GENERAL TERMS AND CONDITIONS OF PURCHASE

1.0 DEFINITIONS

1.1 Unless repugnant to the subject or context thereof, the following expressions herein used shall carry the meaning hereunder respectively assigned to each, namely:

(a) "Bulk Consumables" mean items specifically defined in the Contract Documents to constitute bulk consumables.

(b) "Contract" shall mean the contract as derived from:
- i. The Tender Documents;
- ii. Agreed Variations to the Tender Documents;
- iii. Vendor's Priced bid; and
- iv. The Purchase Order.

(c) "Contract Document(s)" shall mean individually and collectively the documents constituting the contract.

(d) "Defect Liability Period" in respect of:

i. Bulk Consumables shall be the date of delivery plus 6 (six) months;

ii. In the case of other Material(s) shall be 18 (eighteen) months from the date of delivery or 12 (twelve) months after the same have been put in service or commissioned, whichever is earlier;

iii. In the case of altered or replaced Material(s):

i. For bulk consumables:

In case of repair / replacement, Vendor shall extend the warranty of such part further for a period of 6 (six) months from the date of supply of repaired/replaced material. However, in no case the warranty of repaired/ replaced part shall exceed 12 (twelve) months from last supply.

ii. In case of other materials:

In case of repair/ replacement, Vendor shall extend the warranty of such part further for a period of 12 (twelve) months for other materials from the date of repair/ replacement. However, in no case the warranty of repaired / replaced part shall exceed 24 (twenty four) months from the date of commissioning or 30 (thirty) months from last supply, whichever is earlier.
In case of extended Warranty period, extension of Performance Bank Guarantee shall not be required.
"Delivery"

iv. with respect to Imported Material(s) means the date of completing shipment of the Material(s) on board the designated vessel or aircraft at the designated port or place of shipment, securely packed and unless

otherwise determined, shall be deemed to be the date of the relative Bill of Lading or Airway Bill; and

v. with respect to Indigenous Material(s) means the date of completing shipment of Material(s) F.O.R./F.O.T. securely packed and loaded and unless otherwise determined, shall be deemed to be the date of the relative Truck/lorry Receipt or Railway Receipt.

(e) **"Earnest Money Deposit (EMD)"** means the bank guarantee furnished in lieu of EMD {where the amount of EMD is more than Rs 100,000/- (Rupees One hundred thousand only)} or online EMD submission on IOCL's e-tendering portal by the Vendor in support of his/ its bid as required by the Bid Documents.

(f) **"Equipment"** means plant, machinery, equipment, instruments, computer, control and other electronic and electrical systems, and shall include parts, components, assemblies and sub-assemblies thereof.

(g) **"Free Issue Material(s)"** means any equipment, parts or components or spares to be supplied by IOCL to the Vendor which are to be incorporated in any supply of Indigenous Material(s).

(h) "IOCL" means Indian Oil Corporation Ltd., a company incorporated in India and having its registered office at G-9, Ali Yavar Jung Marg, Bandra (East) Mumbai – 400 051 and having the Head Office of its Refineries Division at Scope Complex, Core 2, 7 Institutional Area, Lodhi Road, New Delhi-110 003 and includes its successors and assigns and all persons through whom it acts in any matter for the purpose of the Tender or the Contract.

(i) **"Imported Material(s)"** mean(s) the materials to be fabricated, manufactured or procured by the Vendor outside India for shipment to India under the Contract.

(j) **"Indigenous Material(s)"** mean(s) materials to be fabricated, manufactured or procured by the Vendor within India for supply under the Contract.

(k) **"Inspectors"** means Inspectors nominated, appointed, approved or deputed by IOCL for inspection of the Material(s) prior to Delivery.

(l) **"Material(s)"** means any and all raw materials, manufactured articles, equipment, spares and other goods and supplies whatsoever and includes wherever applicable drawings, data, specifications and intellectual property rights and all services (including but not limited to design, fabrication, inspection, delivery and testing) required to be supplied, done, performed, prepared or undertaken to meet the requirements of the Contract

(m) **"Procurement Coordinator"** means the representative or agency appointed by IOCL for managing, expediting and/or coordinating the supply of Material(s).

(n) **"Project"** means the Project or Refinery for which the Material(s) is/are required.

(o) **"Project Site"** means the site of the Refinery unit or site of the Project for which the Material(s) is/are required.

(p) **"Purchase Order"** means IOCL's acceptance of the Vendors' offer/bid and includes any formal or detailed Purchase Order issued by IOCL pursuant to the acceptance of the bid.

(q) **"Stipulated Delivery Period"** means the date(s) for delivery of the Material(s) as stipulated in the Contract and failing such stipulation, shall mean the date(s) for such delivery(ies) as agreed between the Vendor and IOCL.

(r) **"Tender Documents"** with reference to the Purchase Order mean:

i. Material Requisition/Request for Quote;
ii. General Terms and Conditions of Purchase;
iii. Technical Specifications;
iv. Special Conditions of Purchase (if any);
v. Addendum (a) (if any) to the Tender Documents.

(s) **"Total Contract Value"** means total value of the Material(s) and services to be supplied as specified in the Purchase Order, exclusive of reimbursable taxes and duties.

(t) **"Vendor"** means the successful bidder on whom the Purchase Order is placed.

1.2 Interpretation of Contract Documents

1.2.1 The several Contract Documents forming the Contract are to be read together as a whole and are to be taken as mutually explanatory.

1.2.2 Should there be any doubt or ambiguity in the interpretation of the Contract Documents or in any of them, the Vendor shall prior to commencing the relative supply or work for supply under the Contract apply in writing to IOCL for resolution of the doubt or ambiguity. Should the Vendor fail to apply to IOCL within 7 days from the date of receipt of the Order for its clarification as aforesaid, the Vendor shall perform the relative work and/or make the relative supply at his own risk.

1.2.3 Any item of supply or service relative thereto shown, indicated or included by expression or implication in any document forming part of the Contract shall be deemed to form part of the Scope of Supply with the intent that the indication or inclusion of the supply or service within any of the said documents shall be a sufficient indication of the Scope of Supply or service covered by the Contract.

1.2.4 No verbal agreement or assurance, representation or understanding given by any employee or officer of IOCL or so understood by the Vendor shall anywise bind IOCL or alter the Contract Documents unless specifically given in writing and signed by or on behalf of IOCL as an Agreed Variation to the relative term(s) in the Contract Document(s).

1.2.5 Clause headings given in this or any other Contract Documents are intended only as a general guide for convenience in reading and segregating the general subject of the various clauses, but shall not govern the meaning or import of the clauses there under appearing or confine or otherwise affect the interpretation thereof.

1.3 Irreconcilable Conflicts

Subject to the provisions of Clause 1.2 hereof, in the event of an irreconcilable conflict between the provision of these General Terms and Conditions of Purchase and/or the Special Conditions of Purchase and/or Addendum (a) and/or the Agreed Variations to the Tender Documents and/or the Purchase Order and/or between any of the other said documents so that the conflicting provision(s) cannot co-exist, to the extent of such irreconcilable conflict, the following order of precedence shall apply so that the conflicting provision(s) in the document lower in the order of precedence set out below shall give way to the conflicting provision(s) in the document higher in the order of precedence, namely:

i. Purchase Order;
ii. Agreed Variations to the Tender Documents;
iii. Addendum/Addenda (a) to the Tender Document;
iv. Special Conditions of Purchase;
v. General Terms and Conditions of Purchase;
vi. Other Contract Documents.

2.0 CONFIRMATION OF ORDER

2.1 Wherever applicable, signed Letter of Acceptance (also named as Fax of Acceptance in some cases) shall, normally, be issued through e-mail (scan of the signed document). SAP Purchase Order shall, normally, be issued as an unsigned, system generated document through e-mail.

Without prejudice to the formation of contract by acceptance of bid, the Vendor shall acknowledge the receipt of the Letter of Acceptance (wherever applicable) and SAP Purchase Order within 7 (seven) days following receipt of the Letter of Acceptance or SAP Purchase Order.

