




Plant 1.0 MTPA ALUMINA REFINERY STREAM-5	Client NALCO	Contract Code NAL	Document ID 6695-INS-556-CA-0002	Contract No. 66-6695
	Scope of Work for Contractor - Instrumentation			नालको NALCO नेशनल एल्युमिनियम कम्पनी लिमिटेड National Aluminium Company Ltd.
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<p>tkIS India / Vendor</p> <div style="display: flex; align-items: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg); font-size: small; margin-right: 10px;">Category Codes (Submission Purpose)</div> <div style="flex-grow: 1;"> <table style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 30px; text-align: center;"><input type="checkbox"/></td><td>1</td><td>For Approval</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>2</td><td>For Review / Comments</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>3</td><td>For Information</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>4</td><td>For Engineering</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>5</td><td>For Enquiry</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>6</td><td>For Order Placement</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>7</td><td>Final & Approved</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>8</td><td>Released for Construction</td></tr> </table> </div> </div> <hr/> <div style="display: flex; align-items: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg); font-size: small; margin-right: 10px;">Acceptance Codes (Approval Codes)</div> <div style="flex-grow: 1;"> <table style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 30px; text-align: center;"><input type="checkbox"/></td><td>1</td><td>Approved</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>2</td><td>Approved for Manufacturing / Fabrication with Comments as marked</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>3</td><td>Not Approved / Resubmit</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>4</td><td>Retained for Information / Records</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>5</td><td>Reviewed</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>6</td><td>Reviewed as Noted / Resubmit</td></tr> </table> </div> </div> <p style="font-size: x-small; margin-top: 10px;">Remarks for AC2 : This marked-up drawings is hereby approved for fabrication / manufacturing and shall be re-submitted after revision. This drawing should be revised only to the extent of tkIS India / Owner / Client comments. Any other changes made by you will not be considered unless clearly highlighted in covering letter asking for approval.</p> <p style="font-size: x-small; margin-top: 10px;">This approval / review does not absolve the supplier from the full responsibility for design and fabrication.</p> <p style="font-size: x-small; margin-top: 10px;">Date : ___/___/___ Name : _____</p>	<input type="checkbox"/>	1	For Approval	<input type="checkbox"/>	2	For Review / Comments	<input type="checkbox"/>	3	For Information	<input type="checkbox"/>	4	For Engineering	<input type="checkbox"/>	5	For Enquiry	<input type="checkbox"/>	6	For Order Placement	<input type="checkbox"/>	7	Final & Approved	<input type="checkbox"/>	8	Released for Construction	<input type="checkbox"/>	1	Approved	<input type="checkbox"/>	2	Approved for Manufacturing / Fabrication with Comments as marked	<input type="checkbox"/>	3	Not Approved / Resubmit	<input type="checkbox"/>	4	Retained for Information / Records	<input type="checkbox"/>	5	Reviewed	<input type="checkbox"/>	6	Reviewed as Noted / Resubmit	<p>tkIS India / Owner / Client</p> <div style="display: flex; align-items: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg); font-size: small; margin-right: 10px;">Category Codes (Submission Purpose)</div> <div style="flex-grow: 1;"> <table style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 30px; text-align: center;"><input type="checkbox"/></td><td>1</td><td>For Approval</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>2</td><td>For Review / Comments</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>3</td><td>For Information</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>4</td><td>For Engineering</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>5</td><td>For Enquiry</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>6</td><td>For Order Placement</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>7</td><td>Final & Approved</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>8</td><td>Released for Construction</td></tr> </table> </div> </div> <hr/> <div style="display: flex; align-items: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg); font-size: small; margin-right: 10px;">Acceptance Codes (Approval Codes)</div> <div style="flex-grow: 1;"> <table style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 30px; text-align: center;"><input type="checkbox"/></td><td>1</td><td>Approved</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>2</td><td>Approved for Manufacturing / Fabrication with Comments as marked</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>3</td><td>Not Approved / Resubmit</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>4</td><td>Retained for Information / Records</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>5</td><td>Reviewed</td></tr> <tr><td style="text-align: center;"><input type="checkbox"/></td><td>6</td><td>Reviewed as Noted / Resubmit</td></tr> </table> </div> </div> <p style="font-size: x-small; margin-top: 10px;">Date : ___/___/___ Name : _____</p>	<input type="checkbox"/>	1	For Approval	<input type="checkbox"/>	2	For Review / Comments	<input type="checkbox"/>	3	For Information	<input type="checkbox"/>	4	For Engineering	<input type="checkbox"/>	5	For Enquiry	<input type="checkbox"/>	6	For Order Placement	<input type="checkbox"/>	7	Final & Approved	<input type="checkbox"/>	8	Released for Construction	<input type="checkbox"/>	1	Approved	<input type="checkbox"/>	2	Approved for Manufacturing / Fabrication with Comments as marked	<input type="checkbox"/>	3	Not Approved / Resubmit	<input type="checkbox"/>	4	Retained for Information / Records	<input type="checkbox"/>	5	Reviewed	<input type="checkbox"/>	6	Reviewed as Noted / Resubmit
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1 General

This document specifies the scope of work for instrumentation for this project.

