




Plant 1.0 MTPA ALUMINA REFINERY STREAM-5	Client NALCO	Contract Code NAL	Document ID 6695-PRC-556-CA-0003	Contract No. 66-6695
	SCOPE OF WORK: PROCESS			 नेशनल एल्युमिनियम कंपनी लिमिटेड National Aluminium Company Ltd.
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<p>tkIS India / Vendor</p> <p>Category Codes (Submission Purpose)</p> <p><input type="checkbox"/> 1 For Approval</p> <p><input type="checkbox"/> 2 For Review / Comments</p> <p><input type="checkbox"/> 3 For Information</p> <p><input type="checkbox"/> 4 For Engineering</p> <p><input checked="" type="checkbox"/> 5 For Enquiry</p> <p><input type="checkbox"/> 6 For Order Placement</p> <p><input type="checkbox"/> 7 Final & Approved</p> <p><input type="checkbox"/> 8 Released for Construction</p> <hr/> <p>Acceptance Codes (Approval Codes)</p> <p><input type="checkbox"/> 1 Approved</p> <p><input type="checkbox"/> 2 Approved for Manufacturing / Fabrication with Comments as marked</p> <p><input type="checkbox"/> 3 Not Approved / Resubmit</p> <p><input type="checkbox"/> 4 Retained for Information / Records</p> <p><input type="checkbox"/> 5 Reviewed</p> <p><input type="checkbox"/> 6 Reviewed as Noted / Resubmit</p> <p>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>This approval / review does not absolve the supplier from the full responsibility for design and fabrication.</p> <p>Date : __/__/____ Name : _____</p>	<p>tkIS India / Owner / Client</p> <p>Category Codes (Submission Purpose)</p> <p><input type="checkbox"/> 1 For Approval</p> <p><input type="checkbox"/> 2 For Review / Comments</p> <p><input type="checkbox"/> 3 For Information</p> <p><input type="checkbox"/> 4 For Engineering</p> <p><input type="checkbox"/> 5 For Enquiry</p> <p><input type="checkbox"/> 6 For Order Placement</p> <p><input type="checkbox"/> 7 Final & Approved</p> <p><input type="checkbox"/> 8 Released for Construction</p> <hr/> <p>Acceptance Codes (Approval Codes)</p> <p><input type="checkbox"/> 1 Approved</p> <p><input type="checkbox"/> 2 Approved for Manufacturing / Fabrication with Comments as marked</p> <p><input type="checkbox"/> 3 Not Approved / Resubmit</p> <p><input type="checkbox"/> 4 Retained for Information / Records</p> <p><input type="checkbox"/> 5 Reviewed</p> <p><input type="checkbox"/> 6 Reviewed as Noted / Resubmit</p> <p>Date : __/__/____ Name : _____</p>
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1.0 Intent of Documents

- 1.1 The write up given here is intended to give a guideline to process engineering activities and updation during detailed engineering to be carried out by CONTRACTOR.
- 1.2 Process engineering activities include all activities which are either explicitly defined or implied as being necessary to deliver a complete, safe and efficiently operating units / facilities meeting all requirement of the tender as well as all Statutory & regulatory requirement.
- 1.3 Technical documents are included as a part of this tender as Volume 4. Further, Relevant Licensor technical documents applicable for this tender are also included in the tender as Volume 5.
- 1.4 For carrying out process engineering, the Technical documents (Volume 4) shall be the starting document, supplemented with the Licensor's documents for the unit, and this write up.
- 1.5 CONTRACTOR'S scope shall include all process engineering, necessary for the completion of detailed engineering with the final deliverable being the process design of a complete, safe and efficiently operating units / facilities meeting all requirements of the tender. To achieve this objective, basic engineering work will also be necessary. Such basic engineering along with detailed engineering shall ensure conformance to applicable statutory & regulatory requirement too.
- 1.6 Clarifications, if any, on scope of work shall be sought by CONTRACTOR during the tender stage itself. Such clarifications shall not be processed consequent to award of contract and CONTRACTOR shall be bound to execute all process engineering works implicit for execution of the contract without any impact on the cost and schedule of the Project.

2.0 General

- 2.1 CONTRACTOR shall check the completeness & consistency of the tender documents & Licensor documents for all the units / facilities under their scope of work. In case of any discrepancies observed, most stringent requirement shall be followed after due concurrence with OWNER / CONSULTANT.
- 2.2 All mark-ups done on the Licensor documents by CONSULTANT shall be incorporated in all the relevant design documents by CONTRACTOR, if applicable.
- 2.3 Any change / modification required on the Licensor document or any change / modification required from the Licensor scheme shall necessarily be brought to the notice of OWNER / CONSULTANT and once agreed shall be implemented by CONTRACTOR without any impact on the cost and schedule of the project.
- 2.4 CONTRACTOR shall permit the participation of representatives of the OWNER / CONSULTANT during the engineering phase at CONTRACTOR office for review of the PFDs, P&IDs, and other drawings / documents as deserved / necessary by OWNER / CONSULTANT.
- 2.5 Major changes in the tender documents such as given below will require prior consent / review of LICENSOR / OWNER / CONSULTANT
 - a. Revision of Process Data influencing Material of Construction, size and location of equipment.
 - b. Revisions that may arise due to changes in operation & control philosophy
 - c. Revision of Process Configuration in a section arising out of the constraints not foreseen at the BEP preparation stage.

