VISTA

Visible & Infrared Survey Telescope for Astronomy

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Change Record

Issue	Date	Section(s) Affected	Description of Change/Change Request Reference/Remarks
1	14/08/02	All	First issue for ESO Compliance Review
2	06/09/02	All	Second issue for Invitation to Tender
3	25/03/03	All	Third issue for Contract – includes clarification from pre and post tender periods
4	28/04/03	Several	Fourth issue to incorporate minor changes as agreed and initialled on Contract Version 3.0

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1 SCOPE OF DOCUMENT

1.1 General

This document defines the basic requirements and provides the technical specifications for the design, manufacture, pre-assembly, packing, transport, erection on-site and testing and commissioning of the VISTA (Visible and Infrared Survey Telescope for Astronomy) telescope enclosure building and auxiliary building.

VISTA is a 4m diameter class survey telescope which is being designed to perform pre-planned, ground-based astronomy surveys of the Southern sky. The telescope will be installed on the location of ESO's Cerro Paranal Observatory, in the desert of Atacama, in the North of Chile.

Specifications have been derived from the VISTA conceptual design. As the detailed design progresses, some requirements may need modification.

1.2 Enclosure Concept

An Enclosure conceptual design was developed during Phase ''A' of the VISTA project. The principal objective of this work was to provide the basis for cost estimates and project planning to facilitate a judgement on the feasibility of meeting the scientific objectives within the financial and time constraints. The conceptual design work has also been used for the preliminary definition of space envelopes and interfaces between the various work packages.

Subject to meeting the requirements of this Specification, the Contractor can develop their own solutions to suit their experience and capabilities.

Note: Conceptual design descriptions and drawings are included for information only. It should be noted that it is a proof of concept design. Use of the conceptual design will not remove the responsibility of the Contractor to meet the requirements. Description of the concept is identified by italic text. The volume given in the Enclosure conceptual design is deemed to be valid as the baseline for this specification. Should the volume be violated by the telescope upper structure design then an amendment will be required.

1.3 Definitions

Enclosure Buildings Work Package (EBWP)	The complete deliverable object of this Technical Specification and SOW for the Enclosure Building and Auxiliary Building. It includes any design, design development, manufacture, assembly, test, packaging, transport, erection, commissioning, test and all supporting documentation.

Enclosure	The Enclosure Building.
Enclosure base	The concrete structure that is the support base for the rotating part of the Enclosure.
Dome	Enclosure rotating part.
Auxiliary Building	The adjoining building to the Enclosure that houses plant and support services for both the Telescope and the Enclosure.
Site Preparation	The work to construct the Telescope Platform, Access Road and Services Trench (not part of this Contract).
Telescope Platform	The total platform area consisting of a base rock area called the Main Platform and a compacted and levelled area called the Auxiliary Platform. (not part of this contract)
Telescope Structure	The structure comprising the Ground Interface, Azimuth Drive, Fork, Altitude Drive, Telescope Tube and Cable Wraps (not part of this Contract).
Enclosure Control System (ECS)	The system that controls the Enclosure hardware, itself controlled by the Telescope Control System. The ECS includes the ECS LCU and the ECS PLCs. Only part of the ECS is within this contract.
ECS Local Control Unit (LCU)	A VME/VxWorks based computer system and its software. The ECS LCU is not part of this contract.
ECS Programmable Logic Controllers (PLC)	A local controller that controls the Enclosure hardware. As well as industrial PLCs (or instead of), the ECS PLCs may include CANbus devices.
Telescope Control System (TCS)	The system that controls the ECS and other systems associated with the

	telescope. The TCS is not part of this contract.
Contractor	Refers to the Company entrusted with the design and build of the EBWP.

2 ACRONYMS AND ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
Altitude Angle	Angle above Horizon
ATU	Air Treatment Unit
CANbus	Controller Area Network Bus
CIDL	Configuration Item Data List
EBWP	Enclosure Buildings Work Package
ECS	Enclosure Control System
ESD	Electro-Static Discharge
ESO	European Southern Observatory
HVAC	Heating Ventilation and Air Conditioning
ICD	Interface Control Document
LCU	Local Control Unit
LEMP	Lightning and Electro Magnetic Pulse
LRU	Line Replaceable Unit
M1	Primary Mirror
M2	Secondary Mirror
MLE	Maximum Likely Earthquake
MTBF	Mean Time Between Failures
NTT	ESO's New Technology Telescope
OBE	Operating basis Earthquake
PI	Proportional and Integral (Control)
rms	Root Mean Square
SCP	Service Connection Point
SOW	Statement of Work
TCS	Telescope Control System
UPS	Uninterruptible Power Supply
VISTA	Visible and Infrared Survey Telescope for Astronomy
VLT	ESO's Very Large Telescope
VPO	VISTA Project Office

NOTE Where numerical values of deviations are given, unless they are qualified (e.g. by rms), they are to be taken as maximum absolute values.

TBR: "To Be Reviewed" means that a specified value would be needed for an optimum operation of VISTA. However, this might over-constrain the design. TBR's shall be investigated by the Contractor during the preliminary design phase of the Contract with the aim of providing the VPO with alternatives on which the VPO shall make the final decision.

TBC: "To Be Confirmed" by the VPO during Contract negotiations or at an agreed date during Contract duration.

TBD: "To Be Defined" and agreed between the VPO and the Contractor in charge of the Enclosure work package at the time of Contract signature or at an agreed date during Contract duration.

3 APPLICABLE AND REFERENCED DOCUMENTS

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of the specification shall be considered a superseding requirement.

GENERAL:

AD01	VLT-SPE-ESO-10000-0016	Basic telescope definitions (Issue 2)
AD02	VLT-SPE-ESO-10000-0004	VLT Environmental Specification (Issue 6, 12.11.97)
AD03	VLT-SPE-ESO-12000-0262	Construction requirements of the VLT Observatory infrastructures/buildings/Enclosures related to electromagnetic compatibility (Issue 1 dated 01.07.92)
AD04	VLT-SPE-ESO-10000-0015	VLT Electronic Design Specification (Issue 5)
AD05	VLT-SPE-ESO-10000-2772	VLT CAN open Specifications, issue 1, 18 March 2002.
AD06	VLT-SPE-ESO-10000-0002	Electromagnetic Compatibility and Power Quality Specification, Part 1, (Issue 2.0)
AD07	VLT-SPE-ESO-10000-0003	Electromagnetic Compatibility and Power Quality Specification, Part 2, (Issue 1.0)
AD08	VLT-SPE-ESO-10000-0013	Service Connection Point (SCP) Technical Specifications (Issue 4.1)

AD09	VLT-VER-ESO-10000-0958	Acceptance Procedure Electrical Safety and EMC, (Issue 2.0)

INTERFACE CONTROL DOCUMENTS:

AD10	VLT-ICD-ESO-11310-11320	ICD between main structure and Local Control System, (Issue 4.0)
AD11	ESO Munich, January 1997	Conditions, Rules and Regulations in complement to the "General Conditions of ESO Contracts"
AD12	VIS-ICD-ATC-09000-96010	ICD for VISTA to the ESO Paranal Infrastructure, (Issue 2)
AD13	VIS-ICD-ATC-01000-10000	Interface Control Document between the Telescope Structure the Enclosure, (Issue 1)
AD14	VIS-ICD-ATC-10000-11000	Interface Control Document between the Enclosure and Facility Handling Equipment, (Issue 2)
AD15	VIS-ICD-ATC-05010-11030	Interface Control Document between M2 Assembly Handling Tool and Facility Handling Equipment, (Issue 1)
AD16	VIS-ICD-ATC-12000-10000	Interface Control Document between Coating Plant and EBWP (Issue 1)

SAFETY AND STANDARDS:

AD17	VLT-TRE-ESO-00000-0467	VLT Requirements for safety analyses (Issue 1 of 27 Jul 1993
AD18	DIN VDE 1000 (1979-03)	"General Principles for the Safety Design of Technical Products"
AD19	VIS-PLA-ATC-00001-0019	Project Safety Management Plan, (Issue 2)
AD20	SAF-POL-ESO-00000-0001	Manual of ESO's Policies, Rules and Regulations concerning Safety, Health and Environmental Protection (issue 2)
AD21	BS 8110	Structural use of concrete
AD22	BS6031	Earthworks
AD23	BS8004	Foundations

AD24 EN 196	Testing Cement
AD25 BS 5950	Structural use of steelwork in building
AD26 EN 60 204	Electrical equipment of industrial machines
AD27 EN 61010	Safety requirements for electrical equipment for measurement, control and laboratory use
AD28 IEC 60950-1 (2001-10)	"Information technology equipment – Safety - Part 1: General requirements" (Edition 1.0)
AD29 IEC 60364 (2001-08)	"Electrical installations of buildings - Part 1: Fundamental principles, assessment of general characteristics, definitions" (Edition 4.0)
AD30 IEC 61140 (2001-10)	"Protection against electric shock – Common aspects for installation and equipment" (Edition 3.0)
AD31 EN 60364-5-54	Part 5: Selection and erection of electrical equipment Section X 54: Earthing arrangements and proptective conductors
AD32 VG 95374-4 (1992-11)	"Electromagnetic compatibility (EMC) including Electromagnetic Pulse(EMP) and lightning protection; programme and procedures; procedures for systems and equipment"
AD33 IEC 60664-1 (2000-04)	"Insulation co-ordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests" (Consolidated Edition 1.1 (incl. amendments)
AD34 IEC 60204-1 (2000-05)	"Safety of machinery - Electrical equipment of machines - Part 1: General requirements" (Consolidated Edition 4.1 (incl. amendments)
AD35 ISO 4413:1998	"Hydraulic fluid power - General rules relating to systems" (Edition 2)
AD36 EUR 12266 EN 1988	Eurocode No.8 Structures in seismic regions-Design- Part 1 1-1, 1-2, 1-3, 1-5.

AD37	EUROCODE 1	"Eurocode 1 Basis of Designs and Actions on Structures – Part 2-4: Actions on structures – Wind Actions"
AD38	EN 12077-2:1998 Cranes safety	Requirements for health and safety - Part 2: Limiting and indicating devices (1998-11-18)

APPLICABLE DRAWINGS:

AD39	VIS-DWG-ATC-01000-10000	Telescope Interface to Enclosure (Issue A)
AD40	VIS-DWG-ATC-01000-02040	Telescope Interface to M1 Handling Equipment (Issue A)
AD41	VIS-DWG-ATC-05010-11030	M2 Assembly Handling tool to Facility Handling Equipment (Issue A)
AD42	VIS-DWG-ATC-01000-06130	Telescope Interface to Instrument Handling Equipment (Issue A)
AD43	VIS-DWG-ATC-01000-05030	Telescope Interface to M2 Unit Handling Equipment (Issue A)
AD44	VIS-DWG-ATC-10010-0030	Telescope Aperture Requirements on Enclosure (Issue A) **(2 sheets)**
AD45	VIS-DWG-ATC-10010-0032	Enclosure Forbidden Zone for Mirror Washing and Handling (Issue A)

REFERENCE DOCUMENTS AND DRAWINGS:

RD01	VIS-DWG-ATC-09030-0014	Main Rotation General assembly (Issue B)
RD02	VIS-DWG-ATC-10010-0008	Enclosure Floor Area Azimuth Platform Area (Issue D)
RD03	VIS-DWG-ATC-10010-0012	Enclosure and Auxiliary Building Plan and View (Issue C)
RD04	VIS-DWG-ATC-09030-0013	Concrete Pier Assembly Sequence of Telescope Embedded Beam (Issue B)
RD05	VIS-DWG–ATC-09030-0012	Assembly Sequence of Enclosure Embedded Beam (Issue B)
RD06	VIS-DWG-ATC-09030-0009	Enclosure Floor Area – Intermediate level (Issue D)
RD07	VIS-DWG-ATC-09030-0008	Enclosure Floor Area – Ground Level (Issue D)
RD08	VIS-DWG-ATC-10010-0031	Inflatable Seal General Assembly (Issue B)
RD09	VIS-DWG-ATC-09030-0010	Concrete Pier General Assembly (Issue D)
RD10	VIS-DWG-ATC-09030-0011	Concrete Pier Mat Foundation Detail (Issue B)
RD11	VIS-DWG-ATC-10010-0003	Enclosure and Auxiliary Building / Ground Floor (Issue E)

RD12	VIS-DWG-ATC-10010-0019	Enclosure Mechanisms Main Rotation (Issue D)
RD13	VIS-DWG-ATC-10010-0010	Observing Slit Door General Assembly (Issue C)
RD14	VIS-DWG-ATC-10010-0020	Enclosure Mechanisms Ventilation Door General Assembly (Issue B)
RD15	VIS-DWG-ATC-10010-0021	Windscreen General Assembly (Issue B)
RD16	VIS-DWG-ATC-10030-0001	Enclosure Crane (Issue C)
RD17	'Derk' – Preliminary Geological	Geotechnical Report at the NTT peak site Vista Telescopes, January 2001
RD18	VIS-DWG-ATC-10010-0026	Electric Power Distribution diagramm (issue C)
RD19	VIS-DWG-ATC-10010-0027	Electric Power Distribution medium voltage (issue B)
RD20	VIS-DWG-ATC-10010-0028	Electric Power Distribution grounding/bounding gen-lay (issue B)
RD21	VIS-DWG-ATC-10010-0029	Electric slip-ring/general assembly (issue B)
RD22	ESO – Franz Koch	Analysis Concepts for Large Telescope Structures under Earthquake Load (SPIE Vol. 2871 / 117)

4 THE VISTA GENERAL CONCEPT

VISTA is a 4m diameter telescope dedicated to carrying out imaging surveys of the southern sky. It will be capable of operating in either the visible or infrared by means of two dedicated, Cassegrain mounted, exchangeable cameras. The available field of view will be approximately two degrees diameter in the Visible and 1.6 degrees diameter in the infrared. It will be used to undertake pre-planned key observation programmes. This will be carried out at various wave-bands at fainter magnitudes than those which can be resolved by the current generation of survey telescopes.

The telescope is mounted on a concrete foundation called the telescope pier and has an 'alt-azimuth' mount and a Cassegrain Rotator as shown in Figure 1.

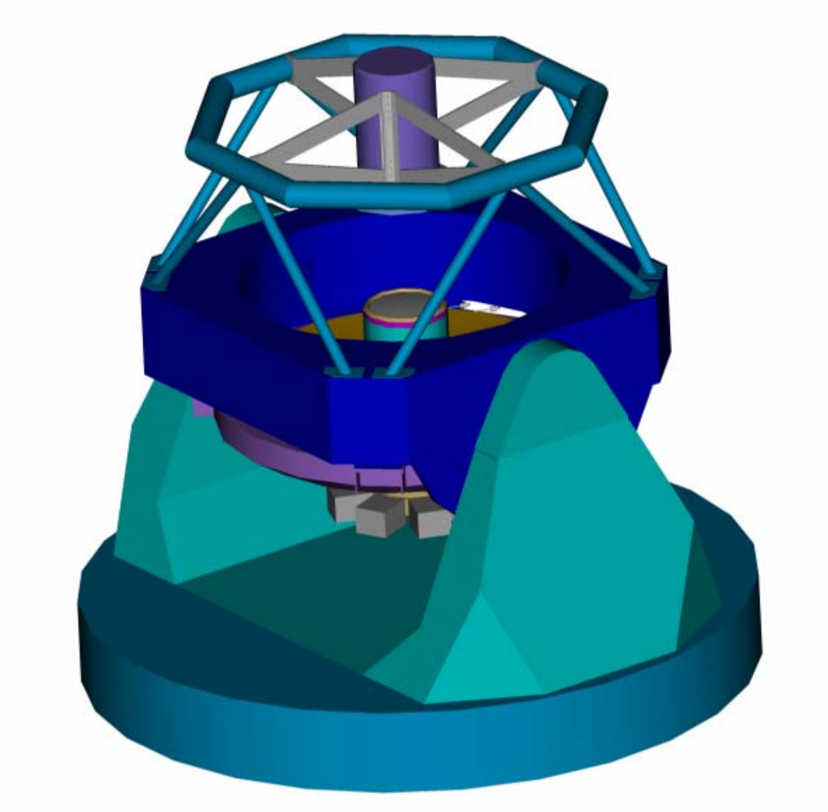


Figure 1: General View of VISTA Telescope (for information only)

VISTA will be located at ESO's Cerro Paranal Observatory on a peak approximately 1.5Km North East of the existing VLT site currently designated the "NTT peak". The elevation is approximately 2520m above sea level.