3.0 PRICE

3.1 Unless otherwise specifically stipulated, the price shall be firm and shall not be subject to escalation for any reason.

3.2 Unless otherwise specifically stipulated, the price for Indigenous Material(s):

i. shall be inclusive of road/rail worthy water-proof packing and forwarding charges upto effecting delivery at F.O.T./F.O.R despatch point and shall also be inclusive of inland freight and local taxes (if any) as leviable on the transportation or entry of goods into any local area or limits pursuant to the Contract; and

ii. shall be exclusive of transit insurance, CGST or SGST/IGST and/or such other imposts which are leviable by law on the supply of goods or their sale to IOCL pursuant to the Contract.

3.3 (a) If it is stipulated that local taxes (if any) are to be borne by IOCL, the Vendor shall arrange for the transporter to pay the same, if any leviable and claim reimbursement thereof from IOCL against proof of payment.

(b) If it is stipulated that dispatch shall be on "freight to pay basis", the Vendor shall advise the transporter to collect the freight from IOCL after the full

quantity of the Material(s) has/have been delivered in good condition to the Project Site.

3.4 Unless otherwise stipulated, the price of Imported Material(s) shall be the FOB/ FCA (as per prevailing ICC INCOTERMS at the time of ordering) price of Material(s) and shall be inclusive of sea/ air worthy water-proof packing and forwarding charges (as the case may be).

4.0 EARNEST MONEY

4.1 A bid is liable to be rejected unless it is supported by earnest money of a value as provided in the Purchase Requisition/ Request for Quote.

4.2 Earnest Money by the tenderers shall be accepted only in the form of online EMD payment on IOCL's e-tender portal or a Bank Guarantee. Bank Guarantee in the format set forth in Annexure "A" hereto may be furnished in lieu thereof if the amount of Earnest Money Deposit exceeds Rs. 100,000/- (Rupees One hundred thousand only).

4.3 If the Earnest Money is in the form of a Bank Guarantee, the validity of the Bank Guarantee shall be extended by the Vendor at the Vendor's cost and initiative for a period of 3 (three) months beyond the date of the acceptance of bid by IOCL, failing which the Bank Guarantee may be encashed by IOCL and the proceeds held as security for the performance of Vendor's obligation and the due discharge of Vendor's liability under the resultant Contract until the Vendor acknowledges the acceptance of the Purchase Order and furnishes the Performance Guarantee. Should the Vendor fail to accept the Purchase Order and/or furnish the Performance Guarantee within the time specified in this behalf, or specifically permitted by IOCL for the purpose, IOCL may encash the Bank Guarantee furnished by the Vendor by way of Earnest Money Deposit and/or forfeit such proceeds or other encashable Earnest Money Deposit held by it in cash without prejudice to any other right or remedy available to it.

4.4 EMD of bidders whose price bids are not opened/ disqualified during techno-commercial bid evaluation (i.e. unsuccessful Bidder) shall be released after price bid opening.
EMD of bidders qualified in the techno-commercial bid but unsuccessful for placement of Purchase Order shall be released after placement of Purchase Order on successful Bidder.
EMD of the successful bidder shall be released on receipt of acceptable Performance Bank Guarantee (PBG), wherever applicable. Wherever PBG is not applicable, EMD of successful bidder shall be returned after order acceptance.

4.5 Earnest Money furnished by a tenderer may also be forfeited in the following circumstances:

a) If the tenderer alters or modifies or withdraws their bid prior to opening of the price bid and within the specified validity period of the Tender; or

b) If the tenderer withdraws their bid after the Tender is opened.

c) In case of submission of false/ fraudulent / forged documents.

5.0 TERMS OF PAYMENT

5.1 For Imported Material(s):

a) The price of Imported Material(s) shall be paid in the currency specified in the Contract.

b) 100% (one hundred percent) of the price of the relative Imported Material(s) (after considering price reduction for delay, if any, as per clause 12.0) will be paid under an irrevocable Letter of Credit against submission of documents specified in the Letter of Credit. The Letter of Credit shall be substantially in the format set forth in the Annexure "B" hereto and shall be established either by the State Bank of India or other bankers of IOCL in India.

c) Unless otherwise specified, the Vendor may draw against the Letter of Credit on presentation of all the following documents:
   i) Invoice
   ii) Clear Bill of Lading/Airway Bill covering the Material(s) invoiced
   iii) Packing list for the consignment
   iv) Third party Inspector's Certificate covering the invoiced Material(s) wherever applicable
   v) Test/Composition Certificate
   vi) Certificate of origin
   vii) Drawing(s)/Catalogue(s) covering the Material(s), wherever applicable.
   viii) Export Certificate, wherever applicable
   ix) Invoice of Inspector's charges, wherever applicable
   x) IOCL's acknowledgement of Performance Bank Guarantee wherever applicable.

d) Bank charges payable to IOCL's banker for opening of the Letter of Credit shall be borne by IOCL and bank charges payable to the Vendors' banker shall be borne by the Vendor.

e) Should the Vendor desire to get the Letter of Credit confirmed by any other banker, confirmation charges will be borne by the Vendor.

f) Unless otherwise agreed, the Letter of Credit shall not permit drawing in more than 3 (three) tranches.

g) Unless otherwise specified, the Vendor shall furnish a Bank Guarantee towards performance favoring IOCL within 15-days of the Purchase Order for an amount equivalent to 10% (ten) of the Price of Material(s) from a Scheduled bank in India (including an Indian branch of a foreign bank) acceptable to IOCL in the format set forth in Annexure "C" hereto valid (in the first instance) for the period specified in Clause16.12

h) In the event that IOCL requests the Vendor to hold or to warehouse the Material(s) for any period after the Material(s) are ready for shipment, the storage charges as agreed, shall be borne by IOCL in addition to the Price.

5.2 For Indigenous Supply:

a) Unless otherwise specified in the Contract, where the total contract value does not exceed Rs.50,000/- (Rupees fifty thousand only), IOCL shall release 100 % of the relative Price of Material(s) within 30 days of receipt of the Material(s) at Project Site and their acceptance.

b) Unless otherwise specified in the Contract, where the total contract value exceeds Rs. 50,000/-(Rupees fifty thousand only) but is less than Rs. 1,00,000/-(Rupees one hundred thousand only), IOCL shall release 90% of the relative Price of Material(s) on delivery of the documents specified in (c) hereof below relative hereto, and will release the balance 10% of the Vendor's invoice within 30 (thirty) days of receipt of Material(s) at Project Site and their acceptance.

c) Unless otherwise specified, where the total contract value of the Material(s) is Rs. 1,00,000/- (Rupees one hundred thousand only) and above, IOCL shall release 90% of the relative price against the documents specified here below relative hereto through IOCL's bankers and will release the balance 10% on the Vendor's invoice within 30 (thirty) days of receipt of Material(s) at the Project Site and its/their acceptance. Unless otherwise mentioned, the specified documents are:

i) Invoice
ii) Clear Railway Receipt/Truck Receipt/Goods Receipt covering the Material(s) invoiced
iii) Packing list for the consignment
iv) Third Party Inspector's Certificate covering the invoiced Material(s)/ Release Note, wherever applicable
v) Test/Composition Certificate, wherever applicable
vi) IBR Certificate/CMRS Certificate, wherever applicable
vii) Drawing(s)/Catalogue(s) covering the Material(s) , wherever applicable
viii) Guarantee/Warranty Certificate(s), wherever applicable
ix) Invoice of Inspector's charges, wherever applicable
x) Freight Memo(s) if freight is not included in the Price and the RR/TR/GR does not give the freight particulars.
xi) Acknowledgement by IOCL of receipt of Performance Bank Guarantee (wherever applicable)

d) The financial settlement of the Vendor's invoice is liable to be withheld in the event the Vendor fails to submit the drawings, data and all other documents as called for in the Purchase Order.

e) Unless otherwise specified, the Vendor shall furnish a Bank Guarantee towards performance favoring IOCL within 15-days of the Purchase Order for an amount equivalent to 10% (ten) of the Price of Material(s) from a Scheduled bank in India (including an Indian branch of a foreign bank) acceptable to IOCL in the format set forth in Annexure "C" hereto valid (in the first instance) for the period specified in Clause16.12.

