



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

2025-06-27

Prepared by (1)	G. Hughes, CTAO On-site ICT WP Coordinator
Prepared by (2)	H. Prokoph, CTAO CLK WP Coordinator
Reviewed by (1)	S. Schlenstedt, CTAO Computing Coordinator
Reviewed by (2)	Bernhard Lopez, CTAO Site Systems Engineer (Acting QA Engineer)
Approved by	M. Miccolis, CTAO Project Manager

Revision History				
Issue	Rev.	Created	Reasons / Remarks / Section	Author
1	A001	2025-01-21	Initial Draft	G. Hughes

Authors	
First/Last Name, Organisation	Contribution Subject/Chapter
Gareth Hughes, CTAO	All Sections
Heike Prokoph, CTAO	All sections.

Abbreviations	
CE	Conformité Européenne
CTAO	Cherenkov Telescope Array Observatory
DLP	Defect Liability Period
ESO	European Southern Observatory
FAT	Factory Acceptance Testing
GPS	Global Positioning System
HVAC	Heating, Ventilation, and Air Conditioning
ICT	Information and Communication Technology
ICD	Interface Control Document
ISO	International Organization for Standardization
LC	Lucent Connector (fibre optics)
MENNEKES	(Standard for industrial power connectors)
NCH	Norma Chilean (Chilean Standard)
NCR	No-Collapse Requirement
NEC	National Electrical Code
NO	Nitric Oxide
NO2	Nitrogen Dioxide
NTP	Network Time Protocol
PDU	Power Distribution Unit
SAT	Site Acceptance Testing
SNMP	Simple Network Management Protocol
UPS	Uninterruptible Power Supply
VRLA	Valve Regulated Lead Acid
WGS84	World Geodetic System 1984
WR	White Rabbit (Precision Timing Ethernet)

Table of Contents

1	Introduction.....	5
1.1	Scope.....	5
1.2	Conventions and Glossary.....	5
1.2.1	Naming Conventions.....	5
1.3	Verification Methods.....	5
1.4	Applicable and reference documents.....	6
1.4.1	Applicable documents.....	6
2	Product Description of the Intermediate Data Centre.....	7
2.1	Components and Equipment.....	7
3	Environmental Conditions for CTAO-South.....	8
3.1	Environmental Conditions.....	8
3.1.1	Meteorological and Natural Site Characteristics.....	8
4	Characteristics.....	9
4.1	Physical Infrastructure.....	9
4.2	Environmental.....	10
4.3	Electrical.....	11
4.4	UPS.....	13
4.5	HVAC.....	Errore. Il segnalibro non è definito.
4.6	Warranty.....	13
4.7	Documentation.....	14
5	Design and Construction.....	16
6	Verification Requirements.....	16

Index of Figures

No table of figures entries found.

Index of Tables

Table 1 CTAO-South Environmental Conditions	8
Table 2 Requirements: Infrastructure	10
Table 3 Requirements: Environmental.....	11
Table 4 Requirements: Electrical	13
Table 5 Requirements: UPS	13
Table 7 Warranty Requirements	14
Table 8 Documentation Requirements	15

1 Introduction

1.1 Scope

This specification defines the minimum requirements and characteristics for purchase, construction, testing, transportation and on-site installation of the Intermediate Containerized Data Centre for the CTAO-South site in Chile. This includes:

- Design of the Data Centre Container,
- Manufacturing of the Data Centre Container,
- Factory Acceptance Test (FAT),
- Transport of the Data Centre Container to the site and installation/integration with CTAO infrastructure,
- Training of CTAO personnel on the use of the Data Centre equipment (e.g. fire suppression, execution of maintenance tasks, etc ...),
- Site Acceptance Test (SAT), and
- Ongoing support.

1.2 Conventions and Glossary

1.2.1 Naming Conventions

<i>Shall</i>	In this document <i>shall</i> indicates an obligation or a commitment on the part of the Contractor or of CTAO.
<i>Will</i>	In this document <i>will</i> 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 Verification Methods

The following verification methods shall be applied:

- **Analysis (A):** Verification by Analysis consists of the use of analytical data or simulations under defined conditions to show theoretical compliance. Analysis (including simulation) is used where verifying to realistic conditions cannot be achieved or is not cost-effective and when such means establish that the appropriate requirement, specification, or derived requirement is met by the proposed solution.
- **Certification (C):** Verification by Certification consists of written assurance that the product or article has been developed and can perform its assigned functions in accordance with legal or industrial standards. The development reviews and verification results form the basis for certification; however, certification is typically performed by outside authorities, without direction as to how the requirements are to be verified. For example, this method is used for electronics devices via CE certification in Europe.
- **Demonstration (D):** Verification by Demonstration consists of a qualitative exhibition of functional performance, usually accomplished with no or minimal instrumentation. Demonstration (a set of verification activities with system stimuli selected by the system developer) may be used to show that system or subsystem response to stimuli

is suitable. Demonstration may also be appropriate when requirements or specifications are given in statistical terms.

