



Statement of Work: Design, Manufacturing, Transport, and Commissioning of a Containerized Data Centre at the CTAO-South in Chile

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| Abbreviations | |
|---------------|---|
| AD | Applicable Document |
| CTAO | Cherenkov Telescope Array Observatory |
| CTAO-S | CTAO South |
| ELT | Extremely Large Telescope |
| ERIC | European Research Infrastructure Consortium |
| ESO | European Southern Observatory |
| FAT | Factory Acceptance Test |
| GPS | Global Positioning System |
| HVAC | Heating, Ventilation, and Air Conditioning |
| INAF | Istituto Nazionale di Astrofisica |
| KIP | Key Inspection Points |
| LC | Lucent Connector (fibre optics) |
| MENNEKES | (Standard for industrial power connectors) |
| PDU | Power Distribution Units |
| QA | Quality Assurance |
| QC | Quality Control |
| SAT | Site Acceptance Test |
| SoW | Statement of Work |
| SWA | Steel Wire Armoured |
| TRR | Test Readiness Review |
| UPS | Uninterruptible Power Supply |
| UTM | Universal Transverse Mercator |
| VLT | Very Large Telescope |
| WGS84 | World Geodetic System 1984 |

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1 Introduction and Scope

1.1 Introduction

The Cherenkov Telescope Array Observatory (CTAO) is an international effort to build the next generation ground-based observatory for gamma-ray astronomy at very-high energies with more than 60 telescopes located in the Northern and Southern hemispheres. The CTAO will be the world's largest and most sensitive instrument for the detection of high-energy gamma rays. With a detailed design and preparation for construction underway it will be built with a significant number of in-kind contributions from participating institutions.

In January 2025, the [European Commission](#) established the Cherenkov Telescope Array Observatory (CTAO) as a [European Research Infrastructure Consortium \(ERIC\)](#). The ERIC legal headquarters are located in Italy and hosted by INAF in Bologna.

The CTAO Central Organisation (CTAO ERIC) is in charge of the construction and operation of the Observatory. The CTAO has two telescope sites, one in the Northern hemisphere on La Palma (Canary Islands, Spain) and one in the Southern hemisphere in the Atacama Desert in Northern Chile, as well as the Science Data Management Centre in Zeuthen, near Berlin (Germany). Further information about the project can be found here: www.ctao.org.

The CTAO Central Organisation is funded by scientific institutions and governmental agencies from more than [10 countries and an intergovernmental organization](#), and it works closely with the [CTAO Consortium](#), scientific collaboration that includes more than 1,500 participants from 25 countries, and the [In-Kind Contribution Collaborations](#).

The [European Southern Observatory \(ESO\)](#) is an intergovernmental astronomy organisation in Europe and the world's most productive astronomical observatory. Supported by its Member States, ESO operates advanced ground-based observatories in Chile, providing state-of-the-art research facilities to astronomers worldwide. ESO's mission is to design, construct, and operate powerful observing facilities and foster international collaboration in astronomical research, enabling groundbreaking discoveries about the universe.

1.2 Scope

This Statement of Work (SoW) is concerned with the Design, Manufacturing, Transport, and Commissioning of a Containerized Data Centre at the CTAO-South in Chile. The goal is to provision a containerized Data Centre, to be deployed on the CTAO-South site, for the commissioning, integration, acceptance and initial data taking of the first seven telescopes. This document outlines all required activities and supplies for the design, manufacturing, transportation, on-site installation and commissioning of the Data Centre, in compliance with the required technical specifications.

1.2.1 Naming Conventions

Shall In this document *shall* indicates an obligation or a commitment on the part of the Contractor or of CTAO.

Will In this document *will* indicates an action which will occur in the future, without implying a firm commitment on the part of CTAO or of the Contractor.

1.3 Applicable and reference documents

1.3.1 Applicable documents

The following applicable documents (AD) form a part of this document to the extent described herein. If not explicitly stated otherwise, the latest issue of the document is valid. In the event of conflict between the documents referenced herein and the contents of this document, the contents of this document are considered a superseding requirement.

| | |
|-------------|---|
| AD-1 | Data Centre South: Procurement Specifications (Part of this Package) |
| AD-2 | Rules and Regulations for contractors on the CTA-S site D10000001009692 C001/F 9 Jan 2025 |
| AD-3 | CTAO Construction – Safety Manual D10000001009798 A001/F 10 Sep 2024 |
| AD-4 | ESO Routing and Packing Instructions (Annex VI) |

2 Scope of Work

2.1 Data Centre CTAO-South

The Data Centre CTAO-South is a critical component for the initial stages of the Cherenkov Telescope Array Observatory (CTAO). It is designed to deploy the software, storage, and network infrastructure essential for the commissioning, integration, acceptance, and operation of the initial telescopes at the CTAO-South Array Site.