6.0 VENDORS' DRAWINGS AND DATA REQUIREMENT

The Vendor shall submit drawings, data and documentation in accordance with (but not limited to) what is specified in the Purchase Requisition/Tender documents and/or Vendor's drawing and data form attached to the Purchase Order, within 30 (thirty) days of the Purchase Order. The types, quantities and time limits for submitting these must be respected by the Vendor and the Material(s) shall be deemed not to have been delivered for all purposes (including payment) until completion of the said submissions to the satisfaction of IOCL.

7.0 FREE ISSUE MATERIALS (for incorporation in the Indigenous supply)

If the Purchase Order involves the incorporation of any Free Issue Material(s):

a) The Vendor shall prior to taking delivery of the Free Issue Material(s) arrange for a Bank Guarantee for the full value of the Free Issue Material in the format set forth in Annexure "D" hereto valid from the date of the receipt of the Free Issue Material(s) until delivery of the Material(s) in which the Free Issue Material(s) has/have been incorporated.

b) The Vendor shall inspect the Free Issue Material(s) at the time of taking delivery thereof and satisfy itself of the quality, quantity and condition of the Free Issue Material(s). IOCL shall not be liable for any claims or complaints whatsoever in respect of the quality, quantity or condition of the Free Issue Material(s) once the Vendor has taken delivery thereof.

c) All Free Issue Material(s) shall be taken delivery of, transported, held, stored and utilized by the Vendor as trustee of IOCL, and delivery of the Free Issue Material to the Vendor shall constitute an entrustment thereof by IOCL to the Vendor with the intent that any transportation, utilization, application or disposal thereof by the Vendor otherwise than for incorporation in the Indigenous Material(s) shall constitute a breach by the Vendor.

d) The Vendor shall transport the Free Issue Material(s) only by such transportation as is suitable and shall hold and store the Free Issue Material(s) only at such place and/or premises that are air and water tight and otherwise suitable for the storage of the Free Issue Material(s) so as to prevent damage or deterioration or theft or other loss, and shall arrange such watch and ward as shall be necessary to ensure the safety thereof.

e) Notwithstanding the Bank Guarantee mentioned in sub-paragraph (a) above, the Vendor shall replace any Free Issue Material(s) which is/are lost, damaged, misused, stolen or deteriorated with other Material(s) of equivalent quantity and quality and condition, and the same shall be deemed to constitute Free Issue Material(s) and the provisions of sub paragraphs (a) to (f) hereof shall apply thereto in the same manner as to the originally supplied Free Issue Material(s).

f) Unused Material(s) from the Free Issue Material(s) shall be returned by the Vendor to IOCL and if IOCL so directs, the Vendor shall dispose of the same by sale or otherwise on such terms and conditions as IOCL may stipulate or approve and the Vendor shall pay to IOCL the sale proceeds of the Material(s) so disposed of by sale.

8.0 THE BILL OF MATERIAL(S)

8.1 Where the price of Material(s) is a lumpsum price and pro-rata payment is envisaged in the Purchase Order, the Vendor shall within 60 (sixty) days of the issue of the Purchase Order furnish to IOCL for approval, a priced and detailed Bill of Material(s)/ Billing Schedule as required covering all Material(s), which shall conform to the price break-up and Total Contract Value given in the Purchase Order. The Bill of Material(s) shall operate as the Billing Schedule for payment of the price of the Material(s). In preparing the Bill of Material(s), the Vendor shall ensure that all contracted Material(s) are included in the Bill of Material(s) so as to ensure that IOCL is not required, due to any oversight or omission, to pay any taxes and duties

on a value in excess of the total Value indicated in the Contract. Should IOCL be required to pay taxes or customs duties on account of such oversight or omission, the Vendor shall reimburse such excess payments to IOCL.

8.2 The Material Safety Data Sheets in the case of catalysts and chemicals and other items where ever applicable shall also be submitted within 30 days after receipt of the Purchase Order.

9.0 MODIFICATION

9.1 IOCL shall have the right to request changes or modifications in the technical documents and/or specifications comprised in the Contract, subject to the Vendor's approval thereto. IOCL shall bear any additional cost and shall be entitled to the benefit of any reduced cost resultant upon any such change or modification.

9.2 As soon as possible after receipt of a written request from IOCL for change(s), the Vendor shall furnish in writing to IOCL an estimate of the additional cost or benefit for the change(s) and/or modification(s) requested and its effect on the delivery date. On agreement with respect to the enhanced/reduced cost and modified delivery time, which shall be finalized within 10 (ten) days of the request for the modification, IOCL shall issue an amendment to the Purchase Order, and the Vendor shall promptly proceed with the change(s)/modification(s) contemplated by the amended Purchase Order.

10.0 SUB-CONTRACTS / *ASSIGNMENT*

10.1 The Vendor shall not assign the Contract in whole or part without obtaining the prior written consent of IOCL.

10.2 The Vendor shall not sub-contract the Contract in whole or part to any entity without obtaining the prior written consent of IOCL.

10.3 The Vendor shall, notwithstanding the consent and assignment/sub-contract, remain jointly and severally liable and responsible to IOCL together with the assignee/ sub-contractor, for and in respect of the due performance of the Contract and the Vendor's obligations there under.

11.0 EXPEDITING

11.1 IOCL may appoint a Procurement Coordinator to manage, expedite and coordinate the manufacture, shipment and/or despatch of Material(s) covered by the Contract.

11.2 The Vendor shall furnish to the Procurement Coordinator within 30 (thirty) days of receiving the Purchase Order, the required number of copies of documents including but not limited to Schedule of manufacture/PERT chart, unpriced copies of sub-orders, phased programme of item-wise manufacture, testing and delivery and any other information and/or documents as may be called for by the Procurement Coordinator.

11.3 The Procurement Coordinator shall have free access to the Vendor's shop and sub-suppliers' shop during normal working hours and shall be provided all the necessary assistance and information to help him perform his job.

12.0 **RESPECT FOR DELIVERY DATES AND PRICE DISCOUNT**

12.1 The time and date of Delivery of Material(s) as stipulated in the Contract shall be adhered to on the clear understanding that the Price(s) of the Material(s) has/have been fixed with reference to the said Delivery date(s).

12.2 If any delay is anticipated by the Vendor in the delivery of the Material(s) or any of them beyond the stipulated date(s) of Delivery, the Vendor shall forthwith inform IOCL in writing of such anticipated delay and of the steps being taken by the Vendor to remove or reduce the anticipated delay, and shall promptly keep IOCL informed of all subsequent developments.

12.3 **(A) In case scope includes only supply**

If any Material(s) is/are not delivered within the Delivery date(s) stipulated in respect thereof, IOCL shall be entitled to a discount by way of price adjustment in a sum equivalent to 0.5% (one half percent) of the price of such Material(s) per week or part thereof that the Material(s) remain(s) undelivered beyond the stipulated Delivery period in respect thereof, subject to a maximum discount of 5% (five percent) of the Total Contract Value. Such discount shall be given by the Vendor by equivalent reduction in the invoice value before presentation of documents to the Bank/IOCL for payment. Should the Vendor fail to deliver the Material(s) or to make such adjustment, the discount may be recovered by any other means.

(B) In case scope of work includes supply and site work

For delay in supply:

The price adjustment shall be applicable @ 0.5% of Total Supply Order Value (excluding site work) per week of delay or part thereof subject to maximum of 5% of Total Supply Order Value (excluding site work).

For Delay in site work:

The price adjustment shall be applicable @ 0.5% of Total Order Value (supply + site work value) per week of delay or part thereof subject to maximum 5% of Total Order Value (supply + site work value).

In no case total price adjustment shall exceed 5% of Total Order Value (Supply + site work).