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- d. Revisions that could influence operation and Process Performance Guarantees.
- e. Revisions in process data / schemes arising out of compliance to statutory obligations as per Indian legislation.
- f. Any other changes having similar consequences as above.

CONTRACTOR shall prepare document Control Index during KOM. It shall be provided to OWNER / CONSULTANT for review / approval. However it is CONTRACTOR'S responsibility to ensure the completeness as per their scope of work and the document shall be updated periodically.

OWNER/ CONSULTANT shall review the process documents revised / prepared by CONTRACTOR as per document of List / Drawings / Documents for Licensor's / OWNER's / CONSULTANT's / Review / Approval (Process)



As-built documents shall be issued by CONTRACTOR for records only. CONTRACTOR to note that the review / approval of the process documents shall be limited only for the revisions duly clouded and change list provided. Any changes, which are not marked / clouded or are not part of change list shall not be reviewed, CONTRACTOR shall be responsible and liable to correct the same at any stage, as required, without any cost and time implication to the OWNER.

CONTRACTOR shall be required to furnish the documents for review and shall not expect CONSULTANT to volunteer any review if CONTRACTOR does not furnish such documents by error or oversight. It is the responsibility of CONTRACTOR to fully comply with the process engineering guidelines and process engineering specifications included in the tender and for executing the scope of process engineering work defined in the tender.

It is expected that whenever any document is submitted to OWNER / CONSULTANT for review CONTRACTOR has ensured implementation of all process engineering aspects required for generation of that particular document and that it is free from errors on this account. Under no circumstances, OWNER / CONSULTANT shall be responsible for an itemized listing of such errors or oversights on part of CONTRACTOR and all responsibilities on such accounts shall rest completely with CONTRACTOR.

CONTRACTOR to note that review and approval by CONSULTANT does not absolve the CONTRACTOR from their responsibility of delivering the product and individual components meeting the requirement of the tender. In case of any non-conformity found with respect to tender at any stage, CONTRACTOR has to rectify / re-supply the non-conforming material without any cost and time implication to the OWNER.

With every issue of revised document, CONTRACTOR shall provide a Comment Resolution Sheet (CRS) which shall include the comments provided by OWNER / CONSULTANT and the corresponding closure action taken by CONTRACTOR.

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HAZOP Study for the unit including Free Issue Material (if any) / Packages / items to be carried out by CONTRACTOR in presence of Supplier / OWNER / CONSULTANT at Contractor's office. Any Changes arising due to HAZOP recommendation and falling under contractor scope of work, CONTRACTOR to include the same without any time and cost implication. Co-ordination for participation in HAZOP with FIM vendors shall be done by OWNER / CONSULTANT as per mutually agreed schedule. CONTRACTOR shall be responsible for obtaining all statutory approvals including but not limited to IBR, Pollution Control Board etc. as applicable.

CONTRACTOR has to provide the supply / return lines required for package units from LSTK package battery limit to vendor package unit.

2.6 PFDs' / P&IDs'

Licensors RTAIL has provided Simplified PFDs / P&IDs as part of BEP. tkIS India has developed PFDs where Licensor has provided simplified PFDs based upon Licensor inputs and LSTK package scope of work.

PFDs / P&IDs development as per legend P&IDs provided in tender shall be in CONTRACTOR'S scope.



All PFDs / P&IDs revisions shall be clearly marked with revision clouds bearing revision number and a detailed change list shall be issued with all revisions.

Updation of P&IDs to incorporate supplier information and changes during Detailed Engineering. Minimum 4 issues as below are envisaged.

- Rev.00 For OWNER / CONSULTANT review and approval (Reissue of P&IDs as per legend P&IDs)
- Rev.01 Incorporating supplier information, changes due to detailed engineering, doing internal HAZOP, etc. and then submission to OWNER / CONSULTANT review
- Rev.02 Incorporating comments from OWNER / CONSULTANT on all the above specified fields and released for construction
- Rev.03 Only envisaged if OWNER / CONSULTANT comments have not been incorporated, which has a resolution mechanism or HAZOP study before release for construction.
- Rev.04 As-built

At every stage of revision, CONTRACTOR shall submit the P&IDs for OWNER / CONSULTANT review.