The Data Centre will be containerized and provide a controlled environment equipped with robust UPS power, fire detection and suppression, and cooling systems to support continuous operation in the challenging conditions of the observatory site. Power will be provided by a CTAO generator, which will also be responsible for powering the telescopes. The interface with the telescopes will be realized via optical fibre cables, ensuring reliable data transmission for telescope control and camera readout.

Computing servers, storage and network will be part of a separate tender process.

This project is time-critical for CTAO, as the data centre is expected to be operational on-site by Q2 2026 to support the telescope's construction. Therefore, the work outlined in this Statement of Work (SoW) shall be completed within the required timeframe to ensure the availability of computing facilities.

The Contractor shall perform all engineering and management tasks associated with the SoW in accordance with the Applicable Documents and good engineering and management practice. All equipment and materials shall be new and without prior use. It is specifically mentioned here that implementation and control of safety, for what concerns both the safety of the containerized Data Centre operation and the managing of safety during the execution of the project, shall be strictly applied by the Contractor.

The Contractor shall, as a minimum but not limited to, perform the tasks listed in this document to ensure the design and operation of the Data Centre is in compliance with the Technical Specification in [AD-1] and all related applicable documents, and perform any other task, which may be necessary for this purpose, even if not specifically listed here.

2.2 CTAO-South

CTAO-South is located in the Atacama Desert in the Northern part of Chile, approximately 120 km south of Antofagasta and 25 km inland from the Pacific Coast. It is situated on European Southern Observatory (ESO) property, close to Paranal, the Very Large Telescope (VLT), and the Extremely Large Telescope (ELT).

Positioned at an elevation of approximately 2,100 – 2,200 m above sea level, the site has the following geographical coordinates:

- Support Site: WGS84, UTM zone 19J (longitude 72W/66W, latitude 32S/24S) 7267550N, 365000E (approximately)
- Array Site: 7269466N, 366822E for the centre of the telescope array site, Figure 1.

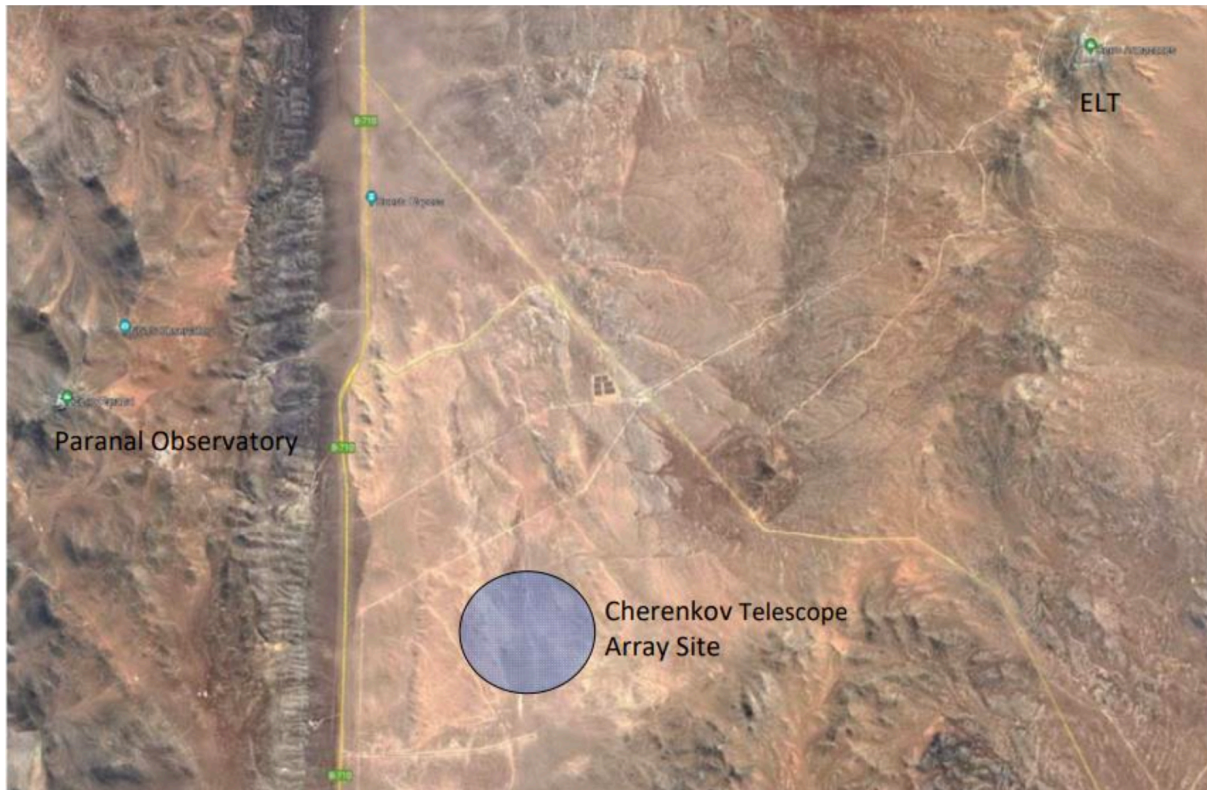


Figure 1 Location of the CTAO-South Site.

