism

The cart will be equipped with four jack screws capable of lifting and lowering the mirror and cell (approximately 15,000 lbs). The jack screws will bear against load carrying pads on the bottom side of the mirror cell. The jack screws will be driven by a single motor with linkages that insure the jacks are synchronized during raising and lowering. Jacking rate will be approximately TBD inch/minute.

3.3 Overload Protection

The cart will be fitted with overload protection devices to prevent jack screw loads from harming the telescope. These will be mounted on the cart wheels. Each overload device will be set to trip a limit switch when the force exceeds approximately 0.375 times the mirror/cell weight. This will limit the total axial load to about 1.5 times the mirror/cell weight.

3.4 Limits Switches and Hard Stops

The elevator motion of the cart will be provided with limit switches to prevent over travel, and adjustable hard stops to lock out elevator motion.

3.5 Service Access

The cart will provide reasonable access beneath the mirror cell for an average sized technician positioned prone on a creeper dolly. Alternately, the mirror/cell may be supported on jack stands once it is on the dome floor and the the cart removed to provide access to the bottom of the cell.

3.6 Adjustments

Each jacking point will be individually adjustable in X,Y, and Z to facilitate engagement to the cell. These adjustments will also allow for X-Y translation of the cell for alignment to the telescope on reinstallation.

3.7 Handling & Storage

The cart will be fitted with lifting points so that it can be lifted with the overhead dome crane. The cart must pass through a hatch in the dome floor TBD by TBD in size. The cart will be designed to fit into the mirror storage box.

3.8 Corrosion Protection

The cart will be operated inside the dome. It will be stored in a weather resistant container out of doors on Kitt Peak. Structural steel surfaces should be primed and painted with high quality paints to inhibit corrosion. Structural tubing should be painted on the inside with a rust inhibiter. Mechanisms should be made out of corrosion resistant materials or provided with seals and boots.

Electrical hardware should be sealed against moisture.

4.0 Environmental

Operating temperature:	0°F to 90°F
Storage temperature:	-20°F to 120°F
Humidity:	Up to 100%.
Elevation:	6838'.
Earthquake zone:	UBC zone 2.