LSST Summit Facility Requirements

Jeff Barr
Project Architect
Telescope & Site Team

Summit Facilities Scope Description

Service & Operations Building

Main Receiving

Platform Lift

Mirror & Camera Maintenance

Control Room

Computer Room

Office Facilities

Main Utilities

Telescope Building (Lower Enclosure)

Telescope Pier

Utilities

Receiving

Storage

Shop

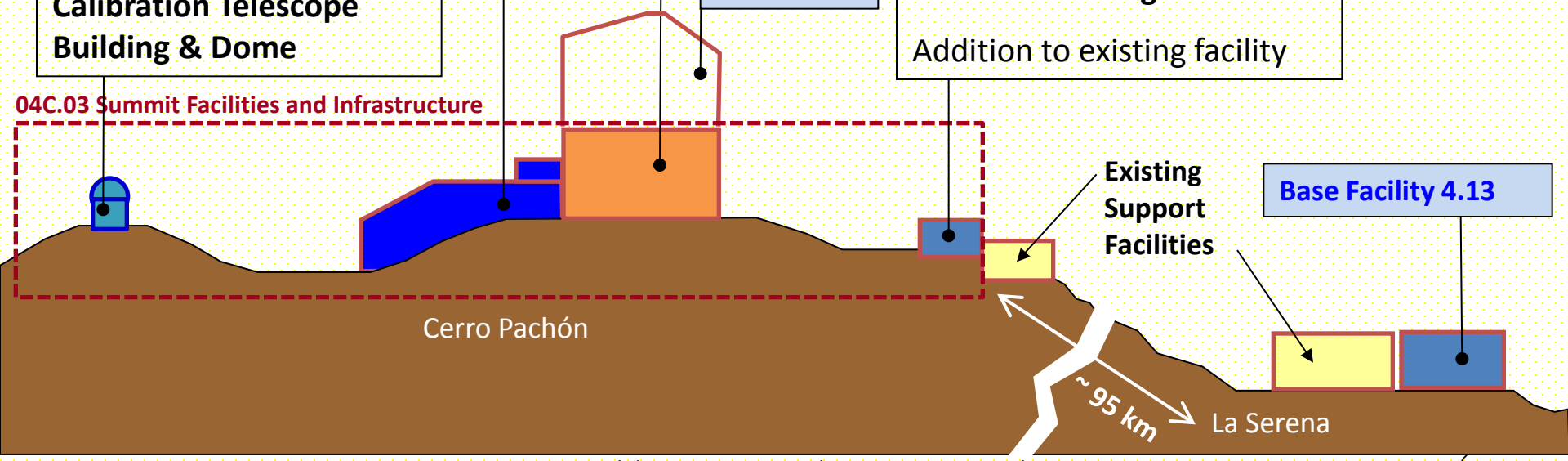
Access to Dome & Telescope

Calibration Telescope Building & Dome

Dome 4.4

Dorm and Dining

Addition to existing facility

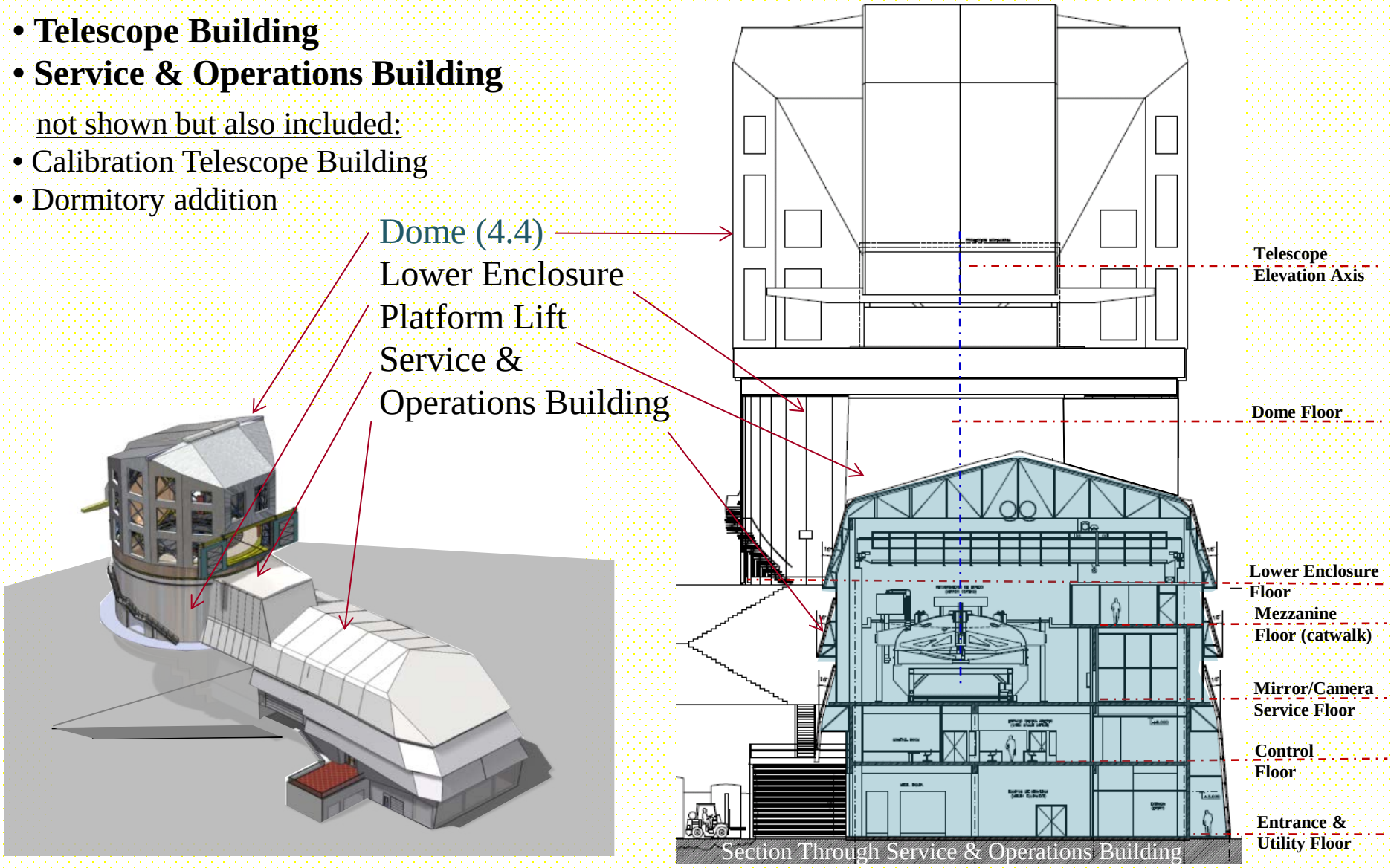


Summit Facilities Description

- **Telescope Building**
- **Service & Operations Building**

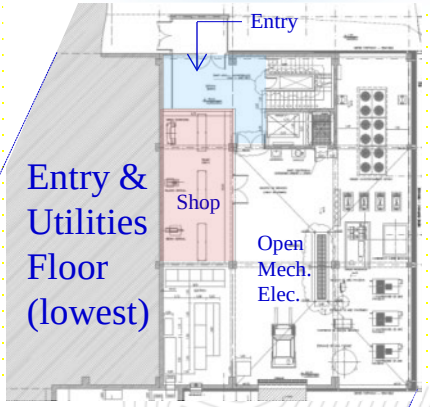
not shown but also included:

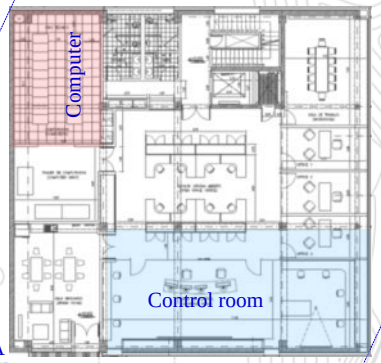
- Calibration Telescope Building
- Dormitory addition



Summit Support Facility Main Buildings

- **Service & Operations Building (~2,500 m^2 gross area)**
  - Entrance & Utility Floor: main entry, shop, mech. & elec. equipment
  - Control Floor: control room, computing, general support
  - Mirror & Camera Service Floor: mirror coating & camera maintenance
  - Mezzanine Floor: passageway to telescope, storage platforms
  - Camera Utilities/Lower Enclosure Floor: connecting level between buildings
  - Platform lift for conveyance of mirror & camera
- **Telescope Pier** (16m D) and **Lower Enclosure** (30m D)
  - Lower Enclosure Floor: utility access, shop, storage
  - Pier Intermediate and Upper Platforms: utility access
  - Dome Floor: access to telescope and dome
  - Telescope Maintenance Platform: service access to telescope

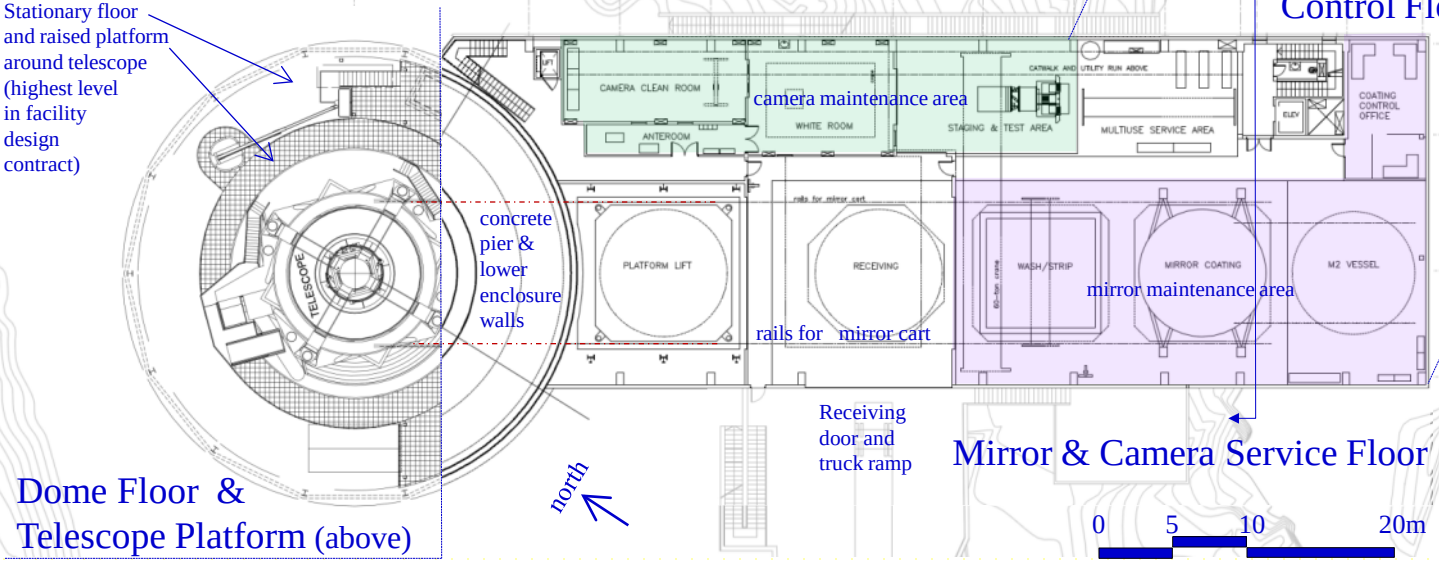




Control Floor (below)

prevailing wind

Stationary floor and raised platform around telescope (highest level in facility design contract)



Dome Floor & Telescope Platform (above)

Mirror & Camera Service Floor

100% Drawings collection-3184

ARCADIS Infrastructure · Water · Environment · Buildings

LSST Large Synoptic Survey Telescope

Key Milestones in Development

- March 2010: A&E Design Contract Kick-off
- January 2011: Submittal of 50% Complete Document
- June 2012: Submittal of 90% Complete Document
- August 2013: 100% Submittal
- Nov 2013 to April 2014: Bid Process for Construction
- June 2014: Contractor Selection
- Aug.-Sept. 2014: Final Design Refinement Phase
- October 2014: Sign Construction Contract and Begin Work On Site

Summit Facility Design Requirements Status

- LSST Summit Facility Requirements have been developed and refined over the past ~6 years in consultation with all Summit Facility user groups
- Contracted Architectural-Engineering team has incorporated requirements into the design of the facility
- Facility was reviewed at the 50% and 90% completion levels by all main contributors to the requirements
- Requirements have now been incorporated in the 100% complete design of the Summit Facility
- Construction Documents (plans and specifications) have now been utilized to bid the facility

Construction is expected to begin in October 2014

- *Requirements* will soon be transformed into *Features*

Primary Suite of Requirement Documents

Comprehensive Requirements

- LTS-53 Summit Support Facility Design Requirements
- LTS-55 Summit Support Facility Preliminary Design Drawings
- LTS-52 Summit Support Facility Electrical Requirements
- Document-7930 Summit Support Facility Supplemental Technical Information

Interface Control Documents

Between Systems

- LSE-65 Camera to Telescope and Site Facility

Within Telescope & Site System

- LTS-101 Lower Enclosure to Dome*
- LTS-77 Telescope to Pier
- LTS-100 Platform Lift to Dome (and Building)*
- LTS-131 Mirror Cart to Platform Lift (and Building)
- LTS-137 Coating Chamber to Facility

*Recently revised

Secondary Requirements Definition

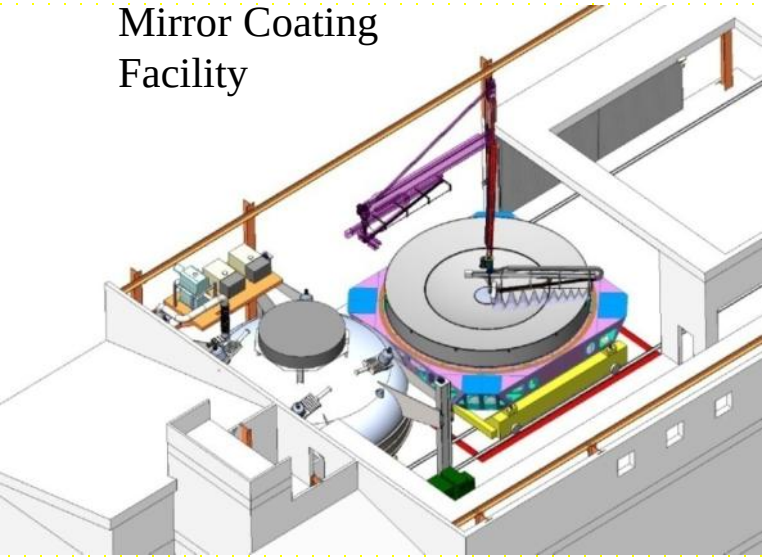
During the course of the Summit Facility design, the Telescope and Site team issued written and graphic instruction to the AE Firm ARCADIS Chile regarding specific aspects of the developing design, including:

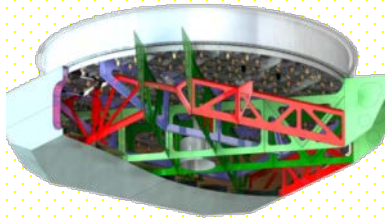
- Equipment-power-cooling loads
- Lighting level requirements for all areas
- Camera utility line lengths
- Modifications defined in formal Hazard Analysis reviews
- Compressed air distribution
- Dome loads and drive locations
- Ventilation and AC for enclosure
- Crane dimensional requirements
- Refinement of requirements for Camera areas
- Design requirements for platform lift
- Area nomenclature and level definition

In addition to these formally prepared supplemental requirements documents, direction was also given to the designers in the form of emails, verbally during meetings (with notes documented), and via teleconferences with the T&S team and other consultants to the process.

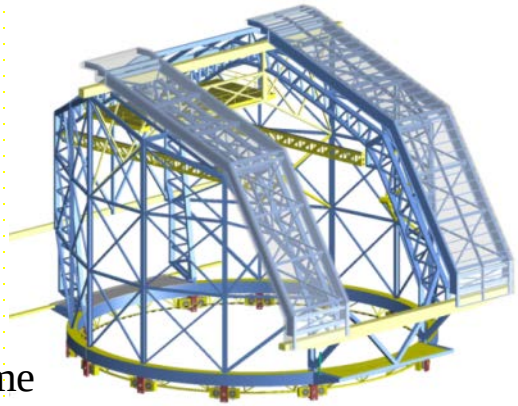
Drivers of Building-Related System Requirements

Mirror Coating Facility

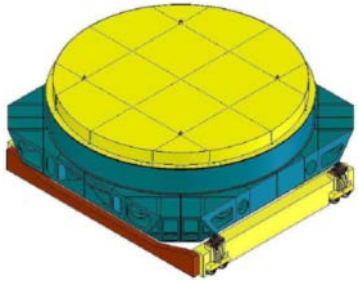




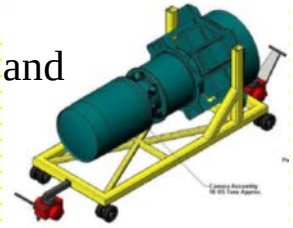
Mirror cell development

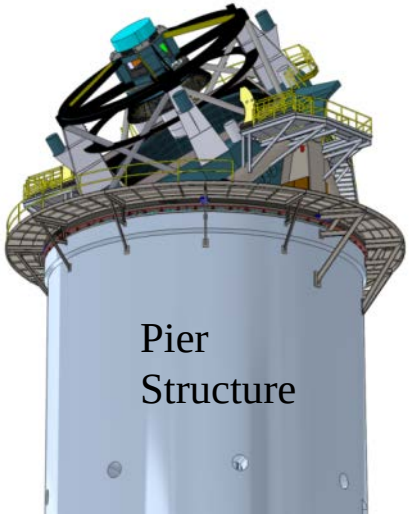


Dome Interface



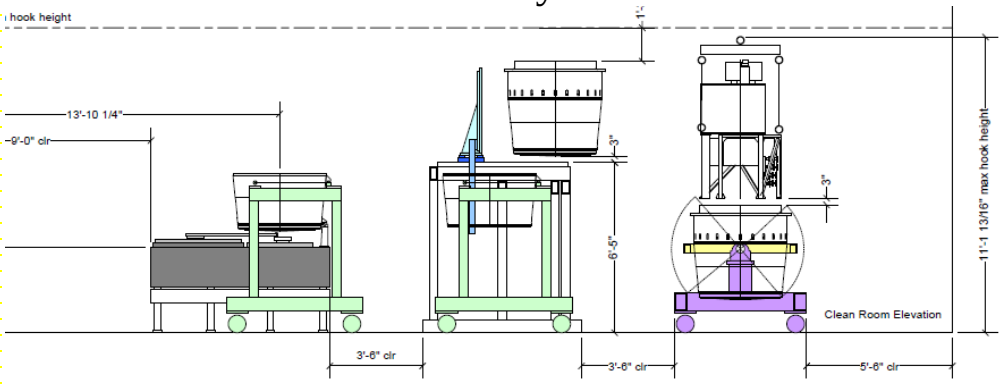
Handling Carts and Procedures





Pier Structure

Camera Maintenance Facility



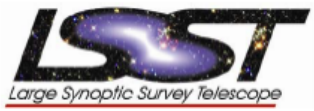
Clean Room Elevation A-A: Integrate Raft Towers into Cryostat

Including formal **safety review** of critical systems related to Summit Facility Design

Fundamental Summit Facility Requirements

- Satisfy very stiff requirement for telescope pier and foundation.
- Provide large scale spaces and high-capacity handling systems for maintenance and coating of mirrors.
- Provide on-site clean room and other facilities for camera maintenance
- Minimize thermal turbulence from buildings and equipment.
- Take advantage of topography to keep support building profile low in relation to telescope.
- Design all critical support/utility systems for safety and high reliability to support demanding survey cadence with minimal down time.
- Design structurally for highest Chilean seismic risk category and historically highest wind loads at Pachón.
- Design for efficiency, economy and maintainability in the Chilean building and construction industry.

Design Requirements Document



Telescope and Site Controlled Document

Handle: LTS-53

Release Status: For Public

Summit Support Facility Design Requirements

Author(s): Jeff Barr

Date: September 11, 2009

Summary: The purpose of this Design Requirements Document (DRD) is to establish the requirements and guidelines for design of the Summit Support Facilities (SSF) required at the mountaintop site of the Large Synoptic Survey Telescope (LSST). These requirements have been utilized to establish a preliminary design, which, together with this DRD, form the starting point for a contract for full design and construction document preparation, as defined in the Statement of Work for Architectural and Engineering Services for the LSST Summit Support Facility.

