

15 SUMMIT FACILITIES

15.1 Introduction

A number of facility buildings will exist on the summit in addition to the enclosure. These are shown on the baseline site plan, Figure 15-1. The overall design goal is to keep heat-producing equipment and activities not directly related to nighttime observing operation separate from the enclosure. The exception is the Control Building located within the footprint of the enclosure. The major buildings at the summit are:

The Facility Building provides offices for the observatory administrative/technical staff and visiting scientists, lab space for assembling and maintaining instrumentation, a meeting/conference room, and common area.

The Auxiliary Building provides bays for assembling the primary mirror cells and large instruments. The primary mirror coating chamber and washing station is also located within this building.

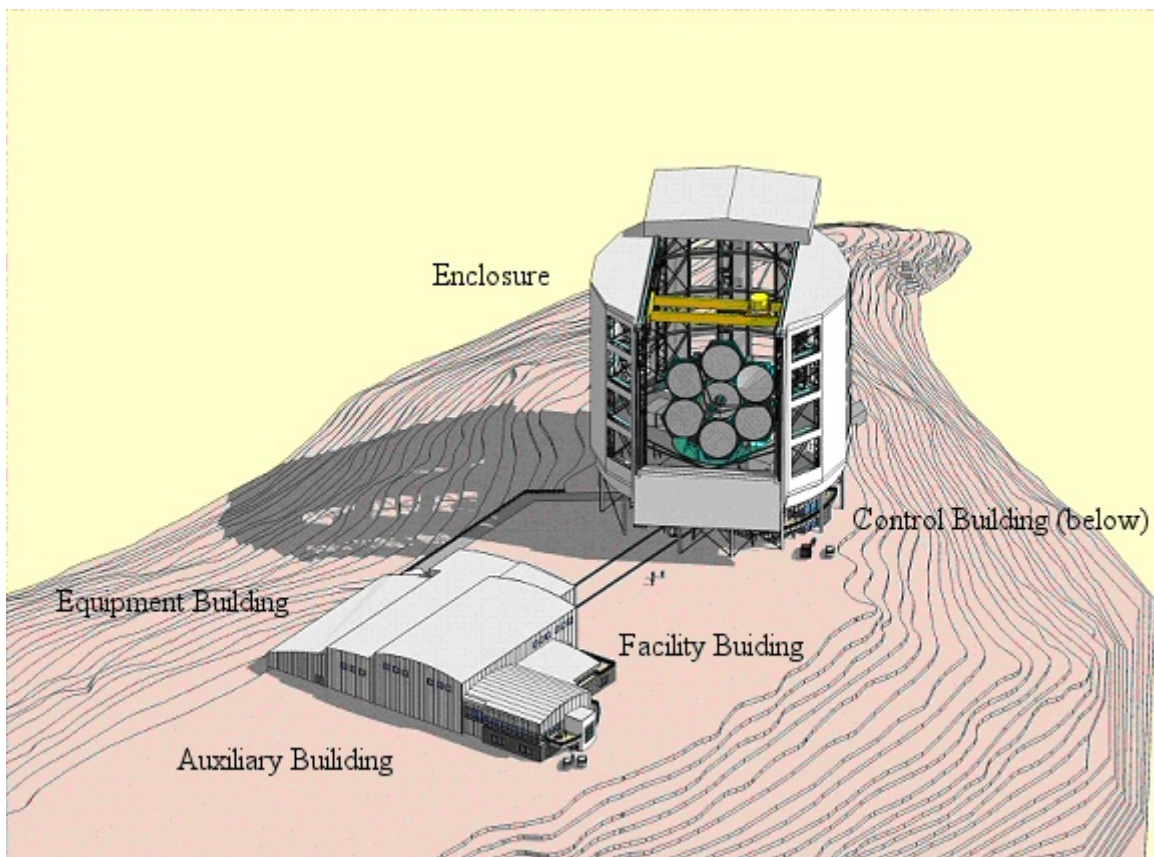


Figure 15-1. GMT Site Facilities.

The Equipment Building houses major mechanical equipment including pumps for the hydrostatic bearings, vacuum pumps for the coating plant, air compressors for the primary mirror system, and the main electrical switch gear for the site.

The Control Building provides space for the control consoles for operating the telescope and instrumentation, work space for organizing and carrying out observations, and common areas (lounge, kitchenette).

In the final design the Facility Building, Auxiliary Building, and Equipment Building may be combined in a single structure as is, in fact, shown on the baseline site plan. This will depend in part on the topography of the site finally selected.

Space and functional requirements for these facilities are contained in the Enclosure and Facilities Design Requirements Document, Appendix 15-1 and are summarized in this chapter.

Other required facilities include a lodge and dining hall on the mountain and a sea-level office for administrative and technical staff and additional lab space. The remainder of this chapter summarizes the requirements and design for the GMT facilities at the summit.

15.2 Requirements Document

Functional and space requirements for the Facility Building, Auxiliary Building, Equipment Building, and Control Building are contained in the “GMT Enclosure & Facilities Design Requirements Document”, Rev. 9, GMT document 293 included in this report as Appendix 15-1. They are summarized in the sections below.