2.3 Technical Specifications

2.3.1 Specifications

See [AD-1] for the detailed set of technical specifications.

2.3.2 Design Elements

The containerized Data Centre design shall contain, at least the following elements:

- Container of sufficient size,
- Foundation Design,
- Internal lighting,
- A set of at least five 19-inch (42U) computing racks (800x1200mm),
- Cable trays and cable management hardware,
- Uninterruptable Power Supply (UPS), to clean incoming power and protect computing elements via battery and automatic shutdown,
- Separated internal power circuits for HVAC, Racks and General-purpose outlets,
- A complete set of Power Distribution Units (PDUs), at least four of which should be remote controllable,
- Internal grounding system

- Interface to CTAO external grounding system,
 - provide at least 2 (two) marked-up for purpose connection points to the external underground earthing grid, provided by CTAO. The grounding- and bonding system of the container shall be internally connected to these points.
- Internal environmental monitoring sensors, able to measure temperature, humidity, airflow and noise levels,
- HVAC system rated to the computing elements to be deployed and which considers the special circumstances of the CTAO-South site (outlined in Technical Specifications [AD-1]), particularly the low humidity levels,
- A fire detection and suppression system that makes use of a gas. The gas system employed shall be suitable for use in Chile,
- Feedthroughs for GPS antenna cable and optical fibre cables,
- Security measures to prevent unauthorized access.

2.3.3 Interfaces

2.3.3.1 Foundation

The Contractor shall prepare the design for the foundation. The foundation will be constructed by CTAO prior to delivery. The Contractor shall coordinate with the CTAO to define structural load requirements, soil characteristics, anchoring methods, and seismic considerations for the containerized Data Centre. The CTAO and ESO will provide the geotechnical information of this area for the design of the foundations. The foundation must support the weight distribution of the container. Grounding and bonding interfaces shall be specified to ensure electrical safety and compliance with relevant standards. Any foundation penetrations for power, cooling, or network connections must be pre-defined to align with the container's interface points, ensuring seamless integration and installation.

2.3.3.2 Power

CTAO will provide the power for the Data Centre via an external generator. The generator will be responsible for powering not only the Data Centre but also the Array Elements including the telescopes. The generator is expected to provide the Container with 400/230 Volts at 50 Hz.

The container shall be power fed by an external plug of type MENNEKES. Vendor shall provide the plug together with the corresponding female part (socket). The plug shall be easily accessible on the outside of the container in a weatherproof cover, IP65 or better.

2.3.3.3 Fibre Optic Cables

A total of up to 12 optical fibre cables will enter the container from telescopes, array calibration devices and the CTAO support site. Each cable is expected to have a diameter of no more than 2 cm and will come pre-fitted with LC-connectors.

CTAO will be responsible for pulling the fibre cables into the container.

2.3.3.4 GPS Antenna

A GPS antenna, provided by CTAO, will be placed on the roof of the container. The design of the Container shall include a place to mount this antenna, for example by providing a rod

installation or mounting plate and corresponding feedthroughs for the antenna cable. Full details to follow.

2.4 Project Key Milestones

CTAO proposes the following tentative schedule with related Key Milestones of the project which may be modified and shall be agreed upon with the Contractor prior to contract signature:

| Milestone Number | Project Schedule and Key Milestones | Estimated Date |
|------------------|---|----------------------------|
| 0 | Contract Signature | T ₀ |
| 1 | Kick-off meeting | T ₀ +1 week |
| 2 | Delivery of Engineering and Design Packages | T ₀ +1 month |
| 3 | Design Review | T ₀ +1.5 months |
| 4 | Factory Test Readiness Review | T ₀ +6 months |
| 5 | Factory Acceptance Test | T ₀ +6 months |
| 6 | Acceptance Readiness Review | T ₀ +9 months |
| 7 | Site Acceptance Test at CTAO-South | T ₀ +9 months |
| 8 | Training of CTAO Personnel | T ₀ +10 months |
| 9 | Readiness for operation | T ₀ +10 months |

Table 1 Project Key Milestones

2.5 Definition of Project Phases

2.5.1 Design (Phase 1)

During the design phase, the Contractor shall gather all relevant information for the outfitting of the container. The Contractor will also need to prepare the detailed engineering of the project and submit the relevant 'as-designed' documentation for review and approval, including the design for the foundation. This phase is intended for finalizing details within the scope of the tendered design and shall not introduce significant technical modifications.