2.7 All modifications and changes, additional tie-in connections with existing (if any) whether major or minor, shall be executed by the CONTRACTOR at no impact on time, cost, safety and quality to the OWNER.

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3.0 Scope of Process Engineering Activities

3.1 Process work to be executed by CONTRACTOR during the course of detailed engineering is given below (3.2.2). Specifically excluded from this section are the following which are deemed implicit in the CONTRACTOR scope:



- a. Process assistance necessary/required by other CONTRACTOR in the course of usual detailed engineering, material requisition and purchase requisition stages, as well as for review/approval of supplier drawings/documents as necessary.
- b. During plant pre-commissioning, commissioning and guarantee runs. CONTRACTOR shall also be responsible for resolving/taking corrective action based on checklists generated by Licensor / OWNER / CONSULTANT without any time and cost implications to OWNER.
- c. Closure of all audits conducted by OWNER / Licensor / CONSULTANT / Statutory authorities prior to plant start up.

3.2 Broad Process Activities

The broad process activities required to be performed are:

- 3.2.1 Complete hydraulic design to guarantee throughput and individual equipment performance as defined in the tender documents.
- 3.2.2 Obtaining and submitting all Package unit P&IDs from suppliers for review / approval in a timely fashion. CONTRACTOR shall thoroughly review and approve the package unit P&IDs before submission to CONSULTANT. P&IDs not reviewed/approved by CONTRACTOR will be rejected by CONSULTANT on submission. CONTRACTOR to ensure proper interfacing of the package supplier's items with the balance of the unit in terms of connectivity, instrumentation, interlocks / controls etc.
- 3.2.3 Whenever selection of material of construction of any equipment / hardware is left to the CONTRACTOR, or in case of new equipment added as part of detailed engineering, CONTRACTOR shall ensure that selected material is consistent with Material of Constructions specified in the tender documents for similar services. All such items for which specifications are generated by the CONTRACTOR shall be submitted to LICENSOR/OWNER/ CONSULTANT for review and approval before manufacturing.
- 3.2.4 In the course of detailed engineering, CONTRACTOR shall carry out safety studies (as detailed out in the HSE documents included elsewhere in the tender) together with representatives of OWNER, CONSULTANT and LICENSOR. The reports of these studies shall be submitted to OWNER / CONSULTANT for review. A Close Out report shall be prepared by CONTRACTOR for all action items and submitted to OWNER / CONSULTANT for review and approval. It will be the responsibility of the CONTRACTOR to incorporate all such changes (resolution of action items) and implement them in plant execution without any cost and schedule implication to the OWNER.



All safety studies performed on the unit's detailed design shall also consider the detailed design of the various package units included in the main plant. This means that the package units shall not be considered as black boxes but will be studied during the safety studies. During the safety study of

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Supplier packages, experts from suppliers shall participate. A study report and Close out report on action items shall be prepared by CONTRACTOR. Any changes to the design of the package units recommended as a result of the above safety studies shall be implemented in the design of those units through their respective package suppliers without any cost/schedule implication.

Any major changes to plant design coming up after the completion of the above safety studies shall be subjected to a safety review similar to the above to ensure safety of final plant design without any cost / schedule implications.

- 3.2.5 Generation of P&IDs for drain system, Fire water system and any other system which is necessary to complete detail engineering.
- 3.2.6 CONTRACTOR to update equipment list and Electrical load list to incorporate supplier information and changes during detailed engineering.
- 3.2.7 CONTRACTOR shall specify all other raw materials required for the unit in addition to the feedstock, reagent, catalysts and utilities discussed in this document. This specification shall include materials, hazard data, method of use, frequency of use, consumption etc. The design shall include all specialised equipment required for their safe use and handling.
- 3.2.8 CONTRACTOR shall identify and procure all the required, consumables, lubricants for start-up of the Plant.
- 3.2.9 CONTRACTOR will identify all effluents and emissions (gaseous, liquid and solid) arising from the process during normal operation and significant abnormal operations.
- 3.2.10 CONTRACTOR to prepare Operating Manual incorporating supplier's instructions, alarms, trips, lubrication schedule etc. CONTRACTOR shall integrate supplier operating manual to main operating manual for the package units and utilities (including 'Free Issue' items).
- 3.2.11 CONTRACTOR to develop detailed procedure / system for pre-commissioning and commissioning, identify the system, mark the system on P&IDs, chemical cleaning requirement etc. and execute the pre-commissioning and commissioning as per the same.
- 3.2.12 Chemical cleaning shall be carried for the following systems as a minimum:
 - Steam and boiler feed water circuits.
 - Lube oil circuits
- 3.2.13 CONTRACTOR shall develop the pre-commissioning and commissioning schedule for the entire project and submit the same to OWNER / LICENSOR / CONSULTANT for review and comments, if any.
- 3.2.14 CONTRACTOR shall design / develop gaseous, liquid and solid waste management, handling and disposal system.
- 3.2.15 CONTRACTOR to provide safety valves sized for fire case relief on all vessels not open to atmosphere but subjected to external fire. This is for meeting the requirements of API etc. This requirement also applies to pressure vessels like cartridge filters, condensate level control pots, etc. as applicable.