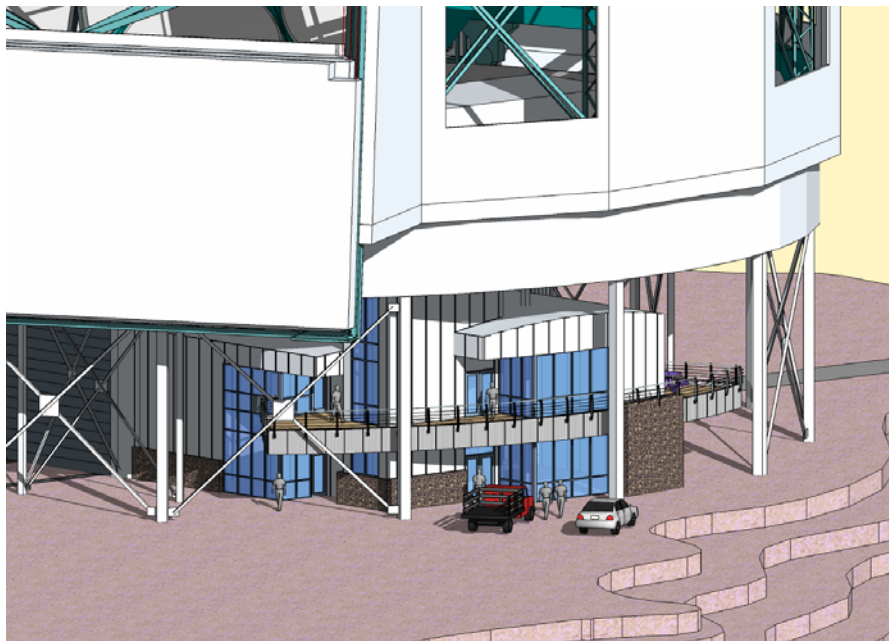


Figure 15-2. Control Building.

15.3 Control Building

The GMT telescope is operated at night from the control building, Figure 15-2, located at ground level on the north side of the telescope enclosure base below the observing level. It is a two-level facility with a total area of 373m², and has the following required spaces:

- Operations room
- Electronics room
- Kitchen/lounge
- Control room
- Science room
- Support spaces

The main entrance and corridor at grade level provides direct access to the operations, electronics and kitchen/lounge spaces, Figure 15-3. Access to the pier and instrument staging is through a door at the end of the corridor.

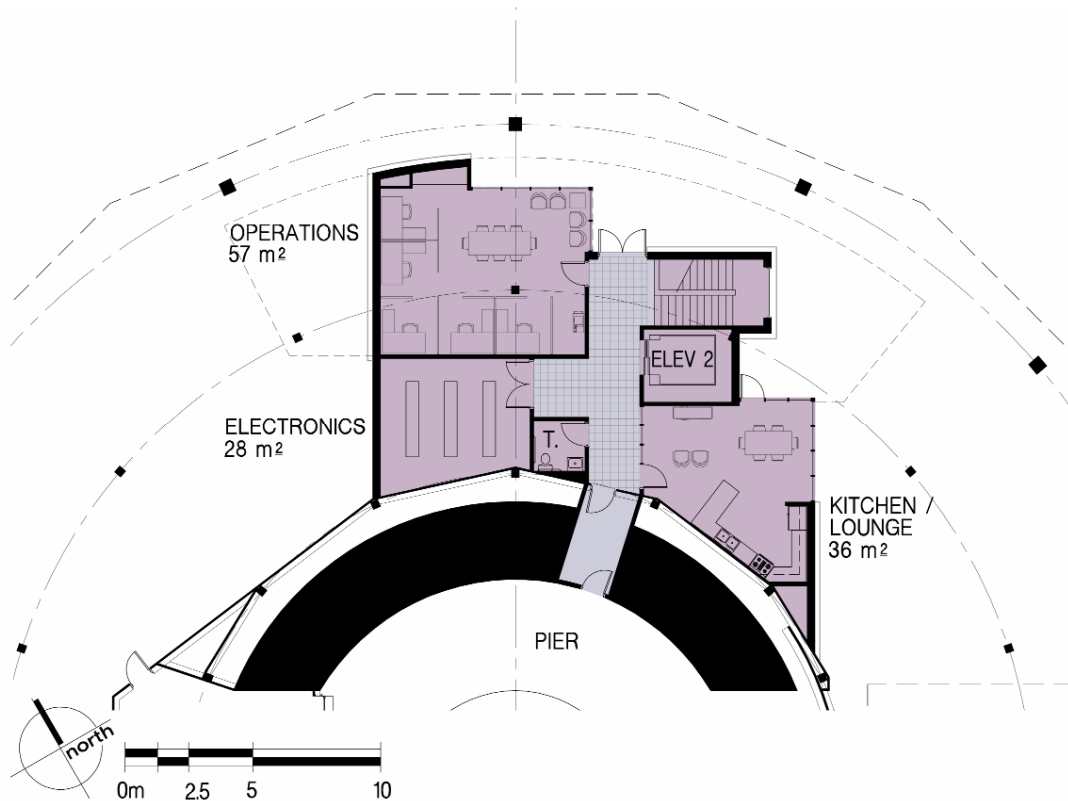


Figure 15-3. Control Building grade level.

The operations room provides the telescope operator's work space, lounge and storage area for the operations manuals, records, etc. The lounge area within the space and adjacent to a corner window provides views of the mountains and the support facility.

Adjacent to the operations room through a pair of doors is the electronics room. This space houses control data analysis computers and communications equipment. At this point in the design, the equipment quantity and size are undefined therefore the space may need to be refined in the next design phase.

The kitchen/lounge area is accessible from the main corridor and has views of the mountains and the support building. The space combines a small kitchen with a lounge area providing personnel an isolated space away from the work areas and direct access from outside.

Adjacent to the main entrance is a stairwell and service elevator (Elev. 2) providing access to the second level and the observing level above, Figure 15-4. The primary function of the second level is the control room which has a continuous counter along one wall, a lounge area at the corner with views to the mountains and an administrative counter for a copier, fax machines, etc.