Document Type: Requirements Document

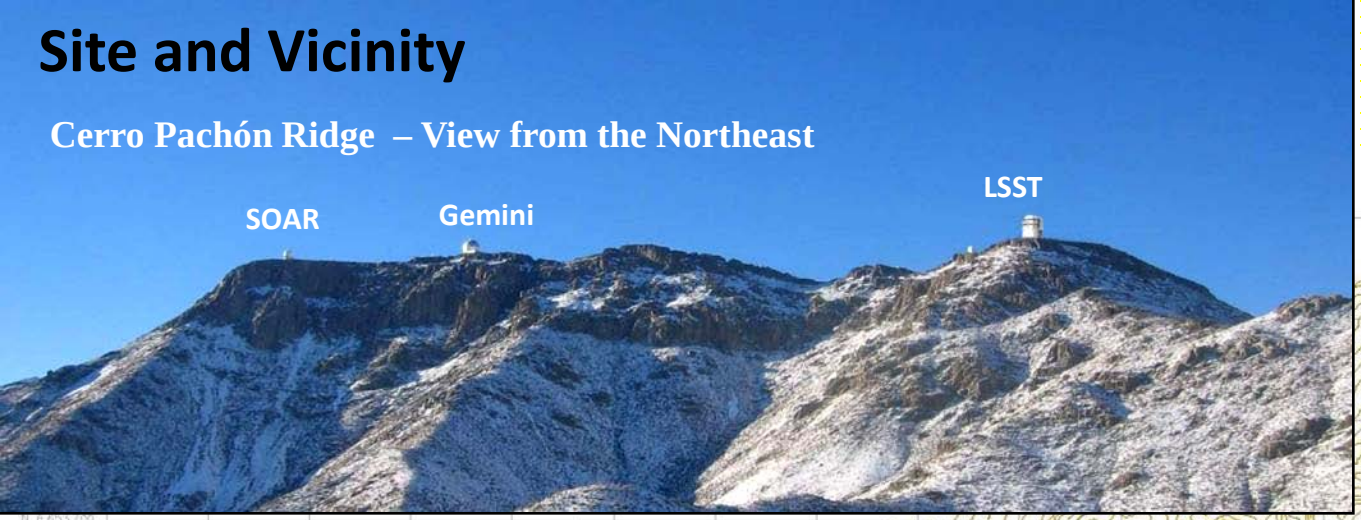
Document Category: Summit Facilities and Infrastructure

Keyword(s): Summit Facility, Service, Maintenance, Building, Summit Control

Table of Contents

Site and Vicinity

Cerro Pachón Ridge – View from the Northeast



SOAR

Gemini

Common Pachón Utility Services

100m grid

N

Dining Hall

Service Yard

Exist electric service

primary

electric line

New electric service (1.6 km)

improved access road (1.1 km)

Proposed LSST Facilities

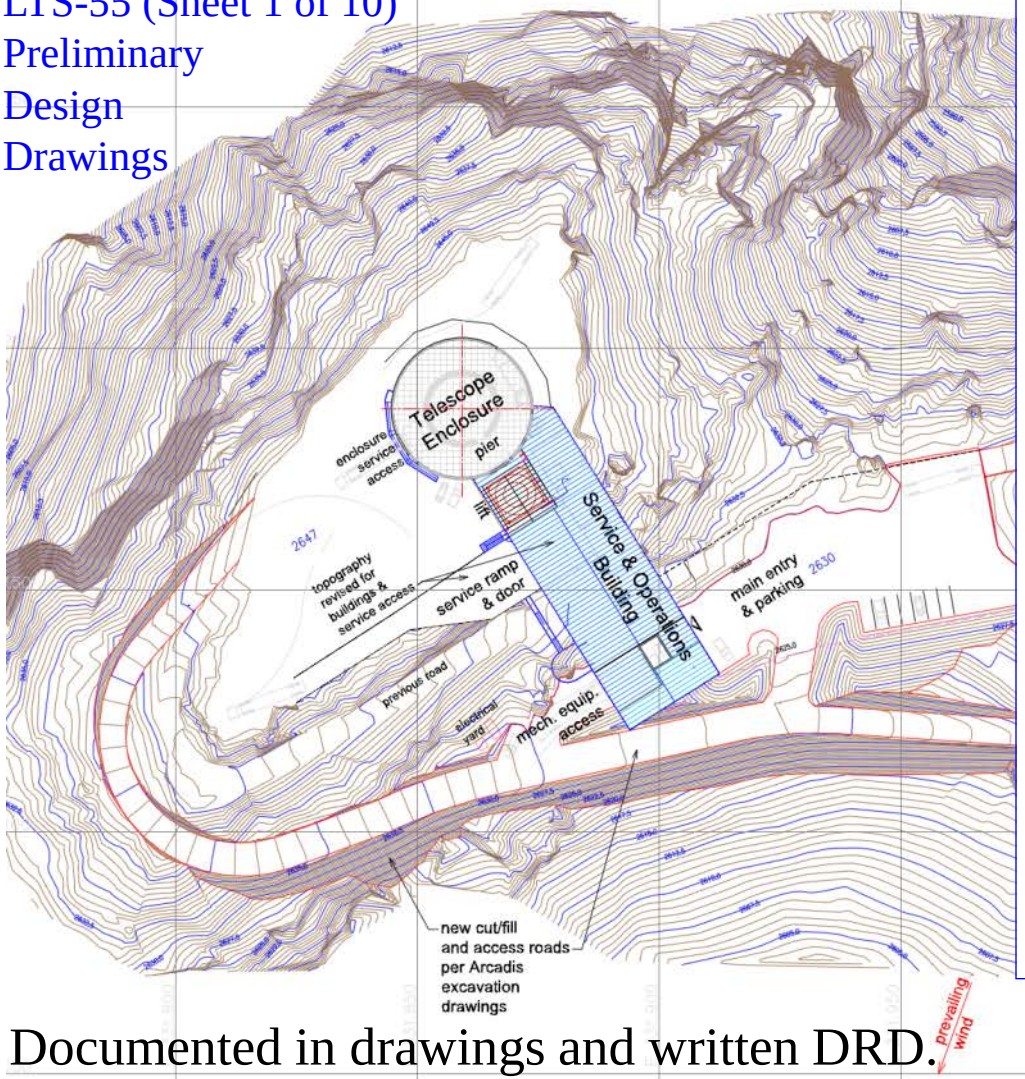
Main utility run:
- Electric 23kVA
- Fiber Optic
- Water

LSST Site (El Peñón)

20 Unit Dorm

Main Documentation of Summit Facility Requirements

LTS-55 (Sheet 1 of 10)
Preliminary
Design
Drawings



Excerpt from LTS-53
Design Requirements Document

LSST Summit Support Facility DRD

1. Introduction and Scope

The purpose of this Design Requirements Document (DRD) is to establish the requirements and guidelines for design of the Summit Support Facilities (SSF) required at the mountaintop site of the Large Synoptic Survey Telescope (LSST). These requirements have been utilized to establish a preliminary design, which, together with this DRD, form the starting point for a contract for full design and construction document preparation, as defined in the Statement of Work for Architectural and Engineering Services for the LSST Summit Support Facility. The documents in Table 1.1 (in Appendix) provide additional detail and background information for all the requirements addressed.

2. General Requirements

Name	Requirement	Identifier
Overall Space Requirement	The SSF shall provide suitable space for the construction, operation and maintenance of the LSST telescope, camera, data processing system, and related equipment. The design of all of these systems is ongoing. As their physical and operational characteristics become more clearly defined, that information shall be incorporated into the design process.	**SSF-GEN1**
Thermal Environment	For the design of all the summit facilities, maintaining a beneficial thermal environment in the telescope light path shall be a fundamental objective. All potential strategies toward that end shall be employed, including: • Remote location of heat generating elements • Orientation and location of the facilities based on prevailing wind direction • Use of materials with low thermal inertia • Active/passive cooling of potential heat sources.	**SSF-GEN2**
Special Operational Considerations	As a survey telescope, LSST has special operational parameters that shall be reflected in the SSF design, including: • A critical requirement for continuous operation • An essentially robotic telescope control program • A specialized observing staff with few or no visiting observers • A substantial & critical requirement for rapid data processing & transmission.	**SSF-GEN3**
Related Facility Elements	This DRD addresses the fixed building installations and focuses on their general form and function. Dimensional criteria for the rotating upper enclosure (Dome), and the telescope support structure (Pier) shall be integrated into the SSF design work. The basic requirements for interface to the dome, telescope and other technical systems are described in this DRD and the Preliminary Drawings. Additional information about these related project elements is available in the SSF Supplemental Technical Information Document. Specific interface control information will be provided to the Architect commensurate with the progress of the SSF design.	**SSF-GEN4**
Consideration of the Site	The physical characteristics and available infrastructure at the selected Cerro Pachón site (El Peñón) are addressed within this DRD commensurate with their impact on the SSF requirements.	**SSF-GEN5**
Code Compliance	All aspects of the SSF shall comply with the 2006 International Building Code and the current edition of	**SSF-GEN6**

4

NORTH

0 10 20 30m
0 20 50 100 ft.

Notes:
- Topography indicated is from ARCADIS plans for initial site leveling and road work. It does not show final topography around buildings.
- Final location and configuration of structures will be refined based on additional air flow and geotechnical studies.

NATIONAL OPTICAL ASTRONOMY OBSERVATORY operated by the ASSOCIATION of UNIVERSITIES for RESEARCH in ASTRONOMY under cooperative agreement with the NATIONAL SCIENCE FOUNDATION

Large Synoptic Survey Telescope Summit Facility · Cerro Peñón, Chile

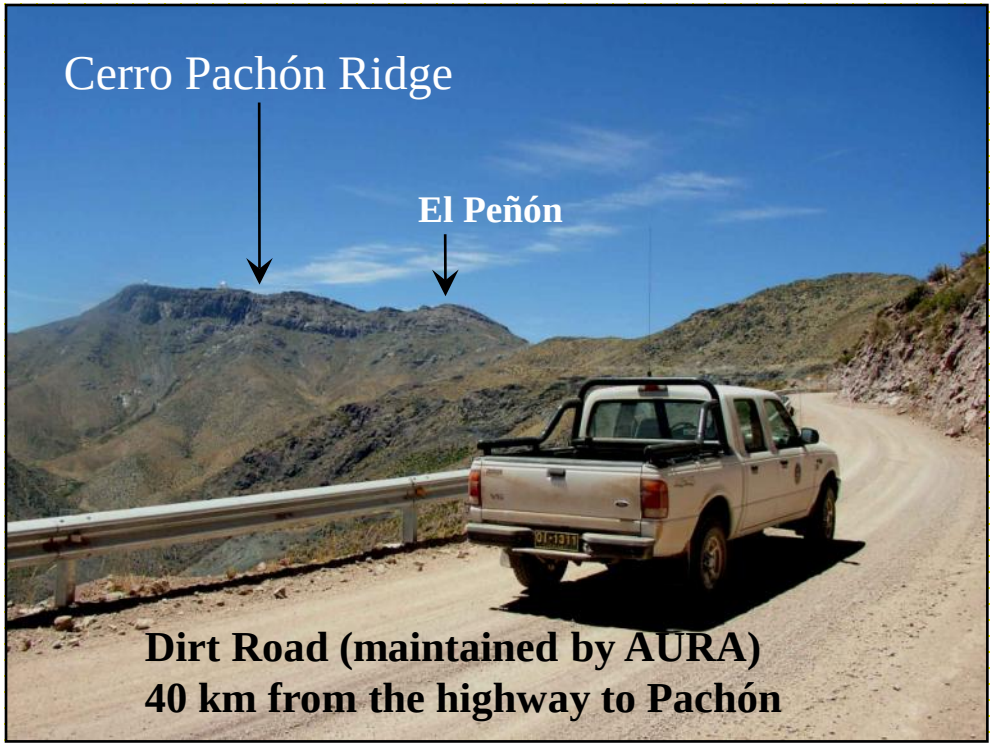
OVERALL SITE PLAN

Large Synoptic Survey Telescope — Telescope & Site Group

size B | scale 1:1000
rev. A
Drawing No. LTS-51201-L01-0001
Date:

Documented in drawings and written DRD.
DRD updated to reflect evolving requirements

Environmental Design Requirements



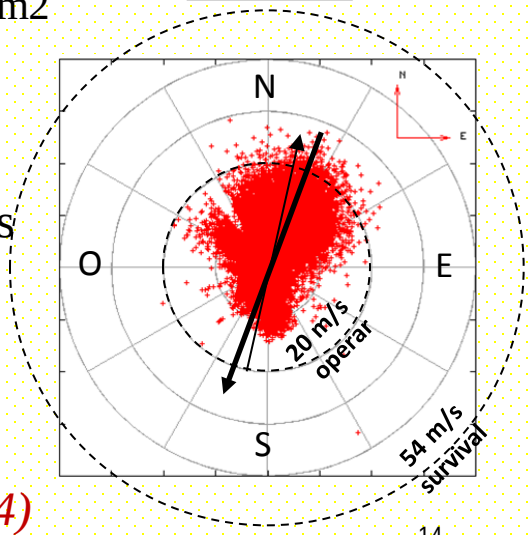
30.2 south Lat. 70.8 west Long. , 2650m altitude

Normal Conditions:
- Temperature: -3 a 19 C (median 11.5)
- Wind: 12 m/s (median 6 m/s)
- Precipitation: minimal

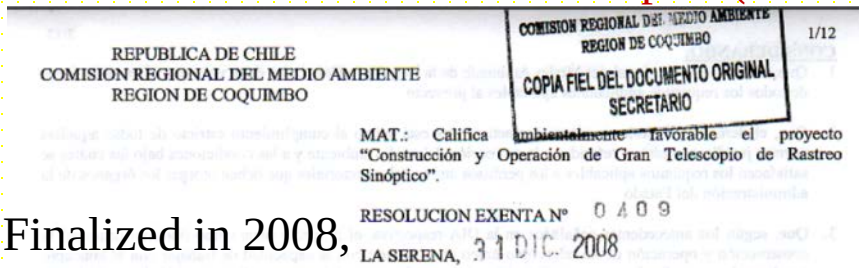
Marginal (Operational) Conditions:
- Temperature: -5 a 30 C
- Wind: up to 20 m/s

Survival Conditions
- Temperature: -10 min.
- Wind: 54m/s
- Snow: 200 kg/m2
- Seismic Event: ~0.4g

Wind Rose



Declaration of Environmental Impact *(Doc. 6999)*


REPUBLICA DE CHILE
COMISION REGIONAL DEL MEDIO AMBIENTE
REGION DE COQUIMBO

COMISION REGIONAL DEL MEDIO AMBIENTE
REGION DE COQUIMBO
COPIA FIEL DEL DOCUMENTO ORIGINAL
SECRETARIO

1/12

MAT.: Califica ambientalmente favorable el proyecto "Construcción y Operación de Gran Telescopio de Rastreo Sinóptico".

RESOLUCION EXENTA Nº 0409

LA SERENA, 31 DIC. 2008

Finalized in 2008,
Defined mitigations being complied with.

These requirements formalized and further defined in: *LSST Summit Environmental Conditions (LTS-54)*

Utility Requirements

Operation of the LSST Summit Facility will require ~1 Mega Watt of peak power

50 Hz, supplied to the site at 23kV and transformed down to utilized voltages of 400V 3ph, 220V 1ph., 110V courtesy outlets

Building utility design (electric, HVAC, plumbing) complies with with latest applicable Codes: Chilean (N.Ch.) and U.S. (IBC, NEC)

Electrical grounding is a critical concern and requires special measures on the dry rocky site.

LSST Engineers interactively reviewed the utility plans and specifications for the building.

Structural design of buildings and utilities complies with Norma Chilena & International Building Code

Sustainable Design

Design and operation of LSST will comply with logical application of *Leadership in Energy and Environmental Design (LEED)* and other sustainable design standards.

Including:

- Maximum effective insulation
- Natural light where appropriate
- Extensive use of local materials
- Key participation of LEED accredited professionals
- Consideration of participation in green energy programs

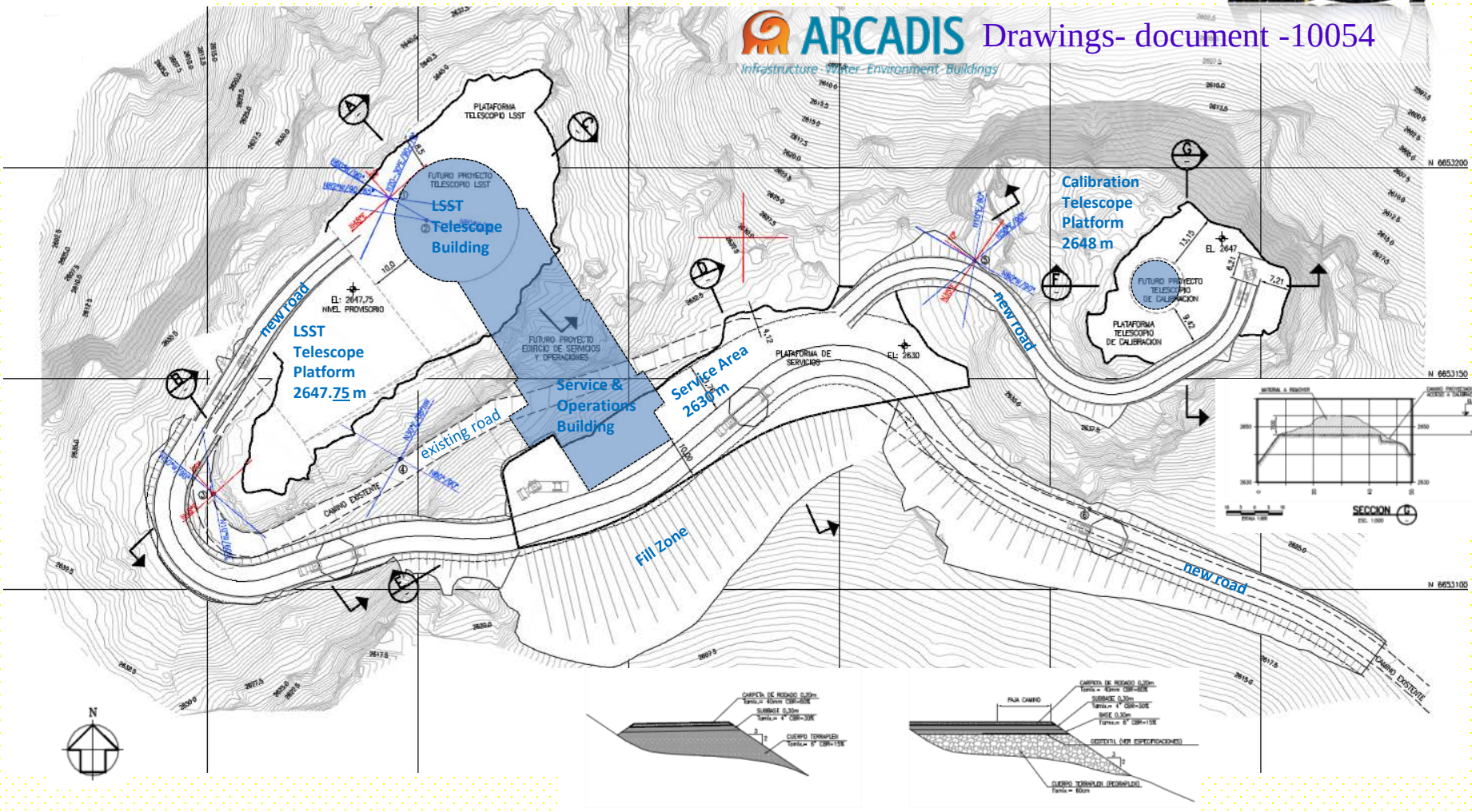
Not Including:

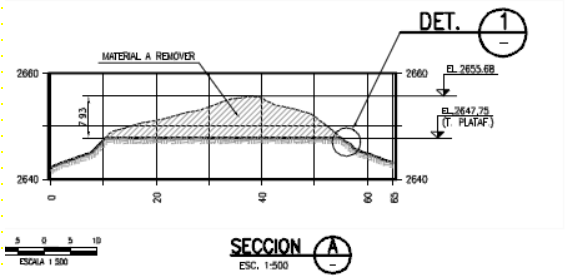
- Major on-site generation of electrical power by wind generators or PV panels
- Conservation measures that compromise key cooling or continuous operation requirements.
- LEED certification or other formal compliance standard