Note:
In case of package items (ordered as a complete system), the price adjustment shall be applicable on the entire order value of that package and not on the value of the undelivered portions (even though a billing breakup has been approved).

In case of purchase of bulk items where tolerance limit is specified (e.g. pipes, cables etc.), price adjustment clause shall be applicable on the actual quantity supplied, within the tolerance limit, instead of Purchase Order quantity.

12.4 Without prejudice to its rights under Clause 12.3 hereof and to entitlement to discount(s) accrued in terms thereof and in addition thereto, IOCL may at any time after the expiry of the stipulated date(s) of Delivery in respect of any

Material(s), at its discretion terminate in whole or part the Contract in respect of the undelivered Material(s) or any of them and either purchase such Material(s) from any other available source at the risks and costs of the Vendor and recover from the Vendor any additional cost incurred by it on such purchase or recover from the Vendor without such purchase the difference between the market and contract price of such Material(s) on the date of termination of Contract relative thereto.

The maximum liability against risk & cost sourcing shall not be beyond the total Contract Value for the undelivered material. Provided, this shall not restrict IOCL's claim for damages or compensation, as the case may be, for acts of fraud, deliberate default, negligence or misconduct by the vendor.

13.0 DELAYS DUE TO FORCE MAJEURE

13.1 If a force majeure event as defined below, affecting the Vendor, arises prior to the expiry of the stipulated Delivery period in respect of any Material(s) and the Vendor intends to claim extension of the stipulated date of delivery in respect of such Material(s) or any of them, the Vendor must advise IOCL by notice in writing of such event by means of communication which secures undisputed service of the notice not later than 10 (ten) days of the occurrence of the event. Such occurrence shall be duly certified by a local Chamber of Commerce or statutory authority. The Vendor shall within 10 (ten) days of the end of the Force Majeure event similarly notify IOCL of such cessation, and of the period and Material(s) for which an extension of Delivery date(s) is consequently claimed. Such notification shall be a mandatory pre-condition to a claim for such extension.

13.2 No failure, delay or omission by Vendor to fulfill any of its obligations under Contract (other than the obligation to make payments when due) shall give rise to any claim against Vendor or IOCL or be deemed to be a breach of a Contract if and to the extent such failure, delay or omission arises from any of the following events not within the reasonable control of Vendor and not attributable to Vendor's fault, negligence or misconduct (each an event of "Force Majeure"):

a) Act of terrorism
b) Riot, war, invasion, act of foreign enemies, hostilities (whether war declared or not), civil war, rebellion, revolution, insurrection of military or usurped power;
c) Ionizing radiation or contamination, radioactivity from any nuclear fuel/ nuclear waste from reaction of nuclear fuel or any other hazardous radioactivity.
d) Epidemics, tsunami, earthquakes, flood, fire, hurricanes/typhoons or other natural disaster.
e) Freight embargoes, strikes at national/ state wide level (for more than 7 consecutive days) where the supplier's works is located.

13.3 For the avoidance of doubt, inclement weather, third party breach, delay in supply of materials (other than due to a nationwide transporters' strike), commercial hardship, strike, shutdown or lockout other than as specified above shall not constitute a Force Majeure event.

13.4 In the event of Force Majeure, Vendor shall bear any costs incurred by it resulting there from. The Vendor affected by Force Majeure shall use all reasonable efforts to prevent and reduce to a minimum and mitigate the effect of delays occasioned by such Force Majeure.

13.5 If the Vendor is prevented from fulfilling its contractual obligations for a continuous period of three (3) months because of Force Majeure, then the Vendor and IOCL shall consult with each other with a view to agreeing on the action to be taken under the circumstances, and failing such agreement, IOCL shall be entitled to terminate the contract in whole or to the extent that its performance is prevented by Force Majeure.

14.0 WARRANTY OF TITLE

14.1 The Vendor warrants that the Material(s) sold and supplied by it to IOCL pursuant to the Contract shall be free from any and all defects in title including but not limited to any charge, third party claim, mortgage, hypothecation, foreclosure, lien, restriction, injunction, attachment or encumbrance whatsoever and shall hold and keep IOCL indemnified from and against any and all contrary claims, demands, actions and proceedings and all costs (including legal costs), charges, expenses and losses suffered or incurred by IOCL as a consequence thereof and/or to defend any such claim, demand, action or proceeding.

14.2 The Vendor shall be understood to have represented to IOCL that the use by IOCL of the Material(s) supplied by the Vendor will not infringe any third party patent rights or pending patent applications or other intellectual property rights. Accordingly, the Vendor will hold harmless and indemnify IOCL against all costs (including legal costs), charges and expenses incurred or any damages or other sums that may be assessed or become payable under any decree or judgment of any court or under any settlement resulting from any suit, claim or action for infringement of third party patents or other third party intellectual property.

15.0 INSPECTION AND TESTING

15.1 In addition to any tests to be conducted by the Vendor under the Contract or any applicable codes or standards, the Material(s) shall be subject to inspection and/or testing by Inspector(s) (including Third Party Inspector(s)) at any time prior to shipment and/or despatch and to final inspection within a reasonable time after arrival at the Project Site. The Inspector(s) shall have the right to carry out the inspection or testing, which will include inspection and testing of the raw materials at manufacturers shop, at fabricators shop and at the time of actual despatch before and/or after completion of packing.

15.2 In addition to testing and inspection by Inspectors, IOCL may nominate an institutional agency like Boiler-Inspectorate for official testing of coded equipment. The Vendor shall ensure that all procedures for preparation and performance of tests prescribed by such institution shall be scrupulously complied and observed.

15.3 Unless otherwise specified in the Contract, the inspection shall be carried out as per the relevant standards/scope of inspection provided alongwith the Tender Enquiry/Purchase Order.

All charges for Third Party Inspectors shall be paid by the Vendor. IOCL shall pay these charges against vendor's invoice, unless agreed otherwise. However, no charges will be payable by IOCL in the event the inspection has become infructuous for any cause.

15.4 All manufacturers' mill test certificates and analytical reports from material laboratories in respect of raw materials employed and components incorporated shall have to be presented by the Vendor.

15.5 Before shipping or despatch, the Material(s) will have to be checked and stamped by the Inspector(s) who may forbid the use and dispatch of any equipment and/or Material(s) which during tests and inspection fail(s) to comply with the specifications, codes and testing or other contractual requirements applicable thereto, and the Vendor shall not tender such rejected Material(s) for supply to IOCL nor shall incorporate the same in any Material(s) to be tendered for supply to IOCL.

15.6 The Vendor will inform IOCL at least eight (8) days in advance of the exact place, date and time of tendering the Material(s) for required inspection and provide free access to the Inspector(s) during normal working hours at Vendor's or his/its sub-Suppliers' works, and place at the disposal of the Inspector(s) all useful means for undertaking the Inspection, checking the results of tests performed, marking the Material(s), getting additional tests conducted and final stamping of the Material(s).

15.7 All tests will be performed at the Vendors' expense and if required by the Inspector(s), shall be conducted in accordance with the Inspector's instructions. The Vendor shall also bear the expense for the preparation and rendering of tests required by the Boiler Inspectorate or other statutory testing or certifying agencies/institutions.

15.8 Unless otherwise specified, all charges for the Inspection shall be borne by the Vendor.

15.9 IOCL may, at its own expense, have its representative(s) witness any test or inspection. In order to enable IOCL's representative(s) to witness the tests/inspections, the Vendor shall notify IOCL at least 30 (thirty) days in advance, of the schedule of all inspection hold points prior to the initiation of equipment fabrication. IOCL shall be notified eight (8) calendar days in advance of any changes in the schedule of inspection. IOCL will advise the Vendor in advance whether it intends to have its representative(s) be present at any of the inspections.

15.10 Even if the inspection and tests are fully carried out, the Vendor shall not be absolved from its responsibilities to ensure that the Material(s), raw materials, components and other inputs are supplied strictly to conform and comply with all the requirements of the Contract at all stages, whether during manufacture and fabrication, or at the time of Delivery as on arrival at site and after its erection or start up or consumption, and during the defect liability period. The inspections and tests are merely intended to prima facie satisfy IOCL that the Material(s) and the parts and components comply with the requirements of the Contract.