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3.2.16 CONTRACTOR to generate / update ISBL utility distribution P&IDs of all required utilities consistent with the final equipment layout of the unit and relative inter-unit location, including necessary additional details such as utility hose stations for air, water and any other utility which may be required. Utilities matching API seal plans for pumps and utilities to supplier packages are to be taken into account while developing the utility distribution diagrams.

Tapping sequence on P&ID to match with the Isometrics for all Process and Utility lines in all distribution headers for all lines. Utilities for which ISBL distribution P&I Diagrams are required are:

- 1) Filtered Water
- 2) Drinking Water / Potable Water
- 3) Plant Air
- 4) Instrument Air
- 5) Steam & Condensate
- 6) Fire Water
- 7) Waste Water
- 8) Any other utility which may be required

Note: Cooling water required for HVAC shall be arranged by CONTRACTOR within package.

3.2.17 CONTRACTOR shall prepare the line list. As a minimum insulation thickness, test medium and test pressures for the various lines shall be incorporated.

3.2.18 Insulation thickness to be provided for lines and equipment.

3.2.19 CONTRACTOR shall provide all safety / pressure relief valves required to protect plant and equipment within the unit. CONTRACTOR shall also quantify the relief loads arising from controlling and significant relief scenarios for each safety / pressure relief valve (e.g. utility failure, blocked-in, external fire, etc.).

3.2.20 All Safety valves required for operational failure cases shall be provided with an installed spare with isolation valve (with interlocking facility). Safety valves provided for failure cases of external fire, thermal relief, exchanger tube rupture may be provided without an installed spare.



CONTRACTOR shall ensure that these requirements for the PSV's are taken care in supplier packages as well.

Safety valves for two phase application will be sized based on DIERS method. CONTRACTOR to perform the required check and update the PSV specification based on same if an increase in relief rate of PSV is warranted.

CONTRACTOR shall undertake a specific review of requirements for pressure relief valves within their battery limits. In case additional safety valves within battery limit are felt necessary, CONTRACTOR shall provide the same.

3.2.21 CONTRACTOR shall provide temporary start-up strainers during flushing in pre - commissioning stages wherever required to avoid damage to rotating equipment.

3.2.22 CONTRACTOR shall provide tag numbers to all the steam traps in the plant and prepare their data sheets. A safety factor of 3.0 needs to be considered for all steam traps in the plant.


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- 3.2.23 CONTRACTOR shall carry out the integration of 'Free Supply' items with connected equipment/piping, electrical system and control system as per layout requirement.
- 3.2.24 All eye wash and safety showers shall be supplied with drinking water from overhead tank. CONTRACTOR to provide required facilities to design Safety shower as per IS 10592. Design should ensure that the water supply temperature during use is safe for personnel protection requirements.
- 3.2.25 CONTRACTOR to note that the equipment layout drawings included in the tender document are only indicative. During detailed engineering, CONTRACTOR has to update these drawings to fulfil various detailed engineering requirements. These requirements include accommodating the footprint (both shape and area) of various package equipment as informed by their respective suppliers. CONTRACTOR has to ensure that the finally decided equipment layout meets all the requirements of the tender document and meets all the guarantees (including hydraulic guarantees) stipulated in tender document and statutory requirements. The above activity is implicit in the scope of CONTRACTOR and no extra claims on account of changes to equipment layout during detailed engineering will be admissible.
- 3.2.26 CONTRACTOR shall provide AC / Ventilation facilities for all plant and non-plant buildings as per applicable regulatory requirement.
- 3.2.27 It will be the responsibility of the CONTRACTOR to demonstrate compliance to Licensor as well as statutory codes and requirements. Any shortcomings pointed out during audits like HSE Design review, HAZOP, Technical Audits etc. shall be taken care of by the CONTRACTOR without cost and schedule implications to OWNER.

4.0 Guidelines for Process Engineering

The following guidelines as applicable shall be followed by CONTRACTOR for carrying out the detailed process engineering. The requirements arising out of the following work shall be included by CONTRACTOR in his offer and no extra claim shall be entertained later.