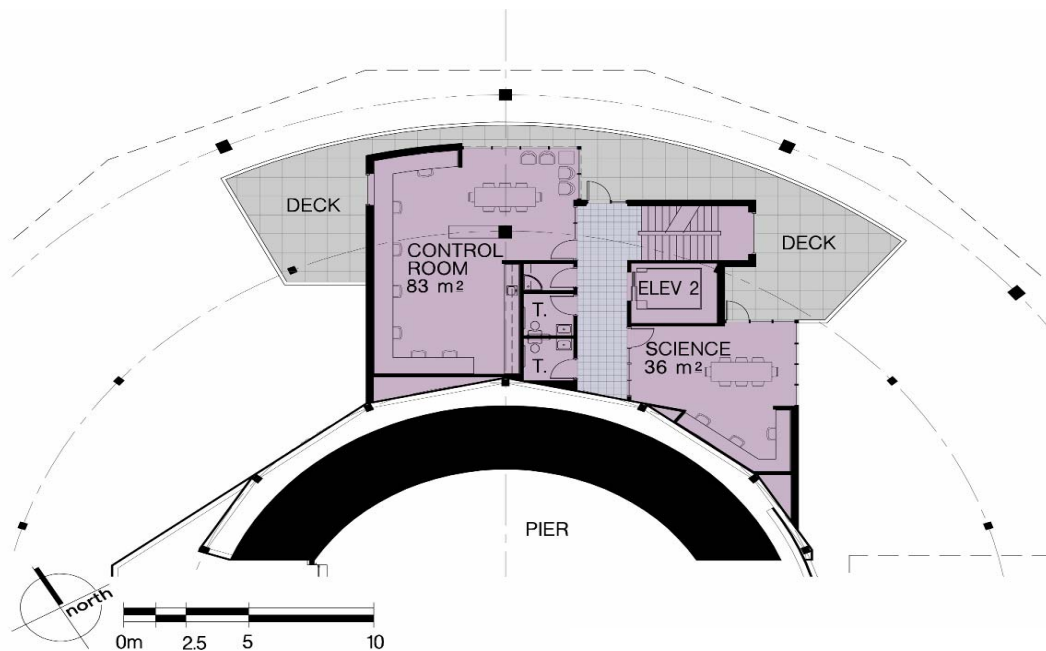


Figure 15-4. Control Building second level.

Near the control room is the science room providing work space for scientists planning their observations and evaluating results. This space also has views to the mountains and direct access to an outdoor deck which curves around to the opposite side of the control room. The deck provides scientists and operators an opportunity to step outside without having to go down to grade level.

All of the control building spaces that are occupied during the daytime have large window walls providing natural daylight into the space and panoramic views of the mountain and other facilities. The ceilings are at 3.5 meters providing a large volume in the space fitting with the window wall.

During nighttime operations, all of the windows are darkened with blackout shades. Insulation around the perimeter walls and roof keeps the heat within the building. Although the control building is structurally attached to the base enclosure, it is thermally isolated with natural ventilation on all sides. The common wall between the control building and the pier is ventilated with ambient air maintaining a thermal barrier. The top of the control building is approximately 2.5 meters below the bottom of the enclosure base providing air flow between the two structures. Double doors (not shown) will provide an airlock to prevent heat from migrating to the enclosure above.

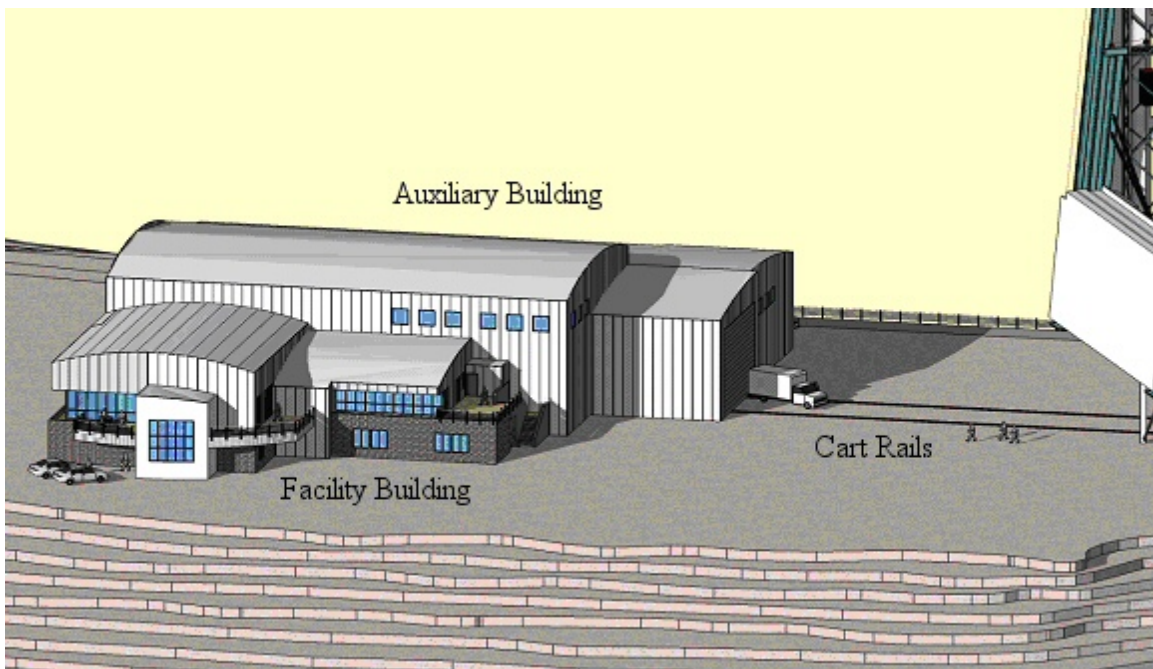


Figure 15-5. Facility and Auxiliary Buildings. The Facility Building provides office and lab space. The Auxiliary Building has bays for storing and working on instruments and the mirror re-coating plant.