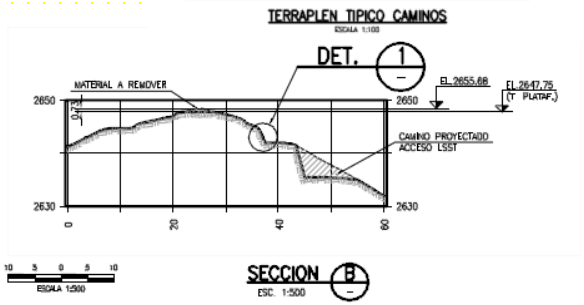
Initial Site Excavation Contract

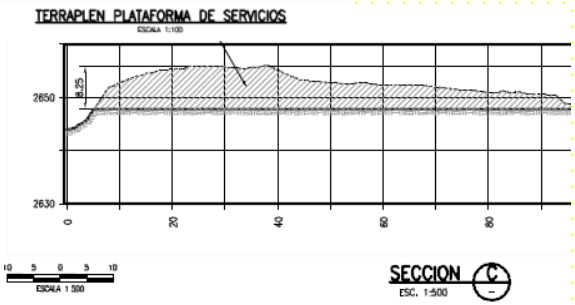
ARCADIS Infrastructure · Water · Environment · Buildings

Drawings- document -10054









Site Leveling Excavation

Initial phase completed in 2011

- **Rocterra Ltda. Who did initial work will be continuing the excavation as subcontractor**
- **Technical inspection and oversight by Site Manager, Technical Inspector and ARCADIS**

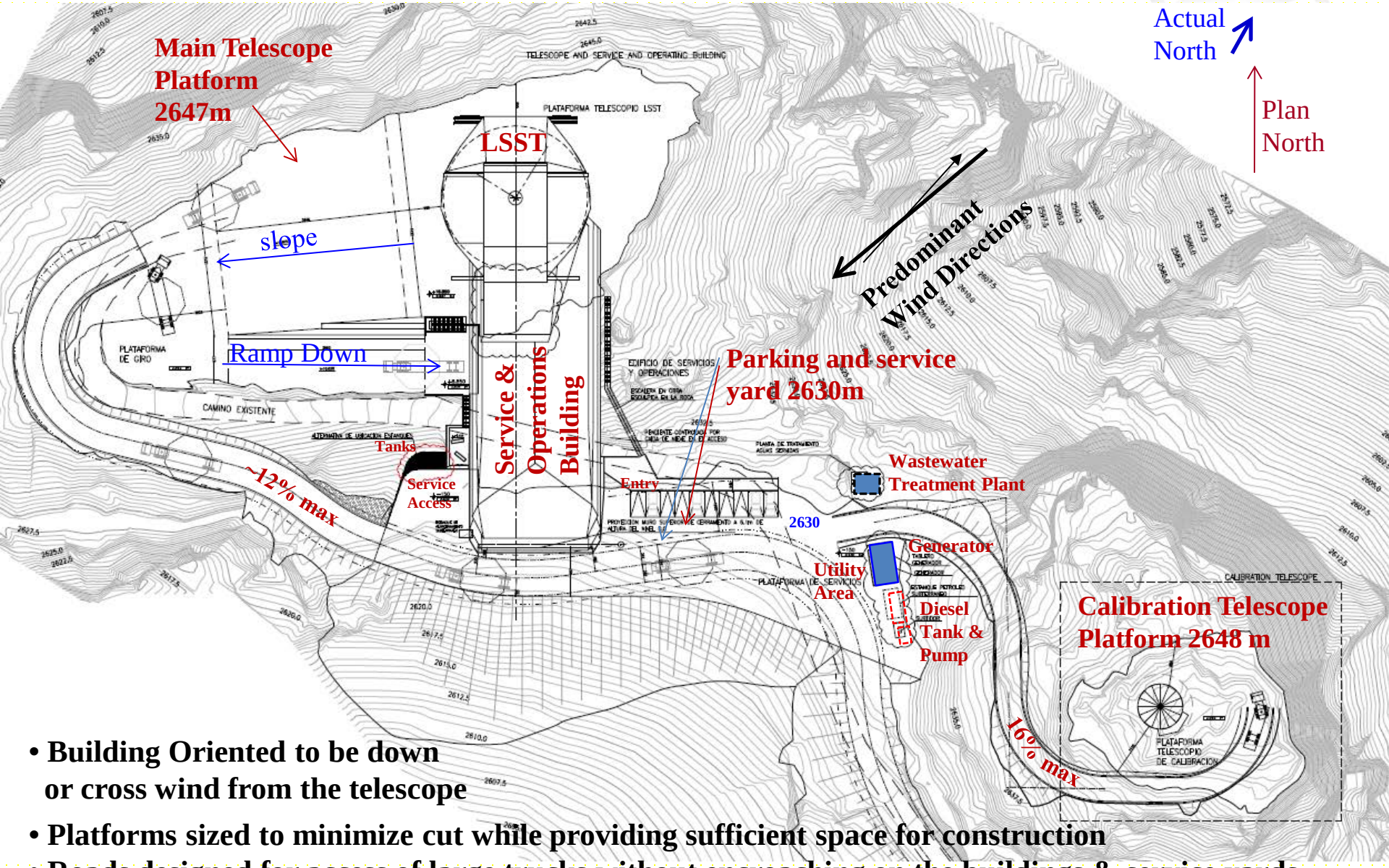
The contractor who did this initial leveling, is proposed to be the excavation subcontractor for completing the platforms and roads.

Engineered Blasting Program

Fill for road bed and Service Platform

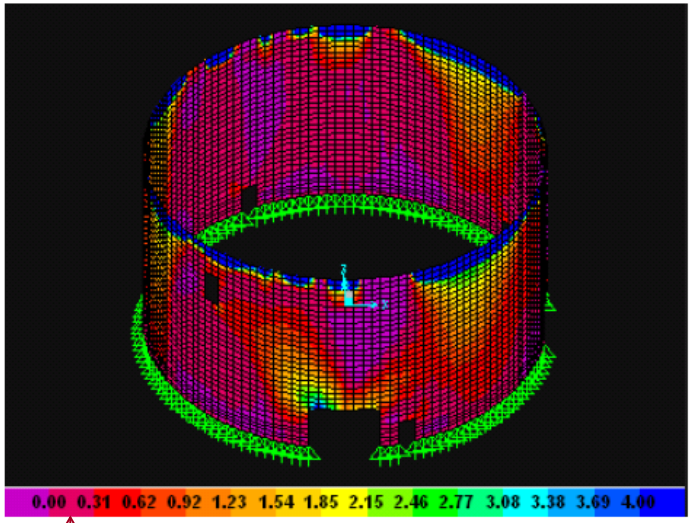
Site ready for construction

Building Orientation – Site Utility & Access Requirements



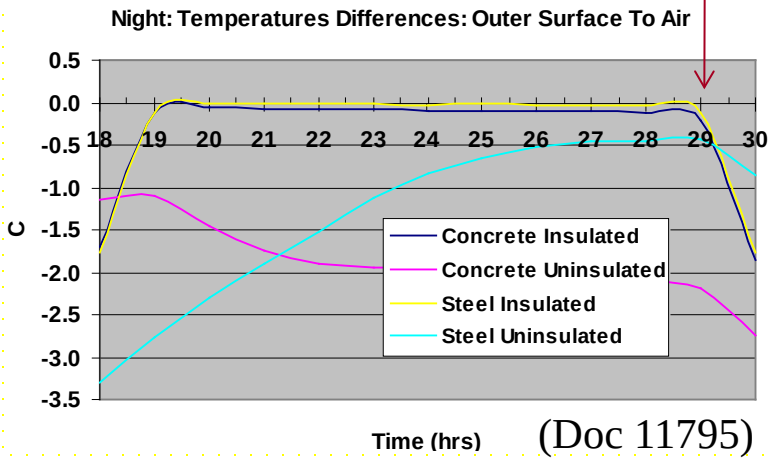
- **Building Oriented to be down or cross wind from the telescope**
- **Platforms sized to minimize cut while providing sufficient space for construction**
- **Roads designed for access of large trucks without encroaching on the buildings & service yards**

Primary Building Structure to meet thermal and stiffness requirements



Momentos Positivos en la Dirección Radial [T-m/m].

Concrete Lower Enclosure: stiffer against lateral force and vibration and (with insulation) thermally benign

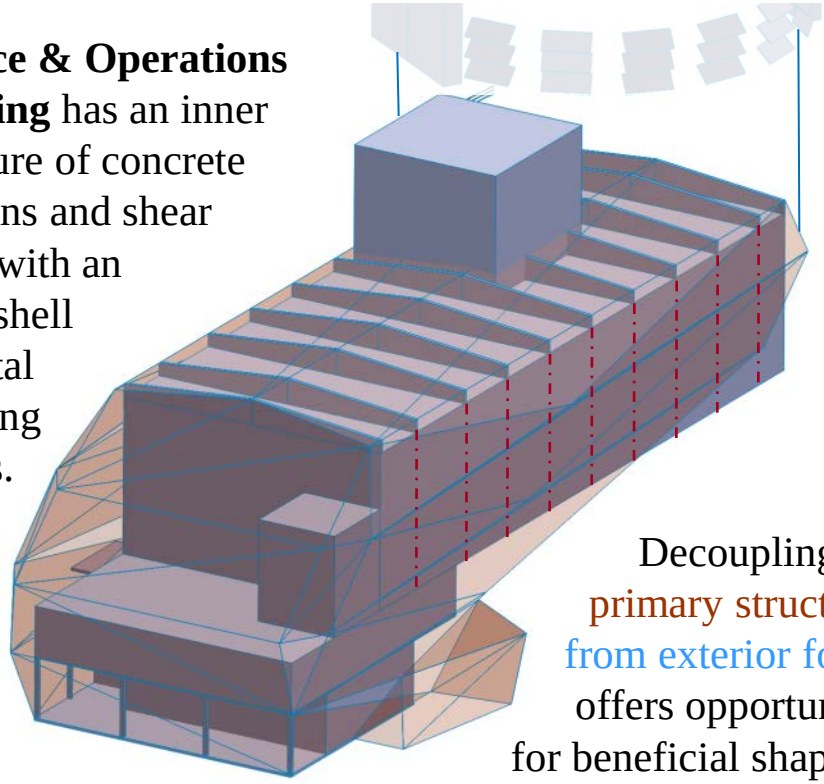


(Doc 11795)

Trade studies (Docs 11782 & 11783) resulted in the selection of concrete as the primary structural material for the lower enclosure wall and S&O building, due to:

- better stiffness,
- acceptable thermal performance,
- lower cost.

Service & Operations Building has an inner structure of concrete columns and shear walls with an outer shell of metal cladding panels.

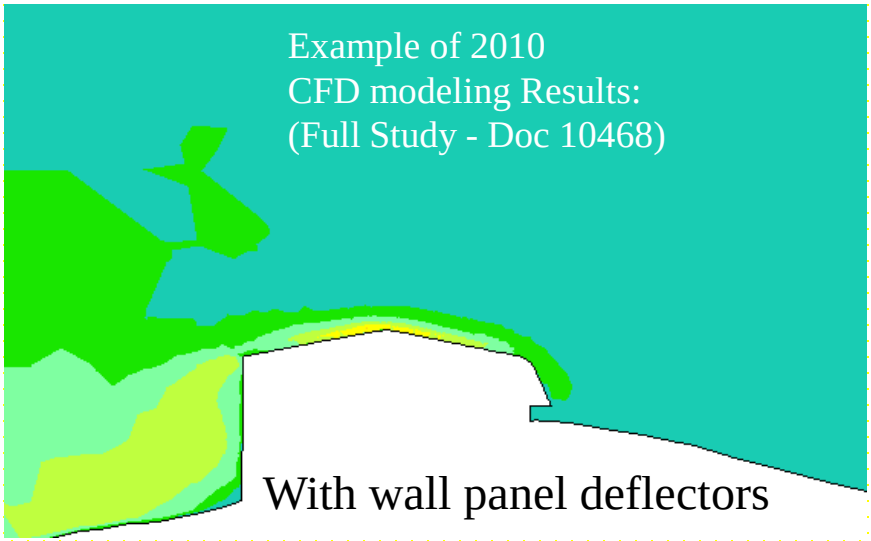


Decoupling of primary structure from exterior form offers opportunity for beneficial shaping

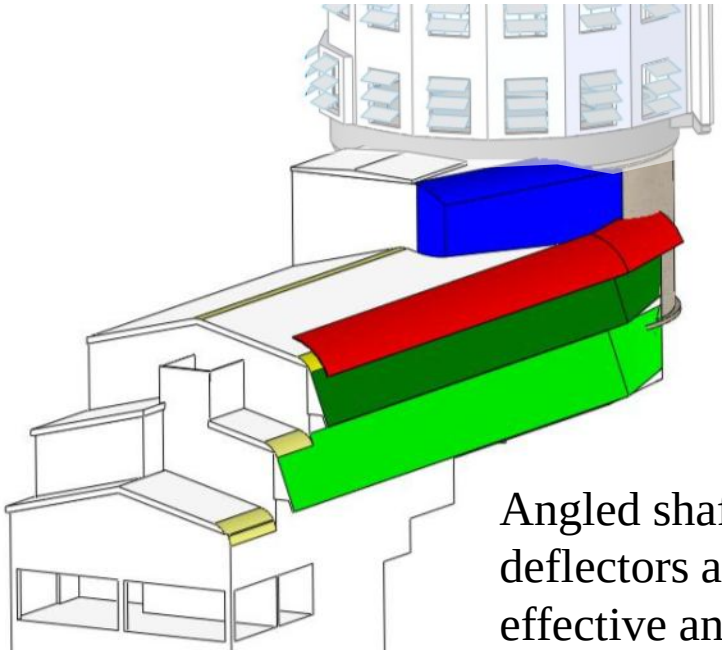
Modifications to meet turbulence reduction requirements

Original baseline

Example of 2010
CFD modeling Results:
(Full Study - Doc 10468)



With wall panel deflectors



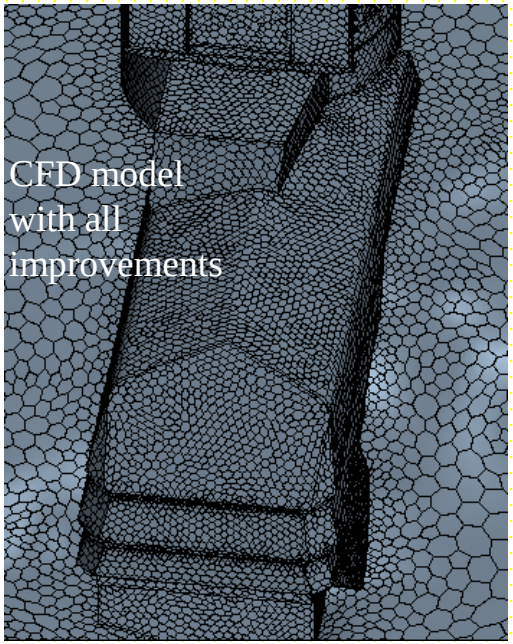
Wind direction

angled shaft wall - effective

top "flap" - not effective

wall panel deflectors - effective

rounded edges - effective



Angled shaft wall, wind-channeling deflectors and curved edges proven effective and added to design

Aerodynamic shaping reduces turbulence

Turbulence created by the platform lift shaft is reduced by an angled wind-facing wall

Angled cladding panels capture upward air flow and channel it around building

Protected linear openings for windows & vents

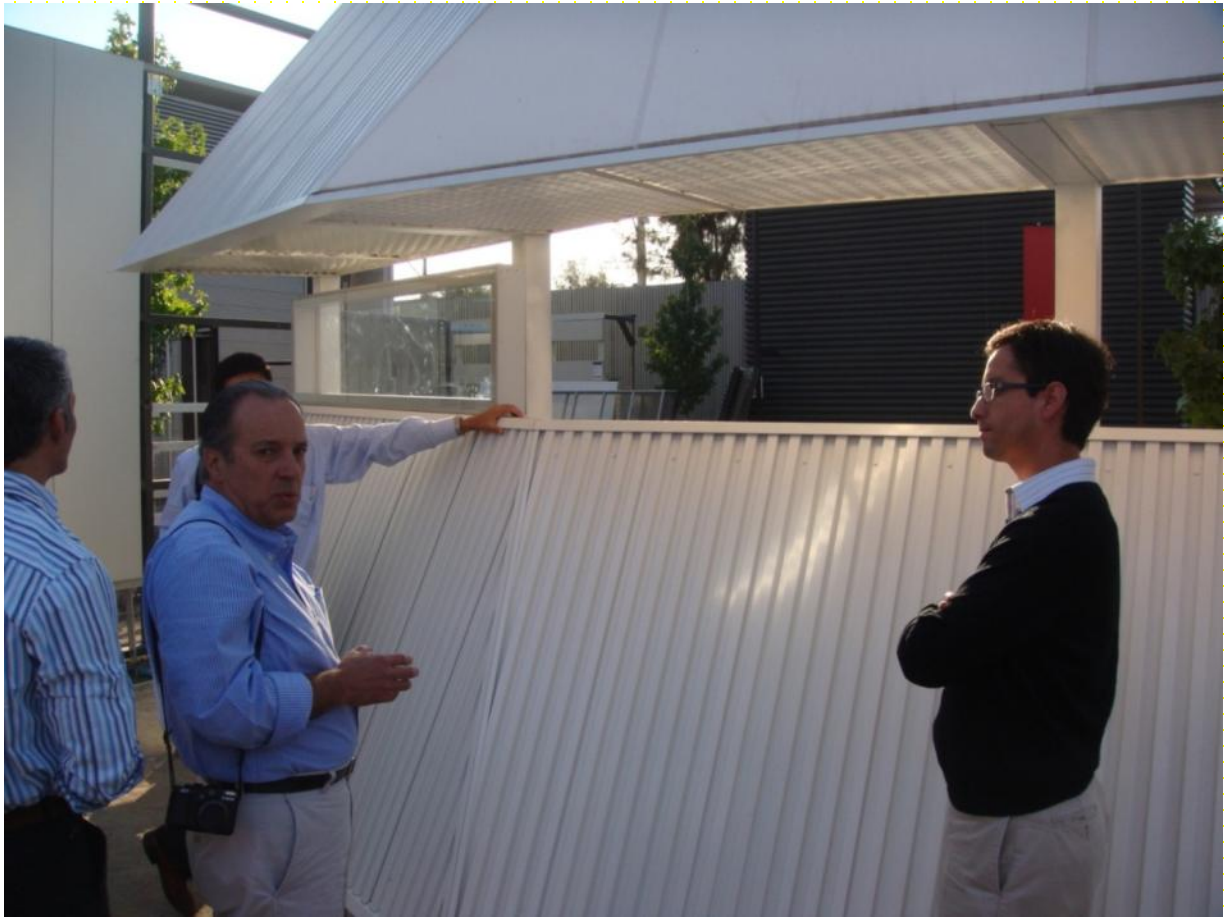
Heated operations area & ventilated equipment area remote from telescope

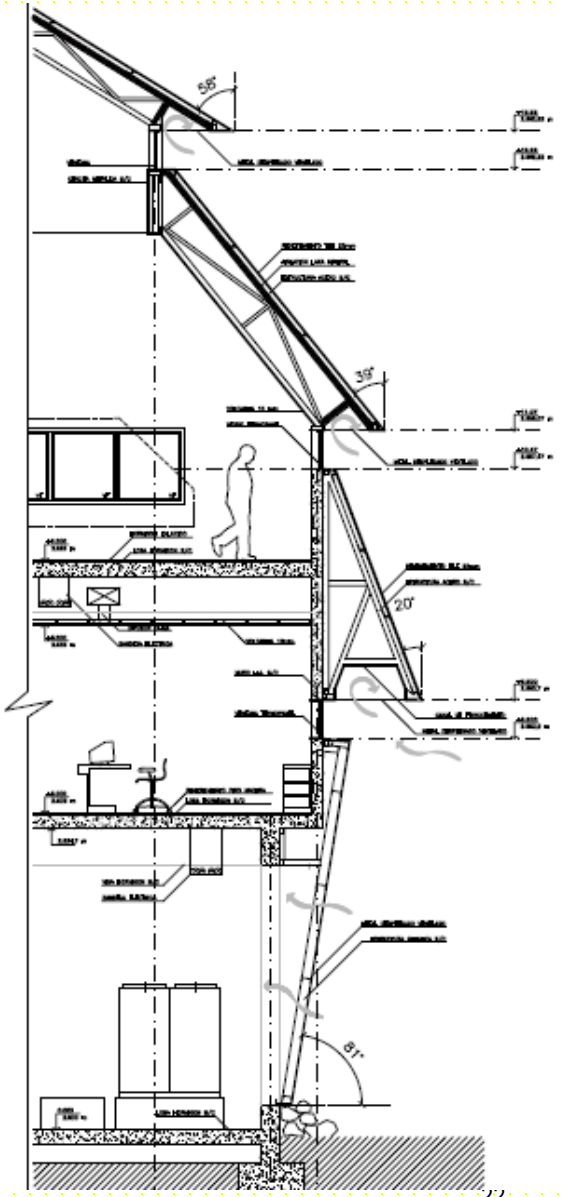
Visually striking new building form is a welcome side effect