- **Inspection (I):** Verification by Inspection consists of performing an examination of the item against applicable documentation to confirm compliance with requirements. Inspection is used to verify properties best determined by examination and observation.
- **Review of Design (R):** Verification by Review of Design consists of using approved records or evidence that unambiguously show that the requirement is met. For example, design documents and reports, technical description documents, and engineering drawings.
- **Test (T):** Verification by Test consists of an action by which the operability, supportability, or performance capability of an item is verified when subjected to controlled conditions that are real or simulated. These verifications often use special test equipment or instrumentation to obtain very accurate quantitative data for analysis.

1.4 Applicable and reference documents

1.4.1 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: Statement of Work (SoW) (Part of this Package)
AD-2	BS EN 50600-2-4:2019
AD-3	ISO/IEC 14763-2:2019
AD-4	Norma Chilena 433 of 1996 modified in 2012
AD-5	ISO IEC 30129:2015
AD-6	NEC IEEE 142:2007

2 Product Description of the Intermediate Data Centre

The Cherenkov Telescope Array Observatory (CTAO) is expected to begin deploying telescopes at its Southern site in Q1 2026. In order to support the construction, testing, integration, acceptance, and operation of the telescopes a containerized Data Centre is required.

The CTAO-South site is located less than 10 km southeast of the European Southern Observatory's (ESO's) existing Paranal Observatory in the Atacama Desert, Chile: WGS84, UTM zone 19J (longitude 72W/66W, latitude 32S/24S) 7267550N, 365000E.

The Intermediate Data Centre will provide CTAO with the ability to install ICT equipment to deploy software to control the telescopes. Power to the Data Centre will initially be provided by a CTAO generator which will be co-located with the Data Centre. The generator is capable of delivering 750 kVA and is also supplying power to the telescopes. Later the power will be changed to mains power via a Power Conditioning System.

2.1 Components and Equipment

CTAO will deploy its own ICT equipment in the Data Centre. The high-level assumptions for the system to be deliver, see Section 2.3.2 of the Statement of Work (SoW) [AD-1]

3 Environmental Conditions for CTAO-South

3.1 Environmental Conditions

3.1.1 Meteorological and Natural Site Characteristics

The meteorological and natural site characteristics for the outdoor installation and operation of the Data Centre are specified below, with all relevant values considered.

CTAO-South Environmental Conditions		
#	Environmental Parameters	Value
1	Design air temperature outdoor	Max. 35 °C, min. -15°C
2	Design air temperature indoor	Max. 30 °C, min. 20°C
3	Sun irradiance (in summer, max.)	1200W/m2
4	Design humidity outdoor min/max	Min. 2 % / max. 100%
5	Design humidity indoor min/max (with air conditioning running)	Min 15 %, Max 50 % (non-condensing)
6	Elevation	2200 m above sea level
7	Ambient conditions	Clean atmosphere, low chemical pollutions, NO, NO2 & SO2 < 4ppb
8	Wind Speed	Average 11km/h, max. 100 km/h with gusts of 170 km/h
9	Snow/Ice loads, Rain, Hail	Snow load max. 20 kg/m ² Max. 20 mm ice layers may form, Rain max. 200mm/24h 5 mm diameter hailstones with kinetic energy of 0.2 Joule
10	Dust	up to 2.9 x 10 ⁵ particles of ≥5µm size per m ³ of air for 90% of the time at 2m above ground. Note: This limit corresponds to the definition of ISO-Class 9 of ISO14644-1 for particles of this size.
11	Explosive Area classification	Safe area, no explosive atmospheres
12	Earthquake Survival	0.5g in any direction