It shall be read in conjunction with the following documents:

- Licensor's Basic Engineering and Design Package (BEDP) (if applicable)
- Various Standards and Standard Specification,

The LSTK CONTRACTOR shall develop the approved for construction (AFC) status taking due account of the various documents, Overall plot plan, overall cable route, instruments installation standards, standard specifications, standards, drawings, mandatory spare list, technical compliance document, vendor data requirement document and any information given within the bid in providing final details for the facilities described within this overall scope of work.



Any instrumentation related item or work, not explicitly mentioned in this document, but necessary to achieve successful implementation of this project, shall be included by the main 'Lump Sum Turn-Key' contractor (the LSTK Contractor or the Contractor) for the project in their scope of supply and work without any implications. Omission of any instrumentation related item or work necessary to achieve successful implementation of this project (in line with the specifications and internationally recognized good engineering practices) from this document does not absolve the LSTK contractor for this project of contractual obligations and his responsibility to include such items/activities in his scope of supply and work without any implications.

The LSTK contractor shall be responsible for complete engineering, procurement, erection / installation and commissioning of instrumentation and controls for the package unit on lump-sum turnkey basis with scope of work as given below (but not restricted to) :

- Site survey (pre-bid and post-award)
- Design and Engineering.
- 3-D modeling of all instrumentation items.
- Hazop Study
- SIL analysis, verification and validation.
- Procurement, Supply, Factory testing and Acceptance.
- Erection/installation, fabrication & erection works, field calibration / testing, and commissioning.
- Training of owner's personnel at OEM's works and at site.
- Systematic handing over to NALCO
- Mandatory spare supply
- Submission of drawings and documents
- Coordination and assistance with Licensor, vendors, Consultant & Owner.
- Obtaining all requisite Statutory approvals from authorities e.g. CCOE, AERB etc.

Any additions of scope related to instrumentation due to completion of residual engineering on contractor's detailed engineering, HAZOP studies and SIL analysis, SIL validation & verification shall form part of scope of work. This includes all units / facilities under contractor's scope including package or non-package items. Any activity specifically not listed in this document, does not absolve the contractor of their responsibility to included such activities in their scope of work & supply, which otherwise is necessary to complete instrumentation work of Lime Slaking package unit of NALCO Alumina Refinery.

All such activities shall be carried out without any implication.

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2 Scope of work

Instrumentation and control system & accessories including field instrumentation, shall be designed, procured, installed and commissioned to monitor and control the plant over the full range of operability in line with the P&IDs developed by LSTK Contractor from FEED documents (if any), specifications prepared by LSTK Contractor and in line with other technical requirements specified elsewhere in the tender document and in BEDP document (if any).

Control system shall automatically adjust controls to correct for disturbances caused by changing environmental conditions, process or utility conditions. The control systems shall also provide orderly control of the Plant during Start-up, normal shutdown and emergency shutdown.

2.1 Scope of work is as given in following table:

DESCRIPTION	E	S	I	ER	COM
Field instruments and valves	L	L	L	L	L
*Remote I/O room for cabinet installation	L	L	L	L	L
*System and marshalling cabinets at remote I/O room	L	C	L	L	L
*Control system(DCS)	L	C	L	L	L
Junction boxes (JBs)/Air manifolds	L	L	L	L	L
Cable between instruments and JB's including glanding & termination	L	L	L	L	L
Cables between JB's and control panel/DCS Marshalling Cabinet including glanding & termination	L	L	L	L	L
Serial Communication Cables (MODBUS or similar) between VFD, Analyser, LSTK Contractor's supplied PLC and DCS Marshalling / System Cabinet including glanding & termination	L	L	L	L	L,D
Interpanel Cabling between Marshalling Cabinets	L	D	D	L	L,D
Cable between HVAC system to DCS Marshalling Cabinet	L	L	L	L	L
Tubes for impulse lines and air supply lines with support	L	L	L	L	L
Tube fittings, cable glands, lugs, ferrules and other erection hardware	L	L	L	L	L
Structural steel for erection work	L	L	L	L	L
Cable trays/tube trays with support	L	L	L	L	L
Cable trays with support inside rack room / control room	L	L	L	L	L
Control / rack room entry with proper sealing with provision for keeping spare entry	L	L	L	L	L
Stanchions & Mounting brackets	L	L	L	L	L
Earth Pits and earthing cables	L	L	L	L	L
Analyser Shelter (If required)	L	L	L	L	L
Drawing / Documents	L	L	NA	NA	NA
PLC systems (in case supplied by vendor)	L	L	L	L	L
Local Control Panel at field	L	L	L	L	L

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- *Note: 1. DCS system overall responsibility for complete plant is with client/Consultant. Vendor shall give required inputs during engineering, participate in FAT at DCS vendor's work's and involve in loop checking & commissioning activities at site.
2. All instruments and system oriented items shall undergo testing and inspection by LSTK Contractor. However inspection of any item at any stage may be carried out by Owner / Consultant at their own discretion.