Investigation of exterior cladding options

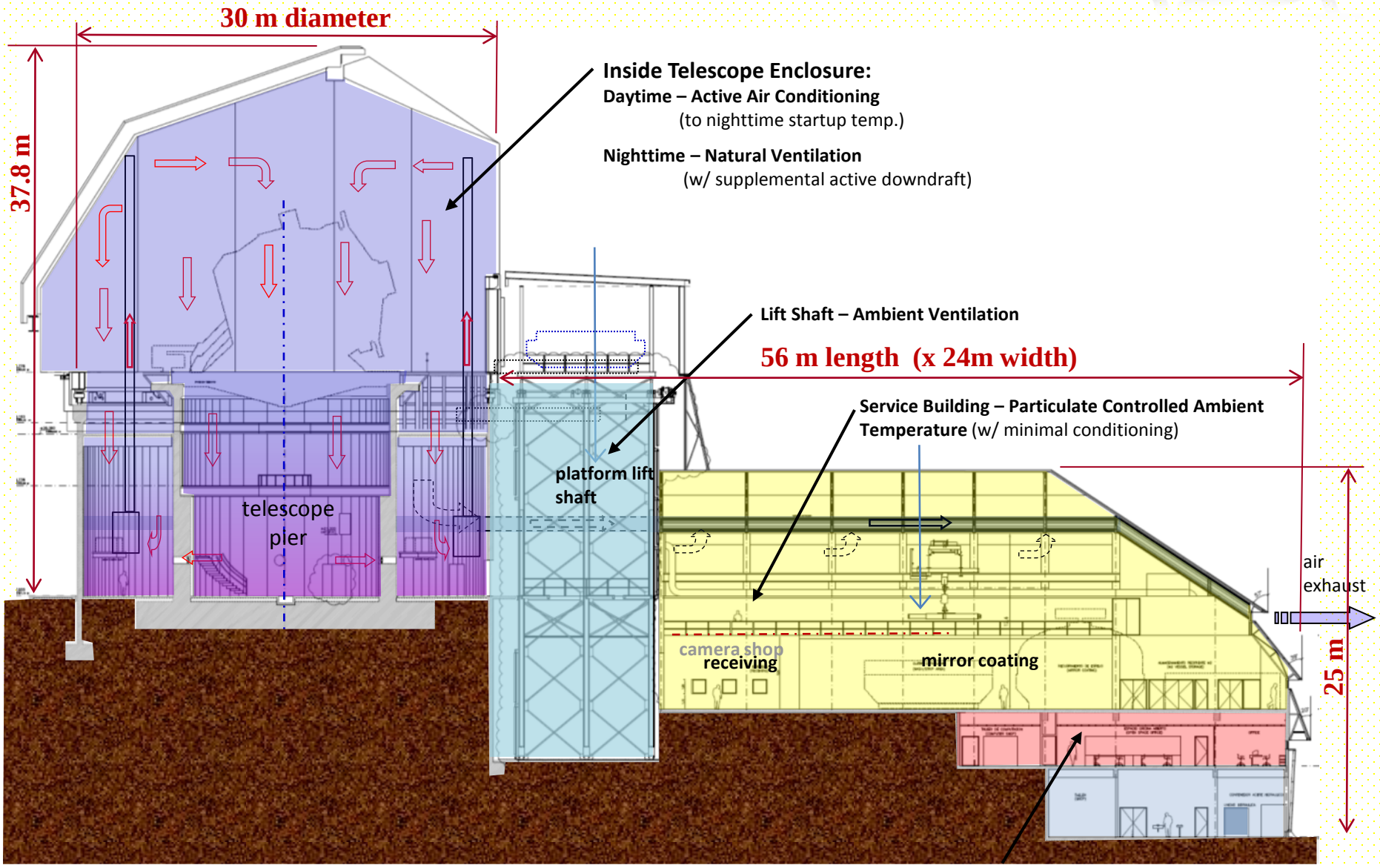
- Standard metal sidings manufactured in Chile are suitable
- Hunter Douglas (Santiago) provided a mock-up of their recommended type with the required angles and configuration

Consider others during Design Refinement
to meet durability requirements and reduce cost



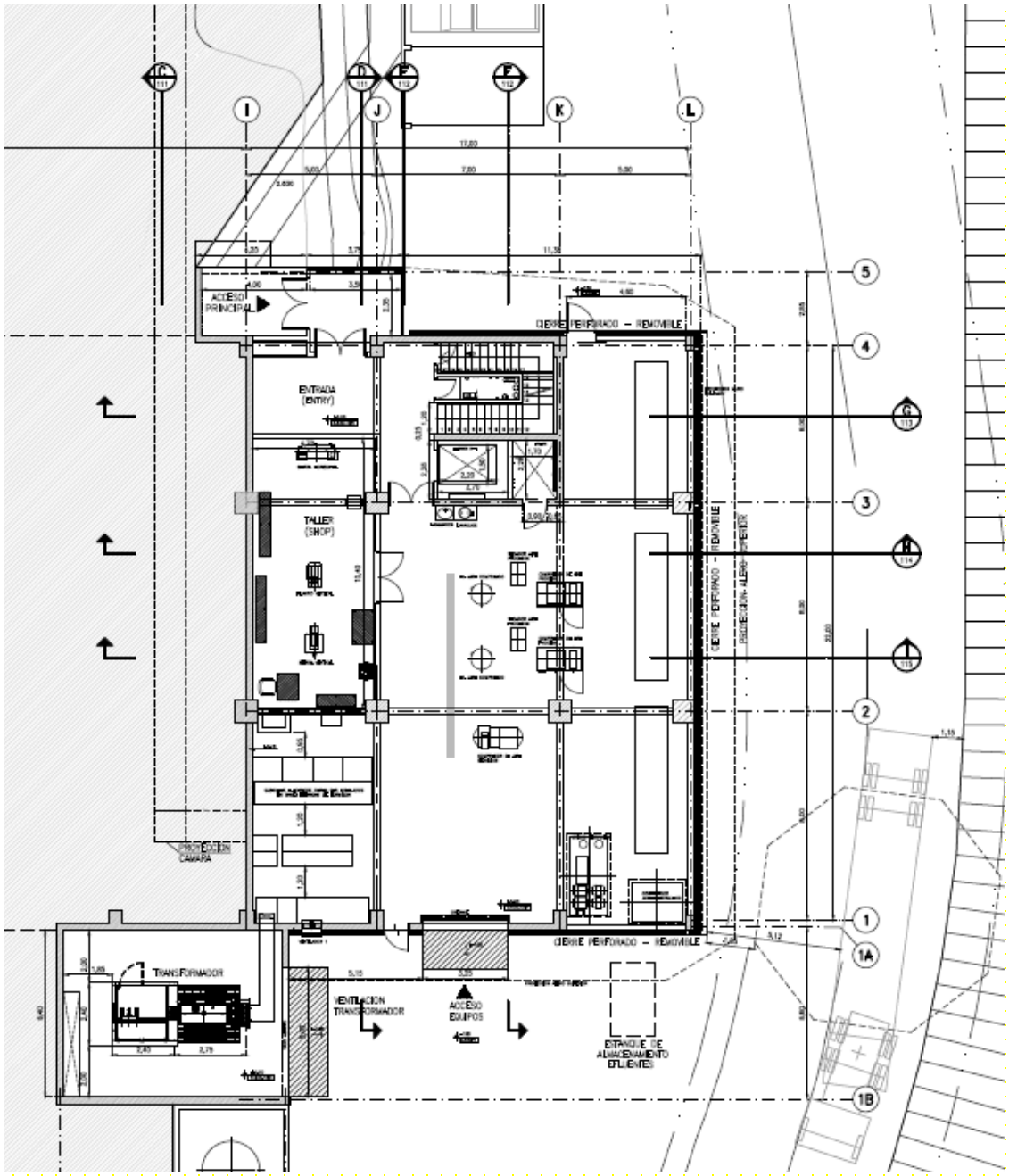


Summit Facility – Zoned to Meet Thermal Requirements



Thermal Management Plan: Doc. LTS-106

Floor Plans

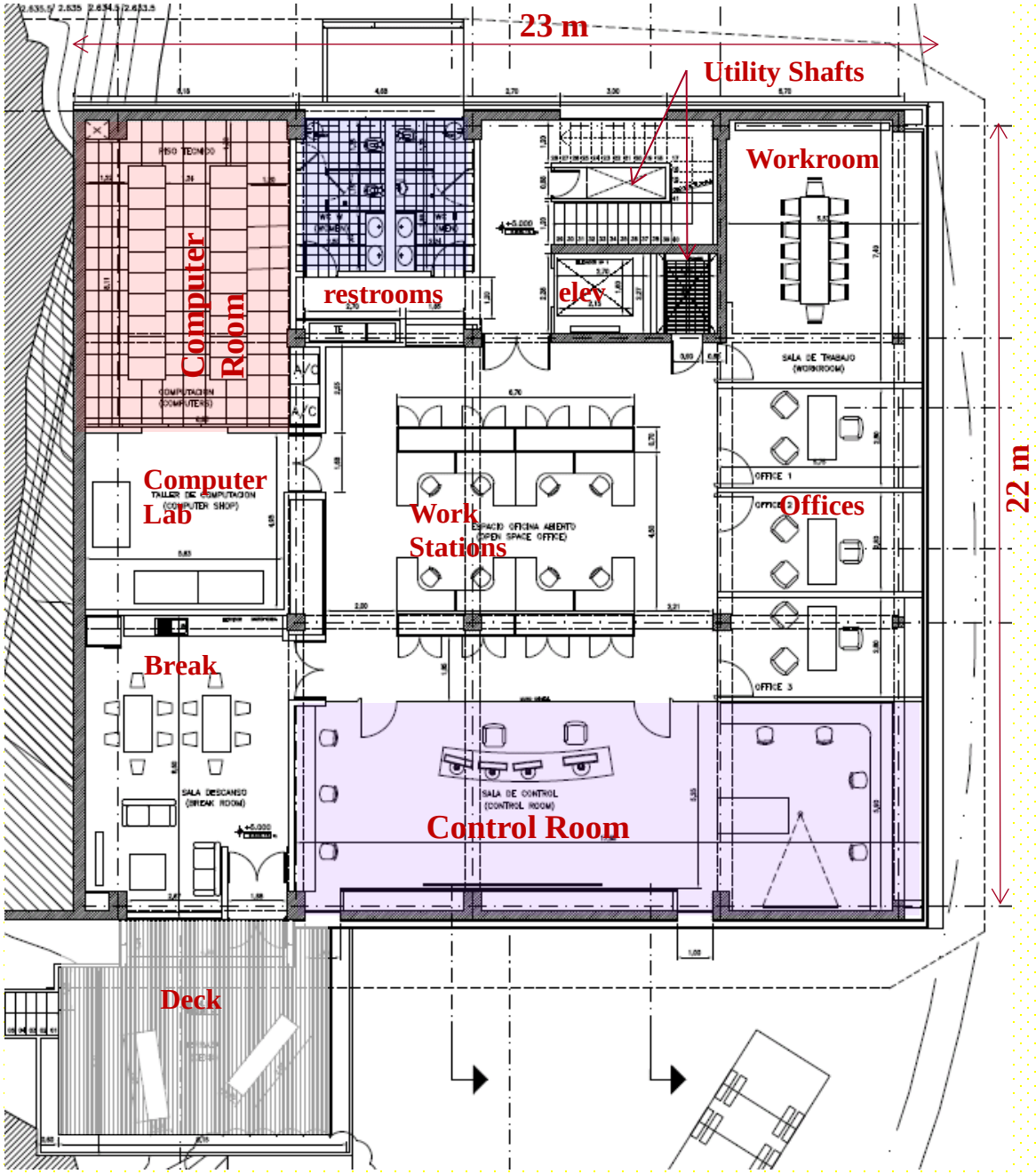


Level 1 (0.0 m)

Entry/Mech. Floor

north

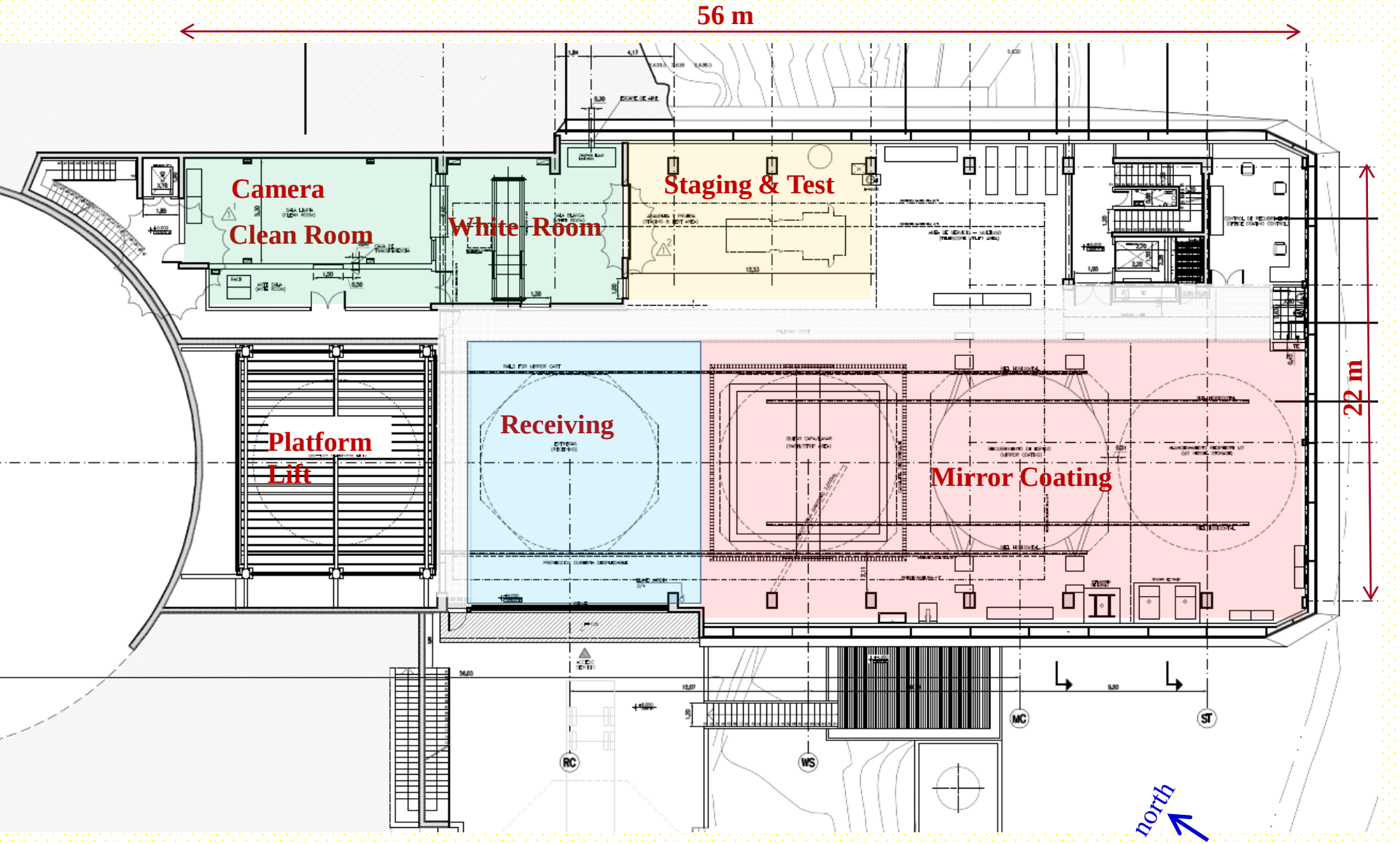
Floor Plans



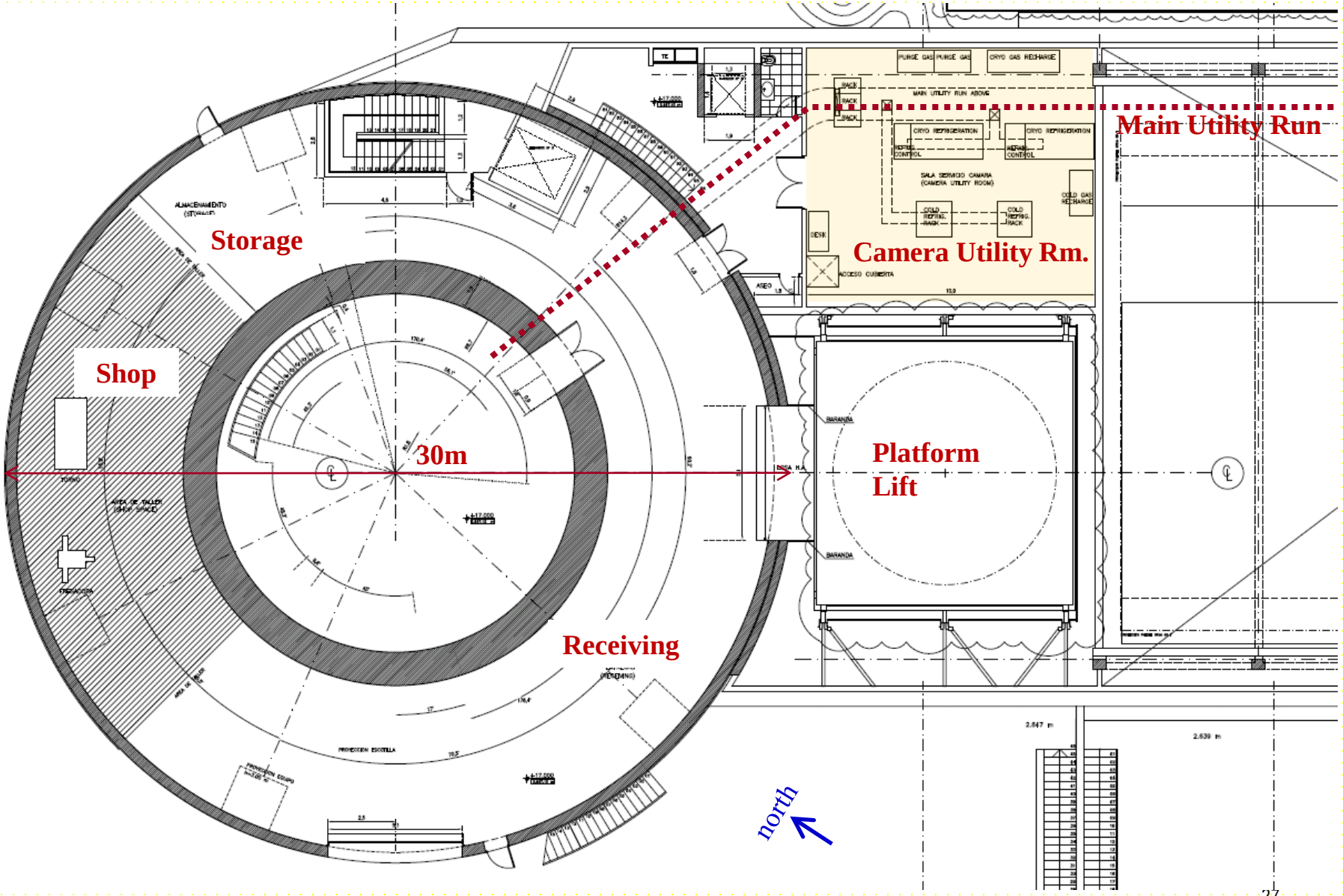
Level 2 (5.0 m)
Control Floor

Floor Plans

Level 3 Mirror & Camera Service Floor (9.0 m)