Table 1 CTAO-South Environmental Conditions

4 Characteristics

4.1 Physical Infrastructure

ID	Name	Statement	Notes
IDC-S-0010	Data Centre Structure Materials	The Data Centre materials shall be fire resistant.	
IDC-S-0020	Data Centre Dimension	The Data Centre shall be provided with sufficient space to ensure a safe and ergonomically working environment.	≥1000mm in front of each rack and ≥600mm behind.
IDC-S-0030	Rack Arrangement	The arrangement of the racks shall follow the 'cold/hot aisle' methodology with airflow pathways clearly defined.	The fronts of the racks shall face the 'cold aisle', the back of the racks shall face the 'hot aisle'.
IDC-S-0040	Rack Dimensions	The Data Centre shall use standard 19-inch racks with a width of 800 mm and a depth of 1200 mm.	
IDC-S-0050	Number of Racks	A minimum of 5 racks (assuming 42U) shall be installed inside the Data Centre.	Alternative designs accommodating 7 racks, where feasible within the proposed container size and infrastructure, are also of interest to support potential future expansion.
ICD-S-0060	Rack Installation	Rack installation shall be designed to operate according to the seismic requirements at the site.	Chilean seismic zone 3.
IDC-S-0070	Cable Management	The Data Centre shall use standard cable management techniques.	Following BS EN 50600-2-4 [AD-1]
IDC-S-0080	Cable Trays	Cable trays for power and network cables shall be provided.	None airflow blocking
IDC-S-0090	Labelling	All equipment and cables shall be labelled and recorded.	Following Table 25 of ISO/IEC 14763-2:2019 [AD-3]
ICD-S-0100	Internal Lighting	Lighting shall be 500 lux in the horizontal plane and 200 lux in the vertical plane.	Measured 1 m above the finished floor in the middle of all aisles.
IDC-S-0110	Emergency Lighting and Signs	Emergency lights and signs are mandatory and shall be placed such that an absence of primary lighting will not hamper emergency exit.	

IDC-S-0120	Light Tightness	The Data Centre Container shall be light tight with no external light leakage.	This is to support the telescopes in scientific data taking, including that the container should not have exterior windows.
IDC-S-0130	Feedthroughs for Cables	The Data Centre Container shall provide feedthroughs for up to 20 cables.	Cables which will be routed into the container are (a) up to 12 optical fibre bundles (max 48-fibres each) with LC connectors attached, (b) up to 4 antenna cables (for GPS and CCTV) with BNC or N-connectors, (c) others (TBC).
IDC-S-0140	Feedthrough Protection	The cable feedthroughs shall be protected from rodents, dust and water influx.	e.g. by deploying cable entry plates or cable glands – unused feedthroughs should be closed/protected as well
IDC-S-0150	Mounting plate/rod for a GPS Antenna	The Data Centre shall provide an interface to host a GPS antenna on its roof.	Design should include a place to mount a GPS antenna, e.g. a mounting plate with screw holes or a rod.
IDC-S-0160	Compliance	All the equipment used shall comply with Chilean and European regulations.	

Table 2 Requirements: Infrastructure

4.2 Environmental

ID	Name	Statement	Notes
IDC-S-1000	Fire Detection	The Data Centre shall be equipped with a fire detection system.	Alarm shall be audible, visible and machine readable via SNMP (v2 or higher)
IDC-S-1010	Fire Suppression	The Data Centre shall be protected by a dry fire suppression system.	
IDC-S-1020	Fire Suppression Gas	The gas used for the fire suppression system shall be non-harmful.	The gas used should be available for use and resupply in Chile.
IDC-S-1030	Environmental Monitoring System	The Data Centre shall have an environmental monitoring system.	The monitoring system shall measure temperature, humidity, airflow and noise level.

IDC-S-1040	Environmental Monitoring Machine Readable	The Data Centre environmental monitoring system shall provide data in a machine-readable format.	Machine readable data shall be available through SNMP (v2 or higher).
IDC-S-1050	HVAC	The Data Centre's environment shall be controlled by an HVAC.	Rated to a 70kW peak power for ICT equipment
IDC-S-1060	HVAC Monitoring	The HVAC shall be monitorable.	Machine readable data shall be available through SNMP (v2 or higher)
IDC-S-1070	HVAC Efficiency	The HVAC shall have a high efficiency	PUE value of < 1.5
IDC-S-1080	Temperature Range	The Data Centre shall contain a cooling system sufficient to maintain a temperature between 20 and 30 degrees Celsius.	See Section 0 above.
IDC-S-1090	Humidity Range	The Data Centre shall be kept in a range of 15%-50% relative humidity (all non-condensing).	See Section 0 above.
IDC-S-1100	Vibration/Earthquake	The Data Centre shall comply with the local earthquake protection standard.	Chilean code NCH433 [AD-4], Chilean seismic zone 3.
IDC-S-1110	Lightning Protection	The Data Centre shall be provided with an appropriate lightning protection system.	Including lightning rods long enough to protect the GPS antenna. Level 1 as defined in IEC 6230.
ICD-S-1120	Dust Protection	The Data Centre shall be sealed to prevent dust particles being distributed by the constant airflow in the container.	Including HVAC filters