The Enclosure Building will provide environmental protection and control to the telescope during operation and standby conditions as well as providing the infrastructure required for the operation of the telescope. The Auxiliary Building will house plant, maintenance and storage facilities. A conceptual outline of the VISTA Enclosure Buildings Work Package (EBWP) is shown in Figure 2.

The Auxiliary Building will also include the necessary housing for the installation of the coating facility for the primary and secondary mirrors.

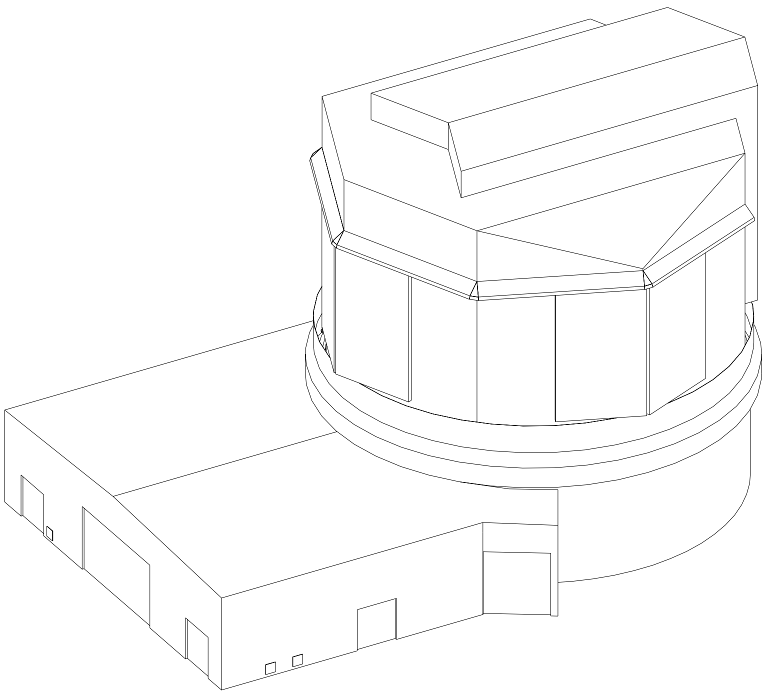


Figure 2: The VISTA Enclosure Buildings Work Package Outline (for information only)

5 VISTA ENCLOSURE AND AUXILIARY BUILDINGS REQUIREMENTS

5.1 Functional Requirements

The VISTA Enclosure Building's (Figure 3) main functions shall be:

- In the closed position, to protect the telescope and its instrumentation against adverse weather conditions, wind, dust, lightning and lightning electromagnetic pulse and to preserve a controlled thermal environment.

- In the open position, to allow the telescope a free field of view by means of a large slit in a rotating Dome. At the same time the Enclosure shall provide controllable ventilation for protection in high winds and good ventilation in low winds.

In addition to these main functions, the Enclosure shall provide (but shall not be limited to):

- A rotating floor at the level of the telescope azimuth platform (fork base) for allowing access to all telescope levels where instruments are to be installed and operated.
- A large floor hatch (or equivalent) for the removal of the primary mirror and telescope instruments to the ground floor area. This area shall be covered during normal observations.
- A central fixed floor at the same azimuth platform level for installing services and allowing maintenance of the Enclosure, the telescope and auxiliary equipment.
- General handling facilities for the lifting of all telescope and Enclosure sub systems and components.
- A mobile access platform that shall enable maximum reach to all internal areas of the Enclosure Dome. (In Figure 3 a fixed maintenance platform/scissor lift is shown for information only).
- Personnel access routes and emergency egress to and from platforms and floors and sub systems.

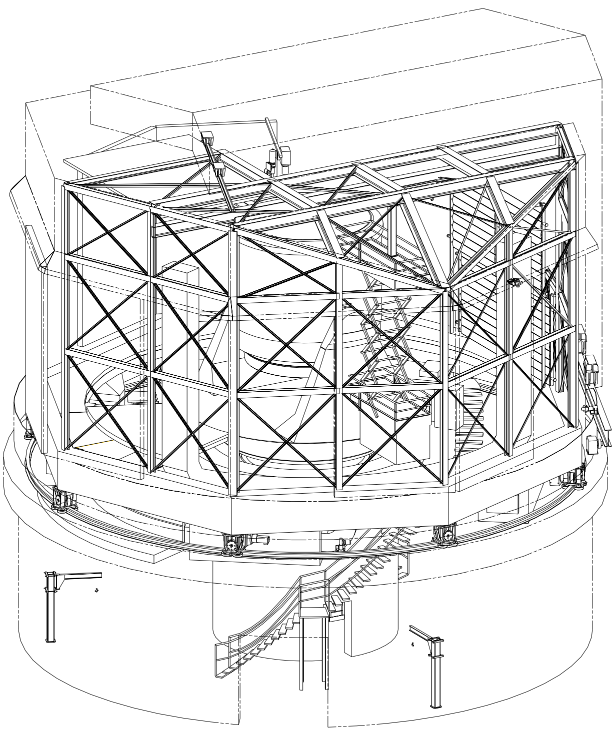


Figure 3: Enclosure Building - Transparent View (for information only)

The Enclosure ground floor (Figure 5) shall locate the following auxiliary equipment (but not be limited to):

- An area for mirror washing and stripping.
- A room for computer facilities.
- An office (combined with computer facilities room).
- Sanitary facilities.
- An instrument preparation room.
- An instruments clean room, class 10000.
- A room for the instrument Helium supply system (closed cycle cooler compressors).
- Access via roller door or similar to the Auxiliary Building for the transfer of the mirrors from the washing area to the coating plant room.
- A room for storage.
- Emergency shower.

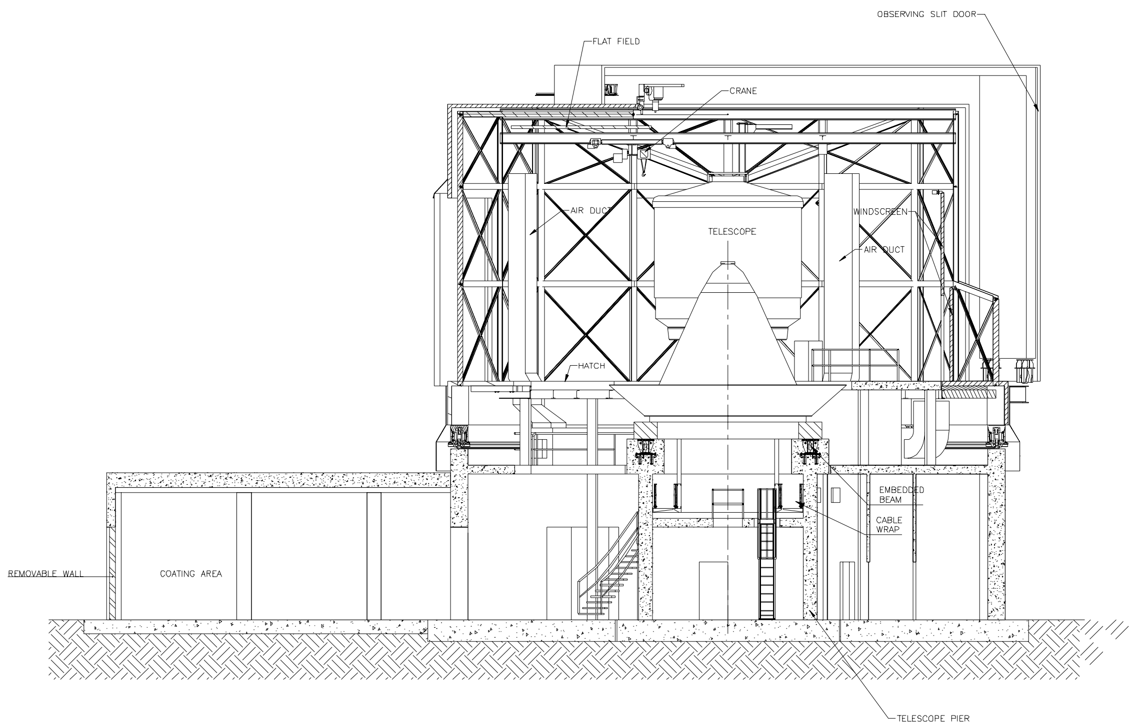


Figure 4: Schematic cross-section (longitudinal) of the Enclosure and Auxiliary Buildings (for information only)

The Auxiliary Building (Figure 5) shall be composed of (but not be limited to):

- A room for mirror coating.
- A room for storage
- A series of technical rooms for the main plant and electrical installations.

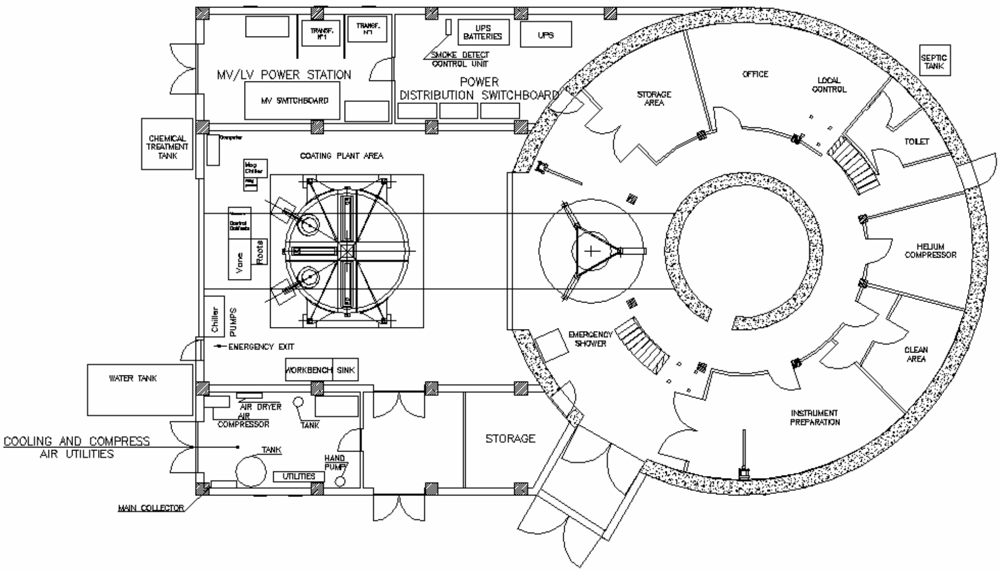


Figure 5: Schematic plan view (ground floor level) of the Enclosure and Auxiliary Buildings (for information only)

5.2 Interfaces

5.2.1 ESO Paranal Infrastructure

The EBWP will be supplied from the main VLT Observatory power generation system as defined in AD12. Power cables will already have been pulled to the Telescope Platform by the Site Contractor (not part of this Contract).

It shall be noted that an interface exists with ESO personnel in specific relation to ESO’s rights of access and inspection given their status as owner of the VISTA site and as future owner and operator of the VISTA telescope. ESO shall have full and unrestricted access to all areas of VISTA work on the Paranal site AD11.

5.2.2 Installations Interface

All major work packages will need to have installation access to the Enclosure or Auxiliary Building. The Dome observing slit (AD44) and Auxiliary Building removable end wall (AD16) shall be the principal access for all other work package installations.

- Temporary removal of the Auxiliary Building end wall shall facilitate the installation of the coating plant and then later the installation of the M1 mirror in the coating vessel (for safe storage purpose).

The Contractor shall be fully self sufficient during installation activities. This includes (but is not limited to) provision for worksite office, storage, toilets and all logistics support for temporary power, fuel and water.

5.2.3 Telescope

The interface between the Telescope Structure and the Enclosure is defined in AD13 and shown in AD44.

5.2.4 Coating Plant

The interface between the Coating Plant and the EBWP is defined in AD16.

5.2.5 Handling

The interface between Enclosure and Facility Handling is defined in AD14.

The Enclosure crane specified in (section 11.1.3) will be the main lifting facility:

- Enclosure crane shall be used for all the major operational lifting operations.
- Other facility lifting equipment shall also be provided for. As a minimum a wall mounted jib crane in the ground floor area and a wall mounted jib crane in the instrument preparation room are required (2m turning radius – TBR);
- A required option shall be for an overhead crane in the Auxiliary Building.

5.2.6 Contractor's Installation and Working

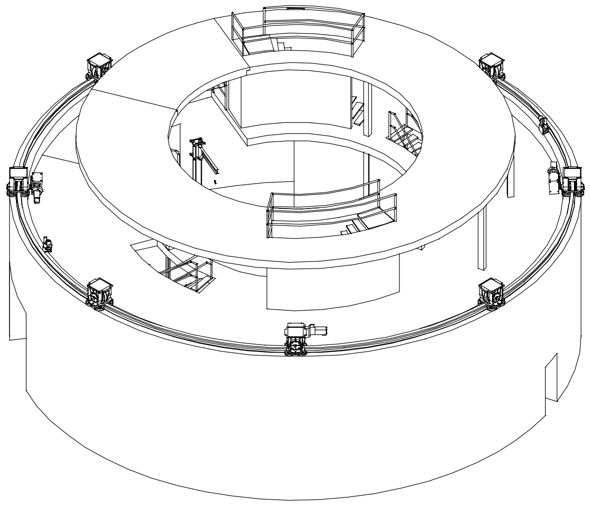
The interface between all Contractor's work site installations and the EBWP is defined in AD11 and AD12.

5.3 Architectural Requirements

The Enclosure shall be designed as a building constructed as a concrete and steel structure where both roof and steel facades are covered with weather-tight and thermally insulating panels.

The Enclosure shall consist of (but not be limited to):

- The Enclosure base is a fixed cylindrical part from +0.00 mm to level +5610 mm (nominal) corresponding to the circular rail level in concrete (RD01). The Enclosure base internal diameter is 18000 mm (nominal) with a wall thickness of 600 mm (nominal).
- The Enclosure base surrounds the lower part of the telescope and shall have two floors, one at the level called the intermediate floor at level +5040 mm (nominal) and one at the level +7900mm called the fixed azimuth floor (RD02).
- This fixed part of the Enclosure includes the staircases between ground floor and intermediate floor and between intermediate floor and fixed azimuth floor (RD01).
- The Telescope pier is a fixed cylindrical part from +0.00 mm to level +5940 mm (nominal) (AD44). The Telescope pier internal diameter is 5200 mm (nominal) with a wall thickness of 500 mm (nominal).



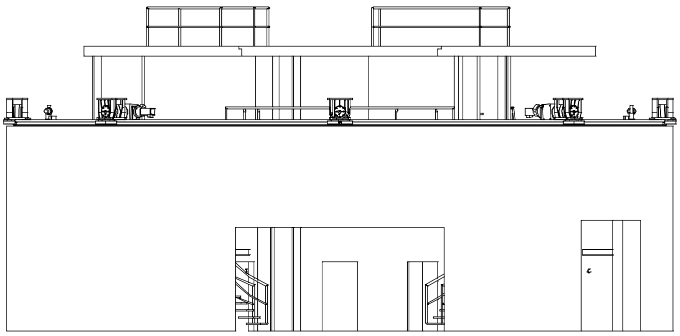


Figure 6: Schematic views of the Enclosure and Auxiliary Buildings (for information only)

Definition: The azimuth floor level consists of three floor parts: the telescope rotating part called the telescope azimuth platform; the Enclosure fixed part called the fixed azimuth floor; and the Enclosure rotating part called the Dome rotating azimuth floor.

- An upper rotating part called the Dome shall have a 5400mm wide observing slit. The observing slit shall be closed by a door(s) or shutter (AD44).
- The Dome shall have the same rotation axis as the telescope azimuth axis and shall be able to rotate independently of the telescope, without any physical interference at any position of the telescope.
- The Dome shall have a floor at the same level as the fixed azimuth floor and the telescope azimuth platform at +7900mm (AD39).
- The observing slit shall be equipped with a moveable windscreen of variable aperture (10.2).

- The Dome shall have ventilation apertures above the azimuth floor level.
- The Dome shall include a roof bridge crane for a variety of handling tasks.
- Ladders and access platforms shall be required for the maintenance of all mechanisms.

6 LOADS

6.1 Load Combinations and Allowable Stresses

The load combinations and allowable stresses shall be as defined in Section 17.

6.2 Environmental Conditions

The environmental specification AD02 is applicable for the EBWP.

6.2.1 General

The equipment shall comply with the requirements defined in the VLT Environmental Specification AD02, unless specifically amended by the requirements defined herein. AD02 describes the overall environmental conditions to be expected in operation, maintenance and storage at the Chilean site and transportation from outside South America.

6.2.2 Wind

In particular the survival wind of v = 50.7 m/s shall be used for the buildings and external facilities. This corresponds to the 100 year return period maximum velocity.