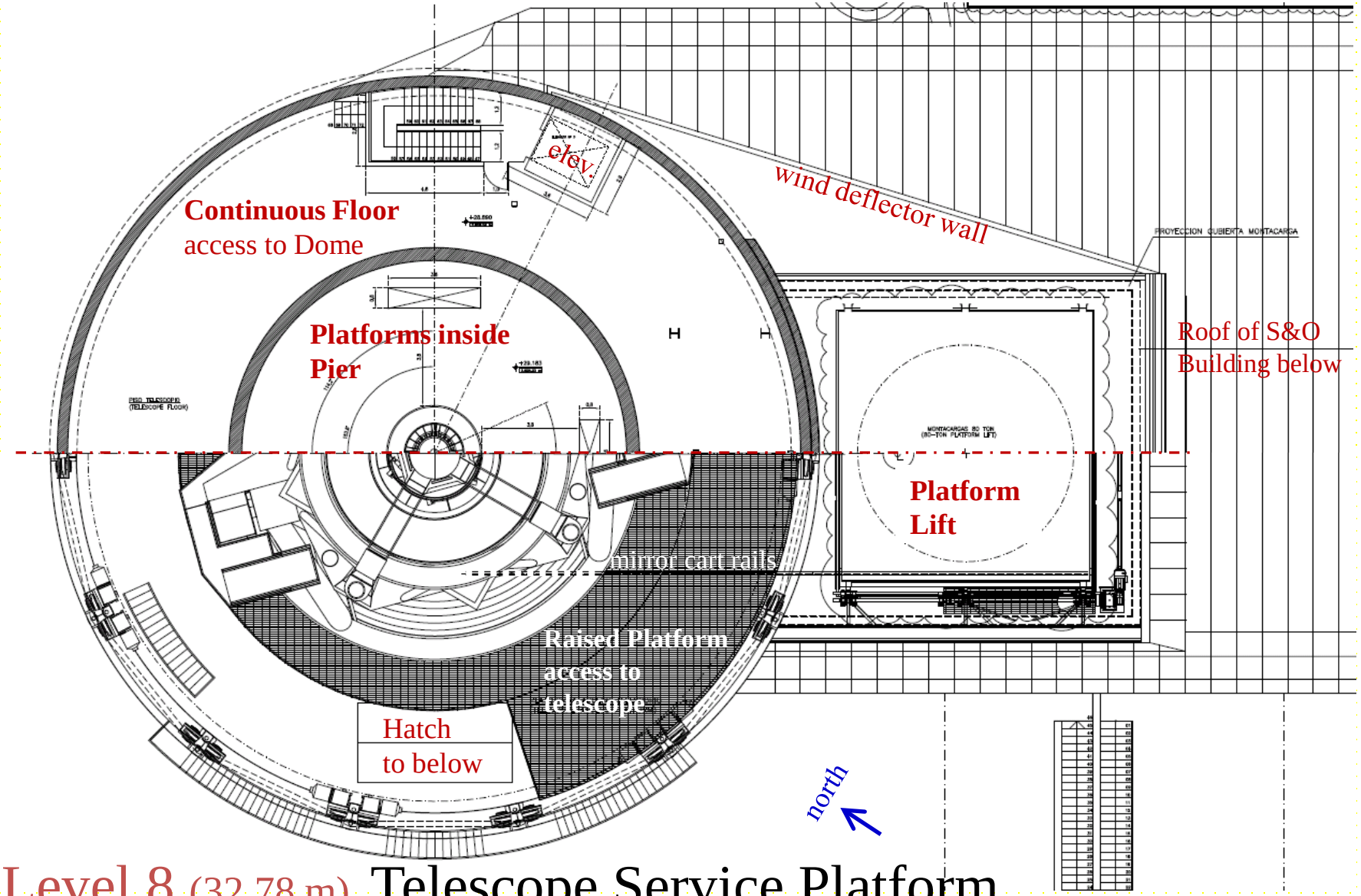


Floor Plans Level 5 - Base Enclosure/Camera Utility Level (17.0 m)



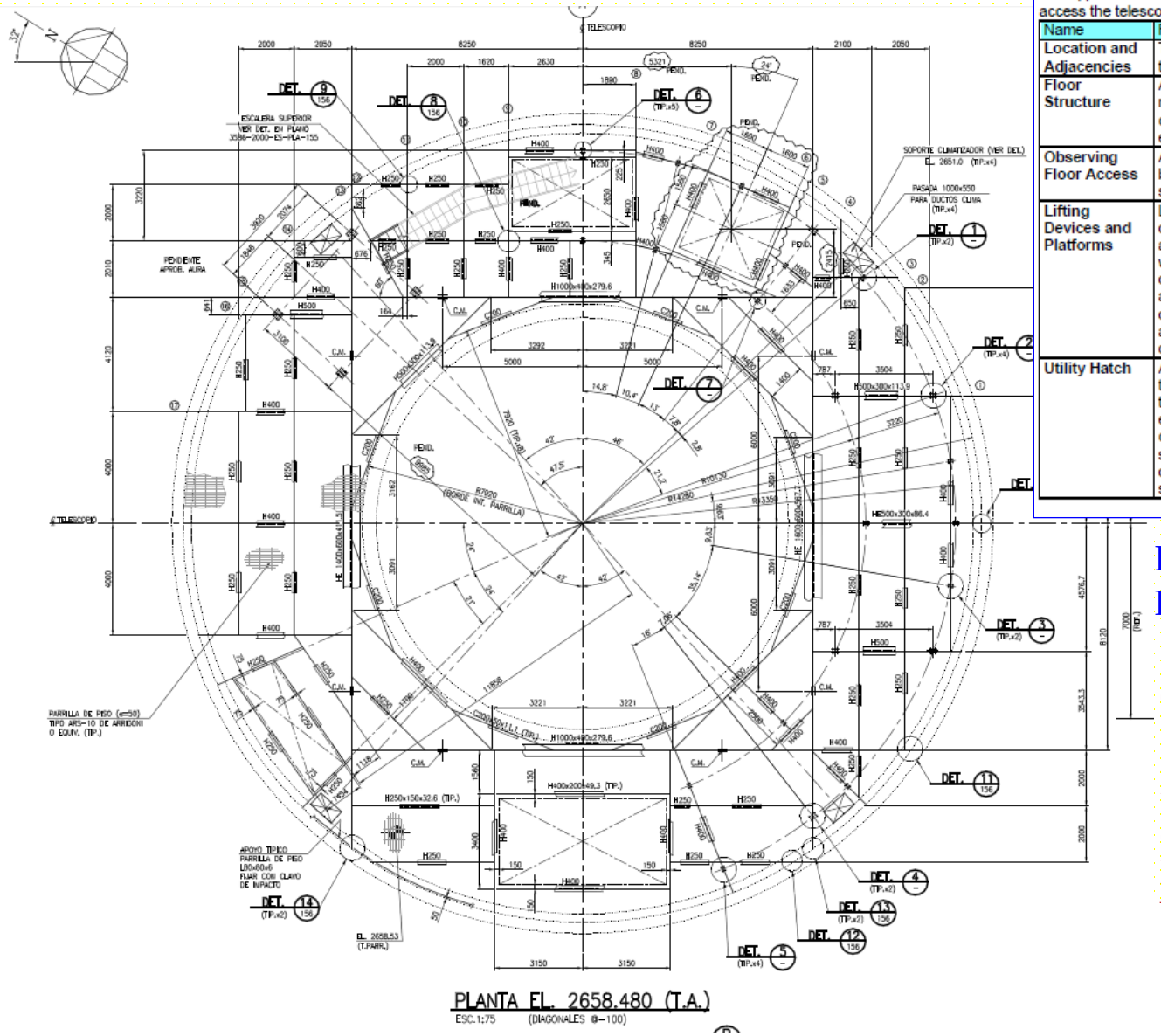
Floor Plans

Level 7 (28.38 m) Dome Floor



Level 8 (32.78 m) Telescope Service Platform

Drawings and specification are in final revision to correct Items found in bidding and modeling



4.1 Observing Floor

The uppermost full floor of the Lower Enclosure will be the observing floor, which serves to access the telescope, camera and Dome.

Name	Requirement	Identifier
Location and Adjacencies	The observing floor shall provide direct access to the telescope.	SSF-LE-OF1
Floor Structure	As a major work area the observing floor requires a robust, versatile floor structure and a solid deck of steel or concrete. The floor will likely incorporate gratings for extracting air from the telescope area.	SSF-LE-OF2
Observing Floor Access	Access to and from the observing floor shall be provided by a platform lift, a personnel-rated elevator, a set of stairs, and a second exit device (stairs or ladder).	SSF-LE-OF3
Lifting Devices and Platforms	Lifting devices and platforms that extend above the observing floor are required for access to the telescope and camera. The dimensional criteria for these devices will be developed by AURA in conjunction with the design of the telescope and camera. This will likely include an articulating-boom lift permanently mounted to the observing floor structure. The observing floor design shall accommodate the fixed and roaming loads of these devices.	SSF-LE-OF4
Utility Hatch	A utility hatch shall be provided in the observing floor for the passage of telescope assemblies, equipment and tools to and from the base level. The hatch shall be large enough (approximately 6m x 3m) to accommodate the camera or the secondary mirror. The location of the hatch shall be such that its center point is within the travel range of the hook of the dome crane, and the full hatch opening shall not be obstructed by platforms or other elements.	SSF-LE-OF5

Excerpt from (LTS-53) Design Requirements Document

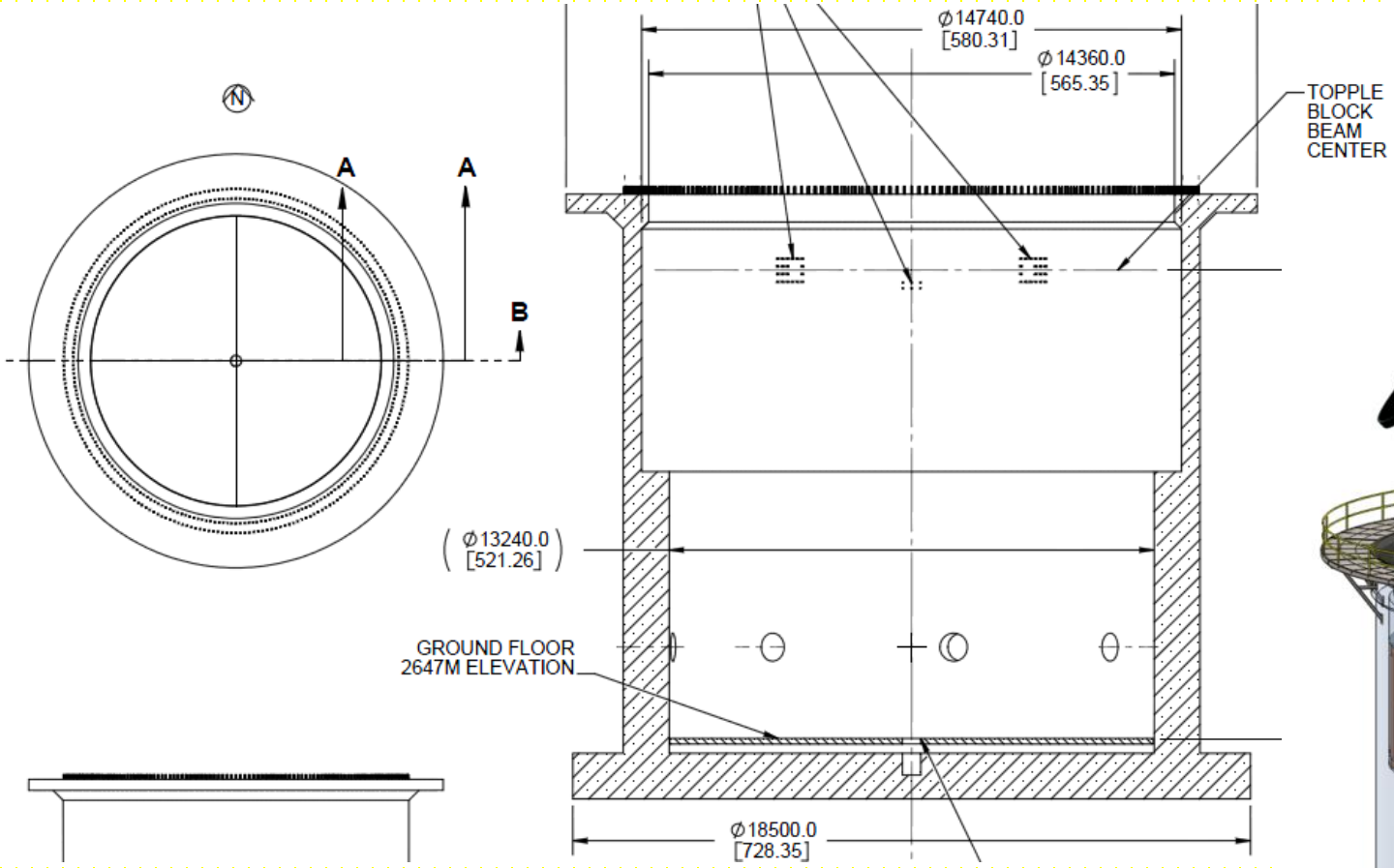
(clouded areas indicate revisions)

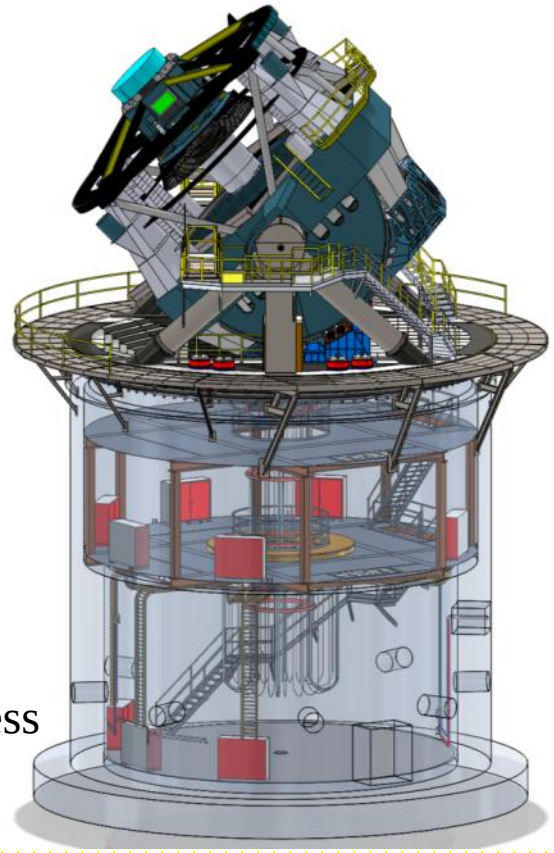
Final corrected drawings and specifications will be posted on Docushare (collection-3184) by August 31, 2014

Interface of Telescope to Pier

(excerpt from ICD Package LTS-77)

Mount contractor requesting a lower pier





Pier structure shaped to maximize FEA modeled stiffness

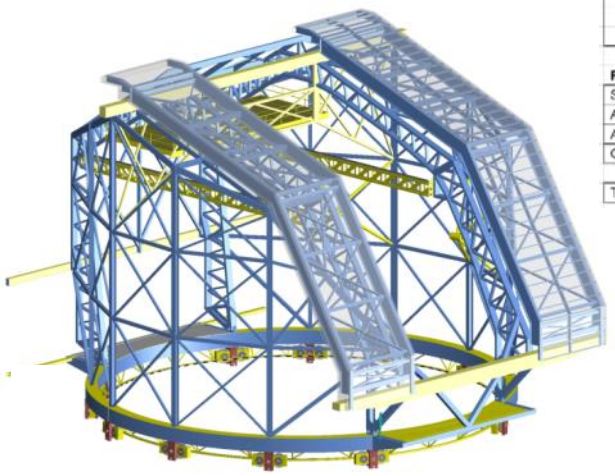
Interior platforms provided for utility access

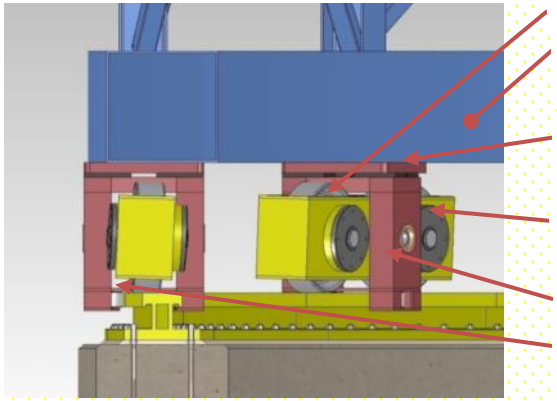
Interface of Dome to Lower Enclosure

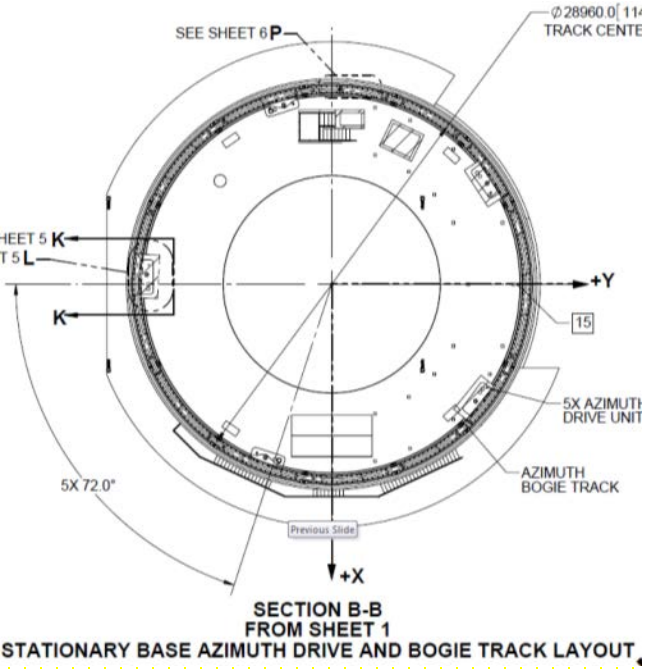
ROTATING DOME MASS PROPERTIES		
TOTAL ROTATING DOME MASS	606	metric tonnes
DOME ROTATING MASS MOMENT OF INERTIA ABOUT Z AXIS	1.20E+08	Kg*m2
CENTER OF GRAVITY ROTATING DOME MASS (DOME COORD SYS)		
X	-0.14	m
Y	-0.82	m
Z	11.5	m

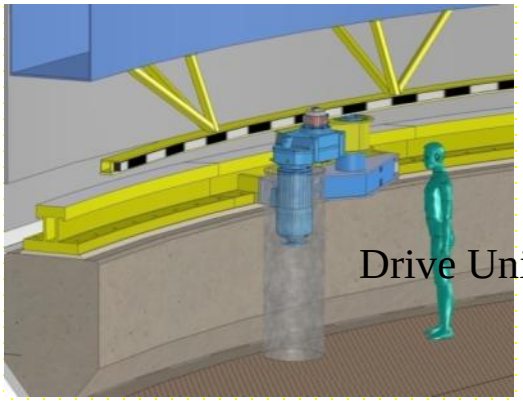
FIXED DOME COMPONENT MASS PROPERTIES:		
SLIP RING COLLECTORS (FIXED PART, 4 EACH)	0.1	metric tonnes
AZIMUTH DRIVE UNITS MASS (5 EACH)	5.7	metric tonnes
AZIMUTH TRACK MASS	74	metric tonnes
GROUT MASS	5.7	metric tonnes
TOTAL MASS ON LOWER ENCLOSURE PIER	691.7	metric tonnes

