



ENGINEERING EXCELLENCE



KEEPING AN EYE ON THE SKY

Cryogenic Control System for the ELT



European
Southern
Observatory

www.eso.org



CASE STUDY 030

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BACKGROUND

European Southern Observatory Extremely Large Telescope (ELT)



The European Southern Observatory's Extremely Large Telescope (ELT) is a groundbreaking astronomical initiative poised to redefine our understanding of the universe.

Currently under construction on Cerro Armazones in Chile's Atacama Desert, the ELT will be the world's largest optical/near-infrared telescope, featuring a 39-meter segmented primary mirror. Designed to tackle some of the most profound cosmic questions, from the formation of galaxies and exoplanets to the nature of dark matter and dark energy, the ELT combines cutting-edge technology with unprecedented observational power.

Once operational, it will offer astronomers a transformative window into the distant universe, enabling discoveries that were previously beyond reach.

ENGINEERING CHALLENGE

Enabling Discovery, Cryogenic Systems Behind the ELT Vision



The Extremely Large Telescope (ELT), developed by the European Southern Observatory, is a flagship scientific instrument designed to explore the universe with unprecedented clarity. Located at high altitude in Chile's Atacama Desert, the ELT requires highly stable cryogenic systems to cool its sensitive optical and infrared instruments.

These systems rely on liquid nitrogen to maintain ultra-low temperatures, minimising thermal noise and ensuring the accuracy of astronomical data.

Operating in the extreme conditions of the Atacama desert, characterised by low humidity, high solar radiation, and significant altitude, demands exceptional reliability from all supporting infrastructure. The cryogenic systems must not only maintain precise temperature control but also ensure uninterrupted operation to avoid missing critical astronomical events.

THE SOLUTION

Cryogenic Control System for the Extremely Large Telescope (ELT)

JBA Engineering was commissioned to design and deliver the control system for managing supercritical gases within the ELT's cryogenic framework. This system governs the transition between liquid and supercritical states, enabling precise thermal regulation and protecting sensitive instrumentation.



To meet the stringent reliability and performance requirements, JBA delivered a full lifecycle solution built around a Siemens PLC control architecture, featuring:

- Siemens S7-1500 PLCs for robust core control logic
- High Availability (HA) I/O modules to ensure system redundancy and fault tolerance. The HA architecture was strategically chosen to meet the ELT site's extreme conditions.
- Real-time diagnostics and feedback loops for dynamic pressure and temperature regulation
- Modular system design to support scalability and future integration
- TIA Portal software for unified engineering, configuration, and commissioning workflows

THE SOLUTION

Cryogenic Control System for the Extremely Large Telescope (ELT)

The control system developed by JBA Engineering for the ELT cryogenic infrastructure integrates advanced capabilities tailored to the extreme operational demands of the Atacama Desert. Key features include:

- **Legacy SCADA Integration:** Seamless connectivity with existing supervisory control systems ensures compatibility and operational continuity.
- **Cybersecure Remote Access:** Remote monitoring and control are enabled in compliance with IEC 62443 standards, safeguarding against cybersecurity threats.
- **Functional Safety Compliance:** Designed and validated by TUV-trained experts, the system adheres to IEC 61508 and IEC 61511 standards, ensuring safe operation under all conditions.
- **Custom Control Panels:** 26 bespoke panels are engineered to meet the specific requirements of the ELT's cryogenic systems.
- **Comprehensive Testing and Commissioning:** Full FAT (Factory Acceptance Testing), SAT (Site Acceptance Testing), and commissioning services guarantee reliable deployment.
- **Long-Term Support:** Remote maintenance and spares management are built in to sustain uninterrupted operation and reduce downtime.

This robust control architecture ensures resilience and minimal downtime, maintaining stable cryogenic conditions essential for the ELT's mission to capture ultra-precise astronomical data in one of the world's most challenging environments.

OUTCOME

Mission-Critical Control, JBA's Contribution to the World's Largest Telescope

JBA's control system delivers robust, high-precision management of cryogenic flows, directly supporting the ELT's mission to observe the universe with unprecedented clarity. Through the integration of Siemens S7-1500 PLCs, High Availability architecture, and advanced diagnostics, the system ensures reliable operation in one of the most demanding scientific environments on Earth.

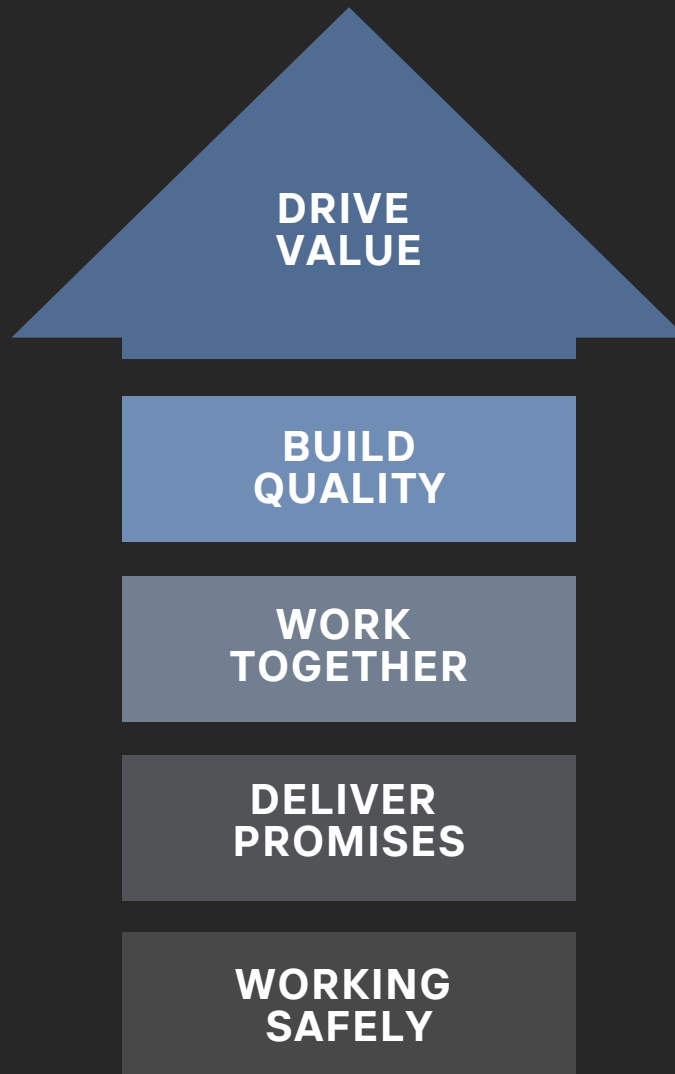
The solution encompassed the full lifecycle, from design and panel manufacture (26 custom units), through FAT/SAT, commissioning, and remote maintenance support. Cybersecurity and functional safety were embedded throughout, with compliance to IEC 62443, IEC 61508, and IEC 61511 standards, ensuring both operational integrity and personnel safety.

This project exemplifies JBA Engineering's capability to deliver mission-critical control solutions in extreme environmental and scientific contexts. The successful deployment at the ELT site reinforces JBA's reputation for engineering excellence, adaptability, and long-term support for complex applications.



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