Table 3 Requirements: Environmental

4.3 Electrical

ID	Name	Statement	Notes
IDC-S-2000	External Power	The Data Centre shall receive power from a single cable with three phases.	Steel wire armoured (SWA) 5-wire, 3-phase / N / PE providing 400/230 Volts $\pm 5\%$ at 50Hz $\pm 2\%$.
IDC-S-2010	Power Plug	The container shall be equipped with an external plug of type MENNEKES.	This 5-pole power plug shall serve as main incoming point of external power. All

			downstream internal power of the container shall be derived from this single feeding point.
IDC-S-2020	Power Plug Protection	The plug shall be easily accessible on the outside of the container in a weatherproof cover.	IP65 or better.
IDC-S-2030	Power Distribution	The Data Centre shall have dedicated power boards and circuits for HVAC, Racks and General-purpose outlets.	230V at 50Hz (racks and general outlets)
IDC-S-2040	Grounding	The Data Centre shall be grounded and have a grounding scheme.	Following ISO IEC 30129 [AD-5]
IDC-S-2050	Ground Resistance	The Data Centre shall have an internal grounding and bonding system.	Following NEC IEEE 142 [AD-6] The external underground earthing grid (by others) to which the container will be connected will be designed to provide a 10 ohm path towards ground.
IDC-S-2055	Ground Connection	The Container shall have at least two connection points for the external grounding grid, connected to internal grounding system.	Including external markings.
IDC-S-2060	Rack Resistance	Each rack shall have a maximum ground resistance of 1 ohm to any device used by the rack.	Protection of the electronic equipment in the racks.
IDC-S-2070	PDU	Power distribution units (PDUs) shall be used to distribute power inside the racks.	
IDC-S-2080	PDU Redundancy	Each rack shall be equipped with at least two PDUs connected to independent electrical circuits.	
IDC-S-2090	Remote controllable PDUs	A total of at least four PDU sockets shall be remote switchable (all within the same rack).	Some equipment (i.e. WR Switches) require the ability to be remotely power cycled via the PDU.
IDC-S-2100	PDU Compliance	The PDU devices used shall comply with Chilean and European regulations.	
IDC-S-2110	General Purpose Power Outlets	The Data Centre Container shall have at least three duplex general purpose power outlets.	Power outlets e.g. for cleaning equipment, power tools, measurement devices etc...

Table 4 Requirements: Electrical

4.4 UPS

ID	Name	Statement	Notes
IDC-S-3000	UPS	The racks within the Data Centre shall be supported by a UPS.	Three phase input and output, provide clean/filtered power for computing elements.
IDC-S-3010	UPS Levels	The systems in the data centre shall be provided with UPS backup power for at least 5 minutes.	The total peak power of the systems is equal to 70 kW.
IDC-S-3020	UPS Monitoring	The UPS shall have tools suitable for monitoring and evaluating the electrical consumption of the equipment.	The UPS API should allow for machine-readable monitoring data (e.g. using SNMP).
IDC-S-3030	UPS Alert	The UPS shall be able to send machine-readable, visual, and audible alerts relating to its operation.	Machine readable alerts shall be available through SNMP (v2 or higher). Including Global status and Load of each phase.
IDC-S-3040	UPS Shutdown	The UPS shall be able to trigger an automatic shutdown of the Data Centre ICT equipment.	
IDC-S-3050	UPS Duration	The UPS shall provide enough battery power to allow for 5 min to shutdown all servers.	
IDC-S-3060	UPS Batteries	The UPS shall use VRLA batteries.	If flooded batteries are used.
IDC-S-3070	UPS Compliance	UPS devices used must comply with Chilean and European regulations.	

Table 5 Requirements: UPS

4.5 Warranty

ID	Name	Statement	Notes
IDC-S-4000	Warranty	The system shall be warranted for a minimum of 3 years.	The warranty should cover both material defects and workmanship issues. Five-year warranty period estimate should also be presented.