15.4 Auxiliary Building

Service and storage space for the mirrors and large instruments is the primary function of the Auxiliary building. In the proposed conceptual design, it is located between the Facility and Equipment buildings and connected to the enclosure with fixed rails allowing the primary mirrors and large instruments to be transported, Figure 15-5. The rails extend through the building for future expansion. The spaces within the building, Figure 15-6 are as follows:

- Mirror coating bay
- Mirror washing bay
- Instrument bays (3)
- Entry bay
- M1 assembly/staging area
- Small optics bay
- Machine shop

The mirror cells and large instruments enter the Auxiliary Building through a roll-up door on each side of the entry bay. This space is isolated from the other spaces maintaining a thermal barrier and cleanliness. The machine shop is adjacent to the entry bay providing a staging area for any work needed in the shop.

A series of intersecting rails connect all of the various spaces within the Auxiliary building. The instrument bays have direct access from the Facility building and are connected with a 5-ton bridge crane with a 10 m hook height.

Along the center bay is the M1 assembly/staging area with a fixed 50-ton crane. This area provides work spaces for installing the primary mirrors in their cell and for lifting heavy instruments.

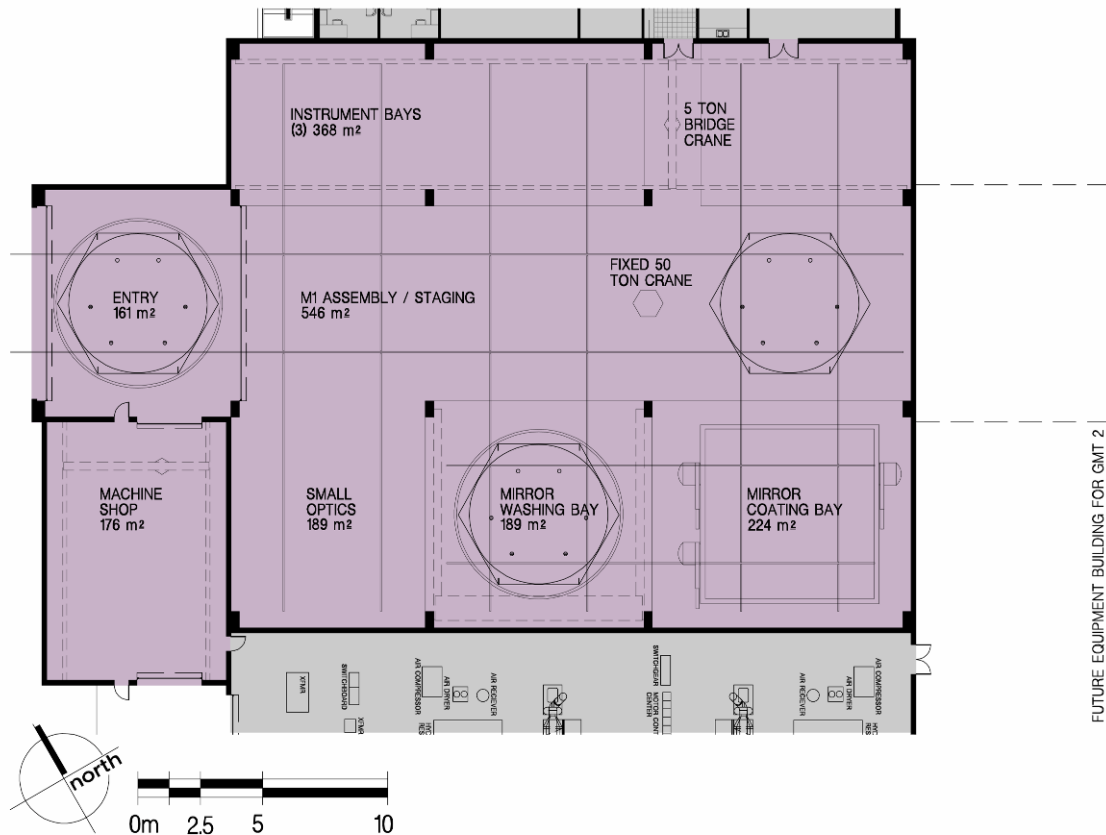


Figure 15-6. Auxiliary Building plan.

Along the south wall and adjacent to the equipment building is the mirror coating and washing bays along with a small optics shop. The equipment supporting these functions is in the Equipment building on the other side of the common wall.

The Auxiliary Building is a steel structure with insulated metal panels similar to the enclosure. Due to the 10 m minimum hook height requirement, the building is approximately 15 m in height along the ridge. Currently the spaces are open to each other for flexibility during integration, but are envisioned to have plastic partitions for dust control and isolation once the facility is in operation. This along with smooth walls helps maintain an instrument lab environment.

Air handlers without cooling coils for the Auxiliary Building are provided with a higher level of filtration by using ASHRAE 25-30% and 60-65% filters minimizing airborne particles in the space. A small heating coil helps to temper the outside air to room temperature. A small portable space heater provides spot heating as required for occupant comfort. Outside air brought in to the space provides a slight pressurization and general ventilation.