Abbreviations:

E : Engineering
S : Supply, packing, forwarding
I : Inspection
ER : Erection at site
COM : Testing, calibration & commissioning at site

L : By LSTK contractor
C : By clients
T : By Consultant
D : By DCS Vendor



2.2 It shall be the LSTK contractor's responsibility to ensure that the quality as specified is met prior to dispatch of instrument items.

2.3 Following shall be the division of responsibility between DCS vendor/Client/Consultant/ LSTK Package vendor:

S.NO	DESCRIPTION	SCOPE		
		Consultant / CLIENT	DCS VENDOR	LSTK CONTRACT OR
1.	Freeze in of tag numbering, typical signal flow diagram, graphic philosophies.	C	I	X
2.	Preparation of I/O list, JB terminal drawings in agreed format.	C	I	X
3.	Preparation of graphics.	C	I	X
4.	Inspection & checking of graphics, logic sequence / interlocks, software and hardware.	X	C	X
5.	Final commissioning of package along with DCS.	C	C	X
6.	Integrated FAT (IFAT) between DCS & LSTK Vendor supplied PLC (if any)	C	C	X

Abbreviations:

C : Coordination
I : Information
X : Primary responsibility

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The philosophy for control shall be:

All indications, controls and interlocks are implemented in a Distributed Control System (DCS) supplied by NALCO. Required engineering inputs by LSTK contractor. It is envisaged that the operation of plant from nearest Rack Room in Sub-Station building / Control Room which is in other's scope. All instruments shall be terminated in remote I/O room. Design of complete remote I/O building including rack room is in the scope of LSTK Contractor. LSTK Contractor to furnish I/O counts required for DCS system to get the control / marshalling cabinet details from DCS vendor for room sizing. DCS vendor also to furnish UPS load requirement & Heat load to LSTK Contractor for their engineering. LSTK Contractor to coordinate with DCS vendor during the course of engineering for such input requirement.

Control and monitoring of process parameters including monitoring, control and interlocking shall be executed in DCS. However any interlock involves tripping of any motor / drive shall be executed in main plant PLC via hardware signal from DCS to PLC. For detail Refer Overall Control System Architecture Drawing in General Engineering Specification.

PLC shall be used for all digital input / output signals related to Electrical motor / drives / Motor Operated Valves / Emergency stop / shutdown / interlock with respect to drives only.

DCS and PLC systems of different control stations are separate and standalone type with respective redundant controllers and other related I/O sub systems. Single Vendor will supply both PLC & DCS systems for the complete 5th stream including that required for LSTK packages. However, any specific local dedicated PLCs required for the process of system, supplied by the LSTK vendor then the same has to be interfaced with the main PLC. Responsibility for interface of these PLCs with Main PLC is with LSTK package vendor.

In case, LSTK Contractor supplies any PLC for control of their system then all monitoring signals should be sent to operator consoles / Central control room via serial link (RS 485 Modbus protocol).

LSTK Contractor to supply local control panels if required in field for operation.

The operations, control and interlock of the Lime Slaking package shall be carried out from DCS/ PLC, located in Lime Slaking package remote I/O cabinet / operator console room.





The weigh-feeder and other electronic control panels are to be located in the control room to avoid problems due to dust.

Other field control units are to be air pressurized having rotameter arrangements for adjusting air pressure.

The DCS for Lime Slaking package rack room / operator console room shall be part of overall DCS system spread over a no. of rack rooms in the refinery plant and finally to the Central Control room (CCR).

LSTK Contractor shall be responsible to fully integrate the instrumentation and control systems with the Distributed Control System (DCS) / Programmable Logic Controller (PLC) (being supplied by the Owner). Contractor shall be responsible to provide all inputs to the DCS / PLC supplier (graphics, I/O list, interlock / shutdown logic diagrams, protocol details, I/O mapping details, memory map, functional schematics etc.) for DCS / PLC vendor to engineer, supply, install and commissioning the control systems required for the complete package. Any software required for interfacing the instrumentation and control systems (analysers, PLC's etc.) with the DCS are in LSTK Contractor's scope.

The description and requirements contained here are concise by necessity and cannot include all details. However, it is the responsibility of the LSTK Contractor to execute the job in accordance with specifications, philosophy, drawings etc. as per tender.

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The scope will cover the following as minimum but not limited to:

Site Survey



LSTK Contractor shall conduct site survey for NALCO Refinery project, both pre-bid and post award. Prior to bidding, LSTK Contractor shall plan and undertake site survey to familiarize and obtain all necessary information related to instrumentation for locations, existing facilities, route survey, site conditions etc. Post award LSTK Contractor shall undertake site survey to obtain existing system details, coordination etc. for executing the overall work such as detail engineering.