IDC-S-4010	Defect Liability Period	All supplied components shall have a minimum 12-month Defect Liability Period (DLP) post-commissioning, covering manufacturing defects and poor workmanship.	Any failure within the DLP shall be repaired or replaced at no cost to the buyer.
IDC-S-4020	Preventive Maintenance	The Contractor shall provide a preventive maintenance schedule for all components during the warranty period.	The maintenance plan shall not void warranty coverage if followed correctly.
IDC-S-4030	Warranty Exclusions	The Contractor shall clearly define exclusions, including unauthorized modifications, misuse, and natural disasters.	Any ambiguous exclusions will be subject to negotiation.
IDC-S-4040	Contractor Responsibility	The Contractor shall cover shipping costs for replacements and provide full warranty support during the coverage period.	Penalties may apply if the Contractor fails to meet response times.
IDC-S-4050	Technical Services	All technical services and warranty services for equipment shall be provided by local companies.	This including power distribution and PDUs, HVAC, fire protection and UPS.

Table 6 Warranty Requirements

4.6 Documentation

ID	Name	Statement	Notes
IDC-S-5000	General Documentation	The Contractor shall provide a comprehensive documentation package covering design, installation, operation, and maintenance.	All documents shall be in English (and local language if required for maintenance of service) and delivered in print and digital format (PDF, CAD, Word, etc.).
IDC-S-5010	Design Drawings	The Contractor shall submit detailed design and as-built drawings in CAD (DWG) and PDF formats.	Includes electrical, mechanical, and structural drawings, as well as rack layouts, cable routings, and airflow diagrams.
IDC-S-5020	Technical Specifications	A full technical specification document covering all components, materials, and performance criteria shall be provided.	Should align with the technical requirements and include compliance with industry standards.

IDC-S-5030	Operations Manual	A user-friendly operations manual shall be supplied, covering day-to-day use, monitoring, and troubleshooting.	Should include fire suppression, power, HVAC, and security system operations.
IDC-S-5040	Maintenance Guide	A preventive and corrective maintenance manual shall be provided, detailing routine inspections, servicing schedules, and spare part requirements.	Must include recommended maintenance intervals for all systems (power, UPS, HVAC, fire suppression, etc.).
IDC-S-5050	Testing and Commissioning	The Contractor shall provide a testing and commissioning plan, including Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) procedures.	Should include pass/fail criteria, test results, and load test documentation.
IDC-S-5060	Warranty Certificates	All warranty certificates shall be provided, clearly stating coverage periods, terms, and conditions.	Includes UPS, HVAC, fire detection and suppression, racks, and software warranties.
IDC-S-5070	Training Plan	A training plan shall be provided, covering system monitoring, troubleshooting, and emergency response.	The Contractor must offer on-site or remote training sessions for CTAO.
IDC-S-5080	End of Life Procedures	Guidelines for decommissioning, recycling, and disposal of obsolete components shall be provided.	Must comply with environmental and e-waste disposal regulations.
IDC-S-5090	CE certification	All components used in the system shall be CE and/or RoHS compliant.	EU safety standards.
IDC-S-5100	Compliance Certificates	The Contractor shall submit all applicable compliance certificates including CE certification.	Must comply with Chilean and EU safety and performance standards.
IDC-S-5110	Licences	The Contractor shall submit all Licenses for supplied equipment.	If applicable.

Table 7 Documentation Requirements

5 Design and Construction

The design and construction of all components shall fulfil all requirements of this specification, and all requirements set in all AD's enforced in Section 1.4.1.

6 Verification Requirements

When the Contractor determines that the work has been completed, and complies with the specifications, the Contractor will notify CTAO to arrange a time for a representative to inspect the installation work. Test reports shall be delivered to CTAO personnel prior to inspection.

A list of items to be corrected will be compiled during these inspections, and a copy will be sent to the Contractor so that any corrections may be made. If needed a re-inspection will be conducted to verify all items have been corrected.

Non-conformalities will be handled following the CTAO Quality Plan. After any necessary corrections are completed and the terms of the specification have been completed, a representative from CTAO will sign a completion form.

Test results shall be completed and given to CTAO prior to final approval.

Any discrepancies found during verification tests (e.g., failed tests) and/or inspections (e.g., observed defects/discrepancies) shall be recorded following the approach defined in the respective quality plan. Recorded non-conformances shall then be managed following the process described in the applicable quality plan.