- All safety reliefs to atmosphere as well as vents to atmosphere shall be routed to a safe location away from working platforms.
- All valves as well as instruments should be easily approachable and should have suitable working platforms for regular maintenance and operation.
- CONTRACTOR shall provide multiple control valves wherever required as a result of detailed hydraulic design to cover the entire operating range (minimum/normal/maximum flow).
- CONTRACTOR to provide piping high point vents and low point drains in all process and utility lines as per engineering standard unless specified otherwise. Refer Piping specification (6695-PIP-G00-EC-0003) for isolation valve / blind flange requirement for vents and drains (including hydrostatic vents) on all process and utility lines.
- In the tender document certain information which has been shown under 'Hold' with or without a remark indicates that this information will be firmed up during detailed engineering. This information will be indicated to the CONTRACTOR during the execution of the project. CONTRACTOR will update

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his design based on this information without schedule or cost implications e.g. Sub-header, Safety valve sizes etc. although shown shall be finalized during detailed engineering.

- f. Units / facilities in scope shall meet the requirements of the various mandatory statutory international and local codes.
- g. **IMPORTANT:** CONTRACTOR is advised in his own interest to ensure proper clouding and marking of all changes to all updated documents. This will ensure smooth and proper review of documents submitted. Documents submitted without clouding / marking of changes shall not be reviewed and shall be immediately returned to CONTRACTOR for resubmission. Any changes made by the CONTRACTOR, but not clouded shall not be reviewed and it shall be the CONTRACTOR responsibility to correct the same at any stage.
- h. All steam users (equipment, instruments, piping etc.) consuming steam during normal operation shall be designed for full vacuum conditions.
- i. Tag numbering of all new equipment, instruments and lines coming as part of detailed engineering shall be done by CONTRACTOR in line with the tag numbering philosophy.
- j. Lines under gravity flow condition shall have no pockets till the respective destinations.
- k. CONTRACTOR shall generate process specifications for all instruments on process/utility line. Further, process specification of any additional instruments added/provided as required during detailed engineering shall also be developed by CONTRACTOR.
- l. Spool pieces wherever required for the easy maintenance/removal of machinery/items shall be provided by CONTRACTOR during detailed engineering. The same shall be marked up in the P&ID.
- m. Slope requirements as indicated in the Licensor / Supplier P&IDs shall be adhered to strictly during detailed engineering by CONTRACTOR.
- n. Blinds, vents and drains required for pre-commissioning shall also be marked in P&IDs.


4.1 Hydraulics

Following are some of the hydraulic checks that need to be performed by the CONTRACTOR, to ensure the said unit/facilities performance as per design. The said list outlines the major activities to be performed by CONTRACTOR and is not to be considered as a complete comprehensive list. Any activities over and above the ones listed below are to be performed by CONTRACTOR to ensure the said unit/facilities performance as per design. CONTRACTOR shall ensure smooth fluid flow between equipment as per the requirements of basic process design. CONTRACTOR shall also ensure smooth operation of each equipment from hydraulic point of view.



- 4.2 Check adequacy of all process and utility lines within battery limits covering all connectivity. Detailed circuit wise sizing calculations shall be documented with sketches and drawing references as appropriate, accounting for relative elevation differences between starting and ending points, likely line lengths for all circuits initially and finally with actual line lengths (for critical circuits). Mechanical design conditions of all equipment, piping and instruments in the circuits may be changed, if found necessary based on pump / compressor shut off pressures, etc. and validated against Piping Material Specifications (PMS) / Equipment Data Sheets / Instrument Data Sheets of the project.

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- 4.3 Relief valve (PSV) sizes and inlet and outlet line sizes wherever indicated in the tender document are indicative only. CONTRACTOR to confirm/size the Safety valve and line sizes to meet the requirements of system hydraulics.
- 4.4 CONTRACTOR shall size all utility distribution headers, sub-headers and lines based on utility consumption figures.
- 4.5 Evaluate all control valves for satisfactory operation at minimum /normal/maximum process conditions and ensure that valves are neither oversized nor undersized. All control valves selected by the CONTRACTOR shall be within controllable range between minimum turn down and maximum capacity.
- 4.6 Availability of pressure drop for flow elements/orifices shall be ensured by CONTRACTOR during hydraulics checking.
- 4.7 Sizing of pump suction / discharge manifold lines based on final pump flow shall be ensured by CONTRACTOR.
- 4.8 Checking of pump hydraulics and revalidating NPSH (A) data based on actual equipment elevations/pipe isometrics shall be ensured by CONTRACTOR.
- 4.9 Non Return Valves (NRVs) wherever required shall be provided after carrying out hydraulic checks. The type and physical location (at site) shall be selected so as to ensure smooth operation during all sets of operating conditions.
- 4.10 All specifications in the tender document such as line size, pump head, compressor differential pressure, vessel elevation, pump/compressor capacity, etc. shall be treated by CONTRACTOR as minimum. Only upward revision shall be done, if called for, based on hydraulic checks, without any cost and time implication to the OWNER.
- 4.11 Utility Distribution P&I Diagrams
- CONTRACTOR to prepare and or update the ISBL Utility Distribution P&IDs for the said Unit / facilities for all utilities.
- Following are some of the points that need to be considered while preparing the utility distribution P&IDs:
- Prepare and update the utility distribution P&ID's for all the utilities consistent with the final equipment layout and relative locations of consuming equipment, availability of pipe tracks/racks on the equipment layout etc. In addition to requirement of utilities for normal uses, requirement of utility hose stations of air & water have also to be indicated in appropriate drawings and provided by routing the distribution header and laying appropriate lines.
 - A jump over line shall be provided between cooling water supply and return headers at the dead end of the header.
- 4.12 Eyewash and safety shower shall be provided as per process requirement and good engineering practice, near chemical handling area.
- 4.13 Process P&I Diagrams
- The process P&IDs have to be developed and updated during detailed engineering based on the established design / engineering practices. Following are the minimum points that need to be considered while updating the P&IDs:

