DESIGN REQUIREMENTS DOCUMENT

PRIMARY MIRROR LIFTER

SPE-O-G0065

Ronald S. Price

April 26, 1995

Design Requirements Document
Table of Contents

1.0 General.

1.1 Scope of the Design Requirements Document. This Design Requirements Document contains the design requirements for the Primary Mirror Lifter for the Gemini 8-M Telescopes.

1.2. Applicable Documents. The Primary Mirror Lifter interfaces with other component parts of the Telescope and support equipment. The following documents contain information applicable to the design of the Primary Mirror Lifter:

(a) 85-GP-2100-0020 Primary Mirror Lifter - General Assembly
(b) 85-GP-2000-0003 Meniscus Primary Mirror
(c) 90-GP-0005-0001 Interface Control Drawing - Coating Vessel / Lifter
(d) 90-GP-0005-0003 Interface Control Drawing - M1 Assembly / Lifter
(d) 90-GP-0001-0038 Coating Facility
(e) TBD Cleaning Cart, Primary Mirror
(f) Enclosure Critical Design Review Package;
(g) Gemini System Interface Control Documents

1.3. Definitions.

1.3.1 Technical Definitions. In this Design Requirements Document, the following capitalized terms shall have the corresponding meanings given such terms in this Section 1.3.1.

(a) Lifting Feet. The "Lifting Feet" are fifteen C-shaped devices, each with a contact pad, that swing underneath the inner and outer edges of the Primary Mirror for lifting.

(b) M1 Cell Assembly. The "M1 Cell Assembly" is the system that consists of all components, equipment and materials mounted on the Telescope Mirror Cell Support Frame that support, define, adjust, and thermally control the Primary Mirror.

(c) M1 Lateral Supports. The "M1 Lateral Supports" are 64 individual Primary Mirror supports distributed around the perimeter of the Primary Mirror and attached to the Cell Structure.

(d) Pivot Point Location. The "Pivot Point Location" is the point where the T-shaped Structure connects to the Upper Framework of the Lifter. The relative position of the Pivot Point Location with respect to the inner and outer lifting feet determines the proportion of load carried by each group of lifting feet.

(e) Primary Mirror. The "Primary Mirror" is an 8 meter diameter zero-expansion glass meniscus mirror with a thickness of 200 mm; it is also referred to as M1.

(f) T-shaped Structures. The "T-shaped Structures" are three steel I-beam structures that hang on pivot points below the upper framework of the lifting fixture. Each T-shaped structure carries four outer and one inner lifting feet.

(g) Upper Framework. The "Upper Framework" is the main structural framework of the Primary Mirror Lifter. It consists of three large I-beams spaced 120° apart, attached to a central hub. The upper surface of each beam has lifting eyes for attachment to a crane, provides a surface for walking to the central area of the fixture for moving the three central clamps, and provides attachment points for a flexible cover to protect the primary mirror surface.

1.4. Coordinate Axes. (a) The coordinate axes used in this document form a right-handed system as shown on Drawing No. 85-GP-2100-0020. The X-axis is parallel to the Telescope elevation axis, positive from left to right looking at the Primary Mirror optical surface with the Telescope horizon pointing. The Z-axis is parallel with the optical axis, positive from the Primary Mirror towards the secondary mirror. The origin of the coordinate system is located at the projected vertex of the Primary Mirror.

2.0 Environmental Conditions. The Gemini 8-meter telescopes and associated support equipment will be subjected to various environmental conditions. These conditions include operating conditions, survival conditions, and transportation and handling conditions. The Primary Mirror Lifter and its component subsystems shall be designed and tested over environments that will ensure their performance in the observatory will meet all requirements of this Design Requirements Document.