15.5 Coating Plant

15.5.1 Concept

This GMT aluminizing system concept is based on a two part chamber similar to what is used to coat the Magellan 6.5 meter mirrors (see Figure 15-7). The system includes a high vacuum section mounted to the auxiliary building and a base or cart to transport the mirror cell assemblies from the Enclosure to the Auxiliary Building. Mirror washing, cell preparation and maintenance will occur in the Auxiliary Building with the mirror and cell inside the cart. The large mechanical roughing pumps will be located in the adjacent Equipment Building.

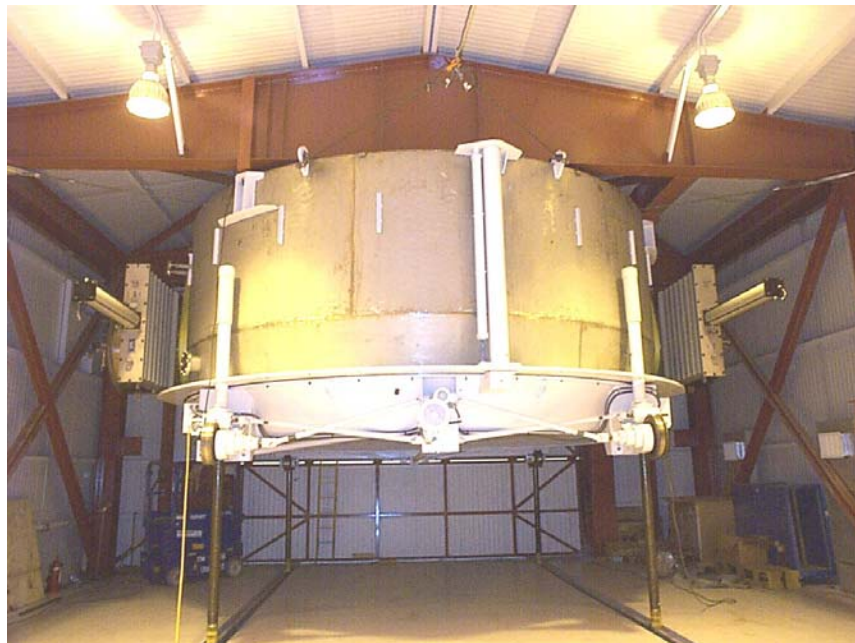


Figure 15-7. 6.5 m vacuum coating chamber at Magellan.

15.5.2 Chamber

Sputtering is the baseline deposition system. Sputtering is currently used to coat the 8 m VLT and Gemini 8 m mirrors. Linear magnetrons are now commercially available in sizes that make a single 8.4 meter long magnetron possible without special development costs. Gencoa and Angstrom Science currently provide linear magnetrons up to 6 meters long. Both vendors can build 8.4 meter linear arrays. A single linear scan system was chosen for its simplicity in design and fabrication. A linear scan system does not require special masks or custom magnetrons common in existing radial scan systems. Aluminum is the baseline deposition material but any number of exotic materials can be sputter deposited. Multiple magnetrons with different source materials can be deposited with a single linear scan system.

The upper high vacuum chamber will be permanently mounted to the auxiliary building. This chamber requires a pumping system similar to the current Magellan chamber. While sputtering is done in the ten micron pressure regime, high throughput cryo-pumps or turbo pumps are required to evacuate the clean portion of the chamber to 1×10^{-7} torr pressure to remove adsorbed water from the mirror surface. Adsorbed water removal is important to minimize OH compounds.

The cart will be sized to accommodate both the on- and off-axis mirror cells. Different supports will be required for the center mirror cell assembly to position it at the proper elevation. The cart will have an access door aligned with access holes on the cells. The cart will have motor driven wheels to transport the cells from the auxiliary building to the telescope enclosure. Acme screw thread jacks will be located in the floor of the auxiliary building to raise the cart and cell and mate them with the fixed portion of the chamber.

Vacuum isolation seals are required to keep contamination from the lower “dirty vacuum” portion of the cell getting to the clean high vacuum section above the mirror surface. These will have to be integrated into the cell and cart design. Pressure relief valves will be required in both directions to insure that no large differentials can occur across the mirrors.

15.5.3 Mirror Removal and Preparation

Outboard Cells

The six outboard mirror cell assemblies will be removed as we have discussed before. The cells will require a separate set of wheels that can be bolted to the side or bottom of the cell. These wheels are required so that the cell being removed from the telescope can be located under the pier while the spare cell in the cart is moved from the Auxiliary building to the enclosure for installation.

Sequence for Outboard Cell Replacement

1. Remove cell to be aluminized and lower to ground level

2. Install wheels and move cell to pier center area
3. Bring cart with spare cell to enclosure access hatch (ground level)
4. Lift cell from cart and install in telescope
5. Move cart and locate cell to be aluminized under the access hatch
6. Lift cell, remove wheels and locate cell in cart for transportation to Auxiliary building

Center cell

The center cell will be removed with the lift as we have discussed before. Wheels or a cart will be required to move the center cell from the lift to the access hatch for lifting with the enclosure crane. A different set of supports are required for the center cell. These can either be installed on the cell or in the cart. The center cell will need lifting lugs.

Sequence for Center Cell Aluminization:

1. Locate cart with spare cell under enclosure access hatch.
2. Lift spare cell, install wheels, lower cell onto rails.
3. Locate spare cell in instrument staging area of enclosure, (ground level)
4. Remove center cell with lift platform, (install wheels or use cart)
5. Move center cell to enclosure access hatch,
6. Lift center cell, remove wheels, install in cart with special supports, transport to auxiliary building.