15.11 The Vendor's responsibility shall also not be anywise reduced or discharged because IOCL or IOCL's representative(s) or Inspector(s) shall have examined or commented on the Vendor's drawings or specifications or shall have witnessed the tests or required any chemical or physical or other tests or shall have stamped or approved or certified any Material(s).

15.12 Unless otherwise specifically permitted by the Contract, no Material(s) shall be dispatched for delivery or delivered under the Contract without being stamped or otherwise approved for delivery by the Inspector(s).

15.13 Notwithstanding approval by the Inspector(s), if on testing and/or inspection after receipt of the Material(s) at Project Site, any Material(s) is/are found not to be in strict conformity with the contractual requirements or specifications, IOCL shall have the right to reject the same and hold the Vendor liable for non- performance of the Contract. The provision of Clause 16.5 to 16.11 shall mutatis mutandis apply to such rejected Materials.

16.0 ACCEPTANCE OF MATERIALS & GUARANTEES

16.1 The Vendor acknowledges that notwithstanding the provision or approval of any drawings, designs, specifications, source of supply or other data relative thereto by IOCL and/or the testing of Material(s) in accordance with the requirements of the Contract or any applicable code or specification and/or any inspection of the input or Material(s) by the Inspector(s) or issue of an Inspection Certificate relative thereto and/or any other act, matter or thing done or required by IOCL to satisfy itself of the quality, quantity, sufficiency or efficiency of the Material(s) prior to delivery thereof and/or the transfer of title and/or risks in relation to the Material(s), shall not be deemed or understood to constitute acceptance of the Material(s) by IOCL nor shall IOCL be understood to have accepted any Material(s) other than plant, machinery, equipment and parts and components unless such Material(s) have been received at the Project Site of IOCL and found to be acceptable as evidenced by a Certificate of Acceptance issued by IOCL, and in case of plant, machinery, equipment and parts and components, unless they have been incorporated into the relative Project Unit and the said Unit has been tested and the relative plant, machine, equipment, part or component has successfully functioned without patent defect.

16.2 To this end, the Vendor guarantees that:

i) All materials used in the execution of the Contract and all Material(s) used in performance thereof shall be in strict compliance and conformity to the characteristics, requirements and specifications of the Contract and suitable for the purpose for which such Material(s) are intended to be used if such purpose has been disclosed or is/are suitable for use to which such Material(s) are ordinarily put to use, if such purpose has not been disclosed.

ii) In the case of machinery, plant or equipment with rated capacities, outputs or other characteristics, that the machinery, plant or equipment as the case may be, shall function to such capacities and/or outputs and shall meet the other characteristics required in respect thereof.

16.3 The Vendor further undertakes to replace any Material(s) if found not to conform to the guarantees aforesaid at any time during the defect liability period applicable thereto. IOCL shall give written notice of the defect to the Vendor and of the rejection of the defective Material(s).

16.4 If the defect can be rectified or repaired without diminishing the quality, utility, efficiency or life of the Material(s), instead of outright rejection of the Material(s), IOCL may at its discretion permit the Vendor to rectify the

defect(s) within a period to be specified by IOCL in this behalf in the notice. In case Vendor fails to take action to rectify the defect(s) within the period specified to the satisfaction of IOCL, IOCL may at its discretion, at the risk and cost of the Vendor in all respects, rectify or repair or cause to be rectified or repaired the defect(s) either by itself or through any other source or agency, or reject the defective Material(s).

16.5 Should IOCL, notwithstanding the endeavour to do so, be unable to rectify or repair or get rectified or repaired the defect(s) within a reasonable time, IOCL may, notwithstanding such endeavour reject the defective Material(s).

16.6 The Vendor shall repair, rectify and/or replace, as the case may be, the defective and rejected Material(s) without entitlement to any extra payment. Prevailing DDP INCOTERMS (as per ICC) or **any other Incoterm which may replace DDP** shall apply for such replacement parts or components or Material(s) at Project Site with respect to imported parts or components or materials.

16.7 The Vendor shall at its own risk and cost remove any rejected Material(s) from the Project Site, and in case of plant, machinery, equipment, parts or components which have been installed, cause the same to be dismantled and removed from the Project Site subject to the Vendor in all cases prior to the removal of the rejected Material(s) from the Project site:

i) furnishing a bank guarantee to IOCL from a Scheduled bank in India (including an Indian branch of a foreign bank acceptable to IOCL) and in a format set forth in Annexure "E" hereto for the value paid by IOCL on the Material(s) rejected; and

ii) undertaking to replace the rejected Material(s) with other Material(s) conforming to the Vendor's guarantees aforesaid applicable thereto.

IOCL shall be responsible for providing any on-site access to the vendor to perform warranty related work.

16.8 The Vendor shall not without the prior written consent of IOCL utilize any rejected Material(s) in the re-supply.

16.9 The Defect Liability Period with respect to any Material(s) replaced, repaired, altered and/or rectified shall be reckoned in accordance with Clause No. 1.1(d) (iii).

16.10 Should the Vendor fail to dismantle and/or remove any rejected Material(s) from the Project Site within the time specified in the notice of rejection, IOCL may without prejudice to any other right or remedy, at the risk and cost of the Vendor cause the rejected Material(s) to be dismantled and sold by public auction or private treaty as it deems fit and hold or adjust the sale proceeds for the recovery of the cost of dismantling, sale and removal of the rejected Material(s) and any amount paid by IOCL towards the price of the rejected Material(s). In so doing, IOCL shall not act as a trustee or constructive trustee of the Vendor and shall be entitled to act solely on the basis of its best judgment without being accountable or liable to the Vendor in any manner except for the proceeds of the sale.

16.11 The time taken for the repair, rectification or replacement of Material(s) will not be added to the stipulated Delivery date for the purpose of calculating price discount, and delivery of such Material(s) shall be the date of Delivery of the repaired, rectified or replaced Material(s).

16.12 As security for the due performance of its obligations and the due discharge of its liabilities under the Contract, the Vendor shall within 15 (fifteen) days of the issue of the Purchase Order furnish to IOCL a Bank Guarantee issued by a Scheduled Bank in India acceptable to IOCL, in the format set forth hereto and marked Annexure "C" hereinbefore. The Bank guarantee shall remain in force for the entire period required for the performance of the contract and the defect liability period plus a 3 (three) months claim period thereafter. Any shortfall in the value of the Bank Guarantee, as a result of encashment by IOCL either in full or in part, shall be made good by the Vendor within 7 (seven) days of notice by IOCL to the Vendor in this behalf. Any failure by the Vendor to furnish the Bank Guarantee or to enhance the Value of the Bank guarantee as stated above shall constitute a default by the Vendor for which IOCL shall, without prejudice to any other right or remedy available to it, be entitled to terminate the Contract with consequences as indicated in clause 12.4, the provisions whereof shall mutatis mutandis apply.

17.0 FREIGHT, TAXES AND DUTIES

17.1 Subject to the provision of Clause 17.2 hereunder, C G S T & S G S T /I G S T payable on the supply and delivery of Material(s) pursuant to the contract will be paid at actual within the contractual delivery date. Any increase in the rates of the CGST & SGST/ IGST within the contractual completion date or approved extended contractual completion date will be borne by IOCL but not beyond the contractual delivery date or extended contractual delivery date. However, the benefit of any reduction must be passed on to IOCL.

17.2 Central GST (CGST) & State GST (SGST) / Integrated GST (IGST) payable or reimbursable by IOCL to the vendor on supply of indigenous Materials shall be included in and shown separately in the vendor's Tax invoice for the Material(s). The vendor shall prior to despatch of the Material(s) obtain from IOCL a list of the documents required by IOCL to enable it to avail of the relative benefits. Payment or reimbursement of CGST & SGST/IGST to IOCL shall be made upon the vendor furnishing the relevant documents.