6.2.3 Natural Temperature

6.2.3.1 Definitions

Operational temperature range is defined as the ambient air temperature under which all performance requirements shall be met.

Functional temperature range is defined as the ambient air temperature under which it shall be possible to operate the system although with degradation of performance

6.2.3.2 Requirements

a) Operational temperature range 0 to 15 °C

b) Functional temperature range -10 to 30 °C

6.2.4 Humidity

All design must take into account the effects of low humidity on site particularly with respect to provision for anti-static protection.

6.2.5 Sand and Dust

The design of both mechanical and electrical components shall take into account sand and dust particulate matter, which may be encountered either during transportation or installation/operation of the EBWP. Typical data concerning the particulate matter is contained in AD02.

6.2.6 Elevation above Sea Level

The design of both electrical and mechanical components shall take into consideration all effects of operating at 2500m above sea level.

All systems using radiative cooling or forced air heat exchange shall be appropriately de-rated for altitude as defined in AD04.

6.2.7 Exposure to Ultra-Violet Radiation

AD02 defines the UV exposure on Paranal. All systems exposed to UV must be appropriately designed for such exposure as defined in AD04.

6.2.8 Earthquakes

6.2.8.1 Definitions

Two design earthquakes are defined by the requirement of AD02: the Operating Basis Earthquake (OBE) and the Maximum Likely Earthquake (MLE).

An OBE is an earthquake of moderate size but with a high probability of occurrence during the lifetime of the telescope, while a MLE is an earthquake of large magnitude but with a lower probability of occurrence.

6.2.8.2 Requirements

The design shall be verified by analysis using the excitation characteristics defined in Section 17.1.3 and must meet the stress requirements of Section 17.1.4 under the load combinations defined in Section 17.1.5.

6.3 Operational Requirements

All mechanisms shall be fully operational under all specified environmental conditions (AD02) with the following clarifications:

All mechanisms shall be fully operational with:

- Mean wind speed up to 18 m/s.
- Gusts up to 36 m/s.
- Observing slit and ventilation aperture(s) must be capable of normal closing in dust storm, rain and snow conditions.

Mechanisms shall not have to be operational (unless specifically mentioned above) under:

- Snow
- Ice
- Freezing rain
- Freezing fog
- Dust storms
- OBE earthquake (AD02) conditions (specifically no physical damage shall be allowed and all systems shall be capable of being automatically reset and reactivated).
- MLE earthquake (AD02) conditions (specifically some physical damage may be allowed (TBR) i.e. preferentially to components that can be more easily overhauled or exchanged, such as wheels but not rails).

6.3.1 Vibration and Noise

The effects of Enclosure vibration and noise on the telescope performance shall be kept to a minimum through good engineering practice and operational considerations such as isolation of vibration sources from the telescope. The components of the EBWP shall be designed such that there is no vibration or noise source connected to the telescope without adequate damping, for example anti vibration plant mountings and flexible pipework.

6.4 Loads Summary

In general the following loads shall be the absolute minimum to apply to the Enclosure and its components:

- Environmental loads up to survival conditions.
- Dead loads of all structural and non-structural elements
- Thermal loads.
- Operational loads (including crane operations).
-

Requirements for analyses are given in Section 17. Combinations of loads as per Section 17.1.5.

6.5 Duty Cycle

In general the following values of Dome duty cycles should be used:

Movement (deg)	**Frequency (occur/night)**	**Velocity (deg/sec)**
180	3	2
90	3	2
30	10	2
10	10	2
3	20	n/a
1	100	n/a
continuous	continuous	400 arcsec/sec

7 CO-ORDINATE SYSTEMS, REFERENCE LEVELS, VOLUMES AND DIMENSIONS

7.1 Co-ordinate Systems and Reference Levels

Reference is made to the definitions given in AD01. In particular the Contractor shall use where applicable the Telescope Geographical Co-ordinates when dealing with the arrangement of the VISTA Enclosure. In both co-ordinate systems the Z=0.0 reference level is the nominal ground level.

The other levels relevant to the Enclosure functions shall be:
- The ground floor level: 0.0mm (reference level) for access to the service rooms.
- The telescope azimuth platform level: +7900mm above the 0.0mm (reference level) for access to the telescope. This level shall be accessed from the fixed azimuth floor.
- The intermediate floor: +5040mm (nominal) for service and maintenance of the Enclosure auxiliary equipment.

7.2 Volume Inside the Enclosure

In any of its configurations (rotation angles, apertures open or closed) the Enclosure shall not physically interfere with the telescope in any of its orientations, with a clearance of at least 1 metre with respect to the internal structures (AD44), considering that:

- The telescope may rotate freely within the Enclosure between vertical and horizontal, although the field of view is not necessarily free in this entire range.
- The telescope can rotate about the azimuth axis (with the telescope tube at any angle within the above range) without restrictions inside the Enclosure.

7.3 Dimensions

The dimensions of the Enclosure in this Technical Specification where given as nominal are dimensions derived from the Enclosure concept. The Contractor shall use these nominal dimensions unless a variation is requested of and approved by the VPO.

The VPO underlines the requirement for a compact EBWP solution, it is thought however that justifiable arguments to increase certain areas and volumes may exist.

8 THE CONCRETE STRUCTURES

Roadmap: The following Section gives a step by step breakdown of the requirements for the Concrete Structures.
- The flow of the requirements breakdown (for each component) starts from high level and leads on to low level and identifies three main structural components namely Enclosure base, Telescope pier and Auxiliary Building structure.
- Following on from this is a phase breakdown of work: this starts from the design activity and leads on to works realisation.

8.1 Concrete Structures General

The concrete structures 'package' is characterised by the following main elements:

- Telescope pier
- Enclosure base
- Auxiliary Building structure

The concrete structures 'package' shall include the following (but are not limited to):

- Foundations
- Ground level rooms
- Intermediate floor(s)
- Walls, floors and roofs
- Staircases and walkways
- Ducts for services
- Concrete platform for the chiller
- Interior doors
- Hatch and handrails
- Accessories

8.1.1 Geotechnical Testing (Not a deliverable of this Contract)

The Geotechnical Testing report will provide all the necessary information for the EBWP Contractor to complete their Concrete Structures design and recommend the position for the Telescope pier axis (Figure 7). An early Geotechnical study report is available (RD17).

The geotechnical investigations will:

- Prove the presence of competent rock to a depth of at least 20m below the likely founding level for the telescope and enclosure piers.
- Confirm the nature and orientation of any structural discontinuities.
- Investigate the presence and location of any weathered and/or fractured zones within the foundation zone.

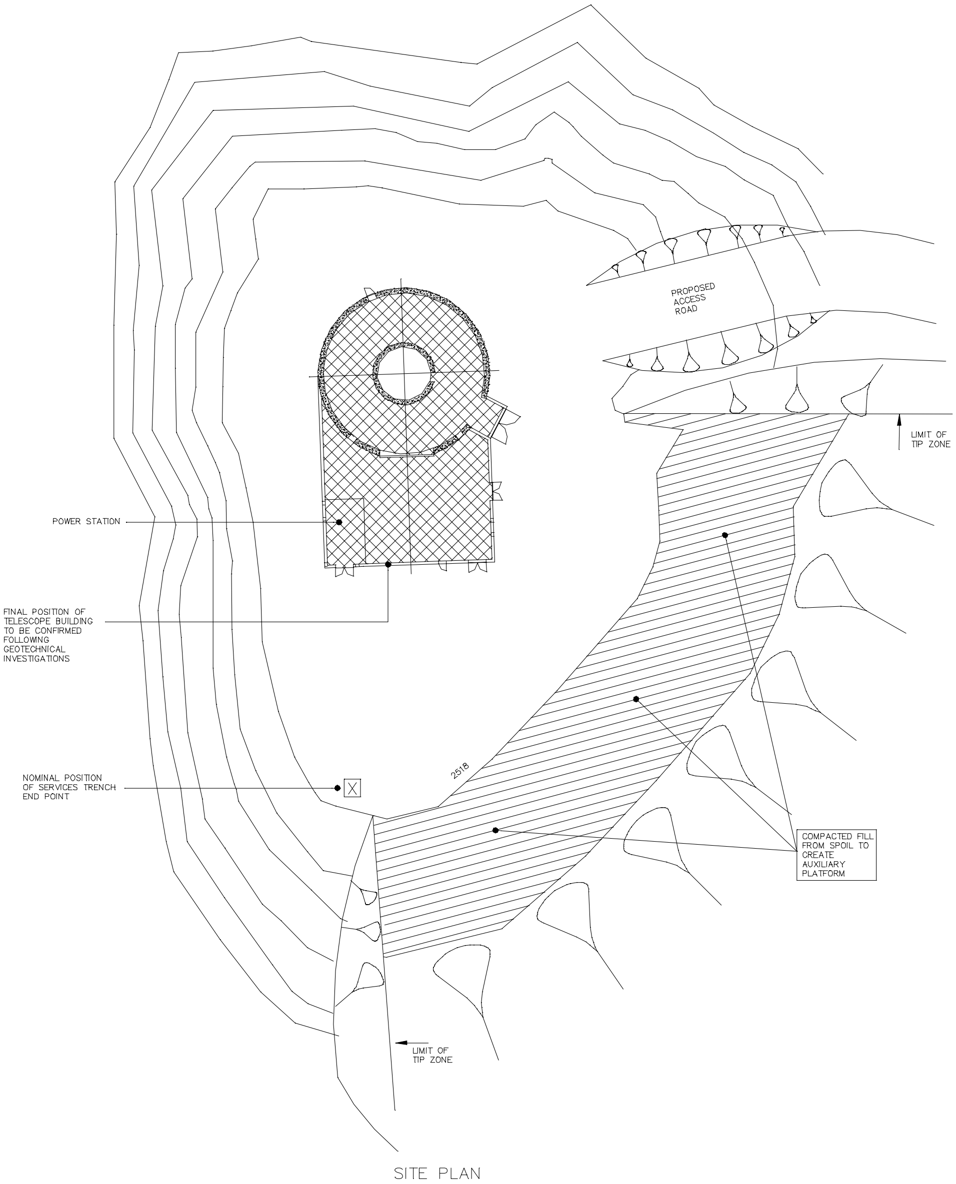


Figure 7: Sketch of VISTA Telescope Platform Outline

8.1.2 Enclosure Base

The Dome shall be supported on a structure consisting of a ring of reinforced concrete (Figure 5).

8.1.2.1 Enclosure Base Requirements

The following is a list of basic requirements. These requirements are further developed later in this Section 8.

- The circular external wall of the Enclosure base shall be concentric with the telescope pier.
- In the volume between pier and Enclosure base wall there are shall be service rooms to house part of the equipment required for telescope operation.
- A mirror and instrument handling area shall be accommodated directly below the hatch. No structure shall encroach on the forbidden zone shown in AD45
- Foundations and structure of the Telescope pier and the Enclosure shall remain isolated from each other to minimise the transmission of wind-induced vibrations, vibrations resulting from the Dome rotation and any other possible vibration source.
- The Enclosure base shall provide access doors for personnel and equipment to the Enclosure and the staircases shall be installed in this access area.
- The Enclosure base shall provide access to the Auxiliary Building Coating Plant room by means of a roller door or equivalent.
- On the upper part of the Enclosure base an embedded beam suitable to receive the circular rail (or equivalent) for the rotation mechanism of the Enclosure shall be installed. The requirement is to distribute the relevant loads to the Enclosure base itself.

8.1.2.2 Enclosure Base Concept Description

The Enclosure Base will be a cylindrical structure, formed in reinforced concrete (RD09). The rotational roof of the Enclosure will be supported on an annular rail which in turn will be located on the upper surface of the Enclosure base wall. The Enclosure foundation is to be isolated from the telescope pier to minimise transmission of vibration to the telescope

A reinforced concrete floor slab will be constructed between the outer face of the telescope pier and the inner face of the enclosure wall. This slab is to be isolated from the telescope pier to minimise transmission of vibration to the telescope.

8.1.3 Telescope Pier Requirements

The following is a list of basic requirements. These requirements are further developed later in this Section 8.

- The telescope shall be supported on a concrete structure consisting of a ring of reinforced concrete as shown in Figure 8 and described in Section 5.3
- In the volume within the pier there shall be access areas for some of the equipment required for telescope operation (AD13).
- The top face of the pier shall incorporate the telescope anchoring system. This is fit for receiving the interface structure for the telescope and for distributing the relevant loads on the pier itself.

8.1.3.1 Telescope Pier Concept Description

The telescope will be supported on a concrete pier. This structure will consist of a vertical reinforced concrete cylinder supported on a circular spread footing which will be engaged into the base rock by piles (RD10). The cylinder will be thickened at the upper end to form a ring beam. Cast into this ring beam will be steel studs (the telescope contractor will supply the studs and fixing template) that will support the rotational (azimuth) bearing of the telescope.

8.1.4 Auxiliary Building Structure Requirements

The following is a list of basic requirements. These requirements are further developed later in Section 8.

- The Auxiliary Building shall be realised with a skeleton made in concrete or steel and/or consisting of foundations, load-bearing columns and by a roof.
- Foundations of Auxiliary Building and Enclosure shall be isolated to minimise the transmission of wind-induced vibrations, vibrations resulting from the plant room and any other possible vibration source.
- In the base floor the embedded rails (with steel check plate covers) for the M1 carriage translation (in the lower coating plant vessel) shall be located (AD16). The Contractor shall design a rail track interface in accordance with AD16.
- The realisation of the concrete works shall include all the openings and the housings for the plant equipment.
- A part of the external end wall in the coating plant area shall be removable and realised as a steel frame and include thermally insulating panels (auto-extinguishing type) as per the Enclosure Building.
- Drainage lines linking the mirror wash and sink areas to the chemicals tank. The Contractor may propose other drains if thought necessary (TBD).
- An Option proposal to include an overhead crane in the Coating Plant area shall be made.

8.1.4.1 Auxiliary Building Concept Description

The Auxiliary Building is made with a skeleton completely made in concrete, consisting of foundations, load-bearing columns, and a roof. On the base floor the rails for the mirror carriage translation will be located (lower coating plant vessel). The realisation of the concrete works will include all the openings and the housings for the plant equipment. The curtain walls will be built in insulating blocks (RD09).

A part of the external end wall in the coating plant area will be removable and realised as a steel frame and include thermally insulating panels (auto-extinguishing type) as per the Enclosure Building.

8.1.5 Excavations, Foundations and Civil Works Design

This Section refers to the development of the detailed Civil Works Design.

8.1.5.1 Final Design of Foundations, Pier and Buildings' Civil Works

This task shall include the design (Standard AD21), design development and design review in order to gain VPO agreement of final design of the foundations, piers, and buildings' civil works.

8.1.5.2 Fundamental Requirements

- The Telescope mass above the concrete pier shall be taken 105 Tonnes (TBC).
- The centre of gravity of the Telescope shall be taken as being at a distance of +2700mm (TBC) above the top of the pier interface (+8640mm (nominal) from ground).
- The pier shall be designed in such a manner that it will not degrade the telescope first resonant frequency of 15 Hz (TBR) by more than 1.5 Hz (TBR).

8.1.5.3 Electrical Requirements

The design of foundations, piers and buildings civil works shall include (but not be limited to):

- Lightning protection system
- Protection system against lightning electromagnetic pulse (LEMP)
- Earth electrode system (AD12). Artificial earth electrodes embedded in the foundations and the reinforcement of concrete exploited as a 'natural' component of these systems shall be planned, designed, erected and tested. In particular, the concrete reinforcement shall be adopted as down-conductors, as a part of the earth-termination networks and shall form the shell of the potential equalisation network of the internal lightning protection system. It shall also be designed and erected to serve as an electromagnetic shield which shall provide protection against LEMP.

The requirements summarised above shall be complied with by fully adhering to the purposes and methods specified in detail by the relevant sections of the AD03 and AD06.

8.1.5.4 Enclosure Concept Description

The conceptual design of the telescope pier in RD09 and RD10 shows a simple mat design with piles.

8.1.6 Excavations, Foundations and Civil Works

The principal Standards are as per AD21 to AD25 or equivalent (ie. ACI).

8.1.6.1 Excavations

This Task shall include all excavations (Standard AD22) required on the Main Platform to accommodate (but not to be limited to) the following:

- Telescope pier foundation and pier structure.
- Enclosure base foundation and base structure.
- Auxiliary building foundations.
- Floor slabs.
- Platform services trench, chiller's trench and services tanks.

The sizes of all such excavations shall be as determined by the Contractor's final design as detailed in the SOW.