The Contractor shall prepare a test plan which includes factory acceptance tests (FAT) and site acceptance tests (SAT) that shall provide the test procedures, with individual parameter acceptance criteria, at the latest at Test Readiness Review (TRR) for CTAO's approval.

After successfully passing the design review and receiving the written approval of the design by CTAO, the Contractor may proceed to Phase 2.

2.5.2 Construction (Phase 2)

Once the detailed engineering project has been approved by CTAO, the Contractor may commence the construction and outfitting of the Container.

After successfully passing the design review the design will be under configuration control and every future change shall follow the change request process.

During this period CTAO will construct the foundation, based on the Contractor supplied design.

2.5.3 Factory Acceptance Testing (Phase 3)

Factory Acceptance Testing (FAT) shall be conducted to verify that all components of the system meet the required specifications before shipment and the Contractor shall provide detailed test procedures beforehand for approval by CTAO. The following checks and tests shall be performed as part of the FAT process:

2.5.3.1 Structure

- Inspect door seals and airtightness,
- Ensure all mounting points, supports, and enclosures are properly installed.

2.5.3.2 Power

- Confirm all power related wiring is properly routed and labelled and the power socket is installed as specified.

2.5.3.3 Environmental

- Cross-check environmental sensor readouts using a calibrated device.

2.5.3.4 Fire Detection and Suppression

- Test fire detection system,
- Ensure alerts are active,
- Verify correct installation of the fire suppression system.

2.5.3.5 Security

- Check door locks and other access control methods.

2.5.3.6 System Testing

- Perform full load power and HVAC tests,
- Conduct power failure tests, including automatic handover.

2.5.4 Transport (Phase 4)

All equipment and materials shall be transported in accordance with Incoterm DPU (Delivered at Place Unloaded), with the designated delivery location specified in Section 2.2. The Contractor shall be responsible for all transportation costs, export clearance, freight, and unloading of the goods at the specified site. CTAO shall be responsible for import clearance, duties, and any applicable taxes in collaboration with ESO. The Contractor shall provide all necessary shipping documentation, including the Bill of Lading, Commercial Invoice, Packing List, and any required customs documentation, according to the ESO Packing and Shipping Instructions [AD-4].

The Contractor shall comply with the following regulations:

- **Fumigation Requirements:** Wooden crates entering Chile must adhere to NIMF 15 regulations. Fumigation certificates must accompany the shipping documents and shall be sent in advance to CTAO.
- **Hazardous Materials & Chemical Import:** The Contractor must comply with all Chilean regulations in effect at the time of transport regarding the import of hazardous and controlled chemicals and ozone-depleting substances. These regulations are detailed in the Logistics Annex "Routing and Packing" of the contract.

During this phase CTAO and ESO will support any customs clearance processes to the site and instructions related to paperwork for import to Chile. For this process the Contractor shall provide to CTAO the required shipping documents.

The Contractor shall be responsible for all damages and losses as may occur during transport and shall ensure that adequate insurances are in place prior to shipments leaving the Contractors or Sub-Contractors premises.

The Contractor shall provide all the resources and equipment, required for the unloading on-site, considering that the unloading area is unpaved. CTAO will not provide any means for supporting this activity. The route to the final deployment will be a stabilized road, however the final approximate 500 metres could be unpaved desert.

The Transport Phase shall be completed by an Incoming Inspection at CTAO-South Site with the system mechanically installed and securely fixed on its foundation under the responsibility of the Contractor. The Contractor shall report to CTAO immediately any deficiency or damage which may have occurred during transport and/or those discovered upon arrival on the CTAO-South Site, with associated supporting material and technical reports, and take remedial action as soon as practicable. Any found defects shall be documented by the Contractor. CTAO may choose to participate in this incoming inspection process.

2.5.5 Deployment (Phase 5)

At the CTAO-South Site the following items shall be considered:

- Preparation of site and survey of deployment location,
- Confirmation that the site is accessible for the delivery vehicle and coordination with on-site personnel,
- Ensure that the required lifting handling equipment (e.g. crane and forklift) is available for the placement of the container,
 - At least two weeks before arrival documentation regarding compliance with local regulations and lifting plan will be available for review by CTAO personnel,
- Fixation of the container,
- Integration with the CTAO power system, connecting power cable to the container and energizing the UPS,
- Integration with lightning protection and grounding.

2.5.6 Site Acceptance Testing (Phase 6)

Upon completion of construction, the Contractor shall perform verification of the completed installation. The documented results must be submitted together with the "as-built"

documentation (see Section 4.4 for the minimum documentation to be submitted) for review and approval by CTAO. The Contractor shall verify the following aspects of the installation.