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- Incorporate / update control valve assemblies indicating control valve size, block and bypass valve sizes, expanders/reducers and drain valves as required.
- Incorporate / update safety valve manifolds indicating safety valve sizes, inlet / outlet line sizes, block valves at inlet / outlet, expanders / reducers at inlet/outlet, depressurizing line, bleed/drain valves, etc.
- PSV isolation valves (upstream / downstream) shall be full port size.
- Incorporate nozzle sizes as per exchanger thermal design, vessel / column information etc. Showing expanders/reducers on piping as necessary.
- Incorporate pump and compressor nozzle sizes as per final supplier data, reviewing pump suction/discharge line sizes for compatibility with respect to piping loads on the pump nozzles, as necessary, and indicating expanders/reducers to match.
- Incorporate / update minimum flow bypasses (constant / variable) for pumps based on ordered equipment data and specifying necessary instrumentation/piping.
- Incorporate set points and sizes of PSV'S, installed on positive displacement pumps.
- Incorporate process-related information on supplier package items, such as compressors, etc. Specifically indicating utility lines required, process interlocks/instrumentation linked to DCS for operator interface on P&ID's, repeat indications in DCS etc. Based on supplier feedbacks. The above activity shall be carried out for Free Issue items also.
- Details for package items like Vacuum System, filters, Conveying system etc. shown on PFDs are minimum. P&ID's have to be developed further by CONTRACTOR based on PFDs provided in tender.
- Wherever in tender document it is indicated that a particular data shall be finalized during detailed engineering, the same shall be completed/generated by CONTRACTOR.
- NPSHA reported for pumps are with respect to source vessel elevations indicated in datasheets / P&ID's. NPSHA for all pumps to be cross-checked based on the actual elevation/locations and piping details. Elevation of the equipment may be increased so as to meet the NPSHR plus margin (as per standard engineering practice) of the pump under information to Licensor / OWNER / CONSULTANT. Such changes will be with approval from Licensor / OWNER / CONSULTANT.
- Requisite instrumentation, piping, etc. For maintaining seals and detecting seal failures in API seal plans shall be provided by the CONTRACTOR. CONTRACTOR shall detail out the seal flushing arrangement, as applicable.
- CONTRACTOR to provide / ensure suction and discharge side drains with isolation valves for positive displacement pumps.
- CONTRACTOR shall clearly identify all two phase (Vapour/liquid) lines and critically evaluate requirement of additional pipe supports, etc., depending on flow regime, pipe lengths, etc.
- CONTRACTOR to show spec/rating breaks at the pump / exchanger / column / vessel inlet and outlet nozzles if the rating / material of nozzles and connecting piping are different.
- CONTRACTOR shall prepare DCS graphics. Same will be reviewed and approved by OWNER / CONSULTANT during FAT of Control system.
- CONTRACTOR to prepare P&IDs for Open & Closed loop drain systems and for sampling systems.

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- CONTRACTOR to incorporate insulation thickness on Piping and equipment.
- Incorporate representation of motor running indication on DCS in P&IDs.
- Incorporate the failure case position of all the control valves as FO (fail to Open) / FC (fail to close) / FL (fail lock).
- Incorporate the drains points at suction and discharge piping for all the pumps for maintenance purpose.
- All drain points shall have isolation valve with end blind.

4.14 Equipment

The equipment data sheets have to be prepared/validated / updated by CONTRACTOR during detailed engineering. Following is a general list of activities to be performed for validation/updating of equipment data sheets.