Dome mass estimate increased from 570 MT to 700 MT

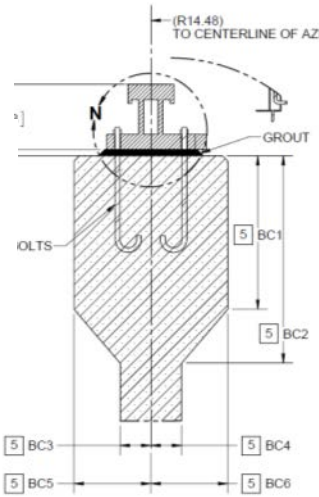


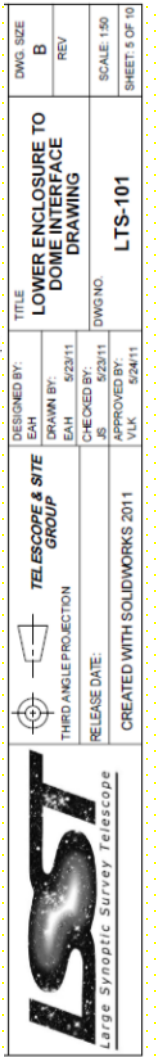






Drive Unit Locations

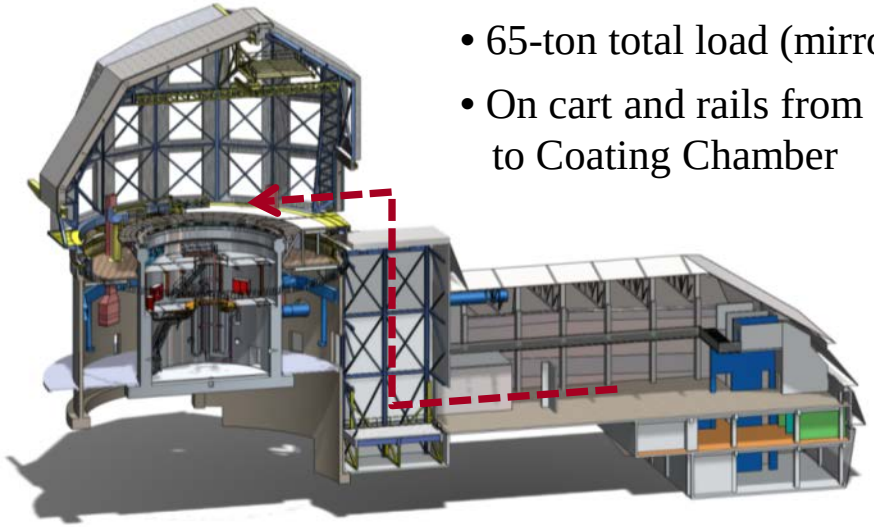




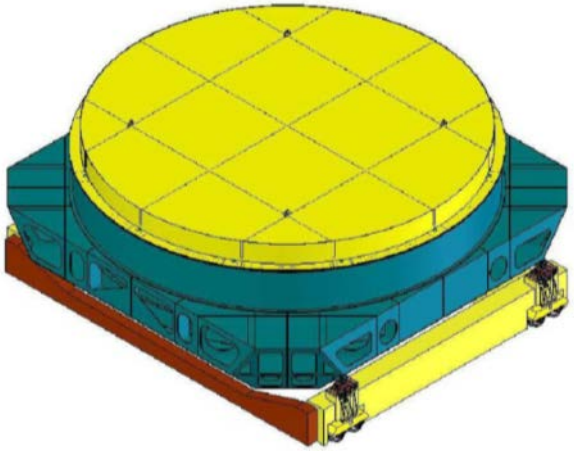
Azimuth Drive

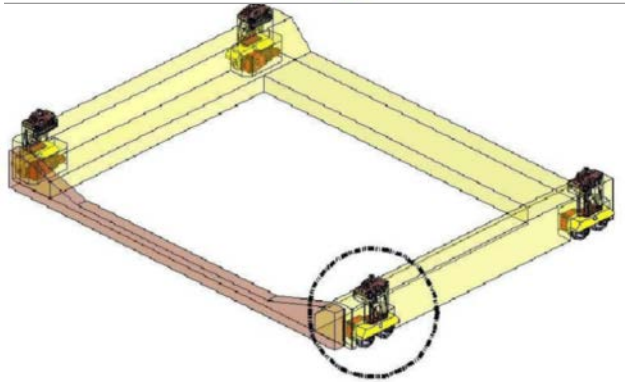
Dome Track at Top of Lower Enclosure

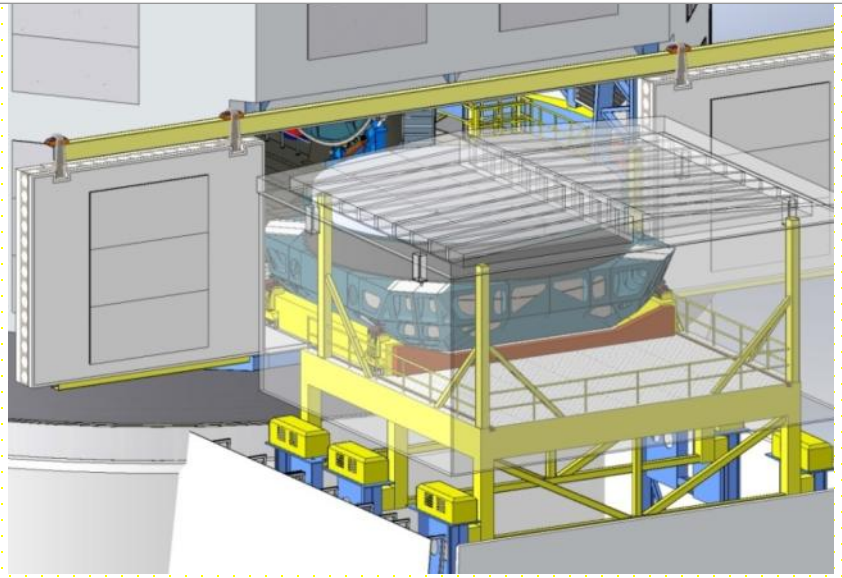
Primary Mirror Conveyance in Building



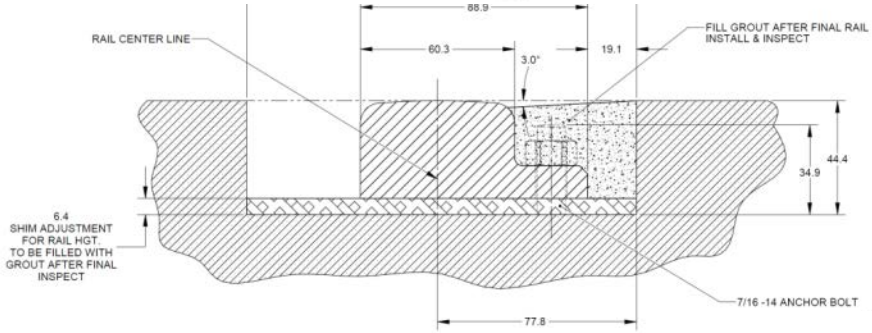
- 65-ton total load (mirror-cell-cart)
- On cart and rails from Telescope to Coating Chamber







M1/M3 Mirror Cart Shown Loading onto Platform Lift

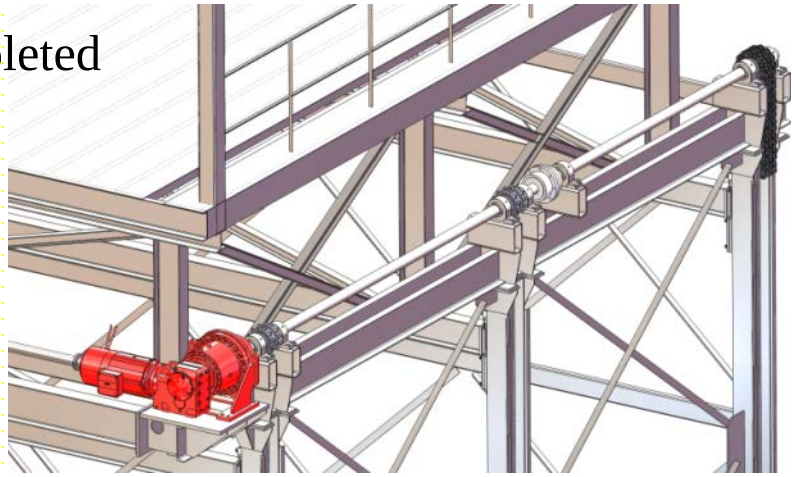


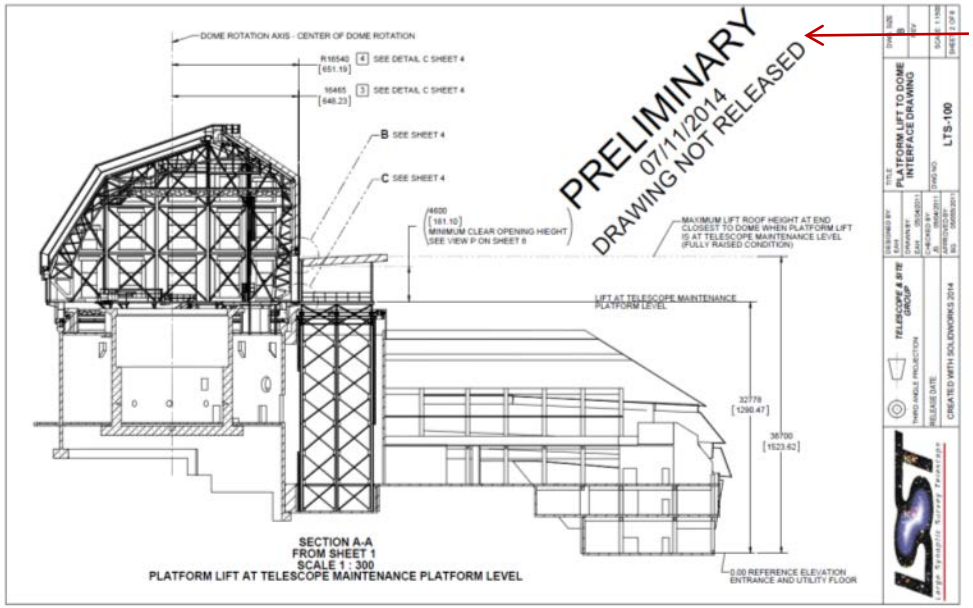
Rail Detail incorporated into Building Design

Platform Lift Requirement and Interface

- Vertical Reciprocating Conveyor from Pflow Industries, a specialized industrial vendor
- Preliminary Design completed with building design
- Interface to mirror cart and dome coordinated by Telescope & Site engineering team

(LTS-100)

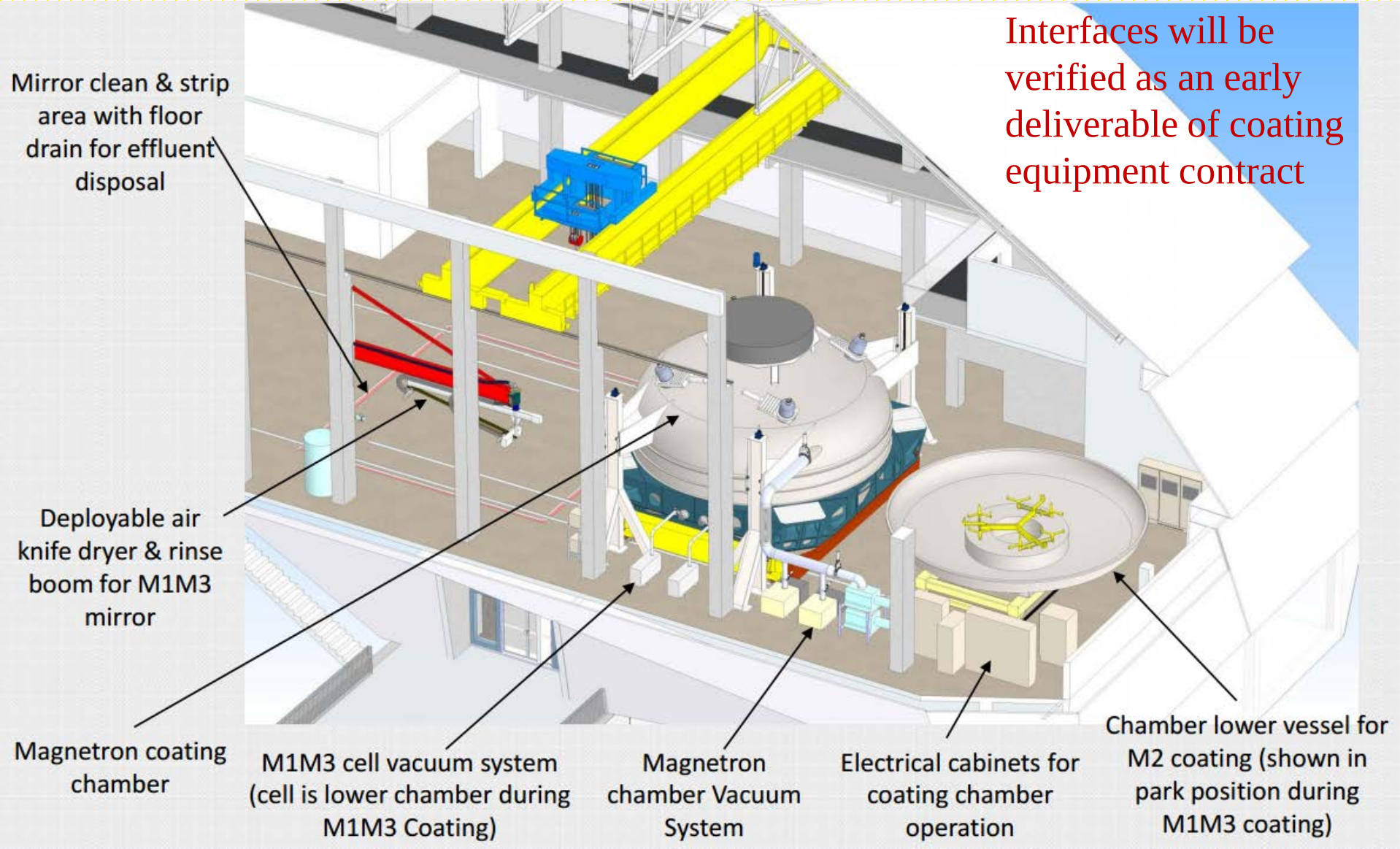




ICD drawing is in revision due to required design refinement including coordination of Pflow-ARCADIS designs

Pflow Industries, Inc. Vertical Lifting Solutions

Coating System Requirements
3D-Modeled and Incorporated into Summit Facility Design



Camera to Telescope and Site Interface Requirement (LSE-65)

Facility Interface Between the Telescope & Site and Camera

Introduction and Scope

This interface requirement package describes the interfaces between the camera and the site support facility when the camera is in the support building on the summit. It is organized around the specific rooms and areas in the summit facility that are used for camera-related operations. Unless specifically stated otherwise, it describes the minimum capabilities and design features to be provided by the summit facility for use by the Camera team. This package does not include the utility interfaces for the camera when it is in operation on the telescope.

1 Site & Building Access

The summit facility road and service drive will have a grade, surface and support capacity for safe passage of a 5-axle tractor-trailer truck, with gross vehicle weight of 45,000 kg (50 tons).

1.1 Access Road Clear Width and Height

ID: CA-TS-FAC-ICD-0001 **Last Modified: 4/26/2012**

The access road for transport of the camera shall have a minimum required clear width SB-Road-Width and clear height SB-Road-Height.

1.1.1 Road

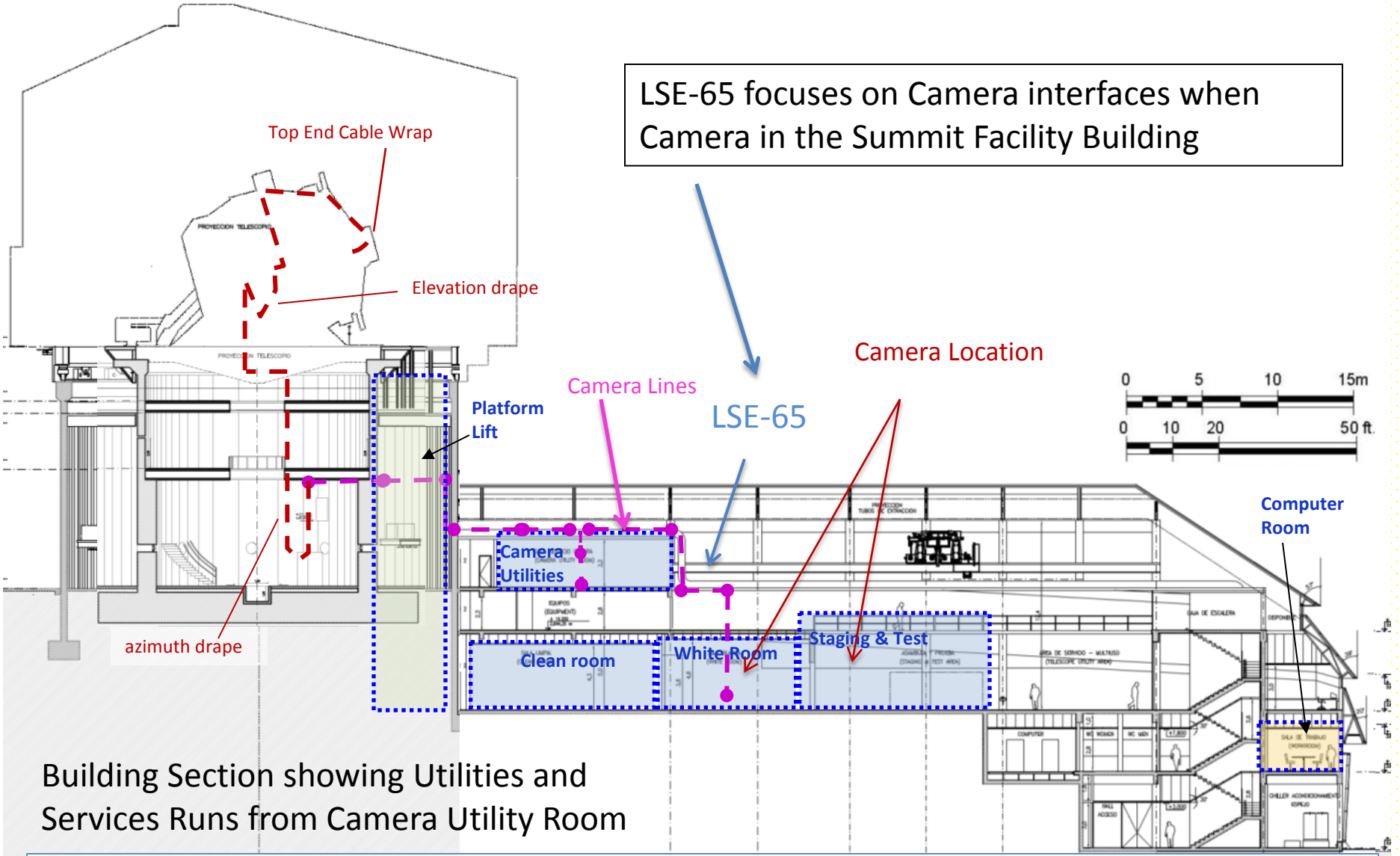
ID: **Last Modified: 7/4/2011**

Description	Value	Unit	Name
Road Clear Width	4	Meters	SB_Road_Width
Road Clear Height	4	Meters	SB_Road_Height

TBDs in this ICD document to be discussed during this community workshop.