2.5.6.1 Structure

- Inspection for damage sustained during transport or installation,
- Ensure the container is levelled and secure,
- Inspect door seals and airtightness,
- Confirm all power related wiring is properly routed and labelled,

2.5.6.2 Power and Electrical

- Incoming power is of the correct voltage, phase sequence, and frequency,
- UPS battery checks (connection and voltage),
- Load testing of the UPS and automatic transfer to battery,
- Installation and testing of any fuses or RCDs,
- Measurement of ground resistance and of the installation of the lightning protection.

2.5.6.3 Environmental

- Test of HVAC system under load,
- Cross-check environmental sensor readouts using a calibrated device,

2.5.6.4 Fire Protection

- Test detection system,
- Demonstrate alerts are active,
- Verify correction installation of the fire suppression system.

2.5.6.5 Security

- Check door locks and other access control methods.

2.5.6.6 Training of CTAO Personnel

- Training on maintenance procedures and operation of the installed equipment, including (but not limited to) HVAC, UPS, and fire suppression system,
- Fire drills and security response training.

3 Project Organization and Control

3.1 General Requirements

The Contractor shall establish and maintain an efficient project organization to fulfil the objectives of this contract. The Contractor's project management office will be responsible for coordinating and overseeing all technical, commercial, and resource-related activities, ensuring effective management across all disciplines required for the successful execution of the contract. All personnel assigned to the project shall be appropriately trained and qualified.

3.2 Personnel

For all personnel working on the CTAO-South Site, the Contractor shall provide the following information, according to what is established in the Rules and Regulations for Contractors at CTAO-South [AD-2, AD-3]:

- List of personnel assigned to the project (role, discipline, etc.),
- CV of the proposed professionals.

3.3 Equipment and Machinery

The Contractor shall provide CTAO during the contract, with the following information:

- List of equipment and machinery that would be assigned to the project, including their purpose in the activity.
- Technical information of the equipment/machinery (photo, year of manufacture, etc.).
- Proof of correct calibration of any equipment used to make measurements relating to the technical specifications.

The Contractor shall be responsible for the safety of its equipment and machinery. Neither CTAO nor ESO will not be responsible safety and security.

3.4 Communication and Reporting

At the beginning of the contract, a Kick-off Meeting shall be held, during which at least the following items must be covered:

- Presentation of the team and the Contractor's internal organization,
- Presentation of the schedule,
- Clarify any doubts and/or confirm pending information,
- Nominate a single point of contact, with the authority to take technical and commercial decisions.

Regular coordination meetings should also be held, monthly during container outfitting and once per week during work on-site. Progress reports shall be provided 1 week before the monthly meetings.

As a minimum, during meetings the following points should be discussed:

- Progress report, including issues found and/or suggested changes
- Review of the schedule and work plan for the following period
- Presence of personnel on site anticipated for the following period
- Provision of materials, vehicles, machines, equipment, etc., for the following period

For any coordination meeting, CTAO will prepare the corresponding minutes, which must also be reviewed and signed by the Contractor. The cadence of the meetings will depend on the stage of the project and will be agreed on between CTAO and the Contractor.

3.4.1 Red Flag Report

A "Red Flag Report" shall be issued by the Contractor within 48h of occurrence of any major problem or event, which has the potential to jeopardize the timely delivery of the project, the achievement of a contract key milestone, or the achievement of the technical performance. This reporting shall apply to major problems at all levels (including safety issues).

3.5 Reviews, Inspection, and Meetings

3.5.1 Reviews

3.5.1.1 Design Review

The Design Review is a scrutiny down to detailed drawings of the complete design. The objective of this review is to check the conformity of the final design with the Technical Specification.

At the Design Review all system aspects shall be specifically addressed through dedicated documents (or sections of documents) included in the data package and dedicated sessions at the review meetings.

3.5.1.2 Test Readiness Reviews

The objective of the TRRs is to verify the readiness of the completely assembled Container to start performance and FAT and SAT:

- The assembly and integration of the Container is completed, and the system is fully operational.
- Approved deviations from the design and manufacturing file are known and documented, including if relevant, any Change Request (CR), Request for Waiver (RFW) and Non-Conformance Reports (NCRs).
- Any remaining open work is known, and it does not influence the planned tests. No open work related to safety is remaining.
- The Test/Inspection Plan and approved procedures are available and up to date.
- Any test tool as defined in the relevant Test Procedure is available and calibrated as needed.

The TRR consists, as a minimum, in a review by CTAO of the related documentation provided by the Contractor and by a joint inspection of the hardware. Formal minutes of meeting shall be held including record of the joint inspection. The successful completion of the TRR allows the FAT or SAT to start.