Pumps, Compressors Fans and Blowers


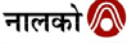
A. CONTRACTOR to check / ensure consistency with respect to the following points between the equipment process data sheet and the P&IDs :

- Type of pump / compressor centrifugal/blower/positive displacement correctly represented in P&ID by checking against PDS
- Auto start/shutdown as required is provided on the P&ID
- Unloading arrangements shown for compressors as per PDS
- Suction/discharge pressure control loops/arrangements provided for positive displacement machines
- Positive displacement machines provided with means to route excess flow back to suction
- Relief valves provided on positive displacement machines

4.15 Vessels / Columns / Reactors / Tank / Dryers / Filters / Silos / Cyclones

A. CONTRACTOR to check/ensure consistency with respect to the following points between the equipment process datasheet and the P&IDs:

- All vessel / column / reactor / tank nozzle sizes, location and number of nozzles on process datasheet matches with P&ID and reducers/expanders as necessary are provided.
- All internals like demisters, vortex breakers, steam coils, agitators, etc. match between the P&IDs and PDS
- If there are any special requirements for orientation of nozzles, the same need to be marked on the P&IDs.



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4.16 Heat Exchangers

- A. Thermal design of all Heat Exchangers for adequacy of area, pressure drop and ensure vibration free operation.
- B. CONTRACTOR to check / ensure consistency with respect to the following points between the P&ID and PDS:
 - Type of exchanger (double pipe, shell and tube, plate type, kettle type, etc.) matches between the PDS and P&ID
 - Tube side and shell side fluids as in PDS are correctly shown on the P&ID
 - Critical distance and elevation requirements as marked on P&IDs and PDS match.
 - If the cold side can be blocked, TSV should be provided on the P&IDs on the cold side
 - Level instrument internals (like weir) are shown on P&IDs (e.g. Kettle).
 - If parallel exchangers are required for some service, requirement of symmetrical piping shall be marked on the P&ID
 - Based on temperature / pressure conditions at inlet and outlet of heat exchanger, whether PMS break, if required is marked on the P&ID
 - Nozzle locations as per PDS are properly marked on the P&ID
 - Expansion bellows, if any are marked on the P&ID

4.17 Instrumentation

- A. Assess fire case relief loads of equipment/equipment groups in same fire grade area.
- B. Prepare Instrument Datasheets for all instruments required for the said Unit/Plant/Facilities incorporating all relevant process & instrument data and further update the same with respect to all detailed engineering changes, including, but not limited to :
 - Control valve pressure drop change due to hydraulics
 - Line size changes
 - Piping class changes
 - Design condition changes
 - Minimum flow by-pass provision / updation
 - Fire case PSV loads
 - Control scheme changes
 - New Instrumentation added
 - Alarm set points based upon supplier inputs
 - Completion of process specifications for instruments, which have not been fully specified in BEP.
 - Rechecking availability of pressure drop specified for flow elements / orifices based on hydraulic check.
 - Preparation of specification for all gas detectors and providing the same at suitable locations

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- C. All unnumbered instruments are to be given tag numbers and data sheet of the same is also to be prepared by CONTRACTOR. CONTRACTOR to also prepare data sheets for additional instruments coming up as per supplier feedback for package items as a part of detailed engineering.
- D. Instrumentation shown in the supplier package items is the minimum requirement. This needs to be updated by the CONTRACTOR (based on supplier inputs) to meet the requirements of the package specifications and to ensure a complete, smooth and safe operating packaged item.



4.18 Scope of work for Packaged Equipment/Units

CONTRACTOR'S scope of work shall include all activities e.g. Engineering, Procurement, construction, supplies and services necessary for turnkey execution of the Package unit from basic design to commissioning and successful performance guarantee test run at site.

- Process Design Basis Package,
- Engineering Design Basis,
- Job Specification,
- Standard specifications,
- Drawings,
- Installation Standards,
- Piping & Instrumentation Diagram (P&ID),
- Data sheets of all equipment

CONTRACTOR shall carry out requisitioning activities including:

- Preparation of Detailed Purchase Requisition for each equipment. The equipment shall be ordered only after approval of Purchase Requisition by OWNER / CONSULTANT (as applicable)
- CONTRACTOR shall review and approve all QAP prepared by suppliers. Same shall be submitted to OWNER / CONSULTANT for information and records.

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5.0 Contractor's scope of supplies and services

CONTRACTOR's scope of supplies and services shall include but not limited to the following.

5.1 Process Design and Engineering comprising of preparation of the following documents:

- Basic engineering design,
- PFD with major controls, material & energy balance,
- P&IDs
- Interlock and logic diagram with full description,
- Equipment and line list with sizes,
- Functional loop schematics, etc.

5.2 Detailed Engineering comprising of:

- Single line diagram
- Plot plan development
- Layouts
- Review/approval of supplier drawings and documents such as General arrangement Drawings, Fabrication and assembly drawings etc.
- Co-ordination in design, procurement, Inspection, testing and commissioning of packaged equipment.

5.3 Procurement of equipment, material and bought out items.

5.4 Shop/Site fabrication and testing.

5.5 Assembly of sub-assemblies.

5.6 Stage wise inspection at shop.

CONTRACTOR shall prepare / approve stage wise Inspection programme of supplier to ensure the integrity of all equipment and piping. This programme should include inspection & testing as per data sheet, design basis, job specs, Standard specifications/standards, codes etc. and CONTRACTOR approved Project Quality Plan.