Detailed Engineering

1. Preparation of Instrument data sheets for all tags appearing in the Final P&IDs (developed by LSTK contractor) and process data.
2. Preparation of instrument Index for the complete package.
3. Preparation of unit wise point database for instruments incorporating tag nos, descriptions, range, engineering unit, set point, alarm set points, trip set points, etc. I/O list for DCS/PLC system, MCC, other associated systems etc., shall be prepared separately.
4. Preparation of Loop Schematic Diagrams of all open & close control loops of DCS/PLC & other associated systems, interlock schemes, unit-wise C&E matrix, unit-wise control narratives, logics for DCS/PLC & other associated systems.
5. Preparation of unit wise Cable schedules including JB schedule, MCC schedules etc.
6. Preparation of unit-wise Grounding/Earthing scheme for all field and operator console room instruments and systems.
7. Design, preparation of complete specifications and material requisitions for all field instruments/equipments (e.g. control valves, On-off valves, Temperature instruments, Level instruments, Flow instruments, Pressure/differential Pressure instruments, analysers, Gas Chromatographs, nucleonic devices, Junction box etc.) Operator console room instruments/systems (e.g. Package PLC, Controllers, signaling systems, interlocking and tripping systems etc.), safety systems, tank gauging system, custody transfer metering system, interfacing equipments & cabling, special instruments etc.
8. Preparation of purchase specifications/requisitions for all of the instrumentation items, which include field instruments as minimum, for the successful bidder. Purchase requisitions shall consist of a consolidated purchase document including all purchase specification agreed pre-order with vendor/manufacturer including data sheets, special instruction / requirements (if any), standard specifications / purchase specifications, testing requirements, quality requirements etc. All purchase requisitions shall be furnished to Owner / Consultant for information/review as applicable.
9. Obtaining SIL (if require) data of various instruments employed from the respective vendors.
10. SIL reviews to international standards IEC 61508 and IEC 61511 shall be carried out to determine the level of reliability and availability required as per detail engineering.
11. Preparation of 3-D models of units clearly indicating the instruments, cable tray/trench, air-line routing etc., Instruments accessibility and other requirements mentioned in the tender document. As minimum, all Inline Instruments and Cable trays to be shown at 60% model review and rest all shall be shown at the stage of 90% model review.

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12. Preparation of unit wise layout of the instruments, JB, tubing, electrical wiring and air supply etc.
13. Preparation of Instrument hook up drawing, Steam tracing Drawings (if require), level sketches and other field engineering drawings for instrument installation showing installation details with list of all materials required for all types of instruments specified. Further fit- up check for Instrument impulse lines, Hydro test, NDT checks and loop checking of all Open/close loops is also in LSTK contractor's scope of work.
14. Preparation of the instruments schedules giving complete bill of materials for items such as temperature, level and pressure gauges, pressure switches, solenoid valves, transmitters, controllers, control valves, pressure regulators, air filter regulators, multi-core cables, single pair, JB's, Cable glands, erection material, tubing, fitting, rack and supports etc.
15. Preparation of specifications and procurement of erection material, tubing, fitting, rack and supports etc. for installation purpose.
16. Preparation of location drawings showing the position of all instruments, junction box and layout of instrument air and cable routing, cable tray, concrete trenches (including Console room /Rack Room) and instrument power cable layout.
17. Preparation of location drawing showing the position of all field JB's and Instruments which do not have electrical/pneumatic connections.
18. LSTK Contractor shall be responsible for providing all relevant drawings and documents to sub package vendors in addition to checking and approval of vendor data and drawings.
19. The BEDP documents have been attached along with the tender (if applicable). The same shall be used as guideline. However checking, verification of the unit BEDP documents, development of all required documents and engineering shall be in LSTK Contractor's Scope of work.
20. Design and Engineering of all Instrument systems including field instruments shall be in accordance to Plant area classifications and relevant statutory requirement.
21. LSTK Contractor shall be responsible for Engineering, procurement including Estimation, Tender floating, technical evaluation, raising Technical Queries to vendors, issuing Purchase Orders for award etc. for all instruments based on the specification prepared, site activities including material receipt at site, calibration, testing, storage, installation, pre- commissioning, commissioning etc. of following, as applicable for the unit, but not limited to:
 - All Field instruments & accessories
 - All Analysers
 - Package Control systems
 - Package Safety systems
 - Machinery Monitoring Systems
 - Condition Monitoring Systems
 - Instrumentation Documentation node
 - Auxiliary Systems (e.g.: Custody Transfer Metering Systems, Tank Gauging (if required) etc.)
 - Cable trays for respective units including field
 - Instruments to Rack room / operator console room.
 - All Cabling and associated accessories.
 - Remote I/O room air conditioned system.

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22. Preparation of remote I/O room equipment/cabinets layout including cable tray. The remote I/O room required for housing DCS / PLC hardware and other instrument items shall be designed, constructed totally by contractor. The following shall be considered as minimum for control station.