The spare cell assembly will remain in the instrument staging area while the center cell is aluminized.



Figure 15-8. Magellan mirror washout station and bridge.

15.5.4 Mirror Washing and Preparation

Access to the mirror surface for washing, drying and surface preparation will be provided by a personnel bridge similar to the one used at Magellan (Figure 15-8). The bridge will be suspended as close to the mirror surface as possible and will travel on rails to provide access to the entire mirror surface.

Inflatable seals and wash drains will be required (similar to Magellan). Access to the mirror center holes on the cells is required to drain the wash water. A hose with an inflatable seal that fits into the mirror center hole will work as a drain on the outboard cells. A drain pan for the center mirror is also required. We will need to design a system for installing this drain pan as well as a plan for a center seal for vacuum.

Filtered deionized water is required in the treatment of mirrors before drying. Two high purity water treatment systems are required with a common manifold to allow filter changes without interrupting the flow of rinse water. These filter deionizing units will be located at the wash area. Nalgene plumbing will be used to distribute the clean water to the mirror surface. Since the mirrors are borosilicate glass a thermostatic mixing valve and a water heater are required to maintain the wash and rinse water at the same temperature as the mirror.

Waste water from the mirror stripping will be diverted via valving to a separate holding tank where it will be neutralized before it is sent to the water treatment facility.

An automated drying system is required to improve the coating process. Gemini and VLT currently use high pressure air with nozzles to force dry the mirrors. A linear nozzle system mounted on the same rails the support the access bridge is a possible solution to this problem.

A final air cleaning system that uses deionized air to remove the dust and particulates before the mirror and cell are mated with the chamber is also required. These units are commercially available from companies such as Ion-Air.

15.6 Facility Building

The function of the facility building is to provide office, instrument labs and other support spaces for staff and visitors. The current required spaces are as follows. The list may need to be revised during the next phase and once an operation plan is refined.

- GMT staff offices
- Visiting scientist offices
- Instrument scientist offices
- Detector assembly and lab
- Electronics lab
- Wet room
- Support spaces, i.e., medical, conference room, storage, etc.



Figure 15-9. Facility Building ground level.

The facility building is a two-story building with the main entrance on the northeast side. Adjacent to the entry is the stair and elevator to the second level and the receptionist desk. The grade level, Figure 15-9, is primarily shared office spaces for visiting scientists and GMT staff. Next to the auxiliary building are the labs and medical first-aid room.

The second level is office space with a conference room and kitchen adjacent to the stair and elevator, Figure 15-10. The conference room is located on the northeast corner with an outdoor deck to capture the mountain views. A deck adjacent to the kitchen provides an outdoor eating and sitting area. Along the office corridors are alcoves with bookshelves for the GMT library.

The exterior of the facility is similar to the control building with insulated metal panels and stone base. The windows are insulated, double pane glass with blackout shades for nighttime operations. The layout and size of the windows takes advantage of the mountain views during daytime use.



Figure 15-10. Facility Building second level.

Both the Facility and Control Buildings are heated and cooled through a traditional hydronic heating/cooling system. A chiller and boiler are located adjacent to the equipment building with distribution piping to the air handlers and fan coils. Central air handling units are used as much as possible to distribute the air to the various spaces. Fan coils are used to cool spaces such as electrical and computer rooms, as their load profiles are different than occupied spaces.

Spaces requiring humidification have walls effectively sealed to prevent the migration of water vapor. A source of reverse osmosis water is provided to extend the life of the humidifier components. If humidity control is not a requirement, an air economizer can be incorporated into each air handling unit as an energy-saving measure. When the outside air temperature is below the return air temperature, outside air can be brought into the unit to reduce the chiller cooling load.

15.7 Equipment Building

The equipment building is on the south side of the auxiliary building and houses all of the major mechanical, electrical and plumbing equipment for the site, Figure 15-11. Outside and adjacent to the equipment building is an outdoor equipment yard for chillers, tanks, etc. This yard needs to be developed in the next design phase. Both the equipment building and yard are separated from the enclosure to keep exhausted waste heat or vibration away from the telescope.

The building is organized with all of the major plumbing and mechanical equipment on grade level and the electrical equipment on the mezzanine level. The mezzanine developed in part from the required height of the adjacent auxiliary building and the need to separate the electrical equipment from the plumbing equipment. The vacuum roughing pump is located directly opposite of the mirror coating chamber along the common wall.

The west wall of the building has a loading dock and roll-up door providing direct access into the space for maintenance and deliveries. Adjacent to the dock and accessible from the equipment building is the machine shop with access to the dock as well.

The total area of the space is determined by the quantity and size of the equipment. For the purpose of the conceptual design, the equipment shown on plan is based on similar equipment from other telescope projects. The building area needs to be reevaluated in the next phase of the project.

The equipment building air handling unit is provided with heating and cooling coils to maintain the room temperature at equipment minimum or maximum operating points. Standard ASHRAE 25-30% filters are provided in the units. An air economizer can be incorporated into each air handling unit as an energy saving measure.

The cooling requirements for the Facility, Control and Equipment buildings are estimated at 334 kW (95 tons); a nominal 422 kW (120 ton) air cooled chiller is required. The chiller has low ambient cooling capabilities and the ability to produce 7°C (45°F) water even when the ambient air temperature is down to 6.5°C (20°F). The heating requirements for the control, facility, auxiliary and equipment buildings are estimated at 527kW (1,800,000 BTUH); an electric boiler is envisioned. Both the chilled and heating water systems have a 20% glycol concentration to prevent freezing of the brine solution.