2.1 Operating Conditions. The Primary Mirror Lifter, while operating as part of the applicable observatory, shall be capable of sustained and continuous operation in complete conformance with the requirements of this Design Requirements Document while being continuously subjected to any combination of the following environmental conditions :

Condition	Requirement
Altitude	Sea level to 4300 meters
Ambient air temperature	-10° to +25° C
Relative humidity	0% to 95%

2.2 Survival Conditions. The Primary Mirror Lifter shall meet the requirements stated in Section 2.1 above, without damage or requirements for repair, after being subject to any combination of the environmental conditions specified below for any duration of time any number of occurrences :

Condition	Requirement
Ambient air temperature	-20° to +40° C
Relative humidity	0% to 100% condensing
Earthquake loads at Primary Mirror	2.7g in X, 1.5g in Y and 1.4g in Z, simultaneously

2.3 Transportation and Handling Conditions. After delivery and any required assembly at the final observatory location, the Primary Mirror Lifter shall meet the requirements stated in Section 2.1 above, without damage or requirements for repair, after being subject to any combination of the environmental conditions specified below for any duration of time any number of occurrences :

Condition	Requirement
Altitude	Sea level to 4300 meters
Ambient air temperature	-20° to +50° C
Relative humidity	0% to 100% condensing, also salt water spray
Shock and vibration loads	5g (shock, any axis)

3.0 Requirements

3.1 Definition. (a) The Primary Mirror Lifter is the assembly used to lift and move the telescope's Primary Mirror as required for initial installation into the telescope and periodic recoating of the Primary Mirror's reflective surface. The specific design requirements for this assembly are described in this Section 3.

(b) The Primary Mirror Lifter is used to remove the Primary Mirror from the shipping container upon initial delivery to the observatory sites, and remove and install the Primary Mirror from the mirror cell assembly, mirror support cart and coating chamber. The assembly drawing of the Primary Mirror Lifter is Drawing 85-GP-2100-0020. A list of subassemblies is provided in Table 1 below.

TABLE 1 - Primary Mirror Lifting Fixture Component List

I. Primary Mirror Lifting Fixture
- **A. Upper Framework**
  1. I-Beams
  2. Central Hub

3. Walkway
4. Railing
5. Protective Covers
6. Support Legs

B. T-Shaped Structure (3 ea.)
1. T-Beam
2. Inner Lifting Foot (1)
3. Pivoting Beams
4. Outer Lifting Foot (4)

3.2 Interfaces

3.2.1 Primary Mirror Interface. The Primary Mirror substrate is a meniscus shaped piece of Corning ULE™ titanium-doped fused silica. The dimensions and configuration of the Primary Mirror are specified in Drawing 85-GP-2000-0003. The Primary Mirror interfaces with the Primary Mirror Lifter as follows:

(a) Outer lifting feet / Primary Mirror. Each of twelve lifting feet bear against the convex side of the primary mirror just inside its outer diameter. These outer lifting feet must clear the lateral support pads bonded to the outer diameter of the Primary Mirror.

(b) Inner lifting feet / Primary Mirror. Each of three lifting feet bear against the convex side of the primary mirror just inside its central hole.

(c) Protective Cover / Primary Mirror. The protective cover shall shield the polished concave surface of the primary mirror from dust, dirt and falling tools.

3.2.2 M1 Cell Assembly Interface. The "M1 Cell Assembly" is the system that consists of all components, equipment and materials mounted on the Telescope Mirror Cell Support Frame that support, define, adjust, and thermally control the Primary Mirror. The three support legs of the Primary Mirror Lifter interface with three pads on the M1 Cell Assembly. This interface provides accurate, repeatable and kinematic registration of the Primary Mirror Lifter and allows bolting of the Primary Mirror Lifter to the M1 Cell Assembly pads if required.

The twelve outer lifting feet of the Primary Mirror Lifter must adequately clear the lateral support mechanisms, definers and outer air pressure seal on the M1 Cell Assembly. The three inner lifting feet must adequately clear the inner air pressure seal and the central baffle clamping mechanisms on the M1 Cell Assembly. Refer to Drawing 90-GP-0005-0003.

3.2.3 Support Cart Interface. The Primary Mirror Support Cart is used to move the Primary Mirror between the observatory floor and the basement of the enclosure for periodic recoating. The Primary Mirror Lifter is used to install and remove the Primary Mirror from the Support Cart. The three support legs of the Primary Mirror Lifter interface with three pads on the Support Cart. This interface provides accurate, repeatable and kinematic registration of the Primary Mirror Lifter and allows bolting of the Primary Mirror Lifter to the Support Cart pads if required.