- The remote I/O room shall be air conditioned.
- Separate space shall be provided for I/O racks, cabinets etc.
- The remote I/O room shall have false flooring and false ceiling unless otherwise specified.
- The remote I/O room shall be illuminated adequately with lighting arrangement which shall not cause any glare at viewing area. The lighting arrangement shall be approved by Owner / Consultant.
- Painting and finish of floor and colour of consols / rack shall be aesthetically matched.
- The main entry to the remote I/O room and equipment entry to rack area shall have door opening 2500 mm (W) x 2700 mm (H) clear space, double door. Escape route for remote I/O room shall be provided.
- The UPS and other electrical equipment shall be housed in separate UPS room with separate cable entry. In general no electrical equipment shall be placed near instrumentation cabinets.
- The remote I/O room layout shall be made in such a way that clearance between back and front rows from the wall shall be 1 meter(min), clearance between two rows shall be 1.4 meter or DCS vendor recommendation and clearance between all rows from side wall shall be equal to 1.5 meter.
- The sizing of remote I/O room shall be made in such a way that 30% spare cabinet space shall be available for future use.
- All racks, cabinets in rack room shall be bolted on to channel bases which is grouted to the floor through base channel and false floor pedestals etc.
- All cabling inside the remote I/O rack room shall be done through trays below false flooring. No cabling shall be left on floor.



23. Power (UPS/Non-UPS) Distribution schemes for all system components in the remote I/O room and for field instruments.

24. Engineering and drawing/document preparation of all cable tray / trenches from field to remote I/O room and from remote I/O room to Operator console room, between operator console room to buildings and wherever required.

25. Co-ordination & resolution of design/engineering and supply issues with suppliers, service providers, field contractors, licensors, DCS/PLC, Third parties and other agencies.

26. All design/ documentation work shall be carried out with the aid of computers with relevant package preferably Smart Plant Instruments (SPI/INTOOLS). Date/Documentation shall be maintained in computer formats in addition to the Hard copy. If SPI is not used for document preparation, then Microsoft Excel has to be used.



27. Participation of LSTK contractor in FAT/IFAT & SAT of the instrumentation system of all instrumentation systems.

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In addition to details mentioned in specification documents LSTK Contractor to ensure following for Instrumentation: (these requirements shall take precedence in case of conflict with any document/specifications),

- i. Steam tracing (with Cu tubing rope and cementing / SS suitable for the environment shall be selected) to be done for impulse line of all the instruments in high viscous & congealing services (even if main process line is not steam traced).
- ii. Instrument impulse piping schedule shall be maximum of sch160 for congealing and corrosive services. This philosophy to be ensured even between piping/equipment and 1st isolation valve(root valve).
- iii. Metallurgy of Instrument cable tray shall be GI. Pre-fabricated cable trays shall be hot dip galvanized. The fasteners shall be electroplated. Cutting of trays at site shall be minimized. As far as possible pre-fabricated bends shall be used. Ladder trays shall be made from angles and flats.
- iv. In case of nucleonic instruments, external protection on detector to avoid external interferences by way of lead shielding (of min 10 mm thickness) shall be provided in addition to any inbuilt protection available along with Instrument.
- v. Earth-pit for control system shall be redundant for each signal type per building. However, there should be minimum 2 or 3 earth pit for each type of signal also the earth pit resistance value shall meet the desired resistance. Additionally, LSTK Contractor to consider minimum one extra earth-pit per signal type for maintenance purpose. Material of earthing electrode, cabling between earth-pit to remote I/O room and star plates inside remote I/O room shall be GI.
- vi. Sizing and selection of all instrument cables (including signal/control/power/FO etc.) shall be based on calculation during detailed Engineering.
- vii. Flange sizing for interfaces shall be as general engineering specification for Instrumentation & Control attached else where.
- viii. Visit of specialist for critical items , like Analysers Tank gauging etc. to be considered for FAT at control system vendor works and for site jobs.
- ix. Canopy / Sunshield / Rain shed shall be min 3 mm thick FRP for field Instruments/JBs/Local panels etc.
- x. Control system hardware (till I/O cards) for Lime Slaking package unit shall be installed in remote I/O room. DCS controller and engineering workstation for the same shall be installed in substation US-501. LSTK contractor shall define the execution methodology based on the Control System Supplier.
- xi. Requirement of UPS for control system / Field Instruments/Interposing Relay panels to be decided by LSTK Contractor during Detailed Engineering in line with specification.
- xii. Contractor shall be responsible to provide all 'as-built' drawings and documents including:
 - a. All purchase documents.
 - b. All Construction related documents.
 - c. All System documents including hardware and software documentation.
 - d. Logistic support certificates for Control system components, analyzers, gas detectors, special flow instruments, tank level instruments, etc.

In addition to above, contractor shall also be responsible for certifying the logic diagram for Lime Slaking package unit and equipment as final and correct.

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- xiii. Access for Instruments shall be provided for maintenance purposes.
- xiv. No windows shall be provided for remote I/O room.