General parameters shall include (but not be limited to):
- The excavations shall be carried out by hydraulic bucket excavator where possible. If the material cannot be excavated by such means, the excavations shall be carried out by close-spaced drilling and hydraulic splitting. (or similar low energy means).
- The surfaces of all excavations shall be to a tolerance of (+50mm, -0mm) on all critical plan dimensions of foundation width, and (+0mm, -100mm) on all critical levels.
- The surfaces shall be left in a hard and competent condition, with no loose or fractured blocks present in the surface layer.

The VPO will indicate whether the spoil material is to increase the auxiliary platform area or to be otherwise disposed of.
- If spoil is to be used to increase the auxiliary platform area, the operations shall respect the existing form and finish of the auxiliary platform. If spoil is to be otherwise disposed of, it may be transported from the main platform to a location within the Observatory area to be indicated by the VPO.

8.1.6.2 Foundations

This Task shall include (but not be limited to) the construction in reinforced concrete of the following (Standard AD23):
- Telescope pier foundation.
- Enclosure base foundation.
- Auxiliary building foundations.
- Floor slabs for both the enclosure and the auxiliary building.
- Trenches and collection and suction tank spaces (as show in RD11 and RD09).

The concrete mix design shall take account of (but not be limited to) the following aspects:
- The environmental conditions.
- The intended aggregates, cement and water.
- The design loading.
- The specified durability.
- The specified shrinkage characteristics.

8.1.6.3 Civil Works

The Civil Works shall include the following elements (Standard AD24):
- Telescope pier.
- Enclosure base.
- Enclosure and Auxiliary Buildings structures.

The Civil Works also include (but not be limited to) the following:

- Ground level rooms.
- Intermediate floors.
- Walls, floors and roof.
- Chillers trench.
- Concrete platform for chiller.
- Collection and suction tanks.
- Underground plumbing.
- Cable ducting.
- Access stairways.
- Fitting such as Interior doors.
- Secondary fixtures and fittings.

Civil Works shall take the following into account (but not be limited to):

- The Civil Works shall ensure that no direct vibration paths exist between the Telescope pier, the Enclosure pier and the Auxiliary building.
- The ground floors shall be constructed such that spillage or water ingress will drain to a sump with subsequent ducting to an external run-off area (potential erosion problems shall be considered).
- An area in the ground floor, designated for primary mirror stripping, shall be provided with cast in drainage channels leading to an external chemicals storage tank.
- The earthing conductors ('accessible terminals', bonding connectors) necessary to bond structural steel members of buildings, down-conductors, metal door and window frames, other metallic parts, bonding bars, equipment and anything else specified by AD03 and AD06, to the concrete reinforcement/earth electrode.
- The concrete reinforcement shall be designed and erected to perform as a 'natural' component of VISTA lightning protection system, of VISTA protection system against lightning electromagnetic pulse (LEMP) and of VISTA earth electrode.
- Purposes and methods specified by the Technical Specifications by AD03 and AD06 - in particular the requirements set by the section '4.6 EARTHING CONDUCTORS ("ACCESSIBLE TERMINALS")' of AD06 - shall be fully adhered to by adapting them to the VISTA Site.
- From the upper part of the Enclosure base, earthing conductors ('accessible terminals', bonding connectors) shall protrude to allow the metallic part of VISTA enclosure to be bonded to the concrete reinforcement of the enclosure circular external wall. These earthing conductors shall be equally spaced along the circumference and – in partial amendment to that specified by the requirement 4.6.1.13 of AD03 – shall be not less than 12. Also the embedded beam (or equivalent) shall be bonded at least in 12 equally spaced points to the concrete reinforcement underneath.
- The telescope pier base plate steel structure shall be bonded at least in 6 equally spaced points to the concrete reinforcement underneath. This in order to allow the telescope azimuth track and bearings to be bonded to the pier concrete reinforcement and through this, to the overall VISTA earth electrode.
- In the realisation of the concrete works there shall be included all the openings and the location footings for the plant equipment.

- As part of the telescope pier for a central section or column of approximate diameter 700mm is required as shown in Figure 6. The height of the central column should be the same as the rest of the telescope pier. This central section does not carry significant load but must thermally match the main Telescope pier.

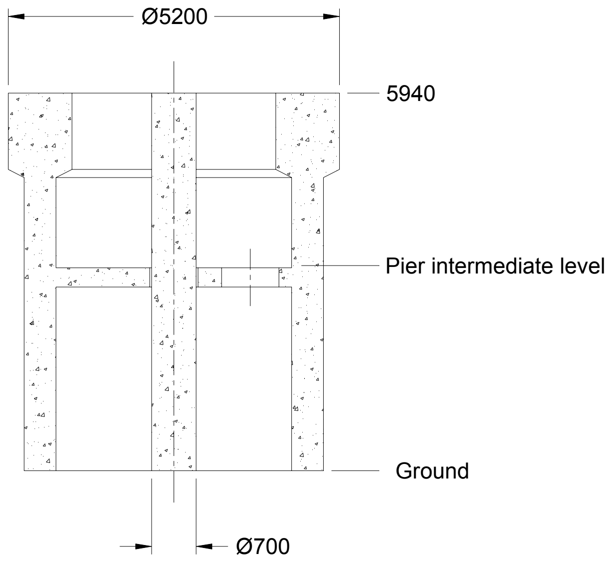


Figure 8: Sketch for option for central column (rebar and steel plates omitted)

The location of the bullet items below are as indicated in RD11.
An integral part of the activities are the auxiliary works required as (but not limited to):

- Water tank: 2000 l tank laid underground, placed outside of the building.
- Septic tank: laid underground, placed outside of the building, shall be specified by Contractor (TBD). This shall be a biological sewage treatment unit.
- Toilet and washroom plumbing and fittings facility.
- Emergency shower and plumbing and fittings.

These items may be relocated for optimisation of the plumbing and drainage requirements by agreement with the VPO (TBD)

8.1.6.4 Floor and Walls

- Between the Enclosure base and the telescope pier a service roof/intermediate floor shall be built at height of +5040mm (nominal).
- Named the intermediate floor, this shall be realised in a steel structure, externally supported directly on the Enclosure's base and internally supported on a series of columns placed along the inner circle (RD06).

As previously described there will be ground floor service rooms for housing service equipment for the telescope and the Enclosure.

- This area shall be designed in compartments in accordance with fire regulations.
- The steel structure of the Intermediate Floor shall be erected as an electrically continuous one and shall be bonded according to the applicable provisions of AD03 and AD06.
- Standards relating to fire shall be specified.

8.1.6.5 Ground Floor and Auxiliary Building Floor

The ground floor of the Enclosure and the floors of the Auxiliary Building are shown in the drawing RD11.

The floors finish shall consist of:
- Concrete surface finishing with good manual levelling
- Special painting for concrete (TBD).

The following floor loadings are required:
- General load 10 kN/m^2
- Localised load 100 kN/m^2
- Rail 120 kN/wheel in static
- Rail 80 kN/wheel in motion

The localised and rail loads correspond to the Coating Plant interface installation. The localised load was considered over 500 x 500 mm area.

8.1.6.6 Azimuth Floor & Intermediate Floor

The finish and requirements for the different surfaces are detailed below and in the drawings RD06 and RD02.
- For all metal floors electrical continuity with their support structures is required.
- Non concrete floors are finished in order to mitigate the risk of ESD damages to electronic equipment (TBR).
- An important element of the azimuth floor shall be the handling hatch (RD02).

The intermediate floor is shown in drawing RD06.
- The intermediate floor shall have a fixed opening for handling.

8.1.6.7 Telescope Pier Intermediate Floor

Inside the telescope pier a pier intermediate floor shall be installed:
- It shall be equipped with an aperture of 1000x1000mm.
- Step irons will allow the access to this platform.
- All metallic structures pertaining to these floors shall be made electrically continuous and shall be bonded in accordance with the purposes and methods specified by AD03 and AD06.

8.1.6.8 Provisional Construction Sequences

The Contractor shall propose his own sequence in the provisional planning schedule as defined in the SOW.

The following sequence is for indicative purposes only.

N°	Task
SQ01	Tracing all the geometry for foundation and auxiliary installations.
SQ02	Preparation of soil, excavation for telescope pier, telescope enclosure foundation, auxiliary building, chiller duct, cables and pipes ducts, tanks and chiller platform.
SQ03	Preparation of foundations (MAT). Positioning of lateral formworks, ducts formworks, chiller platform formworks, etc.
SQ04	Positioning rebars and grounding bars. Positioning of Central Reference Point AD01
SQ05	Casting of foundation mats (inner and outer mat)
SQ06	Preparation of walls formworks and rebars (telescope and enclosure piers, columns of auxiliary building) Positioning of “tune-formworks” for all cables-ducts. Control the positioning referring to the Central Reference Point.
SQ07	Casting of piers walls until the “first level” and the columns until the roof.
SQ08	Positioning and levelling of embedded devices in the telescope pier and enclosure pier referring to the Central Reference Point
SQ09	Final levelling of the embedded devices for the telescope base structure and for the enclosure embedded beam.
SQ10	Casting the last thickness using grouting (like EMACO S55 or S33).
SQ11	Preparation of frameworks and rebars of roof of auxiliary building.
SQ12	Casting of roof of auxiliary building.
SQ13	Preparation of frameworks and rebars for chiller’s trench and for chiller foundation.
SQ14	Casting of the chiller trench and chiller platform.
SQ15	Positioning of all anchoring bolts for the fixation of steel structures fixed to the concrete foundations or vertical walls.
SQ16	Positioning of the carpentry steel structure supporting the intermediate floor, access stairs to the intermediate floor.
SQ17	Preparation of walls of enclosure and auxiliary building.
SQ18	Preparation of formworks and rebars of intermediate floor.
SQ19	Casting of intermediate floor.
SQ20	Positioning of the carpentry steel structure supporting the azimuth floor, access stairs to the azimuth floor.
SQ21	Preparation of floor of auxiliary building (for plant installations).
SQ22	Protections of concrete surface.
SQ23	Coating of ground floor with resin.
SQ24	Coating of walls and other finishing.

8.1.6.9 General Finishing

The General Finishing is characterised by (but not limited to) the following main elements:

- Lay services cabling (power, data and grounding) from platform arrival point to interface termination in the Auxiliary Building services arrival floor area.

- Platform drainage and run-off shall be completed to conform to shed water from the centre of the platform to the sides. No areas shall remain where water may pond to a greater depth than 25mm.
- All works necessary to complete Platform to this Specification and SOW.

9 THE STEEL STRUCTURES

Roadmap: The following Section gives a step by step breakdown of the requirements for the Steel Structures.

- The flow of the requirements breakdown starts from high level and leads on to low level.

9.1.1 General Requirements

Steel structures are required throughout the VISTA Enclosure areas including the roof, the floor, the observing slit door(s), the ventilation door(s), personnel access stairs and walkways (Figure 4).

- The steel structures shall consist of all the necessary elements to transmit the different loads from the rotating part through the fixed part to the Enclosure base concrete structure.
- Structures shall be sub-divided in pre-fabricated sub-assemblies sized in such a manner that standard transport (ISO standard containers) and assembly methods are facilitated.
- Standard, commercially available sections shall be used whenever possible.

9.1.2 Standards and Norms

- All steel structures and related items such as steel quality bolts, high tensile bolts, welds, etc. shall comply with the relevant Eurocodes (eg. Eurocode 1).

The Contractor can apply, BS or ASTM (metric version) or the equivalent Chilean standards and codes but in this case must also demonstrate to the VPO the equivalence.

9.1.3 Loads on the Steel Structures

Some additional requirements and clarifications to 6.4 are given in this Section.

9.1.3.1 Dead Weight

In all calculations and dimensioning of profiles and sections of all structural elements the dead weight of the applicable parts of the structure, sub-assemblies and/or equipment shall be taken into account. Snow and ice shall be accounted for in accordance with AD02.

9.1.3.2 Floor Loading

The following floor loadings are required:
- General loading 10 kN/m^2
- Localised load 1T over 70 x 40mm area.

9.1.3.3 Enclosure Crane Working Load

See section 11.1.

9.1.3.4 Staircases Life Load

According to European or equivalent Chilean standards (AD25).

9.1.4 Earthquake Damage Limitation

Damage limitation design shall take account of possible structure collision during earthquake (see also Section 17.1):

- Eg. between the telescope azimuth platform (or fork base platform) and the Enclosure fixed azimuth platform floor. The Contractor shall propose a solution for a seal joint (TBR) bearing in mind that the one solution is no joint at all.
- Eg. between the telescope pier and the Enclosure intermediate floor.
- Clearance gaps shall be required. These shall be nominated by the Contractor for approval by the VPO (TBR) and based on earthquake damage limitation and safety hazard analysis.

9.1.5 Connection of the Enclosure to the Concrete Base Structure

The Dome steel structure will be connected to the Enclosure base through a circular rail and load beam structure (RD05).

The Contractor shall design and analyse this connection to the base and foundation, taking into account the following (but not limited to):

- All dynamic and static load combinations as defined in Section 17.1.5.
- Multiple (electrically continuous) bonding between the steel structures of the fixed part of the Enclosure and the reinforcement steel of all the radial supporting walls.

The Contractor shall specify and define the civil engineering requirements for the interface and foundation connections.

The current concept is detailed in RD01, RD05 and RD12.

9.1.6 Limitation of Deflections

The deflections of floor elements such as beams, girders and bracings shall be limited to 1/500 of the span (TBR).

9.1.7 Steel Quality

Any grade of steel shall be appropriate to the specified environmental/thermal/seismic environment and the Eurocode 1 or AD25 or equivalent. A 'D'-grade steel such as 50D may be required given its superior low temperature performance (TBR).

9.1.8 Connections

The fasteners connections between the structural elements, stanchions, beams, girders, bracings, supports, may be welded and/or bolted. All provisions about welding, bolting, etc. are contained in AD03.

In all the connections the electrical continuity between the structural elements has to be warranted as required by AD03 for EMC. For the bolted connections high tensile strength bolts shall be used according to the ISO standards.

Welded moment connections, if required, should be executed in the factory and the structures shall be designed and subdivided such that welding on the site shall be minimised.

9.1.9 Circular Rail

The circular rail at the top of the Enclosure base shall be concentric with the telescope azimuth axis (AD13) within the standards as defined in the steel structure norms (AD25) and the drawing (RD05).

The circularity, planarity and deformation tolerances of the underside of this circular rail as well as the inclination angle, if any, shall be determined by the Contractor and agreed by the VPO as a function of (but not limited to):

- The selected rotation mechanism (see section 10.3)
- The loads (see section 17.1.5).
- The operational requirements (see section 10.3)

The circular rail steel grade suggested in the concept design is Grade ARES MRS 125 R90 DIN 536.

9.1.10 Corrosion Protection

All structural elements shall be cleaned and then protected by a highly durable (lifetime >15 years) and resistant paint system considering the environmental conditions.

- The corrosion protection shall be applied in the factory; damage to the protection during transport and assembly shall be repaired at the completion of the structure(s) on site.
- All rolling element bearings shall be sealed and lubricated with an appropriate low temperature rated grease.
- Machined surfaces shall be adequately protected during transport and storage. The provisions against corrosion of bonds specified in AD03 shall be adhered to.

9.2 Cladding, Walls and Doors

The following Section is based on the concept design. The comments of Section 1.2 shall apply.

9.2.1 Specifications and Requirements

The exterior walls, the roof and exterior doors of the Dome shall be cladded with thermally insulating panels, of auto-extinguishing type, externally covered with aluminium corrugated sheet.

In particular all fixings, reinforcement bracings, supports, etc. shall be designed taking into account:

- The mechanical properties of the cladding.
- The survival load conditions.

The cladding system shall have the following characteristics (but shall not be limited to):

- Reduced thermal bridges and continuity of the thermal insulation.
- A high level of water tightness (no water ingress in driving rain conditions).
- A good level of air-tightness (no dust ingress in dust storm conditions).
- Joints and seals between the cladding panels.
- Joints and seals between the observing slit doors, the ventilation doors, the main mirror door and the Enclosure walls and roof. High quality, multi-chamber compressible neoprene seals are recommended.
- Joints and seals between the vertical walls and roof.
- Joints and seals between exterior doors and walls.
- Bonding of the external metal sheets of the cladding for protection against lighting and lightning electromagnetic pulse. Bonding conductors shall allow good and reliable electrical connections to the structural elements. Bonding of dissimilar metals must be reviewed for compatibility.

Note: The requirement within AD06 shall be fulfilled (namely, either a continuous metallic skin roof or a “mesh... of the order of some tens of centimetres”, bonded to the vertical wall cladding, has to prevent the volume under the roof from being penetrated by lightning electromagnetic pulse).