3.2.4 Coating Chamber Interface. The Coating Chamber is used to apply the reflective coating to the concave polished surface of the primary mirror. The Primary Mirror Lifter is used to install and remove the primary mirror from the coating chamber. The three support legs of the Primary Mirror Lifter interface with three pads on the Coating Chamber. This interface provides accurate, repeatable and kinematic registration of the Primary Mirror Lifter to the Coating Chamber. Refer to Drawing 90-GP-0005-0001.

3.3 Requirements

3.3.1 Primary Mirror Stress . The maximum stress induced in the primary mirror while supported by the Primary Mirror Lifter shall be 250 psi tensile.

3.3.2 Positional Registration. The Primary Mirror Lifter shall have slots located in each of the three vertical legs for registration of the lifting fixture with respect to the primary mirror cell, support cart or coating chamber.

3.3.3 Stress in Structural Members. The maximum stress induced in any structural member of the Primary Mirror Lifter while supporting the Primary Mirror shall be 15,000 psi.

3.3.4 Reliability. The Primary Mirror Lifter shall be designed for at least 50 years of service. All components shall be of high reliablity.

3.3.5 Mass. The mass of the Primary Mirror Lifter shall be less than 80,000 N (18,000 lbs.).

3.3.6 Structural Components. The Primary Mirror Lifter shall be fabricated from standard, readily available structural members.

3.3.7 Protection of Primary Mirror Reflective Surface. The Primary Mirror Lifter shall have a removable cover to protect the reflective surface of the primary mirror from dust, dirt and falling tools.

3.3.8 Clearance to Primary Mirror. The Primary Mirror Lifter shall be designed such that there is a minimum of 20 mm clearance between the reflective surface of the primary mirror and the lifting feet when the primary mirror is supported in the Primary Mirror Lifter.

3.3.9 Lifting Points. One set of three lifting points shall be incorporated in the design of the Primary Mirror Lifter. These lifting points shall be located 120° apart on top of the three main beams of the Upper Framework and shall be located at a radius of 1900 mm.

3.3.10 Beams and T-shaped Structure Movement. The range of motion of the beams and T-shaped structures shall be limited to that required to provide kinematic support of the Primary Mirror. Stops and bumpers shall be provided to restrict unnecessary motion of these components.

3.3.11 Lifting Foot Movement. Each of the fifteen lifting feet shall have a dampener attached to it to prevent the free swinging of each lifting foot about its pivot point. Each of the fifteen lifting feet shall have a positive engagement pin to lock each lifting foot in either the retracted or engaged position.

3.3.12 Bearings. All bearings and pivot points located within the Primary Mirror Lifter shall be free of any lubricant, and shall not require periodic maintenance during normal operation.

3.3.13 Platings and Coatings. (a) Surface finishes shall be chosen so as to not adversely affect the functioning of the telescope, and to require minimum maintenance during the life of the telescope.

(b) All parts of the Primary Mirror Lifter shall be finished so as to promote cleanliness of the fixture and to avoid contamination of the primary mirror. It is of prime importance that all protective coatings be of high quality and long life.

(c) All metallic surfaces, other than mating machined surfaces, shall be painted or otherwise protected against atmospheric corrosion and the effects of chemicals associated with the stripping and cleaning of the primary mirror reflective surface.

3.3.14 Maintenance. (a) The Primary Mirror Lifting Fixture design shall ensure that maintenance requirements shall be minimal and all necessary maintenance operations can be effectively carried out without risk to personnel or to the telescope.

(b) The Primary Mirror Lifter shall be designed with standard components to the extent possible. Where possible, items shall be designed so routine maintenance shall require no special tooling.

3.3.15 Interchangebility. The Primary Mirror Lifters fabricated for the Mauna Kea site and the Cerro Pachon site shall be identical and functionally interchangeable.

3.3.16 Safety. The design of the Primary Mirror Lifter shall comply with OSHA safety requirements. During normal operations or when subjected to the environments of Section 2.0, there shall be minimum risk to the hardware and no risk to personnel.

3.3.17 Envelope and Clearance. The outside envelope of the Primary Mirror Lifter shall be as specified in the assembly drawing 85-GP-2100-0020.

3.3.18 Design for Transportation. The Upper Framework of the Primary Mirror Lifter shall be designed in bolt together sections that can be easily transported and assembled at the observatory site.

3.3.19 Access to central clamps. The Upper Framework of the Primary Mirror Lifter shall be designed with an open central hub to allow access by personnel to the three central lifting feet.