Camera to Telescope and Site Interface Overview

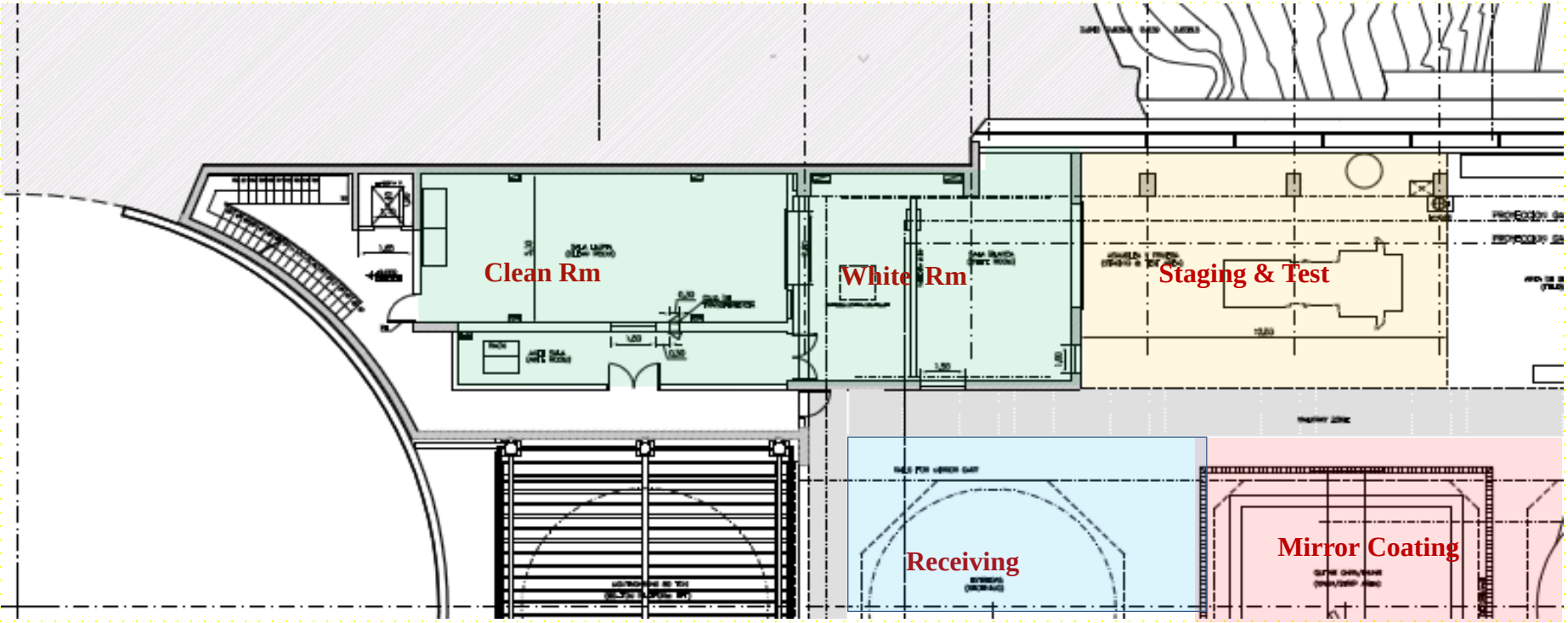
LSE-65 focuses on Camera interfaces when Camera in the Summit Facility Building



Building Section showing Utilities and Services Runs from Camera Utility Room

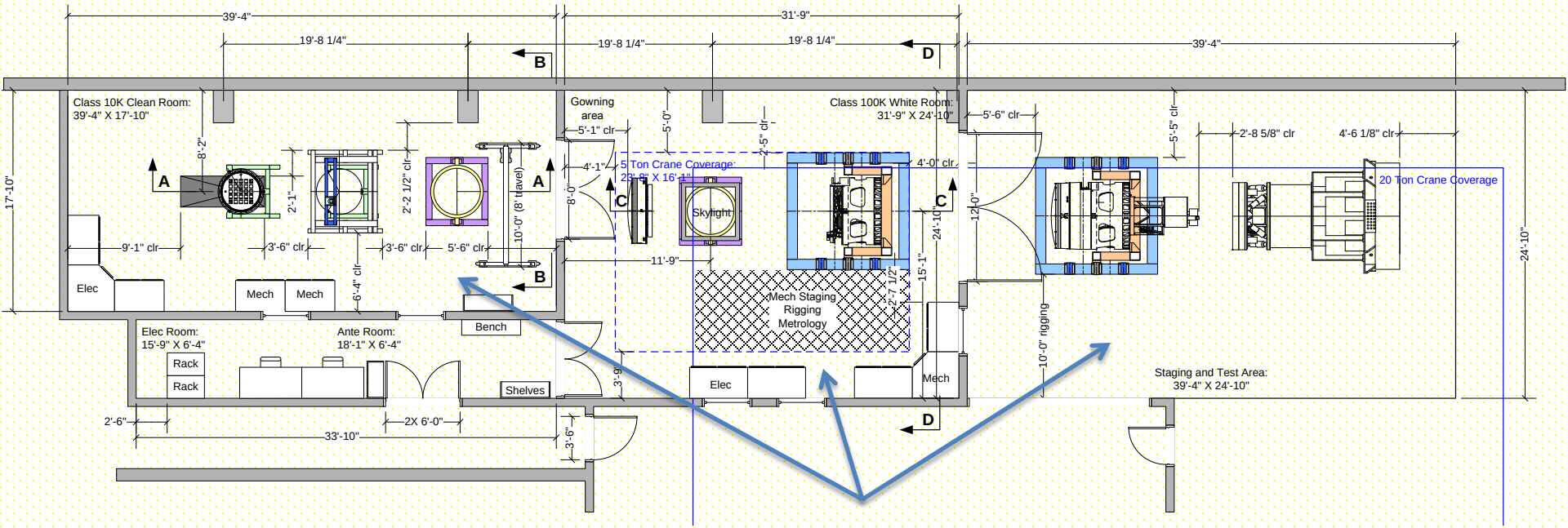
Camera Rooms Integrated within Overall Design of Summit Facility

Camera Maintenance Area

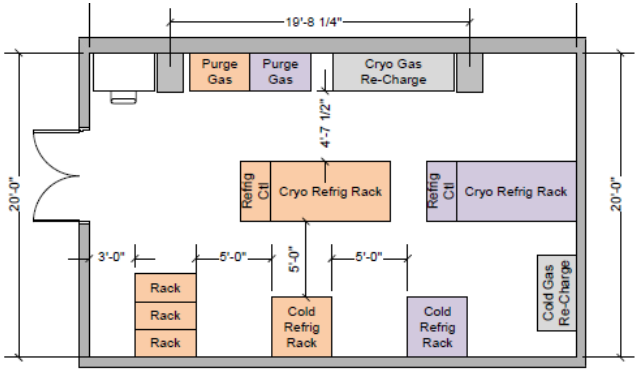


Continuous Camera Service Area on the same floor to provide increasing level of cleanliness for the different steps of camera integration and tests.

Camera Room Occupancy Analysis



Equipment in Utility Room

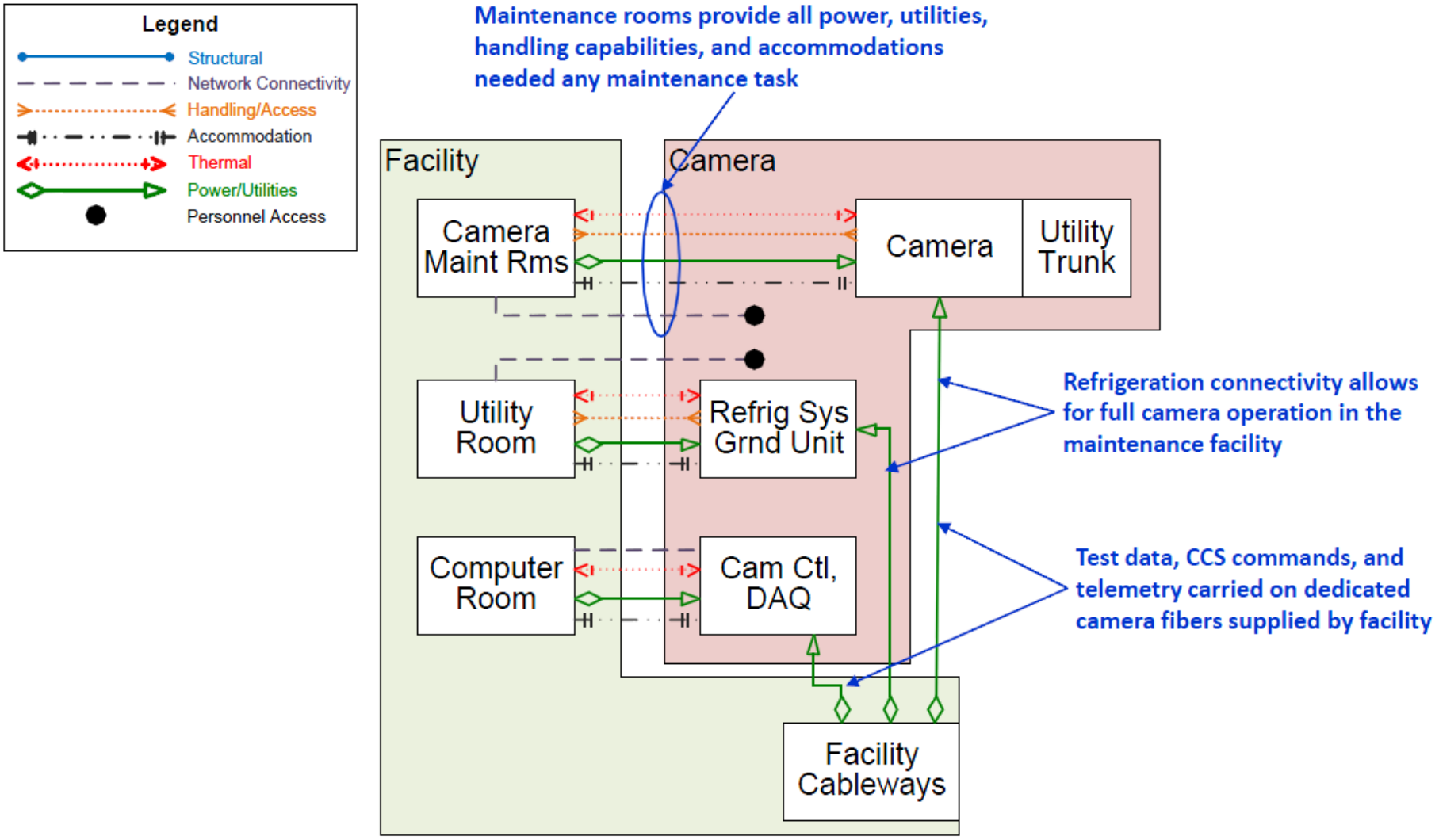


Camera Utility Room
5th Floor

Layout Established based on Camera Team Occupancy Analysis:

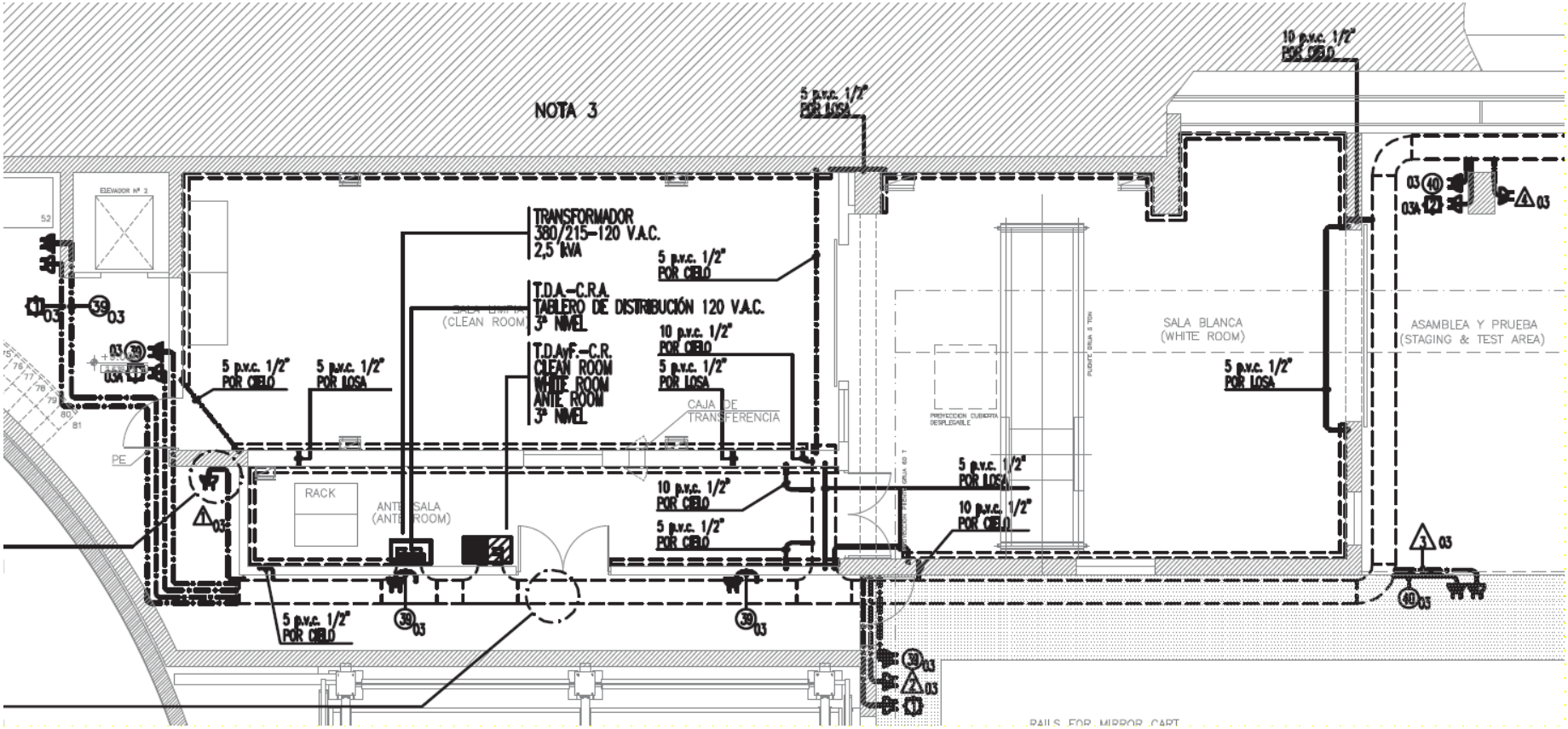
- Staging and Test Area
- White Room
- Clean Room

Camera Interfaces while in its Maintenance Area As Defined by Camera Team



A Few Camera-related Requirements still TBD

- Electrical Outlet Location: TBD pending input from Camera Team
- Distribution panel only provided



- Compressed air also only provided with a main connection

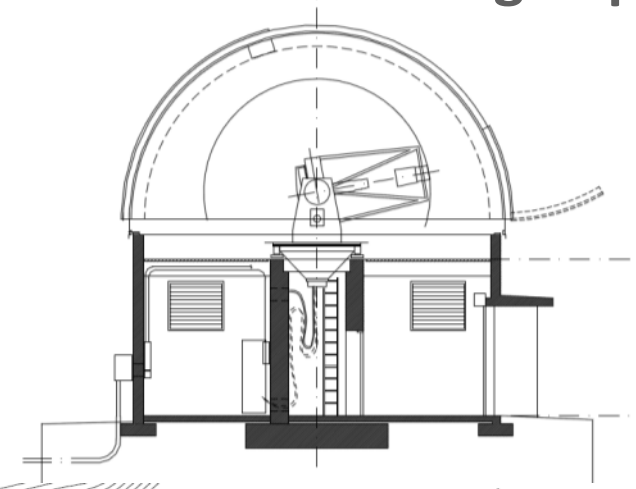
Concrete Radioactivity Level Requirement Definition emerging

- To meet camera terrestrial radiation requirement we are seeking to document radioactivity levels from various construction materials. Biggest concern is concrete (potassium).

LSST Site – Pachon 300 counts natural radioactivity

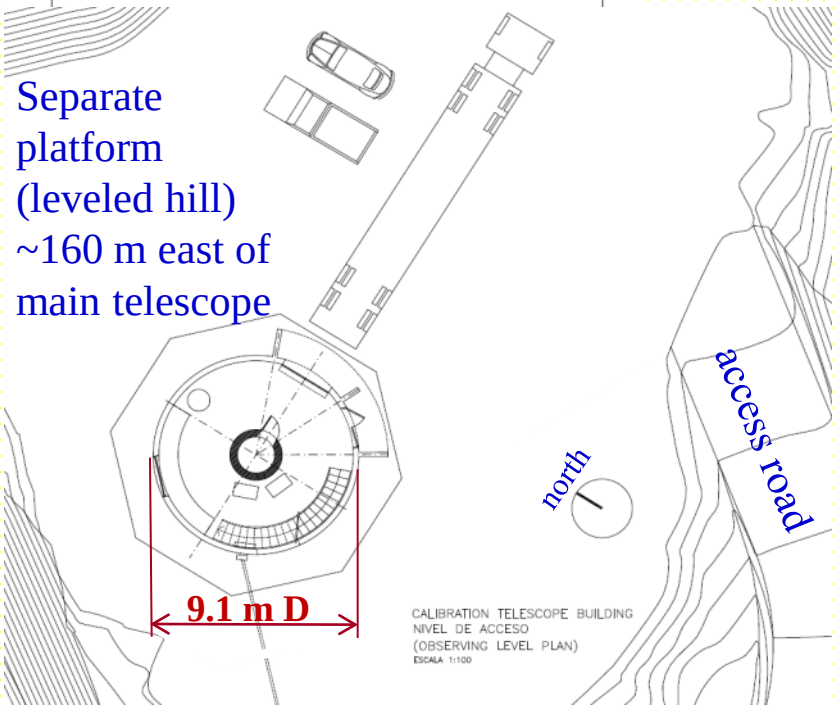
Low levels of natural radioactivity on Pachón had been previously measured in 2013

Calibration Telescope Building Requirements
Handled as an integral part of main building contract

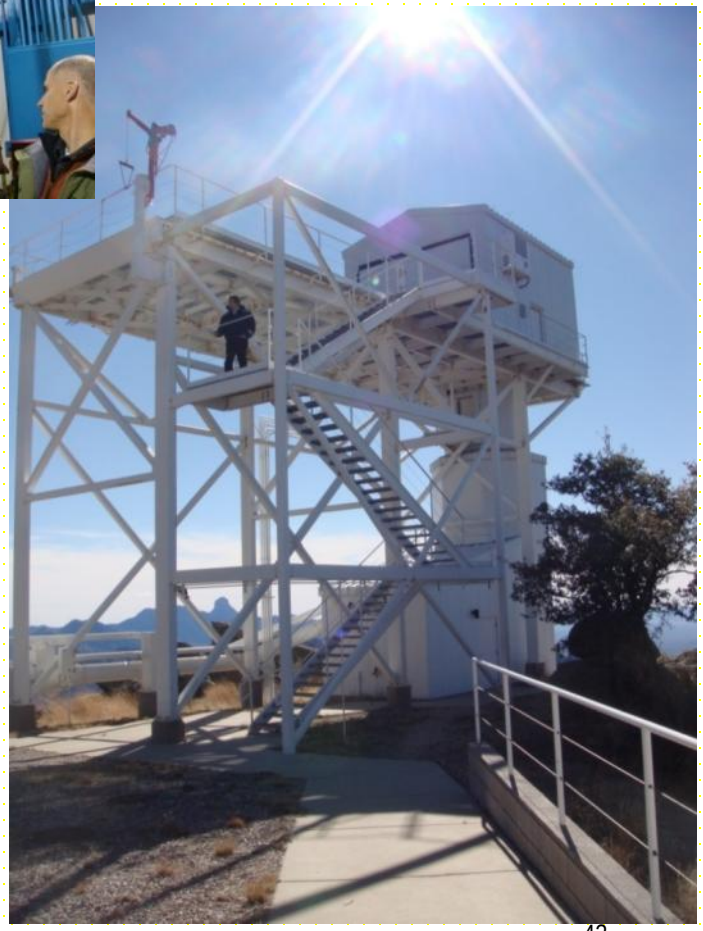


Calypso Telescope to be relocated from Kitt Peak

Separate platform (leveled hill) ~160 m east of main telescope



Detailed design of site and building included in current A/E contract

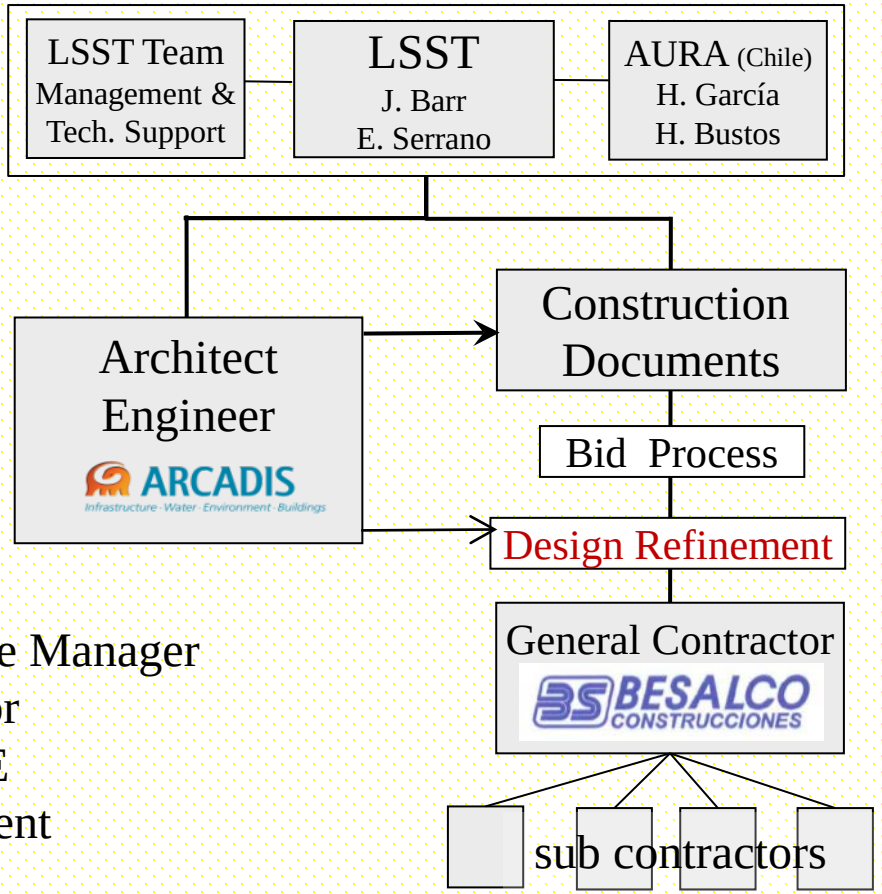


Procurement Methodology & Requirements Verification

Design-Bid-Build Project Delivery

- Well-established relationship between Owner (LSST/AURA), A/E and General Contractor
- Standard arrangement for design and construction in Chile – including many observatories

- Architect-Engineer prepares Construction Documents (working drawings & specifications)
- General Contractor selected in a competitive bidding process based on A/E documents and established AURA bidding and contracting procedures.
- We have added a Design Refinement Phase after bidding and before construction to incorporate input from contractor
- During construction process:
  - Supervision by LSST Architect and Site Manager
  - Inspection by LSST Technical Inspector
  - Technical consultation provided by A/E
  - Approval/direction by LSST management
  - Contractual support from AURA



- Large construction contracting company with extensive resources
- 50 years of experience constructing buildings and major infrastructure in Chile
- Specialized utility, mining and commercial applications
- Extensive experience with critical concrete and excavation

Excellent safety record

Besalco Construcciones S.A.	2010	2011	2012
Horas Hombre	3.617.032	3.444.120	3.991.882
Accidentes Fatales	0	0	0
Accidentes	14	6	7
Días Perdidos	972	490	293
Índice de Frecuencia	3,87	1,74	1,75
Índice de Gravedad	268,73	142,27	79,66

- Projects of note are hydroelectric dams, airports, bridges, the National Congress building, and the gaming Casino in Coquimbo.
- For LSST Summit Facility submitted a fully qualified and complete technical proposal and the lowest economic price of the 4 bids received.