17.3 Freight, if any, along with CGST & SGST/IGST thereon payable or reimbursable by IOCL shall be invoiced and shall be paid/reimbursed by IOCL after receipt of the material(s) at the project site.

17.4 Taxes and duties are not intended to operate as a profit centre but are intended only to meet the relevant costs incurred on this account. If any reimbursement or collection of the taxes or duties by the vendor from the IOCL is in excess of the taxes and/or duties actually paid by the vendor, the vendor shall forthwith refund such excess to IOCL together with interest thereon at 1% (one percent) per annum above the MCLR rate (or rate that replaces it) of SBI from the date of collection until the date of refund.

18.0 WEIGHTS AND MEASUREMENTS

18.1 The shipping documents, invoices, packing lists and all other relevant documents shall contain the same units of weights and measurements as given in the Contract Documents, in respect to the following data:

a. Unit net weight
b. Unit gross weight (including packing)
c. Dimensions of packing

18.2 All weights and measurements recorded by the Procurement Co-ordinator or Inspector(s) on receipt of the Material(s) at the Project site will be treated as final.

19.0 PACKING & MARKING

19.1 All Material(s) shall be suitably packed in weatherproof seaworthy/airworthy packing for ocean/air transport under tropical conditions and/or for rail and road or other appropriate transport within India. The Vendor shall ensure that the packing is strong enough to ensure safety and preservation of the Material(s) upto the Project Site or other point of final destination.

19.2 Material(s) shall be protected by a suitable coat of paint and all bright parts shall be protected from rust by application of rust preventives as may be necessary. All machinery surfaces shall be suitably protected.

19.3 For uniform Material(s) when packed in several cases/crates, progressive serial numbers shall be indicated on each end. In case of bundles, the shipping marks shall be embossed on metal or tag and wired securely on each end.

19.4 A distinct colour splash in say red-black around each package/crate/bundle shall be given for identification.

19.5 All nozzle holes and openings as also all delicate surfaces shall be carefully protected against damage and bad weather. Flange faces of all nozzles shall be protected by blanks. All manufactured surfaces shall be painted with rust proof paint or as specified in the specification.

19.6 All threaded fittings shall be greased and provided with a plastic cap. All pipes and sheets shall be marked with strips bearing progressive numbers.

19.7 All small pieces shall be packed in cases. All fragile and exposed parts will be packed with care and packages will bear the words “HANDLE WITH CARE” in English and in the case of Indigenous Supply, in Hindi also.

19.8 The Vendor shall be held liable for all damages or breakages to the Material(s) due to defective or insufficient packing as well as for corrosion due to insufficient greasing/protection.

19.9 On three sides of the packages, the Vendor shall affix or cause to be affixed the following marks clearly visible in indelible paint

FROM: VENDOR

TO: INDIAN OIL CORPORATION LTD.
[Address]INDIA

PURCHASE ORDER NO.: [ ] Rev. No.:[ ]
10 DIGIT ITEM CODE : [ ]
EQUIPMENT NOMENCLATURE: [ ]
NET WEIGHT: [ ]kg/lb
GROSS WEIGHT: [ ]kg/lb
CASE NO.: [ ]OF [ ]TOTAL CASES
DIMENSIONS: [ ] IMPORT LICENCE NO.[ ]

NOTE: Marking shall be bold with a minimum letter height of 5 cm.

19.10 a) For every shipment, packages must be marked with serial progressive numbering. The numbering will be progressively continued for each subsequent shipment covering the Contract.

b. All packages will bear warning signs on the outside denoting the center of gravity and sling marks. Packages that require special handling and transport shall have their centers of gravity and points at which they may be gripped clearly indicated and marked "Attention Special Load - Handle With Care" in English Language. Any other direction for handling shall also be clearly indicated on the package.

c. Top heavy containers will be marked either "TOP HEAVY" or "HEAVY ENDS'.

d. When packing is clean and light colored, a dark black stencil paint shall be acceptable. However, where packing is soiled or dark, a coat of flat Zinc white paint shall be applied and allowed to dry before applying the specific marking(s).

e. Colour codification shall be used to identify different items e.g, IBR, NACE, Fire Safety Items etc.

19.11 In case of large equipments like vessels, heat exchangers etc., documents contained in a waterproof envelope shall be fastened inside a shell connection with an identifying arrow sign "DOCUMENTS" applied with indelible paint.

20.0 DESPATCH INSTRUCTIONS

For Indigenous Material(s)

20.1 Unless otherwise advised by IOCL or the Procurement Co-ordinator in writing, Material(s) shall not be despatched without prior inspection and/or testing and Release Order/Material(s) Acceptance Certificate issued by the Inspector(s).

20.2 The Vendor shall exercise due care to ensure that the consignment is booked under appropriate railway classification, failing which any additional freight

incurred by IOCL due to the Vendor booking the Material(s) under a wrong railway classification shall be borne by the Vendor.

20.3 The Material(s) shall be consigned in the name of the consignee viz.

Indian Oil Corporation Ltd.,
[Site address]

20.4 The Material(s) shall be transported only through bank approved transporters by the most economical and expeditious mode of transport to the destination as applicable for respective mode of despatches as follows :

a. By Rail in wagon load consignment to : *[Name and address of Refinery / Project to be specified]*

b. By road transport to : *[Name and address of Refinery / Project to be specified]*

IOCL and the Procurement Coordinator shall have the right to advise any change in despatch point or destination and/or mode of transport in respect of any Material(s). Any extra expenditure incurred by the Vendor on this account supported by satisfactory documentary evidence, will be reimbursed to the Vendor by IOCL.

21.0 SHIPMENT AND SHIPMENT NOTICES

21.1 Imported Material

The Vendor shall make shipment only after prior approval of the Inspector(s) unless otherwise specifically authorized in writing by IOCL or the Procurement Coordinator. As soon as any shipment is made, the Vendor shall send advance information by way of FAX message [Fax No 022-26400774] to the Dy. General Manager, Indian Oil Corporation Ltd.(Refinery Division), G-9, Ali Yavar Jung Marg, Bandra (East) Mumbai- 400 051 for Mumbai consignments and to the Dy. General Manager (Fax: 033-24145020) Indian Oil Corporation Ltd.(Refinery Division), Indian Oil Bhavan (Refineries Division) Central Wing,
6th Floor, 2, Gariahat Road (South), Kolkata-700068 for Kolkata consignments (or other specified authority in respect of Material(s) consigned to other Ports), giving particulars of the shipments, vessel's name, port of shipment, Bill of Lading number and date for ocean shipment and Airway Bill number & Date & Flight details for air consignment, total FOB and freight value with confirmation copy to IOCL, addressed to [designation and address]

21.2 Indigenous Material

Immediately after shipment, the Vendor shall inform despatch particulars to IOCL/ Procurement Coordinator hereunder :

1 copy to Dy. General Manager (Materials) , [*Address & Fax no*]

1 copy to IOCL (Stores) addressed to [*Designation, Address & Fax no.]*

In the case of project orders, in addition to the above, a copy to the Dy. General Manager (Project) addressed to: [*Address & Fax no*.]

(PMC as per Purchase Order) addressed to: [*Designation, Address & Fax no*.]

22.0 MARINE AND TRANSIT RISK INSURANCE

22.1 Marine/Air and Transit Risk Insurance shall be covered by IOCL against its Open General Policy.

22.2 The Vendor shall send IOCL information of the proposed shipment/consignment well in advance by telegram/fax/e-mail/courier to enable IOCL to take necessary action for the marine/air/transit insurance of the shipment/consignment.

22.3 The Vendor shall advise the despatch particulars of the shipment/consignment to the Insurance Company by fax / email under advice to the Procurement Coordinator promptly after shipment to ensure that the consignment is fully covered by insurance. Any failure by the Vendor to do so shall place the consignment at the Vendor's risk.