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30. In case, if remote I/O room is having windows then protection grill of suitable material and thickness outside of the windows shall be provided. All system earthing cables shall be laid through conduits through a specific route (through trench or duct with cover). Specific recommendation of system vendor if any shall be taken into consideration for the same.
31. The LSTK contractor is responsible for selection and integration of all instrumentation and control items/equipments for smooth, easy, safe plant operation with high availability.
32. The LSTK contractor shall be responsible for ensuring uniformity of equipment/hardware used in the project and its packages by standardization and minimizing variety of hardware/equipments used.
33. The LSTK contractor shall be responsible for designing and engineering of total instrumentation and controls for the project based on licensor's BEDP (if applicable), HAZOP study, SIL study and ergonomic study requirements and other technical documents in the tender specification.
34. The LSTK contractor shall prepare detailed sizing/calculations, specifications, data-sheets, drawings for construction and installation for all instrument items and construction activities.
35. The LSTK contractor is responsible for approval/review of all post-order vendor drawings and documents.
36. The LSTK contractor shall submit drawings and documents for approval/review/records to Owner / Consultant only after thorough checking and signing/stamping by a competent engineer of the LSTK contractor. This submission shall be as per document titled Documents/drawings for review – Instrumentation.
37. The LSTK contractor shall be responsible for carrying out all project implementation related activities systematically for successful implementation of the project as per stipulated schedule.
38. The LSTK contractor shall be responsible for coordination with various external agencies like statutory authorities, suppliers of instrument items/equipments, third party inspection agencies, sub-contractors, the owner (NALCO) and Project Management Consultant (tkIS) for this project as well as coordination among contractor's own departments/offices involved in implementation of this project for smooth and trouble-free implementation.
39. The LSTK contractor shall be responsible for preparation, compilation and submission of all final and as-built drawings and documents like all purchase documents, construction related drawings and documents, all control and monitoring system related documents (related to hardware as well as software, all package related documents, all documents from manufacturers and suppliers of various items and statutory certificates. Additionally the LSTK contractor shall also be required to certify that submitted interlock and logic diagrams and control strategy/complex loop documents for the project are final and correct. All documents shall be supplied in hard copy as well as soft-copy form.
40. As part of engineering for procurement, the LSTK contractor shall select and prepare technical specifications for instrument items and other tender documents, evaluate offers received from different vendors, prepare order specifications/purchase requisitions and approve/review vendor drawings and documents. All instrument datasheets shall be as per ISA formats and shall contain make and model numbers of instruments in addition to technical specifications. In case the LSTK contractor decides to use own formats for datasheets, these shall contain all the information as per ISA as a minimum. All data sheet formats shall be approved by Owner / Consultant prior to starting of engineering activity.

Procurement, Factory testing and Acceptance



41. All instrument items shall be procured from vendors indicated in the approved vendor list for this project. In case any procurement is to be made from a vendor not indicated in the list, the LSTK contractor shall obtain prior written approval from Owner / Consultant for this.

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42. LSTK Contractor shall also follow the recommended and mandatory vendors of licensors (if applicable). Factory testing/calibration of all items shall be witnessed by the LSTK contractor. Owner / Consultant, at their discretion, may witness testing of any or all items at any stage of manufacture or the final stage. Factory Acceptance Tests shall be conducted for all system oriented items like distributed control system, programmable logic controllers, analysers (with shelter as applicable) etc. as per approved procedures. Such items shall leave the factory only after successful completion of Factory Acceptance test and dispatch clearance from Owner / Consultant.
43. In case the LSTK contractor is required to deviate from specifications given in tender document, the LSTK contractor shall obtain a prior written approval from Owner / consultant giving suitable technical justification. However deviations shall be approved only if absolutely essential.
44. Shop testing and calibration of all instruments shall be carried out / witnessed by the contractor for instrumentation item including DCS, PLC, Analysers, etc. Owner / Consultant shall witness testing of any or all items at various stages during manufacture and / or at final stage before shipment at the discretion of Owner / Consultant. All system oriented items like DCS, PLC, analyzers, gas chromatographs etc. shall undergo factory testing and integrated factory acceptance test. Testing shall be carried out as per approved procedure. No such items shall leave manufacturer's works without factory acceptance test. Testing shall be carried out as per approved procedures.