3.5.1.3 Provisional Acceptance Review

The Provisional Acceptance Review takes place after completion of the SAT at the CTAO-South site. The Contractor shall prepare all Test/Inspection Reports, except for the cases of tests performed by CTAO and deliver the complete documentation package.

The purpose of the review is to verify that all activities specified in this Statement of Work have been completed, that all supplies have been delivered in accordance with the conditions of the Contract and that the product can be handed over to CTAO.

3.5.2 Inspection Points

The Quality Plan, see Section 3.9, shall outline all envisioned inspections and Key Inspection Points (incoming inspections, workmanship inspections, inspections for verification of requirements, etc.). All inspections shall produce an inspection report that is approved and released, and any defects/failures shall be recorded via NCRs.

The Contractor shall inform CTAO about the execution of the Key Inspection Points (KIPs) at least 5 working days in advance and CTAO reserves the right to attend specific KIPs during manufacturing.

3.5.3 Meetings and Progress Reviews

The Contractor shall plan and prepare project meetings and reviews in consultation with CTAO, particularly with regard to the agenda, participants and contents of the meeting.

CTAO reserves the right to be assisted during any meeting and review by experts of its choice.

Unless otherwise agreed, the CTAO shall write the minutes for all formal meetings between the Contractor and CTAO. The minutes shall include an Action Item Record. Both parties shall agree on the content and sign the minutes before the meeting is closed.

3.5.3.1 Kick-Off Meeting (KOM)

The Kick-Off Meeting shall take place within 1 week from Contract signature at the Contractor's premises. The aim is to clarify with the Contractor all technical and managerial aspects required for the execution of the project with particular emphasis on communication rules, and other organizational matters, such as key personnel, responsibilities, and documentation issues.

The Contractor shall present at the Kick-Off meeting the general planning of the project and project phases, with particular details related to the design and quality assurance aspects.

3.5.3.2 Progress Meeting

Regular Progress Meetings shall be held at the Contractor's premises or by Video Conference, to be agreed on case by case, on a monthly basis and weekly in person on-site during the installation-and-commissioning period. The purpose of a progress meeting is to review the

progress of work, both on technical and programmatic aspects, and to highlight and discuss problems or issues in need of special consideration and to determine appropriate corrective measures to be taken. The Progress Meeting shall cover the entire scope of the contract, including programmatic, contractual and technical and safety aspects. For the progress meetings at the Contractor's premises the Contractor shall propose an agenda and provide a Progress Report not later than 1 week ahead of the meeting and agree it with CTAO.

The PowerPoint slides presented at all meetings shall be delivered to CTAO in electronic format before the meeting is held unless otherwise agreed by CTAO.

3.5.3.3 Technical Meetings

In case technical clarifications are necessary, which cannot be covered by the regular progress meetings, either for scheduling reasons or for their technical complexity, technical meetings shall be arranged. They can be requested by CTAO or the Contractor and shall be held as mutually agreed for scheduling and location.

3.6 Configuration Control

The Contractor shall apply Configuration Control according to their own Configuration Control Plan. The implementation of the Configuration Control shall ensure as a minimum:

- The manufacturing file is in line with the design documentation and the product is in line with the manufacturing documentation,
- The activities performed in verifying the product (*analyses, demonstrations, and tests*) have been performed against the configuration of the delivered product,
- The design as presented to CTAO in the engineering review by the Contractor is not changed without prior notice to CTAO,
- Deviations from the requirements of the Technical Specifications are properly documented and submitted to CTAO via RFWs or CRs (see Appendices),
- Effective change control is established and maintained on the configured items,
- All affected participants in the project are aware of changes and participate in the evaluation of their impact.

To satisfy these objectives the Contractor shall, as a minimum:

- Identify, release and manage all the technical documentation that defines the configuration of the end product,
- Control, coordinate, approve or reject, and implement changes to the configuration of the end product whose configuration has been reviewed by CTAO and/or put under configuration control,
- Account all documentation that describes the status of an end product at any point in time,
- Produce a Configuration Item Data List (CIDL), describing the status of the product configuration.

The format of the CIDL will be proposed by CTAO unless it is already pre-defined by the Contractor.

All applicable technical documents, which define the product, shall be put under configuration control at the Design Review.

For the changes of all documents under configuration control change procedures shall apply.

3.7 Change Request Process

All technical changes shall follow the subsequent process:

- A formal Change Request (CR) can be raised by the CTAO or the Contractor,
- The request shall be reviewed, analysing the technical, performance, schedule, and cost impacts of the proposed change. For the technical review corresponding subject-matter experts shall be identified and involved. If deemed necessary by the initiator based on the feedback received, the CR might have to be re-worked and the technical review be repeated, or the CR could be withdrawn.
- The corresponding outcome of the process shall be communicated to all affected parties and then changes shall be implemented. Once all documentation has been updated, the CR process has been completed.