9.2.1.1 Doors

Doors are required for personnel and goods entry at main platform level.

- The doors shall have an aluminium profile frame with an insulating filler and shall respect fire retarding characteristics as per AD20.
- A roller door between the Enclosure and Auxiliary Building as specified in Section 8.1.2.
- They will be complete with hinges and handles.
- External doors shall be fitted with a security swipe card system (TBR).
- Locks are currently not required for internal doors although the flexibility (i.e. provision) to be able to retro-fit locks shall be retained.

9.3 Floor Areas

9.3.1 General

All Dome floor areas, intermediate floors, staircases, etc. are all supported on the steel structures. The finish and requirements for the different surfaces are detailed below.

- For all metal floors electrical continuity with their support structures is required.

9.3.2 Azimuth Floor & Intermediate Floor

9.3.2.1 Requirements

The level of the finished azimuth floor shall coincide with the level of the telescope azimuth platform with a tolerance of ±3 mm (see drawing RD02). The clearance gap shall be as per section 9.1.4.

The intermediate floor is shown in drawing RD06.

The floor finish shall be non-slip, anti-static and dark coloured and shall consist of:
- PVC Conductive flooring, or similar and approved (TBR).
- Copper grid for the connection between PVC conductive flooring parts and with the steel structures.

Inside the telescope pier an intermediate floor shall be installed (as shown in drawing RD06), having the following finish characteristics:
- PVC Conductive flooring or similar and approved (TBR).
- Copper grid for the connection between PVC conductive flooring parts and with the steel structures.
- Plywood (30 mm thickness) or equivalent VPO approved.

The floor live loads are specified in Section 9.1.3 above.

9.3.3 Hatch Requirements

In the azimuth level +7900mm floor, a hatch for instrument and mirror handling shall be installed (RD02).
- The minimum free space diameter of the handling aperture is 5000mm.
- The hatch surface finish shall be identical to the finish of the Dome rotating azimuth floor.
- The level of the closed hatch shall be adjusted to be flush with the surrounding floor level within a tolerance of ±2mm.
- A separate circular central hatch within the main hatch shall be required in order to allow the Dome crane hook to pass for handling operations in the ground floor.
- Guard rails and ‘kick’ plates shall be required around this central hatch (Section 9.3.4).

In the intermediate floor a permanent opening or hatch shall be installed:
- The minimum free space diameter of the handling aperture is 5000mm.

- Guard rails and 'kick' plates shall be required around this central hatch (Section 9.3.4).

The concept hatch (RD02) is composed of three elements, one in the telescope azimuth platform, one in the fixed concrete part of the floor (to be removed and lifted with the crane) and one in the rotating floor which can be folded by winches.

9.3.4 Guard rails

The platforms and staircases as well as the hatch areas on the azimuth floor and intermediate floor shall be equipped with industrial guard rails:

- 1.2m high, solidly fixed to the structures.
- The guard rails shall include a cross bar at 0.6m.
- Guard rails shall be constructed from smooth galvanised steel tubes and supports according to the applicable standards and electrically bonded to the structures.
- Fully removable guard rails incorporating kick plates shall be installed around the hatches in the azimuth (RD02) and intermediate floors (RD06). Removable guard rails shall, once removed, have a storage facility as close as possible to the hatch area.

9.3.5 Staircases

All staircase steps and landings shall be manufactured in galvanised steel grating.

9.3.6 Ladders

Vertical ladders with safety barriers and safety line attachment points shall be installed where required for access to and maintenance of the various Enclosure installations.

10 MECHANISMS

10.1 Observing Slit and Ventilation Openings

Doors or shutters must also be employed for the opening and closing of the observation slit and ventilation openings.

10.1.1 General Requirements

- Particular attention shall be given to the seals and joints between the 'door(s)' and their frames in order to ensure water-tightness (eg. against driving rain), air-tightness (eg. against dust storm), and light-tightness (TBR) in the closed position.
- All exterior doors shall be thermally insulated and thermal bridges shall be avoided. Electrical continuity between the door frames and their surrounding structures is a requirement (AD03).
- All motorised doors shall be equipped with a manual drive to allow door operation under power failure conditions.
- For safety reasons a local door control shall also be provided (as close as possible to each door or door set). Door openings shall be protected by appropriate safety barriers (as per section 9.3.4).

- Hardware interlocks shall be provided to ensure no accidental opening of any door unless the telescope is in the parked position.

10.1.2 Observing Slit Requirements

- The width of the observing slit (clear) opening shall be 5.40m (+0.05m –0.00m).
- The slit length and height requirements must be derived from referring to AD44.
- The maximum allowable time to open or close the slit is <60 seconds.

See section 9.1.1 for the structural steel requirements and section 9.2.1 for the external cladding of the slit 'door(s)'.

Opening and closing of the slit will only take place under the operational wind speeds as defined in section 6.3.

- However, for safety reasons, the door opening/closing mechanisms shall be designed for operation in wind speeds up to 36m/s.
- Independent limit switches are required for indications of slit status for open or closed position. The status of these switches shall be made available to the Enclosure control PLCs (Section 13.8).
- To ensure that during the opening/closing the doors will not jam, synchronisation between the drive motors shall be necessary.

Locking mechanisms to lock the slit door element(s) against the Dome structure in the closed position are required to ensure:

- Water/air/light tightness.
- Sufficient stiffness and strength of the slit door structures under survival wind loads.
- Prevention of displacement of the slit doors during earthquake.
- In the open position, locking against the Dome structure shall also be required to avoid damage during earthquakes. The locking pin motor torque shall be limited to less than full torque when locking, full motor torque shall be applied for the unlocking operation.
- The locking pins shall be equipped with limit/status switches, indicating the position of the shaft. Manual operation of the locking pins shall be possible in the event of a power failure. The status of these switches shall be made available to the Enclosure control PLCs (Section 13.8).

Control aspects of the observing slit mechanism are covered in the section 13.

<u>The VISTA observing slit concept is shown in RD13 for information:</u>
The concept has two 'L-shaped' doors or wings. Each door is powered with two synchronous rack and pinion systems, one in the lower part of the door and one in the upper part near the guide rail.

In the closed position, the observing slit doors have two locking pins in both half parts of the closed slit.

10.1.3 Ventilation Openings Requirements

In the rotating part of the Enclosure (Dome) at least three ventilation openings shall be provided:

- These openings shall be equally sized and equally spaced around the circumference of the Dome.
- The combined open aperture free area shall be not less than $100m^2$ (TBR).
- For safety reasons, the door opening/closing mechanisms shall be designed for operation in wind speeds upto 36m/s.

Since the ventilation openings only have a ventilation purpose, structural bracings do not need to be removed in the area of the opening.

- A system of fixed louvres (simple sheet metal) for the control of stray light shall be installed. Refer to the Figure 9 (for information only).
- Each opening's door(s) shall be motor-driven and equipped with position status switches. Fully variable position control is preferred however as a minimum requirement the closed, half open (or adjustable intermediate point) and fully open positions shall be possible. The status of these switches shall be made available to the Enclosure control PLCs (Section 13.8).

Control aspects of the ventilation door mechanisms are covered in section 13.

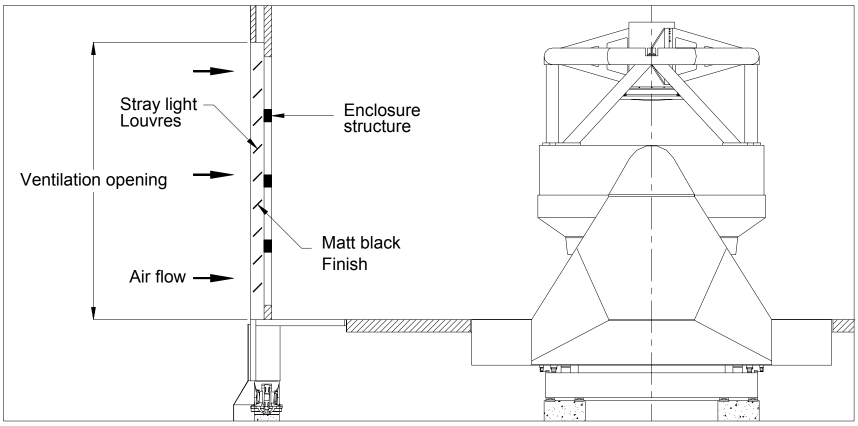


Figure 9: Sketch of stray light louvres

<u>The VISTA ventilation doors concept is shown in RD14 for information:</u>
Three ventilation door sets are shown, two on the lateral walls and one in the opposite wall to the observing slit doors.

10.2 Windscreen

An observing slit windscreen is required for the purpose of protecting the telescope against excessive wind speed leading to wind shake and potentially reduced telescope performance.

10.2.1 General Requirements

The windscreen shall be installed on the inside of the Dome and aligned behind the observing slit aperture.

10.2.2 Windscreen Requirements

The windscreen shall consist of two parts, one fixed one vertically mobile:

- Each part shall be equipped with a series of electrically controlled rotating 'louvres' or 'flaps'.
- The windscreen shall provide a variable aperture (free area) between 60% when fully open and <5% when fully closed.
- The use of the windscreen shall be limited up to the maximum operational wind speeds (see section 6.3).
- The stiffness of the windscreen elements shall be such that resonance due to effects of vortex shedding is avoided.

When the windscreen mobile part is lowered (mobile part is lowered and 'nested' with fixed part) then the highest point of the windscreen structure must not interfere with the telescopes free line of sight at 20° elevation (as shown in the AD44).

The operation to remove the M1 mirror will require removal and set down of the telescope truss and top end on the azimuth platform. The windscreen must be removable or sufficient Dome space must be available for the set down of the telescope truss and top end (AD40).

Control aspects of the windscreen mechanism are covered in the section 13.

<u>The VISTA windscreen concept is shown in RD15 for information:</u>
The windscreen will consist of two parts, one fixed to the azimuth floor and one vertically mobile by means of electric hoists.

10.3 Rotation Mechanism

A system of Dome rotation is required (RD01).

10.3.1 General Requirements

The wind loads shall be evaluated according to the procedures described in the Eurocode N°1 while the seismic loads shall be evaluated according to the Eurocode N°8.

The procedures adopted for the drives calculations will be according to good engineering practice and selected manufacturers' recommended procedures.

- A design priority shall be to ensure that installation, removal and replacement operations are made as simple and safe as possible.
- The use of specialised equipment for installation or maintenance shall be minimised.
- The proposed system shall be capable of meeting the requirements of rotation under 75% availability of rotation mechanisms (eg. 3 out of 4 working, 6 out of 8, etc.).
- Dimension tolerances shall be carefully specified by the Contractor for the important circularity and planarity factors.

10.3.2 Rotation Mechanism Requirements

- Sustain all vertical and horizontal Dome loads as defined in Section 17.1.5.
- Unlimited rotation in both rotation directions.
- Slew speed of not less than 2°/sec (both directions).
- Provide variable rate of velocity between 0 and maximum.
- Variable acceleration for range 0 to 0.5°/sec^2 (maximum not less than 0.5°/sec^2).
- Stop the rotation from maximum speed in less than 5 seconds in emergency situations.
- Allow easy adjustment and assembly during the on-site erection of the Enclosure.
- All mechanical parts shall be adequately protected against corrosion.
- Choice of materials between wheel and track shall ensure that wear occurs preferentially on the wheels.

<u>The VISTA rotation mechanism concept is shown in RD02 and RD12 for information:</u>
The concept rotation mechanisms are 4 support-wheels motorised by means of brushless motors complete with braking system and by 4 idle support wheels. The wheels are installed in the Dome while the circular rail is fixed at the concrete support structure of the Enclosure. All the wheels will be equipped with a 4-roller guide with equaliser shaft and anti-turnover device.

10.3.2.1 Drive Motors and Velocity Servo

The motor torque shall be determined by taking into account the following (but not limited to):
- The static and wind calculations.
- The friction of all moving components.

The surface temperature of exposed surfaces of the Enclosure drive motors and their associated control electronics and power supplies that are located within the Enclosure, shall not differ from the ambient temperature during night-time operation of the telescope by more than 4°C. This shall assume the duty cycle as specified in section 6.5.

- The motors and amplifiers shall be protected with adjustable current (torque) limiters.

A velocity servo control drive system with an input for the velocity reference command incorporating tacho generators shall be required thereby allowing all speed and acceleration combinations as specified. Further control aspects are covered in the section 13.

- The motors shall be equipped with electromagnetic brakes, which engage automatically in case of power failure and/or emergency switching and allow the stopping of rotation in the required time.

<u>The VISTA drive motor concept is shown in RD12 for information:</u>
AC drive motors with reduction gears will be used for the drives to rotate the Dome. At least two drive motors will be equipped with tacho generators.

10.3.2.2 Parking Position and Locking Pin

The parking position is defined by the position whereby the dome crane (see section 11.1) is located in its rest position which is centred (±5mm) above the centre line of the hatch in the azimuth platform floor.
During the daytime and in general when no observations are performed, the Dome shall be placed in one of two parked positions (handling position and 180° opposite position):

- In the parked positions it shall be rigidly connected to the fixed part of the Enclosure by means of one electrically driven locking pin and two park holes diametrically opposed.
- The Dome shall be able to reach the parked position with a repeatability of ±10mm (at the park hole diameter.
- A mechanical jack driven by an electric motor shall operate the locking pin.
- The motor shall be equipped with a torque limiter set to less than full available torque for the moving of the pin into the hole. Full torque shall be available for the withdrawal of the pin.
- The locking pin shall be equipped with limit/status switches, indicating the position of the shaft.
- Manual operation of the locking pin shall be possible in the event of a power failure.

10.3.2.3 Safety Clamps

The Dome shall be secured against vertical lift-off under severe earthquake and survival wind conditions:

- The safety clamp system shall not be in contact under normal conditions and operation.

10.3.2.4 Position Encoder

The rotation of the Dome shall be monitored with an absolute encoder.

11 AUXILIARY EQUIPMENT

11.1 Cranes

The primary means for handling of equipment inside the Enclosure is a bridge crane suspended from the roof support structure, located in the central area of the Dome roof and fully traversing the Dome diameter. This crane is called the Dome crane and is based on the current Concept.

11.1.1 General Requirements for Dome Crane

The requirement is for a 10T safe working load crane to be installed.

11.1.2 Standards and Norms

The crane shall be designed in compliance with the FEM (Federation Européene de la Manutention) supported Eurocode regulations AD38.

11.1.3 Dome Crane Requirements

The crane arrangement can be seen in the AD44.

- Safe working load: 10T
- Hoisting height: 16m (nominal from 0.00 level).
- Minimum clear distance: 1m from hook in highest position to any telescope structure element.
- Hoist speed: 2 speed: 100 and 2000 mm/min (TBR)
- Horizontal speeds: 2 speed: 100 and 2000 mm/min (TBR).

Dome crane control:

- By Radio Frequency (RF) remote control. The RF transmission links shall be robust to interference by similar local systems such as the dome RF link, by means of spread spectrum techniques or similar technology.
- From control boxes installed near the hatches in the azimuth floor and at the intermediate floor level and the ground floor floor level.
- A lock and key system shall prevent simultaneous operation from different control positions.
- Manual control with velocity control joysticks for the Enclosure and crane is required (operator transportable). These default to slow speed but have a fast speed enabled on holding down an override button.

Limit switches and hard-wired interlocks shall be provided:

- A hardware signal shall be provided from the crane to indicate when the crane is in use or out of the park position.
- It shall be possible to inhibit crane operation by means of an external hardware input signal.

Other handling equipment:

A mobile access platform shall be installed for handling and access support in the Dome area:

- Safe working load: 300kg
- Shall enable maximum reach to all internal areas of the Enclosure Dome.(TBR)

(note: if mobile platform does not have access to areas of the enclosure, separate access shall be provided)

In the ground floor two swing hoists shall be installed for handling purposes (AD16).

- Safe working load: 1T
- Hoisting height: 3.50m minimum (from 0.00 level)
- Turning radius: 2.0m (TBR)

An Auxiliary Building overhead crane is required.

- Safe working load: 1.5T
- Hoisting height: 3.50m minimum (from 0.00 level)

11.2 Flat Field

A system for carrying out flat fielding of the telescope shall be installed within the enclosure. The system may be installed permanently or may be deployable by remote control. The contractor shall determine the position within the Enclosure and the system design at preliminary design stage. This system consists of a flat field and a flat field light system which may consist of multiple sources as required to meet the illumination requirements.