Installation, Field testing / calibration & Commissioning

45. The LSTK contractor for the project shall be responsible for systematic field calibration/testing, erection/installation, commissioning, site testing and acceptance (by Owner / Consultant) of all instrumentation and control equipment and other items, indicated in item 3.0 - Scope of supply in this document, in line with specifications, manufacturers' recommendations and internationally recognized good engineering practices to achieve successful implementation of the project as per stipulated schedule. Field calibration of instruments shall also include calibration of packaged instruments.
46. All system oriented items like distributed control systems, programmable logic controllers, analysers, machine monitoring systems and special instruments like ultrasonic flow meters, mass flow meters, electromagnetic flow meters, ultrasonic and radar type level instruments, nucleonic instruments and tank gauges shall be installed, tested and commissioned under supervision of experts/specialists from respective vendors. The LSTK contractor shall be responsible for arranging experts/specialists services at site.
47. Factory Acceptance Test (FAT) and calibration of all instruments shall be carried out / witnessed by the LSTK Contractor. Owner / Consultant shall witness testing of any or all items as indicated in inspection categorization plan. All system oriented items like PLC(s) etc. shall undergo factory testing and integrated factory acceptance test (IFAT). No such items shall leave manufacturer works without successful FAT test duly okayed by Owner / Consultant. Testing shall be carried out as per approved procedure.
48. All cables meant for the DCS/PLC system shall be brought by the contractor from the field upto the marshalling cabinets of DCS/PLC (provided by owner), terminate and tested the cables by LSTK Contractor. All the cables meant for Package PLC shall be brought to the remote I/O room PLC cabinet and terminate / tested the cables by LSTK Contractor.
49. All serial cables between package PLC & DCS, etc. shall be supplied, terminate and laid by the LSTK Contractor.
50. LSTK Contractor shall coordinate with DCS/PLC vendor to carry out the loop checking.
51. All testing, calibration and adjustments of instruments shall be part of LSTK Contractors scope.
52. The LSTK contractor shall be responsible for loop checking and pre-commissioning of integrated instrumentation and control including package equipments/items in a systematic manner. Any problems found during loop checking and field testing shall be corrected by making suitable modifications in equipment/item/installation and proper functioning of respective items shall be verified.

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53. The LSTK contractor shall be responsible for conducting Site Acceptance Tests(SAT) for all system oriented items like distributed control system, programmable logic controllers, analysers, machine monitoring systems as per approved test procedures. Any problems detected during SATs shall be rectified and proper functioning of the system shall be verified.
54. The LSTK contractor shall be responsible for systematic stage wise testing and checking of all instrumentation items/equipment at site and acceptance of the same by PMC and owner as per approved site procedures. The contractor shall be responsible for systematic hand over of instrumentation and control items/equipments for the project to the owner as per approved procedure.
55. The LSTK contractor shall be responsible for safe and efficient management of site stores, materials and equipments and timely mobilization of resources.
56. The LSTK contractor shall follow good house-keeping practices.
57. The LSTK contractor shall prepare and maintain all documentation for site work as per approved site procedures.

Warranty

58. Warranty for PLC and alarm system shall be three years from the date of final handover of complete system. For other instrumentation items, warranty shall be provided as per commercial section.

Training

59. The LSTK contractor shall also be responsible for arranging training of owner's personnel at works and/or site for system oriented items like programmable logic controllers, analysers and special instruments like ultrasonic flow meters, nucleonic level instruments etc. Training for PLC and Analysers (each type) shall be as per the following tables



i) Package PLC Training

Sr. NO.	Description	Duration	No. Of Batches	Persons Per Batch	Location Of Training
1.	Application Engineering (Implementation) Training for each PLC type	2 weeks	1	6	At vendor's works
2.	Operation staff (For PLC only)	1 week	3	6	At vendor's works

ii) Analyser Training for each type of analyser

Sr. No.	Description	Duration	No. Of Batches	Persons Per Batch	Location Of Training
1	Engineers (Implementation) Training	2 Days	1	4	At Vendor's works

Any activity specifically not listed in this document, does not absolve the LSTK Contractor of their responsibility to include such activities in their scope of work, which otherwise is necessary, to complete instrumentation work for the Project. All such activities shall be carried out by the LSTK Contractor without any cost & time implication.



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3 Scope of Supply

- 3.1 Supply of all items related to instrumentation and control system as indicated in Licensor's BEDP (if applicable) and other tender documents. This shall include instrumentation and control system of all package units in the LSTK contractor's scope as identified in the tender documents.

The scope of supply includes (but not limited to) the following:

- i. All field instruments including transmitters, gas detectors, pressure, temperature and level gauges and transmitters, control valves and on-off valves with all the required accessories, flow elements and assemblies, flow meters of various types, switches, tank level instruments, analysers (with analyzer shelters and sample handling systems as applicable) with relevant accessories as per finally approved P&IDs and other documents generated by the LSTK contractor to complete this project.
- ii. All erection and installation material like impulse piping, prefabricated / site fabricated hookup assemblies, tubing, pipe and tube fittings, structural steel, fasteners, cable trays, ducts and RCC trenches, canopies for instruments, instrument supports, cable glands, consumables and accessories for installing instrument items.
- iii. Supply of all erection material for installation of any control system equipment such as DCS / PLC, analyzers / gas chromatographs etc., Power supply distribution units or any other cabinets / racks/consales plant buildings.
- iv. All types of instrumentation related cables like cables for signals, control, thermocouple extension, RTD, power cables, fibre optic cables, data communication cables, earthing cables/strips with all necessary accessories between :
 - Individual instruments to field junction boxes
 - Instrument / equipment to local control panel
 - Local panel and junction box to control room or any other room/location with control equipment
 - All cables between package related local control / monitoring panel and junction boxes to control / monitoring equipment in remote I/O room.
 - Instruments in field and control / monitoring equipment in control room(s)
 - Between substation / switchgear and rack / control room, local control panel, field.
 - Power distribution boards (electrical) and power distribution panels for control equipment in rack room.
 - Power distribution boards (electrical) or Power distribution panels (rack room) and instrument/control equipment in control room or any other location.
 - Communication interfaces in DCS for other systems to communication interfaces in other systems
 - Various system cables for the control systems supplied by contractor as well as from control system supplied by contractor to system supplied by others.
 - All earthing cables and strips (GI) between earth pit to the various control systems supplied by contractor in various plant buildings, local panels, gauge boards, junction boxes.
 - Any other additional power supply / power cable required by LSTK Contractor to complete the job in all respect.
 - Any other cable required for hardware supplied by contractor to complete the job in all respect.
- iv. Instrument cable trays, RCC trenches, perforated GI cable trays, ladder cable trays, angle cable trays, structural supports, road crossings, culverts, accessories for cable laying.
- v. Junction boxes and cable glands for different types of instrument signals such as intrinsically safe and non-intrinsically safe 4-20 mA DC, thermocouple, RTD, shutdown (for solenoid valves), switch contacts alarm, power etc.
- vi. All items and accessories for instrument air distribution infrastructure like manifolds, pipes, fittings, tubes, tube fittings, valves etc.
- vii. Local control panels / local gauge boards and accessories as required.