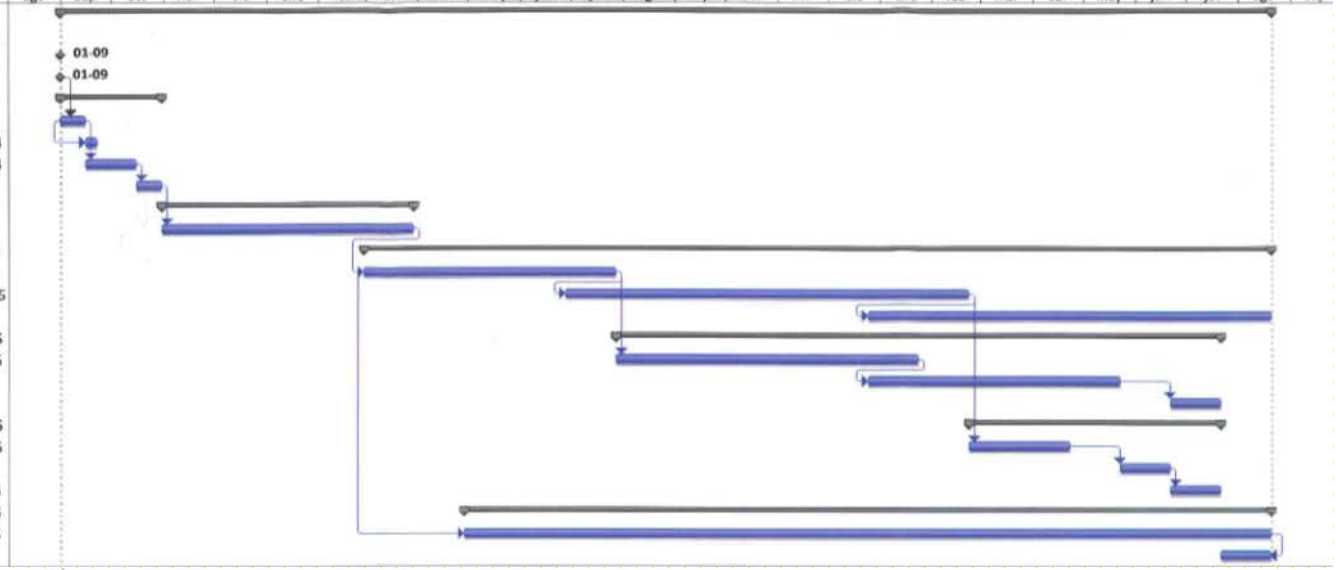
Enjoy Casino in Coquimbo – Constructed by Besalco in 2008
(Location of LSST Board meeting in 2011)

BESALCO CONSTRUCCIONES

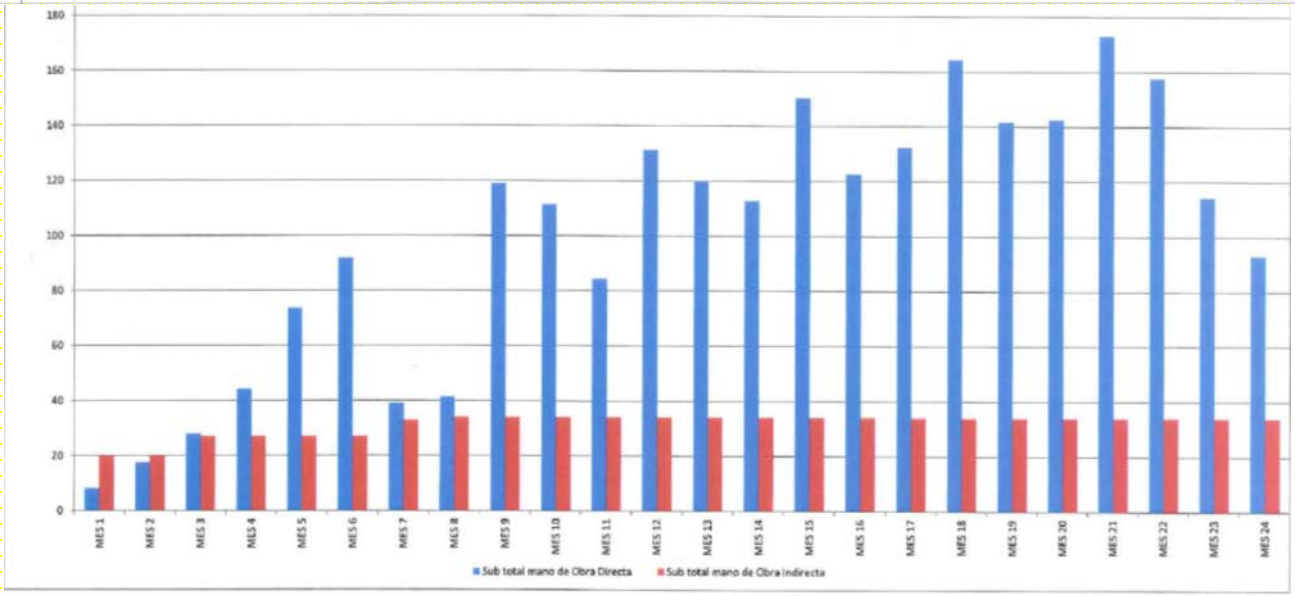
GRAN TELESCOPIO DE EXPLORACIÓN SINÓPTICA LSST, EDIFICIO DE MANTENIMIENTO, CONTROL Y BASE DE CÚPULA

LSST

d	Nombre de tarea	Duración	Comienzo
1	**PROGRAMA PRELIMINAR GENERAL PROYECTO" GRAN TELESCOPIO DE**	**720 días**	**lun 01-09-14**
2	**Hitos**	**0 días**	**lun 01-09-14**
3	Entrega de terreno	0 días	lun 01-09-14
4	**Obra Preliminares**	**60 días**	**lun 01-09-14**
5	Piano Instalación de Faenas	15 días	lun 01-09-14
6	Acreditación	7 días	mar 16-09-14
7	Instalación de faenas	30 días	mar 16-09-14
8	Movilización	15 días	jue 16-10-14
9	**Movimiento de Tierras**	**150 días**	**vie 31-10-14**
10	Mov. Tierra y Sostenimiento	150 días	vie 31-10-14
11	**Frente 1: Edificio de Servicios**	**540 días**	**sáb 28-02-15**
12	Obra Civil	150 días	sáb 28-02-15
13	Estructuras Metálicas	240 días	dom 28-06-15
14	Terminaciones	240 días	vie 25-12-15
15	**Frente 2: Telescopio LSST**	**360 días**	**mar 28-07-15**
16	Obra Civil	180 días	mar 28-07-15
17	Estructuras Metálicas	150 días	vie 25-12-15
18	Terminaciones	30 días	mié 22-06-16
19	**Frente 3: Telescopio Calibración**	**150 días**	**mar 23-02-16**
20	Obra Civil	60 días	mar 23-02-16
21	Estructuras Metálicas	30 días	lun 23-05-16
22	Terminaciones	30 días	mié 22-06-16
23	**OTROS**	**480 días**	**mié 29-04-15**
24	Total Instalaciones	480 días	mié 29-04-15
25	Entregas	30 días	vie 22-07-16



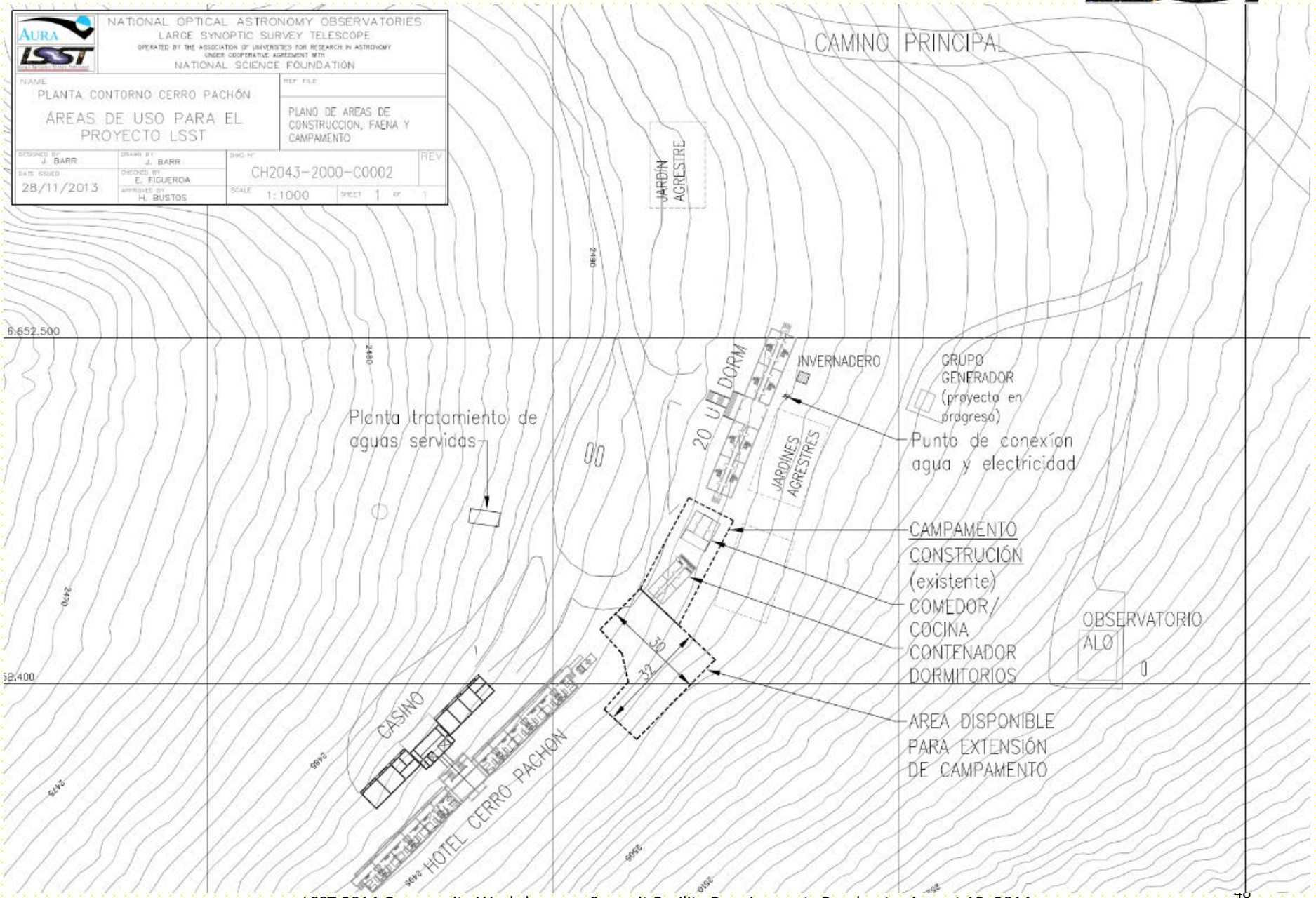
- 24-month construction project proposed
- $25.6M proposal
  14% over-budget
- Design Refinement phase prior to construction to focus on cost reduction



	MES 1	MES 2	MES 3	MES 4	MES 5	MES 6	MES 7	MES 8	MES 9	MES 10	MES 11	MES 12	MES 13	MES 14	MES 15	MES 16	MES 17	MES 18	MES 19	MES 20	MES 21	MES 22	MES 23	MES 24
Sub total mano de Obra Directa	8	18	28	44	74	92	39	42	119	112	84	131	120	113	151	123	133	165	142	143	173	158	114	93
Sub total mano de Obra Indirecta	20	20	27	27	27	27	33	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34

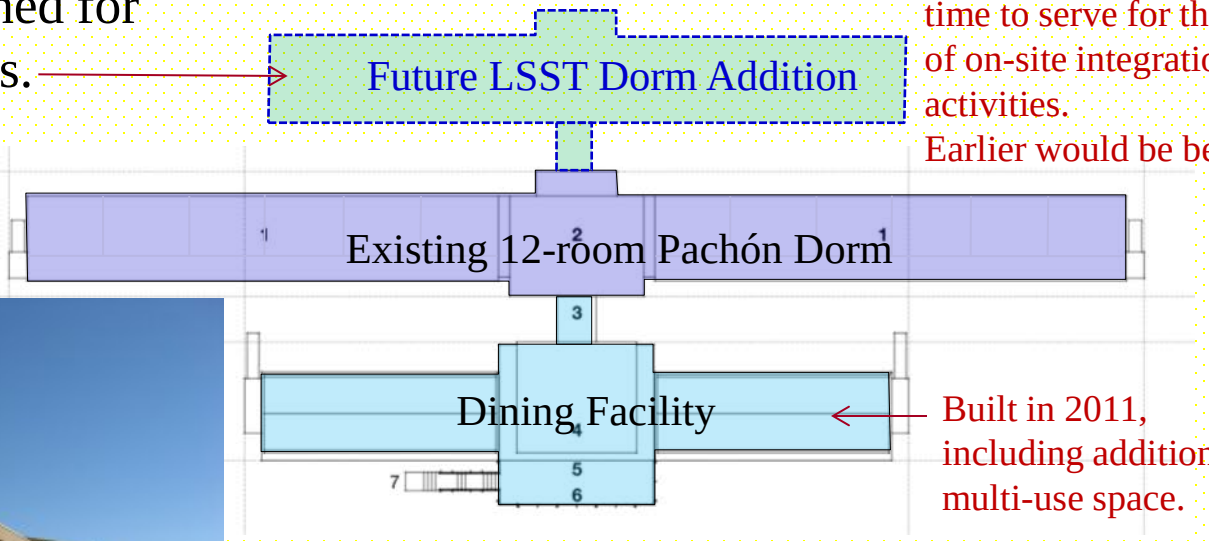
Areas Identified for Use During Construction and Beyond

Pachón Hotel/Casino Area During Construction



Addition to Pachón Dormitory

- Existing Dorm/Dining Facility at Cerro Pachón will be expanded to accommodate LSST in addition to existing Gemini and SOAR use.
- Facility is master-planned for future dormitory rooms.
- Dining facility will also serve LSST



Scheduled to be constructed in 2017 in time to serve for the bulk of on-site integration activities.
Earlier would be better!

Built in 2011, including additional multi-use space.

Neighbor Issues and Related Requirements

Utilities

- **Electrical service** – during construction and permanent operational demand
- **Fiber Link** – installation/connection details, usage protocols
- **Water Use** – tie in to existing tank, augmentation to storage or supply schedule

Construction logistics

- **Use of Roads** by large trucks and other construction vehicles
- **Dust and Debris** control
- **Explosive Excavation** – extent, type, control measures and monitoring
- **Daily work schedule** – any anticipated provision for afterhours work

Coordinated use of mutual services

- **Safety** – oversight and emergency response
- **Pachón Casino** – increased use and coordination, meal shifts.
- **Lodging** – increased use, dormitory expansion design and construction
- **Existing Casino** – conversion to new use
- **Old 20-unit dorm** – dedicated to LSST during construction?
- **Workshop & equipment** – sharing construction and long term
- **Vehicle fueling** – Mostly by contractor during construction. LSST to provide Pachón facility?

Formalized Means of Cooperation

- Protocol for dealing with potential conflicts and special requests
- Establish appropriate points-of-contact (Site Managers) and oversight hierarchy
- Formal committee with regular interactions – at least weekly during construction
- Some issues Pachón-centric; others impact Tololo and should include their input

Anticipated Critical Occupancies of Summit Facility

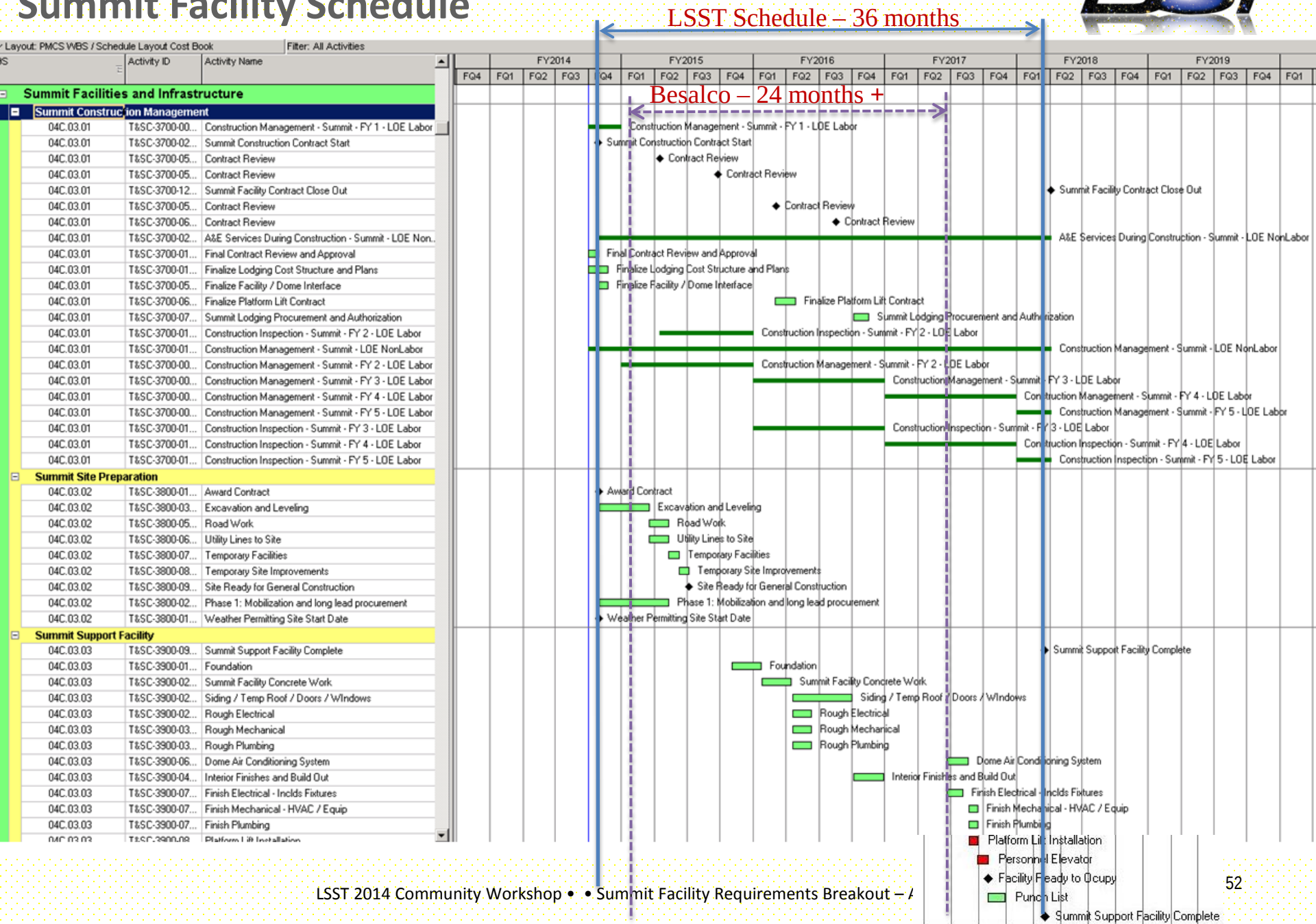
- August 2016: Dome arrival on site – Lower Enclosure needs to be ready early*
- December 2016: Substantial Completion of facility and site construction project (Beneficial Occupancy Date)
- February 2017: Platform Lift on site
- April** 2017: Telescope mount on site – Dome may not yet be complete*
- July** 2017: M2 mirror on site
- October 2017: Coating facility on site – Late for M2; just in time for M1/M3*
- January 2018: M1/M3 on site
- June** 2020: Camera on site

**Critical arrivals during in winter months or immediately before

*Pacing of Summit Facility wor k is compressed; similar to a fast-track project.

- Even with the advance excavation work complete and being shovel-ready at NSF approval, the Summit Facility construction will be pressed to work fast.
- Schedule subject to some optimization.

Summit Facility Schedule




LSST 2014
CONSTRUCTION START