5.7 Customs clearances.

5.8 Insulation, cladding, and painting of the unit.

5.9 Supply & Transportation.

5.10 Unloading prolong storage/preservation and security at site.

5.11 Movement of material equipment, consumables etc. at site.

5.12 Construction, erection, installation, grouting, assembly, hook ups and field testing.



5.13 Filling of lubricants, Oils, consumables etc. (for first filling and replacement during cleaning / flushing).

5.14 Clear the work spaces of all construction aids, debris etc. and provide a tidy work place from pre-commissioning stage.

5.15 Pre-commissioning and assistance to Owner's personnel during commissioning.

5.16 Satisfactory performance guarantee tests at site.


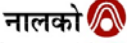
5.17 Specific operating and maintenance instructions for easy operation and quick maintenance of all items and the Package unit.

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- 5.18 Handing over of plant to the OWNER as per OWNER / CONSULTANT's satisfaction.
- 5.19 Obtaining all statutory approvals as per GENERAL CONDITIONS OF CONTRACT
- 5.20 CONTRACTOR shall prepare a comprehensive equipment List produced on a Data Basis showing all items classified on the basis of each Process and utility unit. Equipment list shall also identify equipment requiring:
- Approval from Statutory authorities
 - Code Stamping
- 5.21 Equipment list shall include the following against each item:
- Equipment / item tag numbers
 - Description
 - Technical details including dimensions
 - Drawing number
 - Supplier
 - Data sheet number
 - Design flow, pressure and temperature
 - Special features if any, etc.
- 5.22 CONTRACTOR shall refer and comply with Project Engineering Specifications for Electrical, Instrumentation, Static Equipment, Piping and Quality Assurance as applicable to various packages. These specifications are included discipline wise in the tender documents.
- 5.23 The packages defined in tender are indicative. CONTRACTOR may revise the scope of each package unit depending on availability of suppliers with prior permission from OWNER / CONSULTANT. In such cases, basic and detail engineering of separate systems, if required to be done by CONTRACTOR and to be submitted to OWNER / CONSULTANT for review.
- 5.24 Scope of Supply

CONTRACTOR'S scope of supply shall include but not be limited to the following:

- All equipment as per the equipment indicated in equipment list and Licensor documents.
- All electrical, instrumentation and controls.
- All supports for equipment, piping, ducting etc.
- Foundations and Foundation Bolts for all equipment and supports
- Installation, site testing & commissioning
- First fill of all lubricants and hydraulic oils.
- In addition to above, any special tools and tackles required for operation and maintenance of the


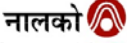
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plant and equipment.

- Spares for start-up and commissioning. Construction, pre-commissioning, commissioning as per project spare philosophy
- Special Tools required for operations and maintenance of the Plant.
- Spares for 1year normal operation (only itemized price list with recommended quantity to be furnished).
- Engineering studies
- List of Laboratory equipment if any and Chemicals
- Documentation
- Any other item though specifically not asked for in the document but required for safe and efficient operation of the plant and equipment.

All items / components of the packages shall be procured in line with the relevant project standard and design basis included in this tender elsewhere.

Sub suppliers selected for the components / items of the package shall be from the approved supplier list for the project. CONTRACTOR needs to take prior approval for any deviation from approved suppliers.

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SCOPE MATRIX

S.No.	ACTIVITY	LSTK Package	
		CONTRACTOR's Scope	CONTRACTOR's Confirmation
	Process		
1.0	Complete process design for package based on basic scheme shown in tender documents.	Yes	
2.0	Develop P&IDs based on tender requirement giving details of all equipment	Yes	
3.0	Prepare Data sheets for all the equipment within the Package.	Yes	
4.0	Hydraulic checks to verify line sizes, prepare, instrument and control valve data sheets, determine piping design pressure, NPSH and pump heads based on piping layouts.	Yes	
5.0	Develop utility distribution including UFD and utility consumption table.	Yes	
6.0	Prepare Line List for all the lines included in the Package.	Yes	
7.0	Develop Operating and Control Philosophy	Yes	
8.0	Prepare Alarms List & Trip schedule	Yes	
9.0	Prepare Effluent & Emissions schedule	Yes	
10.0	Hazardous Area Classification as applicable shall be furnished.	Yes	
11.0	Prepare Operating & Maintenance Manual	Yes	
12.0	Pre-commissioning, Commissioning activities & Operating assistance for 3 months from the date of Mechanical completion.	Yes	
13.0	Owner's Operator's Training	Yes	
14.0	Safety Studies and close-out of all recommendations as listed in Document 6695-PRC-G00-BG-0001	Yes	
15.0	As- built documentation	Yes	