For a template of a CR form please refer to Appendix A. Once prepared, a CR form (MS Word or text format) shall be submitted via e-mail to the involved parties to initiate the process. A CR shall be processed within 10 working days.

Although not covered by the description above, managerial and programmatic changes shall also follow a change request process.

3.8 Request for waiver process

If during the execution of the whole project items do not result to be compliant with the specified requirements, the Contractor shall notify CTAO by issuing an NCR according to their Quality Control Plan.

Thereafter, and with no reasonable remedy for such non-compliance, the Contractor is entitled to submit to CTAO a request for waiver. CTAO will accept or decline the waiver based on economical, technical and schedule considerations. The process follows the same steps as described in the previous section.

For a template of a Request-for-waiver form please refer to Appendix B.

3.9 Quality Management

The Contractor shall issue a Quality Plan including Quality Assurance (QA) and Control (QC), which must be approved by CTAO before any construction activities, including those on-site, commence. The Contractor shall implement all activities required by the approved Quality Plan throughout the entire project. This plan shall also be enforced on subcontractors to the extent necessary for the proper execution of the project.

At a minimum, the QA activities to be carried out during the execution of the contract must be identified, as well as what type of quality records and documentation must be collected and/or prepared. The corresponding records must be controlled and delivered for the following items:

- Power systems and maintenance documentation,
- Correct installation and testing of the UPS, PDUs, and grounding systems,
- Performance tests of air conditioning, airflow, and humidity control,
- Installation and functionality check of fire detection and suppression systems,
- Proper installation and labelling of equipment,
- Load testing of power and cooling systems at full capacity,
- Submission of as-built drawings, certifications, and inspection records.

3.10 Risk Management

The Contractor shall establish and maintain a risk management process that identifies the risks to the project, their impact and possible mitigation actions to lower the risk and/or the impact. The process shall pay particular attention to risks relating to critical hardware, software, processes, documentation, as well as physical and functional interfaces.

The Contractor shall identify its procedures related to the assessment and the control of project risks (performance, schedule...). More specifically the Contractor shall keep an updated Risk Register to be reviewed, as a minimum, at each Progress Review, and upon request by CTAO.

3.11 CTAO Rights

For the purpose of this project, CTAO shall be granted access to the Contractor's facilities involved in the project with sufficient notice, and not involving the disclosure of proprietary design, processes, inventions, or any information of commercial nature. This includes also auditing of QC activities.

During the on-site construction activities, CTAO personnel reserves the right to visit and inspect the Contractor's work sites at any time. CTAO staff may also request the submission of relevant documentation, such as QA protocols, certificates, or other materials related to the execution of the work, for review. CTAO reserves the right to bring in external experts to support CTAO in managerial and technical areas of this project.

In the event of serious misconduct on-site involving the safety of personnel or any actions that pose a risk to CTAO or third-party facilities, CTAO personnel have the authority to suspend work immediately. Operations will remain halted until the situation is addressed and resolved in coordination with the Contractor's on-site representative(s) and CTAO.

3.12 Safety Management

3.12.1 Site Safety

For the installation, testing and commissioning at the Contractor's facility, safety shall be covered by the Contractor's factory applicable safety regulations, for Chile the Contractor shall designate a Site Safety Delegate with authority and responsibility for all safety-related aspects. This includes as a minimum:

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- Review and supervise all safety relevant installations, procedures and operations on CTAO-South Site to ensure compliance with the contractor's site safety manual, the specified requirements of [AD-2], and applicable European and Chilean legislation,
 - Maintain the Hazardous Material List (Hazmat),
 - Perform training of Contractor's personnel in line with the valid requirements above on all relevant safety issues and procedures,
 - Stop the work in case of danger for life and limb and order immediate mitigation in cases of non-compliance with safety measures and procedures,
 - Evacuate from the Site personnel (repeatedly) breaching safety rules,
 - Maintain appropriate safety log(s),
 - Ensure treatment of any accident or safety relevant mishap (including near-misses) according to valid rules and regulations.

The Contractor and their subcontractors shall provide to their personnel all necessary safety equipment which must be approved by CTAO's safety engineer.

The Contractor must establish and maintain effective prevention and occupational safety management, in accordance with the rules and regulations in force, and appropriate to the activities being carried out, its location and its environment. The Contractor shall ensure that all aspects described in [AD-2] and [AD-3] are met.

3.12.2 Product Safety

The Contractor shall deliver all equipment with CE marking and the Declaration of Conformity. This shall be demonstrated during FAT and at the latest during acceptance. The information shall be delivered to CTAO. All relevant basic, generic, and product specific directives for the CE marking process shall be applied by the Contractor.