23.0 SHIPPING AND SHIPPING DOCUMENTS

23.1 <u>For Imported Materials(s)</u>

a. The Vendor shall arrange with Vessel owner(s) or Forwarding Agent(s) specified in the Contract documents for proper storage of the Material(s) in a manner so as to facilitate the handling and off-loading at the port of destination and to avoid any over carriage or discharge.

b. The Bill(s) of Lading/Airway Bill shall be made out in favor of "Indian Oil Corporation Ltd." [Refinery/Unit] or to the order of the L/C opening bank, and the notify column should indicate [Designation] Indian Oil Corporation Ltd. [Refinery Division], G-9, Ali Yavar Jung Marg, Bandra (East), Mumbai- 400061 for port of discharge Mumbai and to the Dy. General Manager, Indian Oil Corporation Ltd., Indian Oil Bhavan (Refineries Division) Central Wing, 6th Floor, 2, Gariahat Road (South), Kolkata-700 068 for port of discharge Kolkata or other specified authority in respect of Material(s) consigned to other ports.

c. All columns in the body of the Bill of Lading/Airway Bill namely marks and Numbers, material description, weight particulars, etc. should be completed accurately and such statement should be uniform in all the shipping documents. The freight particulars should mention the basis of freight tonnage, heavy lift charges, if any, surcharge, discount, etc. clearly and separately and the net total freight payable, shown at the bottom.

d. The Bill of Lading/Airway Bill shall be free of any liability of IOCL to the carrier for demurrage.

e. The Bill of Lading/Airway Bill shall indicate the following:

Consignee : Indian Oil Corporation Limited
[Name of Refinery/Project]

f. All documents viz. Bill of Lading/Airway Bill, invoices, packing list, freight memos, country of origin certificate, Third Party Inspection Release Certificate, inspector's certificate, Export certificate (wherever applicable), test certificates, drawings and catalogues should be in the English language.

g. i In addition to the Bill of Lading/Airway Bill, which should be obtained in 3 (three) stamped originals plus as many copies as required, invoices, packing lists, freight memos (if the freight particulars are not shown in the Bill of Lading), country of origin certificate(s), Third Party Inspection Release Certificate, inspector's certificate, Export certificate (wherever applicable) and test/composition certificate, shall be made out against each shipment in as many number of copies as are shown in Clause 23.3.

ii. The Bill of Lading/Airway Bill, invoice and packing list must specifically show uniformly, the marks and numbers, material description, contents case-wise, country of origin, consignee's name, port of destination and all other indicated particulars. The invoice must show the unit rates and net total FOB price. The invoice must cover also items packed separately and the value shown accordingly.

iii. The packing list must show, apart from other particulars, the actual contents in each case, net and gross weights and dimensions and the total number of packages.

iv. (All documents must be duly signed by an authorized representative of the Vendor.

23.2 In case of FOB contracts:\

i) Shipping Arrangements shall be made through nominated freight forwarders (in the country of exit) as detailed in the Purchase Order and freight will be accordingly paid by IOCL in Indian Rupees.

ii) The Vendor shall furnish to the respective nominated freight forwarder, the full details of consignment such as outside dimensions, weights (both gross and net), No. of packages, technical description and drawings, name of the supplier, ports of loading etc. two weeks prior to the proposed date of shipment to enable the concerned agency to arrange the shipping space.

23.3 The Vendor shall obtain the shipping documents in required number of sets including three original stamped copies of the Bill of Lading/Airway Bill immediately after the shipment is made and airmail the shipping documents in the manner stipulated hereunder to ensure that the documents so forwarded are received at least one week before the vessel's arrival. The Vendor shall be fully responsible for any delay and/or demurrage in clearance of the consignment at the port due to delay in forwarding the shipping documents. If in terms of the Letter of Credit , the complete original set of documents are required to be sent to IOCL through the bank, the distribution indicated below will be confined to obtaining copies of documents only.

Documents	**IOCL (Office that issued the PO)**	**IOCL (Port Office)**	**IOCL (Project Site)**
Bill of lading/Airway Bill	3 (including 1 original)	1	1
Invoice	2	2	1
Packing List	2	2	1
Certificate of Origin	2	2	1

Test/Composition Certificate	2	2	1
Third Party Inspection Release Certificate	1	1	1 (original)
Drawing/Catalogue	1	1	1
Invoice of Third Party/Lloyds for Inspection Charges, wherever applicable.	2	1	1
Export Certificate (where applicable)	1	1	1

24.0 INVOICING & NEGOTIATION OF DOCUMENTS

24.1 Indigenous Material(s)

a. Unless otherwise directed by IOCL, Invoices and other documents shall be forwarded by the Vendor to IOCL as stipulated hereunder:

i. Original Invoice+1 copy of document as per Purchase Order to the Dy. General Manager (Finance), [Address, Fax No., e-mail id]

ii. 1 copy of Invoice with original documents as per Purchase Order to Dy. General Manager (Materials), [Address, Fax No., e-mail id] along with technical catalogues, Inspection certificate and Inspectors Release Note.

b. Where payment is to be released to the Vendor against despatch documents through the bank, the Vendor shall forward two complete original sets of the documents specified in clause 5.2(c) to the specified banker of IOCL with a stipulation that the banker shall forward one set of the documents to IOCL with LSC intimation and acceptance before retirement of the documents from the Bank. One complete set of all of the abovementioned documents shall be sent to the Dy. General Manager (Materials) [Address, Fax No., e-mail id]. Documents will not be retired by the bank failing strict compliance by the Vendor of the above mentioned despatch requirements.

c. Where payment is to be released to the Vendor directly by IOCL, two sets of all the documents mentioned in (b) above shall be submitted/forwarded directly to the Dy. General Manager (Materials) [Address, Fax No., e-mail id] and upon processing, the payment shall be released through the Finance Department, by cheque/RTGS/NEFT.

25.0 TRANSFER OF TITLE AND RISK OF LOSS

25.1 For Indigenous Material(s):

The transfer of property and risk in Indigenous Material(s) shall be deemed to take place as follows:

a) For delivery F.O.R. or F.O.T. despatch point: On handing over the Material(s) to the carrier against receipt of clean Railway Receipt/Truck or Lorry Receipt and such receipt having been handed over to IOCL.

b) For despatch F.O.R destination station : On removal of the Material(s) by IOCL from the railway authorities at the destination station.

c) Equipment sent freight/carriage paid to the Project Site: On receipt of the Material(s) by IOCL at the Project Site.

25.2 For Imported Material(s):

The transfer of property and risks in Imported Material(s) shall be deemed to take place as follows:

a) For FOB / FCA deliveries: On handing over the Material(s) to the carrier and issue of clean Bill of Lading/Airway Bill (except for freight to pay) and its transmission to IOCL.

b) For CFR deliveries: Transfer of title and risk of loss passes to IOCL when delivered on board the ship by vendor who pays the transportation cost upto the destination port or to the designated destination airport (as per INCOTERMS).

26.0 **TERMINATION**

26.1 Without prejudice to IOCL's right to price adjustment by way of discount or any other right or remedy available to IOCL, IOCL may terminate the Contract or any part thereof by a written notice to the Vendor, if:

i) The Vendor fails to comply with any material term of the Contract.

ii) The Vendor informs IOCL of its inability to deliver the Material(s) or any part thereof within the stipulated Delivery Period or such inability otherwise becomes apparent.

iii) The Vendor fails to deliver the Material(s) or any part thereof within the stipulated Delivery Period and/or to replace/rectify any rejected or defective Material(s) promptly.

iv) The Vendor becomes bankrupt or goes into liquidation.

v) The Vendor makes a general assignment for the benefit of creditors.

vi) A receiver is appointed for any substantial property owned by the Vendor.

vii) The Vendor has misrepresented to IOCL, acting on which misrepresentation IOCL has placed the Purchase Order on the Vendor.

viii) Violation of Integrity Pact, if applicable.

26.2 Upon receipt of said termination notice, the Vendor shall discontinue the work on the Contract so far as terminated, and matters connected therewith.