The system shall comply with the following requirements:

- The illumination of the flat field shall be 100 ± 10 Lux and even to within 10% over its entire area (TBR).
- The illumination shall be repeatable to ≤ 0.5 % (TBR).
- The flat field shall have a minimum area corresponding to a 4.5m diameter. This area has to illuminate the whole of the telescope aperture and is therefore dependent on the field's distance from the telescope.
- The flat field shall be perpendicular to the telescope optical axis when the telescope is pointed at the flat field.
- The flat field light sources shall be installed in the Enclosure and not on the telescope.
- The flat field light system shall provide a minimum of 2 sets of lights. Each set location shall have three independently switchable sets of bulbs ie. Select set1 or set2 or set3 independently.

11.3 Moon Screen

A mobile structure, which functions as a Moon Screen, shall be installed in the Dome roof area.

The system shall comply with the following requirements:

- Its horizontal position shall be controlled above the telescope in line with the observing slit.
- When not in use the screen shall not obstruct the telescope beam.
- Shall be opaque.
- When fully deployed, the moon screen shall extend to a minimum of 2.0m beyond the azimuth axis of the telescope in the direction of the observing slit.
- The position of the mobile structure shall be monitored and remotely controllable to at least 5 equally spaced steps over the range of deployment.
- If Contractor is combining the flat field and moon screen systems then greater positional control may be required (TBR).

11.4 Thermal Control System

The thermal control system can be subdivided (but not limited to) the following elements:

- Air Conditioning System for Enclosure (Dome) and service area (intermediate and ground areas) and Auxiliary Building
- Cooling System (telescope and general services)
- Ventilation Doors
- Measurement System
- Inflatable Seal for Dome to Enclosure base

11.4.1 General Requirements

In order to ensure adequate observing conditions with no (or minimal) wind flow through the telescope, it is required that all internal surfaces of the Enclosure have at the start of the night a temperature very close to the predicted minimum air temperature Tmin for the coming night. Therefore a temperature T_0, normally equal to Tmin will be defined every day as the driving temperature for the Enclosure thermal control system. However, in order to avoid icing inside the Enclosure T_0 shall never be lower than 0°C. The thermal control objectives shall be achieved by:

- Minimising the heat input both from the external environment and from the lower Enclosure ground floor by adequate insulation and seals (RD08).
- Air-conditioning the inner volumes of the Enclosure during the day when the Dome is closed (Full Enclosure during the day and the area under Azimuth platform during observation). Cooled air shall be distributed and mixed homogeneously in the entire volume of the Enclosure by means of air outlets distributed along inner surfaces, including the upper part of the Dome when the Dome itself is locked in the parking position.
- Both the passive components (insulation, seals) and the air conditioning system shall maintain, inside the Enclosure, surface temperatures not exceeding at sunset (when the Enclosure is to be opened) a pre-set temperature (T_0 + 2°).
- The Contractor shall perform a thermal analysis of the environment inside the Enclosure during typical day cycles.
- In order to achieve the desired cooling performance for the internal surfaces, the air conditioning system shall be capable of achieving a mixing rate of ≥10 volumes/hr in the Enclosure air volume.

11.4.2 Design Constraints

In addition to the technical requirements, calculations and analyses shall be developed on the basis of the possible and most unfavourable functioning conditions which may occur under operational and survival conditions.

The entire thermal control system shall be designed and calculated on the basis of the following functioning conditions:

- temperature operational range: 0 to 15°C
- typical night temperature gradient: -0.4°C/h
- assumed day/night air temperature difference: 10°C
- A relative humidity of 30% shall be assumed.
- Solar radiation as defined in the AD02.

For the cooling system the cooling water mix contains 33% monoethylene glycol.

11.4.3 Air Handling for the Enclosure

The heat transfer due to input and infiltration of external air shall be controlled:

- The external air quantity must produce a light overpressure (≅ 5mm H_2O) so as to facilitate the expulsion of the internal air.
- It is necessary to introduce to the environment (by air treatment units), external air in required quantities.
- The Enclosure, in particular its seals and connections, shall be designed with the aim of obtaining an internal maximum air renewal rate of 1 volume per hour in the closed Enclosure, taking into account of the pressurisation requirement (≅ 5mm H_2O).

11.4.4 Heat Load

The Contractor shall develop a heat load budget based on the information provided here and augmented by the heat loads generated from Contractor's equipment.

11.4.4.1 Heat Load Enclosure

The heat load of the interior of the closed Enclosure shall be evaluated considering the following components (but not limited to):

- The heat transfer due to input and infiltration of external air. For dimensioning purposes a day/night air temperature difference of 10°C shall be considered.
- The conductive heat transfer from the external surface. This is a function of the temperature distribution on the external surface and which in turn is affected by the following external loads
  - The solar energy absorbed by the Enclosure.
  - The infrared radiation balance.
  - The convective heat transfer at the external surface.
  - The heat generation of occupants: 2 persons shall be assumed. (0.3 kW/person).
  - The heat generation of lighting and fan motors in the Enclosure.
  - An additional heat load from the telescope structure of 1.2 kW.
  - An additional heat load for cooling all Enclosure metal structures.
  - The heat extracted by the fans of the electrical cabinets placed on the Enclosure's rotating part.
  - The conductive heat transfer from the external surface in the area below the azimuth floor.
  - The conductive heat transfer from the floor in the service area (office/instruments preparation room etc) to the area below the azimuth floor.

11.4.4.2 Heat Load Ground floor rooms

The heat loads to be considered for the Ground floor rooms are (but not limited to):

- The heat transfer due to input and infiltration of external air.
- The air renewal considered in a rate of 1 volume (living areas) per hour (the total volume is approximately 400m3).
- The conductive heat transfer from the external wall surfaces.
- The heat generation of lighting in the Ground floor rooms.
- The conductive heat transfer from the internal wall surfaces.

The following (average) residual thermal loads produced inside the areas are:

- Office 2 kW
- Intake 0.5 kW
- Instruments 2.5 kW
- Personnel 1.2 kW
- Lighting 1.4 kW
- Toilets Room 1 kW
- Clean Room 1 kW
- Other equipment for Ground floor rooms (TBD).
- Heating of the office, toilets, instrument preparation room and clean room shall be controlled locally to that room with the target temperature being 18°C ±2°C.

11.4.5 Cooling System (Chilled Water)

A number of heat dissipating systems are located inside the Enclosure and also on-board the telescope structure itself. The heat produced by these systems shall be removed by means of a cooling system based on a liquid coolant.

The cooling system shall have a primary cooling circuit to provide refrigerated water for all facilities located on the VISTA site such as (but not limited to) telescope, Enclosure, hydraulic oil plant, Auxiliary Building and other technical rooms.

- Each facility has a secondary cooling circuit which is coupled to the primary circuit through a 'shunting' (heat exchanger) unit. This secondary circuit distributes the coolant to the various facility systems. Inside each system one or more cooling processes may be installed each having its own control.
- The cooling system shall have dewpoint (TBD with location) and flow sensors.
- The system shall guarantee a constant flow from the source.
- Two pumps (per circuit) shall be installed (one duty and one stand-by).
- Automatic changeover shall be made in case of failure of the duty-pump or done weekly for normal duty sharing purpose.

11.4.6 Cooling Liquid Production

The cooling liquid production shall consist of a chiller unit approximately 50 m from the telescope area in a SW direction (exact positioning shall be approved by VPO, TBD).

- An elevation change will be necessary. This shall be taken as 3m below main platform elevation (TBR).
- The cooled liquid shall be pumped from the reservoir (located in the Auxiliary Building), from which the distribution collector and relevant secondary circuits are supplied.
- The chiller shall be dimensioned to supply also the service area, excluding the mirror coating area.
- The pipes connecting the chiller to the reservoir shall be pre-insulated and installed in a covered (under ground level) duct (RD09).
- The pipes (external to the building) shall be laid on a sand bed. Above the pipes, the power cable and the signal/control cable conductors shall be installed within insulating pipes. All the pipes must be covered by a sand layer and then one of soil to ensure protection to potential external pressures such as crossing vehicles.
- The chiller system shall be able to supply the liquid needed at T0 – 8°C in the worst case conditions (demand conditions).

11.4.7 Air Conditioning System

The air conditioning system shall consist of a secondary chilled coolant circuit which feeds a number of air treatment units (ATUs).

- The temperature of the chilled water supplied by the primary circuit will be (T_0 - 8°C), however never colder than -8°C.
- The air treatment units shall be self-cooling, so that no heat is dissipated in the ambient air or in the structure of the Enclosure. In any case any ultimate heat dissipated shall be taken into account.
- The control system shall be integrated in the general ECS (13.8). All the relevant signals and measurements data shall be available at ECS level.

11.4.8 Cleanliness

Filters and other provisions, such as a slight pressurisation (~5 mmH_2O) shall aim to keep the interior of the closed Enclosure dust-free.

- The design goal shall be to maintain a clean environment of class 30000 for the coating plant room and class 10000 for the instrument clean room (TBR).

All other areas are not class constrained although there is a general objective to minimise dust ingress.

11.4.9 Measurement System

The supply of the air conditioning system shall include all detectors for measuring air and water treatment, pressures, flow, as well as the status of motors, valves, etc. which are required for the optimal functioning and control of the chilled water circuits and the air treatment units. This includes as a minimum (range and accuracy TBR):

- 1 external air temperature sensor
- 1 external air pressure sensor
- 1 external relative humidity sensor

- 1 temperature sensor for cooling liquid supply.
- 1 temperature sensor for cooling liquid return
- 1 dew point sensor
- 1 external anemometer

Additionally the following measurement points located inside the Enclosures shall be supplied which shall be monitored by the ECS:

- 4 surface temperature probes on the azimuth platform
- 2 surface temperature probes on the inner surface of the slit doors (upper and lower parts)
- 6 surface temperature probes along the inner surface of the walls
- 4 surface temperature probes on the inner surface of the Dome roof
- 2 air temperature probes in the intermediate floor at the Enclosure base.

11.4.10 Thermal Loads on Cooling System

The following heat sources in addition to those according to the Contractor design shall be cooled:

SYSTEM	COOLING LOADS
TELESCOPE	9 kW
TELESCOPE LCU	1.5 kW
LCU (SPARE)	1 kW
HELIUM COMPRESSOR	10 kW
MIRROR COATING (FOR INFORMATION)	0 kW – standalone

- The surface temperature of all Dome area electrical/electronic cabinets and other electrical equipment located inside the Enclosure, shall not differ from ambient temperature by more than 4°C during night-time operation of the telescope. In order to meet this requirement, equipment may be connected to the chilled liquid supply via the secondary cooling circuit (fixed users) or injecting by fans the produced heat down to the pier intermediate floor, where ATUS are located.
- Drive motors for the slit doors, ventilation doors, and windscreen, that are only used intermittently during the night, as well as equipment that is not normally in operation during this period, shall be exempt from this requirement.

11.4.11 Cooling Liquid Temperature and Pressure Requirement

The cooling system shall provide at each cooled subsystem, a coolant liquid at a temperature of 8°C below the ambient air temperature (set by the TCS/ECS).

The cooling system shall not be driven below the dew point +1°C in order to avoid condensation on the equipment; only in this case is a deviation from the requested set temperature accepted.

11.4.12 Cooling System Implementation Requirements

The whole piping system shall be designed for high reliability regarding leakage tightness.

- It shall be welded wherever possible.
- All piping shall be isolated with "Armaflex" or equivalent. Where mechanical damages can occur it shall be protected.

The pipework shall be made such that transmissions of vibrations to the telescope structure are minimised. In order to achieve this, at least the following precautions shall be taken:

- Use of resilient pipe hangers and supports.
- Flexible joints in the piping at the locations of the pumps.
- Flexible connections across clearance gaps between Auxiliary Building and Enclosure and between Enclosure and telescope foundations shall be necessary.

11.4.13 Control System

The cooling control system (13.8) shall have a local control panel which allows operation in stand-alone mode.

11.4.14 Seals

The gap between the Dome and the Enclosure base wall shall be sealed off when the Enclosure is not moving. To ensure this, the following shall be provided:

- A simple labyrinth seal arrangement impeding dust and wind entry.
- An inflatable hose ring fitting into a protective housing when not inflated.
- Inflatable seals on top of the fixed part of air ducts.
- An air-compressed plant for inflating and discharging of the seals with the necessary control and maintenance devices placed in the Auxiliary Building. The air shall be dried and filtered (section 14.1).
- During night operations the hose is deflated. After the work is finished, it shall be inflated and is kept under pressure..
- The time needed for inflating or deflating shall be < 5 minutes.
- An mechanism requiring seal deflation shall be interlocked against operation while the seal is inflated.

For sealing of observing slit and ventilation aperture refer to section (10.1.1).

<u>The VISTA seal concept is shown in RD08 for information:</u>
A simple labyrinth seal arrangement impeding dust and wind entry.
A horizontal stop ring adjustable in height fixed to the sheeting between the Dome building and the Enclosure base wall in continuation of the thermal insulation.
A U-shaped 'felly' ring with top open and anchored in the concrete.
An inflatable hose ring fitting neatly into the felly ring section when not inflated.
Four small inflatable seals on top of the fixed part of air ducts.

An air-compressed plant for inflating and discharging of the seals with the necessary control and maintenance devices placed in the Auxiliary Building.
An interlock making the Enclosure rotation dependent on the deflation of the seals.
Between the stop ring and the top edge of the felly ring there is a gap of about 10mm which closes by inflating the hose.

11.4.15 Cooling of Auxiliary Building

It shall be necessary to remove from the Auxiliary Building the heat (or residual heat) produced from the various machines (pumps, transformer, UPS, air compressor, etc.):

- For this purpose, an air duct system with air gratings in correspondence to the different rooms shall be used.
- The renewal air is introduced from the exterior by means of air grating placed in the lower part of the perimeter walls. These inlet gratings shall be protected from water and dust.
- At the exhaust duct entry a fan enables the discharge of the heat in an exhaust, to an outlet point away from the telescope area (at least 20m SW direction); the exact location shall be agreed with VPO.

The Auxiliary Building concept cooling goal will be achieved by maintaining a temperature < T_0+5°C on the external surfaces of the Auxiliary Building at sunset.

12 ELECTRICAL INSTALLATIONS

12.1 General Electrical Specification

For the Enclosure the general electrical specifications as defined here and in the relevant Applicable Documents (AD03,AD04,AD06,AD07,AD08,AD09,AD26,AD27,AD28,AD29,AD30,AD31,AD32,AD33, and AD34).

- The Contractor shall consider only high quality, long-life components in the electrical installations. Make and type shall be specified by the Contractor.
- The final decision on the components to be implemented shall be taken in common agreement between the Contractor and VPO, taking into account VPO requirement to standardise electrical network components on the Paranal area.
- The Contractor shall be responsible for defining the location of penetrations in walls and slabs to permit the installation of the cables, piping and ductwork in agreement with the VPO.

Due to the isolated location of the VLT Observatory, electric power consumption must to be optimised.

12.2 Electric Power Distribution

From the main generators at base camp, a dedicated Medium Voltage MV (10kV) line will be provided. One step down transformer shall be supplied and then from this point Normal (400 VAC 3 phase 50 Hz) and UPS power distribution needs shall be met.

The main electric power supply for the Enclosure shall be derived from the main switchboard located in the service rooms in the Auxiliary Building.

In this main switchboard the following outgoing circuits shall be provided (but not limited to):

- Power factor correction (if needed)
- Service Connection Points SCP (AD08)
- Socket outlets boxes at different location.
- HVAC switchboard
- Chiller
- Air compressor
- Lighting distribution
- Auxiliary Building service switchboard
- Mirror coating auxiliary service switchboard
- Helium compressor
- Spare outlets
- Telescope utilities switchboard (via cable wrap)
- Enclosure rotating part switchboard, which is supplied via slip rings
- UPS

- Each outgoing supply line from the switchboards shall be individually equipped with a circuit-breaker with overcurrent and residual current release (where foreseen) in accordance with the electrical load connected.
- The main switchboard shall be furthermore equipped with an input line circuit breaker, coming from an externally portable power generator set to be used for emergency situations (generator not part of this contract).
- Electric power shall be transferred between the fixed and the rotating part of the Enclosure by means of a power rail (slip-ring) which shall include at least 6 rings: 3 phases, neutral, protective conductor (earth) and lightning protection. The lightning protection shall have sufficient brushes bonded to the structure, symmetrically distributed along the Enclosure circumference.
- UPS shall allow for key safety systems and maintain computer systems for 10 minutes. The safety hazard analysis shall identify all other systems requiring UPS cover.