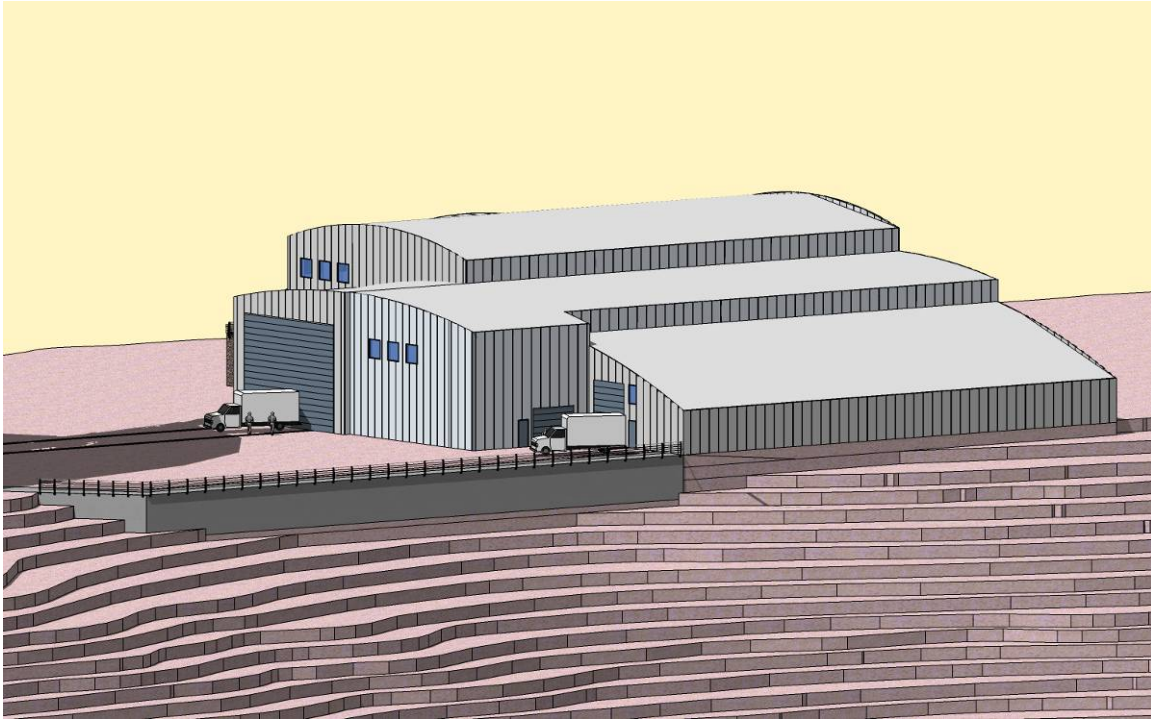


Figure 15-11. View of the Equipment Building and Utility Tunnel (left foreground).

List of equipment that is in or near the Equipment Building:

Mechanical and Plumbing:

- Hydrostatic bearing oil pumps
- Vacuum pumps
- Primary mirror air compressors & dryers
- Chillers for the primary mirror supports
- Instrument cooling chillers
- Dome cooling chillers
- Boilers
- HVAC chilled liquid and hot water pumps
- Water storage tanks
- Sewage holding tank
- Chemical waste holding tank

Electrical:

- Standby generators
- Main service transformer
- Service entrance
- Distribution panel

15.8 Ventilation Tunnel

The purpose of the ventilation tunnel is to extract stagnate air and heat from the telescope pier and mezzanine level and exhaust it away from the telescope, Figure 15-12. The tunnel is located west of the observatory, extends 40 meters beyond the building and has a 1.70-meter minimum diameter to reduce duct system losses. The telescope pier is ventilated by a single 18.9 m³/sec (40,000 CFM) utility set fan located at the end of the ventilation tunnel. The air volume provides about 25 air changes per hour for the pier interior space. Air enters at the telescope mount and through openings at the mezzanine level. Air enters the mezzanine level through exterior wall-mounted louvers with the velocity limited to 19.5 m/min to minimize noise generation.