The Contractor shall prepare and update a Hazard Analysis during the design phases to comprehensively assess the safe design, operation and maintenance of the system and its subsystems.

4 Deliverables

4.1 Products

The Contractor shall deliver the following products:

- Container of sufficient size,
- Internal lighting,
- A set of at least five 19-inch (42U) computing racks (800x1200mm),
- Cable trays and cable management hardware,
- Uninterruptable Power Supply (UPS),
- Separated internal power circuits for HVAC, Racks and General-purpose outlets,
- A complete set of Power Distribution Units (PDUs), at least four of which should be remote controllable,
- An internal grounding system and means for connection to CTAO grounding system, for electrical safety,
- Internal environmental monitoring sensors,
- HVAC system,
- A fire detection and suppression system,
- Feedthroughs for GPS antenna cable and optical fibre cables,
- Security measures to prevent unauthorized access.

4.2 Services

The Contractor shall provide the following services:

- Container transportation, placement and fixation,
- Power System Integration,
- Cooling and HVAC System Installation and testing,
- Fire Detection and Suppression System setup and testing,
- Quality Control Inspections & Testing (FAT, SAT, Load Testing),
- As-Built Documentation and Compliance Certification,
- Licenses for supplied equipment (if applicable),
- Training for On-Site Personnel on Operations and Maintenance.

4.3 Consumables

The Contractor shall provide all consumables and materials required to carry out the work outlined in this scope of work.

4.4 Documentation

The Contractor shall prepare at least the following documents for the design review ("as-designed"):

- Detailed engineering report, including detailed technical specifications:

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- Including mean time between failure values for equipment in particular the HVAC system,
 - Estimates of the number of spare parts required for HVAC, fire protection and UPS systems on a 3- and 5-year time scales,
 - Installation drawings including corresponding details ("as-designed"),
 - Work plan and schedule,
 - Quality Plan.
 - Foundation design

For final acceptance, at least the following documentation must be submitted:

- Updated detailed engineering report, including any deviations,
- Installation drawings including corresponding details ("as-built"),
- Material Certificates,
- Records of inspections and other quality controls, according to the quality assurance protocol,
- Test reports and verification logs.

5 Appendix A: Change request form

(Please send the described information in MS Word format or in text form to the Configuration Management Specialist.)

Change Request (CR) Form

CR document number: (to be inserted by CTAO):

Date:

CR Title:

Requested by:

Affected subsystems:

Affected document(s) to be revised:

Impact on:

☐ Requirements Science ☐ Cost/Resources ☐ Schedule ☐ Safety ☐ Technical
☐ Operation ☐ Other:

CR Description:

- Detailed description of proposed change:
<Describe what exactly should be changed, and how; if new formulations are considered, please include the proposed wording already here>
- Justification:
<Describe the rationale for this change – why is this change needed?>
- Impact statement(s):
<If this change is made, which parts of the system are affected, and how? List here all anticipated impact items individually, per affected sub-system or work package.>
- Summary of impact (state concerns and/or merit per impact area):
<Include a summary of your concerns and/or merits related to the above-mentioned impact items.>
- Risk of approving/not approving the change:
<Are there any relevant risks for the observatory related to approving or not approving this CR?>
- Affected products to be modified:
<Include a list of products and/or documents that would have to be modified if the proposed change would be approved.>
- Any other information:
<Include here any other information deemed relevant for the assessment of this CR.>

CCB disposition: (this information will be added during the process)

Signatures: (approval signatures will be defined and acquired during the process)

6 Appendix B: Request-for-waiver form

(Please send the described information in MS Word format or in text form to the Configuration Management Specialist.)

Change Request (RFW) Form

RFW document number: (to be inserted by CTAO):

Date:

CR Title:

Requested by:

Affected subsystems:

Affected document(s) to be revised:

Impact on:

☐ Requirements ☐ Science ☐ Cost/Resources ☐ Schedule ☐ Safety ☐ Technical
☐ Operation ☐ Other:

RFW Description:

- Detailed description of the request for waiver:
<Describe exactly the deviation and the non-conformance; elaborate on the possibilities to address the deviation.>
- Justification:
<Describe the rationale for this waiver – why is this the best choice of the alternatives?>
- Impact if waiver if approved (state concerns and/or details per impact area):
<List here all anticipated impact items individually, per affected sub-system or work package.>
- Impact if waiver is not approved (impact on cost/resources and/or schedule):
<List here impact on cost/resources and/or schedule if the waiver is not approved, per affected sub-system or work package.>
- Any other information:
<Include here any other information deemed relevant for the assessment of this RFW.>

CCB disposition: (this information will be added during the process)

Signatures: (approval signatures will be defined and acquired during the process)