The following major systems are listed with an estimation of their nominal (maximum) power ratings (TBC):

- Coating Plant = 60 kW
- Helium Compressor = 20 kW
- Telescope Utilities swb1 = 20 kW
- Telescope Utilities swb2 = 20 kW

The following switchboards, referred to the above-mentioned drawing, are NOT part of the present supply:

- "Telescope Utilities Switchboard 1"
- "Telescope Utilities Switchboard 2"

12.3 Cabling

- All electric cabling shall be installed in galvanized steel ducts protecting the cables from mechanical shock, dust and fire.
- Cable ducts shall terminate properly in junction boxes, motor control boxes, switchboards, switches, sockets, etc.
- Cable sections shall correspond to the connected load. Continuity of the protective conductor shall be tested for safety AD29.
- Power, control and signal cables shall be shielded and the shield earthed at both extremities, as specified by AD04. This requirement may be relaxed where cables are installed within metal ducts and conduits providing equivalent shielding.

12.4 Equipment

- Breaking of fault currents shall be carried out by means of circuit-breakers.
- Switches and socket-outlets, motor control boxes, and in general control and function boxes shall be sealed. Socket-outlets will be equipped with spring-loaded lids.
- Lighting switches shall be installed at a height of 1.20m above the floor. Socket outlets may be installed 0.20 or 1.20m above the floors only in the Auxiliary Building.
- Video image and sound (from Within the Telescope area) shall be made available at the Enclosure PLC interface (for return to VLT control room)

12.5 Lighting

- Around the circumference of the fixed parts of the Enclosure, lighting fixtures shall be installed to give an illumination at the floor level 100 lux minimum. The same requirement applies for all areas of the azimuth platform.
- On the upper part of the Enclosure, powerful floodlights shall be mounted as required during equipment handling with the crane. Illumination to be attained in a range 300 lux at the Az floor level.
- Ceiling lighting to illuminate the crane operations shall be provided.

12.6 Emergency Lighting

- Exit lights and emergency lights sufficient to permit safe egress from the buildings shall be supplied when normal power is interrupted.

- Sufficient lighting fixtures shall be provided in stairs, walkways, exits, the azimuth floor and the pier rooms so that failure of any one unit shall not leave any area dark or endanger persons leaving the building.

12.7 Control Signals, Commands and Cabling

- All interlocks and status contacts as well as remote controlled switches for motors, valves etc. shall be operated at 24 V DC.
- Contact and switches shall be connected to programmable logic controllers (PLCs) which connect via a data link to the Enclosure main controller (ECS/LCU).
- All control cabling shall be installed in ducts and be separated from the power cabling according to the requirements of AD06. Twisted pair cables are preferred for all control functions.

12.8 Fire Alarm System

Although Paranal Observatory does offer a fire fighting service the Contractor shall supply a stand alone system for VISTA EBWP. This shall include (but not be limited to):

- A system of smoke detectors and fire alarms, distributed in both fixed and rotating parts shall be fitted to assure safety of the personnel and equipment (according to European or equivalent Chilean standards).
- The system shall control also the fire resistant doors of the technical compartment at the ground floor level and in the Auxiliary Building and also in the access stairs area from intermediate floor to azimuth floor (walls and doors) (TBR).
- This system shall be connected to the ECS to send the alarm to the Control Building via the TCS.
- A local alarm shall be provided for.
- Local Fire fighting (extinguishers or other) according to European standards (EN54, EN3)or equivalent Chilean and AD20.

13 CONTROL SYSTEM

13.1 Overview

The Enclosure will be controlled by a Enclosure Control System (ECS), interfaced to the Telescope Control System (TCS) via a Local Area Network (see Figure 10). The ECS consists of a Local Control Unit (LCU), a VME/VxWorks based computer with software, and a network of control units (PLC's), as well as all sensors and actuators needed to control and supervise the Enclosure hardware. The LCU is not within the Enclosure Work package.

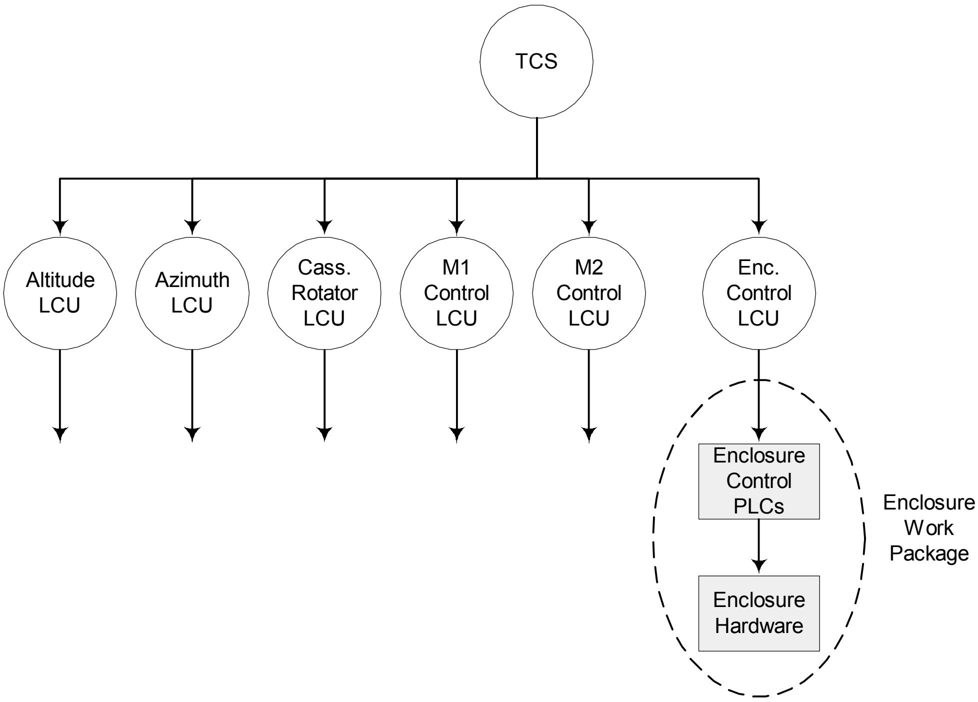


Figure 10 Relationship of the Enclosure Work Package with other telescope packages.

The LCU provides a standardised software interface to all functions of the Enclosure Control System from the rest of the VISTA system. Some of these functions may be performed directly by the LCU, but the majority are executed by the PLCs. The LCU handles communications both to the TCS and to the PLCs.

The PLCs, connected in one or two networks to each other and to the LCU, provide the direct connections to sensors and actuators.

13.2 Control Panels

All the Enclosure functions shall be possible to be controlled locally (near the device) from a standard control panel. A switch shall set this local mode and the status of the switch shall be provided as an input signal.

Manual overrides shall exist in all systems controlled by the Enclosure Control System.

13.3 Control Hardware

The ECS PLCs shall comprise a hierarchical network of controllers linked to:

- the various sensors that detect the Enclosure status, such as encoders, contact and end switches, flow and temperature sensors, etc. The Contractor shall define a comprehensive test plan covering all status and input signals.

- all electrical drives, valves, etc. which drive the motion mechanisms and the thermal control systems.

The Control hardware shall comply with the requirements of the *Electronic Design Specification* (AD04). CANbus devices may also be used as specified in the *CANopen Specifications* (AD05). These documents specify the following control hardware relevant to the Enclosure:

- Siemens S7 series (Preferred CPU S7-300), (TBR)
- Siemens LOGO! micro-PLC for local non-networked PLC functionality
- CANbus devices connected to the LCU
- other devices complying with IEC 61131 subject to prior approval
- Esters DC 24 temperature acquisition system

These documents also specify how the hardware shall be used and the Contractor shall comply with these specifications.

13.4 Interfaces

The ECS PLCs shall communicate with the ECS LCU using the standard communications medium supported by the devices.
Communications interface: CP341
Communications protocol between LCU and PLC: RK512 based on 3964R

The Contractor shall supply the software for communication between the PLCs and LCU, i.e. the software that receives commands and requests from the LCU, and the software that sends status and information from the PLCs to the LCU.

13.5 General Requirements

All controlled loops shall be closed within the PLCs.

The ECS PLCs shall process the following inputs:

- Signals from the sensing devices in the Enclosure.
- Commands and queries from the TCS (via the LCU).

The outputs shall include:

- Status data as queried by the ECS LCU
- Signals to the hardware units (motors, heat exchangers, etc.)

The following general requirements shall apply to the ECS PLC software:

All relevant signals (voltage levels, currents, switch positions, temperatures etc.) shall be available as input signals in the PLCs and readable from the LCU.

All moving or adjustable devices shall be available for individual, independent movement (adjustment) for test and maintenance purposes.

There shall be software checks to prevent a requested operation from being performed if not safety compatible with the subsystem status.

The ECS has to take the equipment of any Enclosure subsystem to a safe state in any error, emergency or dangerous situation. Every such situation shall be documented as a status signal, available in the LCU.

There shall be a description of all malfunction events and the corresponding actions to be taken by hardware and/or software.

All possible failures that the software can detect shall also be handled by the software, which shall bring the system to a safe and well-defined state.

There shall be an in-depth failure analysis during the design phase, identifying and describing failures and actions when detected.

The Contractor shall produce a list of errors, alarms and warnings (potential alarm situations) reported by the subsystem. The list shall contain all items that the software can detect in terms of hardware and software malfunctions. There shall also be a help text for each entry in the list, describing the reason and recommended action.

13.6 Interlocks

Hardware interlock systems shall be implemented to:

- prevent Dome rotation when locked
- prevent motion of the slit doors when locked
- prevent telescope motion when the crane is not in park position
- prevent crane operation unless the telescope is in the park position
- prevent opening of any slit or ventilation doors unless the telescope is in the parked position.

In addition the Contractor shall implement all necessary interlocks to fulfil the safety requirements.

Further requirements for interlocks are specified in the Electronic Design Specification (AD04).

13.7 Testing

The complete ECS functionality shall be tested by the Contractor up to and including the PLC level. The LCU shall be simulated by a testing unit, e.g. PC with appropriate software and interface, supplied by the Contractor and agreed with the VPO.

13.8 Functions

This document defines functions but not detailed interface definitions. Commands implementing these functions shall be defined by the Contractor (and approved by VPO), in the detailed design phase. These commands and interface details shall be incorporated in an Interface Control Document supplied by the Contractor and approved by the VPO.

Functions shall include, but not be limited to, the following:

Windscreen functions:
1. Get windscreen status.
2. Get windscreen position.
3. Set windscreen aperture.
4. Set windscreen to absolute position.

Slit door functions:
1. Open/close slit doors (or single slit door). (TBR)
2. Lock/unlock slit doors.
3. Get position of slit doors.
4. Get status of slit door lock device.

Ventilation doors and hatch functions:
1. Open/intermediate/close doors.
2. Get position of doors.
3. Get position of hatch.

Air conditioning functions:
1. Set control parameters for air conditioning system.
2. Get control parameters for air conditioning system.
3. Set control parameters for cooling system.
4. Get cooling status.
5. Start/stop air conditioning system.
6. Start/stop air cooling system

Flat Field:
1. Deploy/park (if appropriate)
2. Switch illumination on/off
3. Set illumination level.

Moon Screen:
1. Get moon screen status
2. Get moon screen position
3. Set moon screen position

Dome Rotation Control:

1. See Section 13.9.7.

13.9 Dome Rotation

13.9.1 Fine and Coarse Modes

There shall be two modes of Dome control operation: fine and coarse.

Fine position mode shall be used when the telescope is tracking a target, in which case the position error shall be small. In this mode the Dome drive is essentially slaved to the Azimuth axis of the telescope and follows it.

Coarse position mode shall be used when the telescope moves between targets. In coarse mode position error is not so important, but fast recovery and smooth entry into fine mode shall be necessary.

13.9.2 Position and Velocity Loops

The Dome drive control loop shall have an outer position loop (which receives external position commands) and an inner velocity loop. In addition the drive motors shall be driven by power amplifiers which shall use a current control loop.

Dome external position updates will be received from the LCU at a rate of ~1/second.

The absolute accuracy of the reported Dome position shall be better than 0.05 deg rms (TBR).

13.9.3 Overspeed Limits

The Dome control system shall not allow movements exceeding the following limits:

- maximum velocity: ± 2.9 deg/s
- maximum acceleration: ± 0.75 deg/s/s

13.9.4 Fine Position Mode

Fine mode operation is required when the difference between an external position update and the present position is less than 0.28 deg.

The control system shall move the Dome position smoothly between position updates by, e.g., estimating the next position and moving in velocity mode towards the estimated position. Upon receiving the actual demanded position, the control system may then move the small distance between the estimated demand and the actual demand. The difference between the actual Dome position and the estimated required position at all times in this mode shall be less than 0.1 deg.

The Contractor may suggest other control schemes that would maintain the low position error required in this mode and prevent excessive acceleration or jerk between position updates.

13.9.5 Coarse Position Mode

Coarse mode operation is required when the difference between an external position update and the present position exceeds 0.28 deg.

In this mode, the Dome shall be capable of moving at up to the maximum values defined in section 13.9.3 above. A trapezoidal velocity profile shall be used as required for large differences in commanded angles.

Entry into fine mode shall occur when the position error has decreased to less than 0.28 deg. It is not necessary for the Dome to follow the Azimuth axis during this mode, but the Dome should reach the target position as fast as possible. This may produce large temporary differences in the relative angle between Dome and telescope azimuth.

13.9.6 Manual Controls

The Dome shall be capable of operation from a local control panel. Local control shall be in velocity mode. The velocity in both directions shall be controlled from a single spring-loaded return-to-zero joystick. The Dome velocity shall be proportional to the joystick position with respect to its zero position. The joystick maximum positions shall correspond to the Dome maximum velocities.

The local control panel shall also have an emergency stop button that links to the telescope emergency stop system using a non-software electrical connection that does not rely on software.

13.9.7 Functions

Commands implementing the functions listed below shall be defined by the Contractor (and approved by VPO), in the detailed design phase. These commands and interface details shall be incorporated in an Interface Control Document supplied by the Contractor and approved by the VPO. Dome rotation control functions shall include, but not be limited to, the following:

1. The Enclosure shall follow the telescope, via the commands received by the LCU, by means of an absolute encoder that is used to close the position loop.
2. The “tracking” error shall be monitored by the controller and given available to the LCU.
3. Enable/disable power amplifiers.
4. Enable/disable brakes.
5. Lock/unlock Dome rotation.

6. Send back status information including:
   - position error (with respect to the demanded position)
   - actual position
   - actual velocity
   - actual torque
   - status of locking devices
   - status of all other devices connected to the PLCs

13.10 Radio Link

Communications between the fixed and rotating parts of the Enclosure shall be implemented using a radio link.

The data transmission technique shall be robust to interference. The working frequencies shall be defined with VPO during the detailed design phase.

The two antennae shall be located at the Azimuth rotating and fixed floors.

14 PLANT INSTALLATION

14.1 Compressed Air System

It will have to be installed a compress air system consisting of the following main elements:

- 800 lt/min 8 bar compressor (TBC)
- 1000 lt air receiver
- air dryer at freezing cycle
- distribution net consisting of 2 off air outlets (fast-lock type) for azimuth floor, intermediate floor and ground floor. 4 off for the instrument preparation room ~~lab space~~ and 1 outlet for the instrument clean room.

14.2 Helium Compressor

The Helium Compressor Package is not part of this Contract.
Services however, shall be provided for the Helium Compressor Package.

- Specifically SCPs A, B and C are required (AD08).

14.3 Chemical Washing System

The following shall be required for mirror stripping and cleaning.

- 500 l storage tank for De-ionised water with gravity feed to point of use. (No part of this contract)
- Drainage channels to a chemicals storage tank.
- Compressed air for mirror drying (SCP C AD08).
- 3 phase power supply for pumps (SCP A AD08).

14.4 Water System

Pumping shall be required to supply toilets, sinks and showers from the 2000 l storage tank to the distribution network.

- Pumping and distribution system.

15 RELIABILITY MAINTAINABILITY AND SAFETY REQUIREMENTS

15.1 Enclosure and Auxiliary Buildings Lifetime

EBWP shall be designed for a minimum lifetime of 25 years of operation, comprising an average 12 hours of duty and 12 hours of stand-by per day.

15.2 System Reliability

15.2.1 Overall Availability

The system shall be designed and manufactured in order to ensure that the total lost observing time does not exceed one night every two years.

15.2.2 Time Available for Maintenance

Allowing for pre-/post-observation calibration activities, eight hours per day (average – subject to season) will be available for EBWP maintenance. Any maintenance activities which can be completed (including any required fault identification and diagnosis) in this eight-hour period will not result in lost duty time.