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- viii. Earthing infrastructure like earth pits for system earth, IS earth and protective earth, earthing cables, strips and busbars, earthing electrodes etc.
- ix. Any other erection/installation/commissioning material/equipment necessary for installation and commissioning of various instruments/equipments.
- x. Spares as applicable for Instrumentation items.
- xi. Hardwired consoles as required.
- xii. Analyser shelters as required. All online process analyzers / gas chromatographs shall be supplied with built-in Auto calibration without operator intervention, complete with required calibration apparatus/ calibration gas cylinders etc.
- xiii. Power supply distribution infrastructure for instrumentation and control equipment. UPS power to control systems shall be distributed through Power Distribution Cabinets (PDB).
- xiv. Any special tools/equipments for instrumentation items.
- xv. All drawings and documents – both, for review by Owner / Consultant during engineering and final/ as-built documentation in hardcopies as well as soft copy (CDs/DVDs) form in a suitable compilation.
- xvi. Heat tracing, painting and insulation requirements for instruments, impulse lines, sample lines as required.

3.2 For items supplied as part of package units, the LSTK contractor shall supply all the necessary items required for its proper installation and commissioning. The items of supply shall include the following but not limited to –

- a) field instruments,
- b) control valves with accessories,
- c) tubes and tube fittings,
- d) junction boxes, local control, panels, local control equipment, gauge boards
- e) branch cables from instruments up to junction boxes / local control panels / local control equipment,
- f) all cables between junction boxes, local control panels and local control equipments,
- g) cable trays, cable glands and cabling/wiring/termination accessories for items indicated against “e)” and “f)” above,
- h) all items for instrument air distribution within package downstream of tie-in point
- i) control systems in the vendor scope as per package control philosophy in GES,
- j) all items/materials for installation of instrumentation items.

The LSTK contractor’s scope of supply with respect to the package units shall be as follows:

- 3.2.1 Supply of hardware and software pertaining to Package PLC (if applicable) as per tender documents and the inputs given by the vendor.
- 3.2.2 The package PLC system shall have the following:-
 - PLC with dual redundant CPU & 16 channel I/O configuration.
 - PLC DO shall be through DIN rail mounted auxiliary relay with contract rating of 10 amp, 230V.
 - Licensed PLC programing S/W & MMI S/W shall be supplied.
 - UPS shall be provided to PLC system & Engineering / Operator work stations.
 - PLC Room & operator cabin shall be air conditioned.
- 3.2.3 All types of cables (including signal, power, data communication and optical fibre cables) between control equipment located in control room and junction boxes/ local control panels / local power distribution panels / other related local control equipment along with accessories like cable glands etc. for glanding and termination of cables at both ends. All necessary cable ducts/trays/RCC trenches for these cables shall also be supplied by the LSTK contractor.

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- 3.2.4 Utilities like power (of different types) and instrument air at suitable locations near the equipment (power distribution panel/local control panel/package junction box/utility tie-in point).
- 3.2.5 The bulk materials (tubes, tube fittings, cable trays, fasteners, structural steel, branch cables from instruments up to junction boxes/local control panels/local control equipment, all cables between junction boxes, local control panels and local control equipments, etc.) are in the scope of supply of the package unit vendor. The LSTK contractor shall integrate the requirements of these package unit items in the overall plant requirements. The LSTK contractor shall check drawings and documents of the package unit items to ensure that adequate quantity of the bulk material is supplied and relevant inputs/outputs for control and monitoring of the package unit items (equipments) are included in DCS/ESD/PLC supplied by the Control system Vendor. It shall be responsibility of the LSTK contractor to supply bulk materials if any of the bulk material supply is found to be short during erection work and complete the erection work as per stipulated schedule.

3.3 The LSTK Contractor shall also supply Air Conditioning units for remote I/O room to facilitate commissioning of control systems till main HVAC unit for remote I/O room is commissioned.