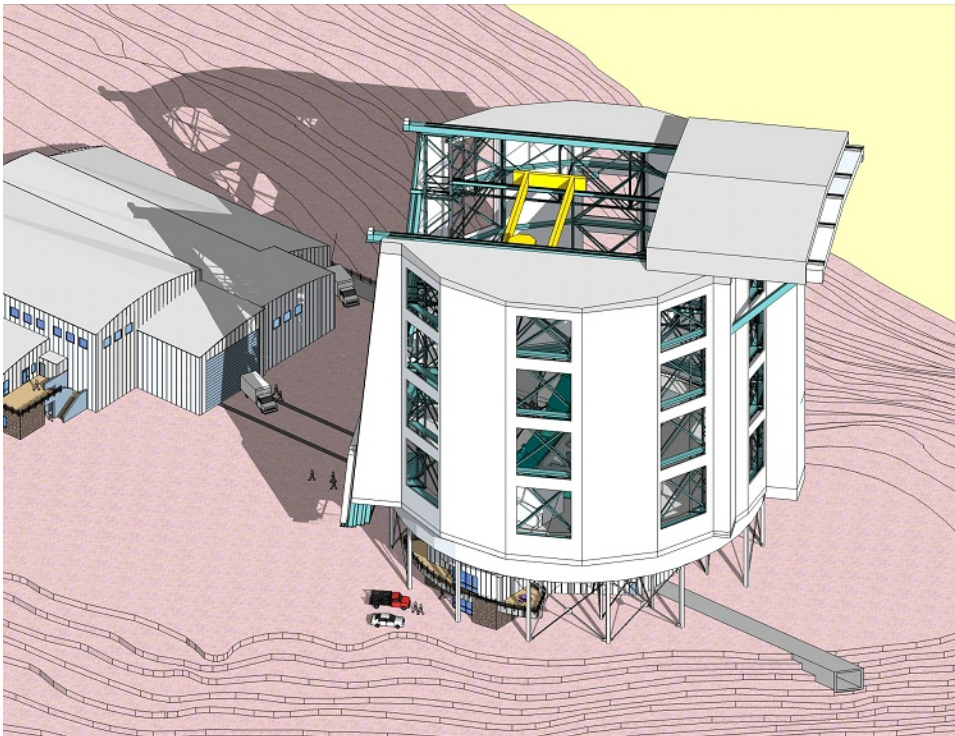


Figure 15-12. Enclosure and ventilation tunnel.

15.9 Utility Infrastructure

Domestic water is stored in a 38 m³ (10,000 gallon) steel storage tank. Water is drawn out of the tank and a duplex booster pump skid raises the water pressure to 550 kpa (80 psig) for distribution. An ozone water purification skid will maintain water quality. Water is piped to the site by an existing distribution system at Las Campanas Observatory. The water is held in a cistern located near the summit that may double as the storage tank for the fire system.

If soil condition permits, a septic tank with leach field will be installed, otherwise a 38 m³ (10,000 gallon) waste holding tank will be provided. This tank needs to be pumped

approximately once a week. The waste removal truck should have its own pump to remove the waste.

Waste from the mirror coating process is collected and stored in an 11.5 m³ (3,000 gal) underground double containment tank. All underground piping to the tank is double contained. The chemical waste removal truck should have its own pump to remove the waste. Manual neutralization of the waste must be done prior to removal.

Two 150-200 horsepower compressors provide 12.6 m³/sec of air at 1.0 Mpa (150 psig) for the primary mirror support system. The compressors will be alternated in service to provide a hot spare. The air is dried through a desiccant dryer down to a -40° C (-40° F) dew point. Controls will include a moisture sensor to only purge the dryer when the desiccant needs to be recharged as an energy saving measure. An 11.5 m³ (3000 gallon) storage tank provides sufficient storage capacity to carry through momentary power interruptions.

All spaces except the telescope enclosure are covered by a wet or dry pipe fire sprinkler system. A 115 m³ (30,000 gallon) water storage tank will be required along with an electric fire water pump to support this system. Where accidental discharge of water is a concern, a dry pipe pre-action system or gas based system should be installed. Gaseous fire suppression systems should be backed up by water-based system in the event the fire is not suppressed.

Utility electrical power shall be provided by the local Chilean electrical utility company to the GMT site via a 23 kV, 3 phase, 50 Hz overhead distribution pole line. The overhead line will transition to underground from a pole riser with fused cutouts and lightning arresters, and serve the site's main pad-mounted service entrance transformer. Service transformer shall be pad-mounted, oil filled type with internal lightning arresters located on a concrete containment pad.

From the service transformer to the equipment building, an underground duct bank consisting of a secondary service entrance lateral is provided to serve the equipment building main electrical service entrance equipment located in the main electrical room. The main electrical service entrance equipment shall consist of bottom feed incoming section, main disconnect switch with integral ground fault protection, and distribution sections. Over-current protective devices, such as the main disconnect switch and devices provided in the distribution section, shall be fully adjustable type circuit breakers. The circuit breakers will be sized for each feeder and main service entrance rating as determined by the facility electrical loads being served and the available short circuit current, as calculated from the available fault current from the utility company or standby generators, and the overall electrical power system one line diagram.

Standby electrical power is generated on site using two diesel-driven standby generators, each rated at 750 kW at 0.8 power factor (937.5 kVA), 277/480 volt, 3 phase, 4 wire operating in parallel. Paralleling type switchgear and controls is provided to allow the two standby generators to operate in parallel for a total combined capacity of 1500 kW (1875 kVA). In addition, the generator paralleling switchgear monitors and controls the

transfer of electrical load from utility power source to the standby generator source during the loss of normal electrical utility power. The current rating and capacity of standby generators are estimated, and need to be refined as the total electrical loads for the GMT Facility (all buildings) becomes available during the next design phase. Once final electrical loads and worst case motor starting event(s) are established, the standby generators can be sized with engine/generator de-rating for project site altitude, and fuel type.

At the Equipment building main electrical room, the main service entrance equipment is rated at 277/480V, 3 phase, 4 wire, estimated to be 3000 ampere bus. From multiple feeders fed by the main service entrance equipment, electrical power is provided and distributed throughout the building using distribution and sub-distribution panels. A second voltage transformation to 120/208V, 3 phase, 4 wire, is provided using a large, single dry type transformer and associated distribution and sub-distribution panels located throughout the facility. A single 277/480V, 3 phase, 4 wire feeder shall be routed from the main service entrance equipment located at the equipment building to the enclosure via a underground utility tunnel connecting the two buildings together. A central static UPS is provided and sized as determined by the electrical UPS type loads being served as will be determined by the project's electrical load calculations. UPS electrical power is provided to mission-critical loads such as rack-mounted electronic equipment, communication computer servers, etc. as identified by the project, and is distributed throughout the equipment building using sub-distribution panels.

15.10 References

Johns, M. 2006, GMT Enclosure & Facilities Design Requirements Document, Rev. 9, Document 293, GMT.

M3 Engineering 2005, Giant Magellan Telescope- Enclosure and Facilities, Document 1386, GMT.