15.2.3 Specific Reliability Requirements

A <u>Failure</u> is defined as an event causing complete loss of observing capability and which cannot be recovered by corrective maintenance (including fault identification) in less than 4 hours.

The Enclosure and Auxiliary Buildings including all support system shall be designed for a Mean Time Between Failures (MTBF) of 3 years.

As a general rule, a high reliability shall be enforced in the design and manufacturing process by appropriate methodology and review.

15.3 Maintainability Guidelines and Requirements

15.3.1 Maintenance Approach

ESO will operate VISTA and perform the on-site maintenance. Therefore the maintenance philosophy to be considered during the design of VISTA is the one established by ESO at the Cerro Paranal Observatory. The major elements of this philosophy are as follows:

The maintenance work-load and therefore manpower at the Chilean site shall be minimised and shall be limited as far as possible to preventive maintenance tasks.

Maintenance work shall be performed at system level and by exchange of module (Line Replaceable Units, LRUs) when practical. LRUs are defined as units which can easily (i.e. without extensive calibration etc) be exchanged by maintenance staff of technician level, and that can be easily shipped to a suitable ESO repair location, or to an industrial supplier for repair.

This concept implies that spares LRUs must be available at the observatory.

Three different category of maintenance shall be considered:

1. Predictive Maintenance
2. Preventive Maintenance
3. Overhaul

15.3.1.1 Predictive Maintenance

Predictive maintenance is "condition driven" preventative maintenance. Instead of reliance on life-time statistics, predictive maintenance uses direct monitoring of the system performance or condition. Typical examples are testing of gearbox oil for bearing deterioration or monitoring of drive currents for change in loading characteristics. The Contractor shall define the predictive maintenance tasks applicable to this work package, and any special tools, services or equipment required.

15.3.1.2 Preventive Maintenance

Preventive maintenance tasks shall be accomplished by no more than two trained technicians with a minimum of special equipment or tools. The Contractor shall define the preventive maintenance tasks and schedules applicable to the EBWP, and any special tools, services or equipment required.

15.3.1.3 Overhaul

Overhaul is defined as special preventive maintenance operation during which the equipment is not operational and observing time is lost. Overhaul involves removal of the equipment from the EBWP and partial or total disassembly. Limited overhauls for VISTA lasting up to 48 hours can be undertaken during the periodical re-coating of the primary mirror, provided they do not impact the coating process.

Wherever possible overhaul should be avoided, with preference given to predictive and preventative maintenance. The Contractor shall define any overhaul tasks and schedules applicable to the EBWP, and any special tools, services or equipment required.

15.3.1.4 On-Site Repair/Corrective Maintenance

On site repair is normally limited to the in-situ exchange of line-replaceable units (LRUs). The faulty LRU will be sent to the ESO repair location or to an industrial supplier for repair.

As a general rule, an LRU replacement or other repair activity shall be accomplished by a maximum of two trained technicians with a minimum of special equipment or tools in a maximum time of 4 hours. The Contractor shall define a list of spare parts and propose this list to the VPO.

16 SAFETY REQUIREMENTS

The AD19 shall apply.

16.1 General Safety Requirements

The general principles of safety design of technical products defined in AD18 shall be applied.

16.2 Electrical Safety

The electrical installations on the Enclosures shall be designed, erected and verified in compliance with AD30, AD31 and AD26.

Electrical and electronic equipment to be installed onto the Enclosure shall exhibit the following compliances:

a) equipment for measurement, control and laboratory use shall comply with AD27 (EN 61010-1 incl. Amd. S) or equivalent and be proposed to ESO for explicit approval;
b) information technology equipment shall comply with AD28 (IEC 950 incl. Amd.s) or equivalent and proposed to ESO for explicit approval;
c) other equipment shall comply with the applicable IEC product safety standard or equivalent and be proposed to ESO for explicit approval.

16.3 Pneumatic Safety

The piping including connections of the compressed air system shall be designed in accordance with AD18.

16.4 Cooling System Safety

The cooling system shall be designed in accordance with the electrical safety requirements in accordance with AD18.

16.5 Operational Safety

a) None of the following cases shall lead to a category I or II hazard except where the associated risk is acceptable as per AD19:

- Independent operator error
- One operator error plus one hardware failure
- One or two hardware failures
- One or two software failures
- Power failure
- Emergency braking
- Earthquake (OBE or MLE)
- Wind loading

Design and construction of all moving mechanisms shall consider the following:

- Due to its unlimited rotation capability, there shall be no mechanical end-stops or limit switches for the Dome rotation limitation. All other moving mechanisms shall be equipped with limit switches and end-stops to control the extent of movement.
- All end-stops shall have appropriate damping characteristics to prevent damage in the event of a control failure.
- All moving mechanisms shall be equipped with an audible alarm system to indicate door movements.
- The main observing slit doors shall also be equipped with a visual movement warning alarm.
- All doors, vents and blinds shall be equipped with systems that prevent personnel from being squeezed or crushed (photocell device, pressure switch etc.)
- All moving systems shall be equipped with Emergency Stop buttons, interlocked to cut power to the relevant drives and apply the brakes as necessary as appropriate. The Emergency Stop buttons shall be placed near the mechanisms in question (in the case of the Enclosure Dome, this will require several Emergency Stop buttons spaced around the circumference.

16.6 Emergency Stop System (ESS)

Completely independent Emergency Stop System (ESS) shall be installed which fulfills the requirements of AD26.

Purpose

The purpose of the ESS is

a) to cut off all electrical and other energy sources likely to present a hazard risk

b) to stop immediately the motions of machines, drives etc. which cause the actual dangerous situation
c) to alert the Operation Supervisor and the VLT emergency services

Activation
The ESS shall be activated by
Actuation of an Emergency Stop Button (ESB)
An external signal input with galvanic isolation.
A telescope emergency signal input with galvanic isolation.

Required Effects
With the exception of the interaction with safety installations/devices described later the ESS shall
Switch off ALL electric power sources with voltages in excess of 50 V with respect to earth
Switch off ALL other energy sources likely to present a hazard risk
Stop the motions of ALL machinery, drives and other equipment
All emergency stop buttons (ESB) shall have the same effect

The ESS shall be activated either by actuation of an Emergency Stop Button (ESB) or by two externally provided "Central Emergency Signals".

Required Effects
- With the exception of the interaction with safety installations/devices described later the ESS shall
- switch off ALL electric power sources with voltages in excess of 50 V with respect to earth
- switch off ALL other energy sources likely to present a hazard risk
- stop the motions of ALL machinery, drives and other equipment
- All emergency stop buttons (ESB) shall have the same effect
- A galvanic separated "Emergency Contact" to be used by the telescope shall be available.

Positioning of the Emergency Stop Buttons (ESB)
The number and position of the ESB will be defined during the Engineering Phase taking into account the requirements of the applicable safety standards. They shall be installed in red boxes protected by breakable glass (like those for fire protection signalling).

As a general guideline, the ESB shall be placed:
- where they are clearly visible and always accessible
- close to all doors
- in locations defined by local conditions (Enclosure stairs, hatches, removable guard rails)
- in close vicinity to hazardous equipment or areas, i.e. hatch guard rails

Interaction of Emergency Stop Systems with other Safety Installations/Devices
The activation of the ESS shall not affect any safety installations/devices necessary for the evacuation of the buildings (i.e. emergency lights, alarms, smoke detectors etc.) nor hinder

activities of the emergency services or other emergency operations, nor shall the activation reduce the level of safety.

Those safety installations, devices and equipment remaining live after the activation of the ESS shall not present any danger to the people and shall be painted in orange and/or marked by means of distinctive warning signs.

Motion stop buttons
Motion stop button system shall be installed on the Enclosure and connected to the telescope which will be used to initiate motion stop operations and which includes the motion stop switches of the service connection points.

The system shall consist of a variable number of stop button switches and a central relay box which provides the electrical power for the system and relays. The principle functional diagram is given in the section 4.6 of AD04:

The total number of stop buttons shall be < 20 but shall be expandable. The location of the stop buttons (both on telescope and Enclosure) is TBR during the design.

Central relay box

- Number of galvanically separated normally open switching contacts: maximum 15 for 48V/1 Amp.
- Number of galvanically separated relay status monitoring contacts: 1 per relay.
- Number of stop button chain interfaces which will be bridged if not used: maximum 10.
- A relay controlled by the crane interlock (to the telescope). This relay has 2 contacts.

Motion stop buttons

- Number of galvanically isolated normally closed contacts: 2/24V approx. 1 Amp.

16.7 Safety Analysis

At the beginning of the design phase a preliminary hazard list (PHL) and subsequently a preliminary hazard analysis (PHA) shall be prepared by the contractor down to subsystem level, i.e. Enclosure Dome, doors, windscreen, aux. equipment (crane, etc.)

17 REQUIREMENTS FOR ANALYSES

17.1 Structural Analyses: General

All Finite Element analyses necessary for the verification of the design and the performance of the EBWP shall be performed with a numerical code agreed with the VPO. The structural model shall be sufficiently detailed to provide an accurate description of the quantities under study (stiffness, displacements, stress and frequencies, etc.).
The analysis error due to mesh density shall be ≤ 10%.

17.1.1 Gravity Load Analysis

The effect of gravity shall be taken into account by means of FE analysis.

17.1.2 Wind Stress Analysis

Dynamic and static wind stress analyses shall be performed.

The effect of the wind to be expected during operational conditions or survival conditions shall be verified by means of a finite element analysis.

The wind load application method shall follow the methods of AD37.

17.1.3 Seismic Analysis

General

The seismic analyses shall be based on the modal response spectrum technique. The design response spectra for OBE and MLE are given in AD02. The applicable percentage of critical damping to be used is:

- 3 % for OBE for the buildings, pier and enclosure (Page 33 of AD02)
- 5 % for MLE for the buildings, pier and enclosure (Page 29 of AD02)

For the verification of specific scenarios, where the equipment is in a configuration which is used only occasionally (for example M1 mirror in coating plant), a reduced Response Spectrum may be used (MLE_{LR}). In particular this is covered by the curve of AD02.

- MLE_{LR}: Mirror Maintenance 1%, q=1.0, B1 (Page 45 of AD02)

The model used and the number of dynamic degrees of freedom shall be such that an accurate modal response is obtained up to a frequency of 35 Hz The model shall include the foundations and the interface to the ground.

The Square Root Sum of the Square method (SRSS) shall be used in order to combine the contribution of the various modes. The three spatial components of the response shall be combined according to the provisions of Chapter 6 of the Eurocode 8, Part 1.

17.1.4 Stress Verification Criteria and Limits

a) The stresses and loads shall be within the limits permitted by the Applicable Documents and any regulations in force at the Contractors premises and at the telescope site. In the absence of any such requirements in the case of metallic parts the maximum allowable stresses shall be:

Case	Criteria	Limit

Operational Loading	Mechanical Stress in Mechanisms	Manufacturers recommendation or Fatigue limit/2
	Mechanical Stress	Fatigue limit/1.5
Short Term Accidental Loading	Mechanical stress in mechanisms	Manufacturers recommendation or Fatigue limit/1.2
	Mechanical stresses	0.2% Proof Stress/1.5 (metallic parts)
Survival Loading	Mechanical Stress	0.2% Proof Stress/1.2, Ultimate Tensile Stress/1.5 (metallic parts)

17.1.5 Load Combinations

The load combinations for verification of stresses, displacement and the performances under the specified conditions, shall take into account the sum of the relevant individual load cases applicable to the subsystem or part under examination. It is the Contractors responsibility to define the plausible worst case combinations. The Load combinations shall include but are not limited to the following:

<u>Operational Loading</u>

a) Gravity + Differential Thermal Expansion(Functional) + Wind (Operational) + All Enclosure Dynamic Loads (operational)

<u>Short Term Accidental Loading</u>

b) Gravity + Differential Thermal Expansion(Functional) + Wind (Operational) +Enclosure Dynamic Loads (Emergency Braking)

c) Gravity + Differential Thermal Expansion(Functional) + Wind (Operational) + OBE

<u>Survival Loading</u>

d) Gravity + Wind (Survival) + Snow + Ice

e) Gravity + MLE

Note: In addition to the above all specific component or sub-assembly load cases shall be identified and specified including all handling loads both for installation and for routine testing / service.

18 ELECTROMAGNETIC COMPATIBILITY – EMC

18.1 General

The VISTA Enclosure (and Auxiliary Building) shall exhibit complete electromagnetic compatibility among the parts, components, devices, apparatus and equipment of which it is comprised (intra-system electromagnetic compatibility). No malfunction, degradation of performance or deviation from specified parameters shall be allowed because of lack of intra-system electromagnetic compatibility.

Minimisation of the electromagnetic interference between the VISTA Enclosure and its environment shall be a driver in the design and manufacture of the VISTA Enclosure (inter-system electromagnetic compatibility)

The achievement of intra-system and inter-system electromagnetic compatibility shall be the subject and purpose of the EMC system analysis required by Statement of Work (by VISTA Project Office). (The outcome of such an analysis shall include, without being limited to, cases of concern, tests to be performed (testing plan), installation and mitigation guide-lines, further remedial measures, etc.)

As a prerequisite in achieving intra-system and inter-system electromagnetic compatibility, the VISTA Enclosure shall comply with the requirements set by the applicable documents AD06 and AD07.

Construction provisions useful to fulfil some of these requirements are specified by AD03.

Electronic design, cabling and interfacing shall be performed according to AD04.

The present section is not intended to make void or to constitute a waiver of the above-mentioned specifications which shall remain fully applicable to the VISTA Enclosure contract. Purpose of the present section is simply to provide guidance and help in fulfilling the requirements of the EMC and Electronic Design specifications.

18.2 Electromagnetic Environment (protection against lightning, protection against lightning electromagnetic pulse - LEMP, power quality)

The VISTA Enclosure will be installed, operated and located within the electromagnetic environment specified by AD06 and, therefore, shall comply with the requirements imposed by this AD06. In particular it will be exposed to direct lightning strokes, i.e., it will be placed within a lightning protection zone LPZ 0A, as defined by the AD06.

This entails the following requirements (valid for Enclosure and Auxiliary Building):

1. The VISTA installations shall be so designed, built and assembled as to be protected against direct lightning strokes. In order to achieve this, the requirements enforced by the AD06 shall be adhered to, in particular those contained in its subsection "3.2.2 External lightning protection systems (LPS) of the telescope area". The lightning protection system shall be realized adopting natural components as extensively as practicable.
2. The VISTA installations shall be so designed, built and assembled as to protect its inner volume against lightning electromagnetic pulse (LEMP). In order to achieve this, the requirements enforced by the AD06 shall be adhered to, in particular those contained in

its subsection "3.2.4 Internal lightning protection system and protection against lightning electromagnetic pulse (LEMP) of the telescope area".

3. According to subsection "3.3.1 Protection against overvoltages of the electrical installations" of the AD06, insulation co-ordination and overvoltage protection shall be provided for the VISTA installations. This implies, in particular, that its electrical installations shall constitute an installation category (overvoltage category) III and shall provide an overvoltage category II to the (electrical and electronic) equipment installed within the Enclosure and the Auxiliary Building.
4. Should the "passive" methods implied by section "3.2 PROTECTION AGAINST LIGHTNING" of the AD06 be not sufficient, the protection against overvoltages of electronic installations and equipment shall be supplemented according to subsection "3.3.2 Special provisions for protection against overvoltages of electronic installations and equipment" of the AD06.
5. In general, any telescope area electrical and electronic installations shall be protected against overvoltages which could inject into them through their I/O, signal, control, DC and AC power lines to be laid into or connected to the VISTA Enclosure and the Auxiliary Building.
6. The telescope area power system is specified in order to provide electric power with the quality described by section "4. PERFORMANCE REQUIREMENTS" of AD06.
7. VISTA shall not worsen such power quality, i.e., it shall provide electric power at its output AC lines within the compatibility limits specified by section "4. PERFORMANCE REQUIREMENTS" of AD06.

18.3 Equipment

Note. The term "port" is used according to the definition given by the European Standards CENELEC EN 50 081-1:1992 and EN 50 082-1:1992, viz.,

"port": particular interface of the specified apparatus with the external electromagnetic environment.

The term "Enclosure port" does not refer to the VISTA Enclosure but is used accordance to the definition given by the above-mentioned EN standards, viz.,

"Enclosure port": the physical boundary of the apparatus through which electromagnetic fields may radiate or impinge.

18.3.1 Emission

The electrical and electronic equipment to be installed onto and/or integrated into VISTA shall comply with the emission limits specified by the AD07.

18.3.2 Immunity

The electrical and electronic equipment to be installed onto and/or integrated into the VISTA Enclosure shall comply with the applicable immunity limits specified by the AD07.