26.3 On termination of the Contract, without prejudice to any other right or remedy available to IOCL under the contract, in the event of IOCL suffering any loss on

account of delayed delivery or non-delivery, IOCL reserves the right to claim and recover damages from the Vendor in respect thereof.

26.4 Notwithstanding anything to the contrary herein contained, IOCL will be at liberty to take independent administrative action to place the Vendor under 'holiday list' for delay or non-performance of its contractual obligations or any of them.

26.5 Action in case of submission of fraudulent documents :

If any information given by a bidder/ tenderer is found to be incorrect in any particular considered by IOCL to be relevant for the evaluation of the bid/ tender, or is found by IOCL to misrepresent or conceal facts, or if any of the documents submitted by the bidder in support of or relevant to the bid/ tender is found by IOCL to be forged, false or fabricated, IOCL may reject the bid, and without prejudice to any other right(s) of action or remedy available to IOCL, IOCL may forfeit the Earnest Money given by the bidder in order to compensate IOCL for the expenses incurred by it in considering the bid (and not by way of penalty) and take action for putting the bidder on holiday list for such period as IOCL in this behalf considers warranted and / or remove the bidder from any approved list of vendors / contractors. If prior to the discovery of the incorrect information, misrepresentation or forged, false or fabricated document (s), the bid has resulted in a contract, the Contract shall be liable to be terminated by IOCL with consequences of termination as provided in Cl 26 of the General Purchase Conditions.

27.0 RECOVERY OF SUMS DUE

Whenever there is any claim against the Vendor for payment of sums of money arising out of or under the execution of the Purchase Order, IOCL may, without prejudice to any other mode or source of recovery available, recover the same from any sum(s) then due or which at any time thereafter may become due to the Vendor under this or any other contract with IOCL and/or by recourse to any bank guarantee available to IOCL for this purpose, and should these sum(s) be not sufficient to cover the recoverable amount, the Vendor shall pay IOCL on demand, the balance.

28.0 NON-WAIVER

Failure of IOCL/IOCL's representative(s) to insist upon adherence to any of the terms or conditions incorporated in the Contract or failure or delay to exercise any rights or remedies herein or by law accruing, or failure to promptly notify the Vendor in the event of breach or the acceptance of or the payment for any Material(s) hereunder or approval of any design or Material(s) shall not release the Vendor and shall not be deemed a waiver of any right of IOCL to insist upon the strict performance thereof or of any of its rights or remedies as to any such Material(s) regardless of when the Material(s) are shipped, received or accepted nor shall any purported oral modifications or revisions of the Contract by IOCL or IOCL's representative(s) act as a waiver of the terms hereof.

29.0 COMPLETE AGREEMENT

The Contract Document(s) including, technical documents, drawings and specifications and other Annexures to the Contract documents constitute the entire agreement between the Vendor and IOCL in relation to the Contract arising out of the Purchase Order. Changes or amendments will be binding only if the

amendments/modification are agreed to in writing as an amendment/variation to the relative Contract Document and signed by an authorised representative of IOCL.

30.0 EXCLUSION OF THE GOVT. OF INDI A'S LI ABILITY

30.1 It is expressly understood and agreed that IOCL has entered into the Contract solely on its own behalf and not on behalf of any other person or entity. In particular, it is expressly understood and agreed that the Government of India is not a party to the Contract and will have no liability, obligation or right whatsoever under the Contract. It is expressly understood and agreed that IOCL is an independent legal entity with power and authority to enter into the Contract solely on its own behalf under the applicable laws of India. The Vendor expressly agrees, acknowledges and undertakes and accepts that IOCL is not an agent, representative or delegate of the Government of India and that the Government of India is not and shall not be liable for any act, omission, commission, breach or other wrong or liability arising out of the Contract. The Vendor hereby expressly waives, releases and forgoes any and all actions or claims, including cross claims, impleader claims or counter claims, against the Government of India arising out of the Contract and covenants not to sue the Government of India for any manner of claim, cause of action or thing whatsoever arising out of or under the Contract.

31.0 TECHNICAL INFORMATION/CONFIDENTIALITY

31.1 Drawings, specifications and details shall at all times be the property of IOCL and shall be returned by the Vendor to IOCL on demand. The Vendor shall not make use of any document, drawing, specification, data or any other information connected with the Contract, for any purpose at any time, save and except in the implementation of the Contract.

31.2 The Vendor shall not disclose the technical information furnished or gained by the Vendor under or by virtue of or as a result of the implementation of the Contract and shall make all efforts to ensure that the technical information is kept confidential.

31.3 Notwithstanding anything contained in this contract to the contrary, nothing contained herein shall be construed as transferring between the parties any patent, trademark, copyright or other intellectual property rights relating to the supply of equipment and / or materials, or provisions of services covered by this contract, and all such rights are hereby expressly reserved to the true and lawful owners thereof.

32.0 MODE OF COMMUNICATION

32.1 It is understood that IOCL is a multifaceted and multi-locational organization and that for any communication to receive attention it is a prerequisite that the communication is properly addressed and that the subject of the communication is properly identified. To this end, except where otherwise provided, all communications, drawings, invoices, shipping notes, packages, packing lists and other document connected with reference to the Contract shall in the heading boldly set out the Purchase Order Number and date, and shall be addressed to the following:

Dy. General Manager (Materials) [Office issuing the Purchase Order]	Phone	Fax
Dy. General Manager (Projects) [Site address]	Phone	Fax
Dy. General Manager IOCL [concerned Port office]	Phone [Concerned Office Address]	Fax

(For imports)

With copies to the following in case a Procurement Co-ordinator or Project Management Consultant is involved:

(i) Resident Construction Manager Phone Fax
[Site address]

(ii) Dy. General Manager (Inspection) of the Procurement Co-ordinator/Project Management Consultant.

33.0 PART ORDER/REPEAT ORDER

The Vendor hereby agrees to accept part order at unit prices without limitation and also agrees in case of bulk consumables to accept repeat order(s) during a period of 6 (six) months from the date of original Purchase Order at the same unit price(s) and on the same terms and conditions.

34.0 ARBITRATION AND GOVERNING LAW

34.1 Arbitration: All disputes or differences which may arise out of or in connection with the Contract including any dispute or difference regarding the interpretation of the terms and conditions of any clause thereof which cannot be amicably resolved between the parties may be referred to Arbitration.

The Vendor may select one person out of a panel of three persons nominated by IOCL who shall act as the sole arbitrator.

The Arbitration proceedings shall be governed by and conducted in accordance with the Arbitration and Conciliation Act, 1996 as amended from time to time. The seat of the arbitration shall be New Delhi, India. However, with the consent of IOCL and the Vendor, the arbitrator may agree upon any venue at London or Singapore.

Laws of India only would be applicable.

34.2 Arbitration in case of order on Indian CPSE shall be governed by the prevailing guidelines of Department of Public Enterprises (DPE).

34.3 **CONCILIATION**

At any time prior to or during arbitration of any arbitrable dispute(s) pursuant to IOCL's Arbitration Clause, if eligible, the Vendor may seek resort to the Conciliation under the Indian Oil Conciliation Rules, 2014 as amended and / or re-enacted from time to time. The proposal for conciliation shall be made in accordance with said Conciliation Rules. The said Rules are available on the IOCL's website.

34.4 Governing Law: The Contract(s) shall be construed in accordance with and governed by the laws of India. IOCL shall warrant that the terms and conditions of the Purchase Order shall be valid under existing Indian laws.

35.0 **JURISDICTION**

35.1 Notwithstanding any other Court or Courts having jurisdiction to decide the disputed issue, and without prejudice to the provisions or generality of the Arbitration clause, jurisdiction to decide the question(s) arising out of or relative to the Contract in all matters touching or affecting any arbitration, or arising out of or in relation to or under or in accordance with the Arbitration and Conciliation Act, 1996 or otherwise under or with reference to the Contract shall vest exclusively in the court(s) of competent civil jurisdiction at _____ [where the contract(s)/Purchase Order shall be signed on behalf of IOCL] or at New Delhi and only the said Court(s) shall have the jurisdiction to entertain and try any such actions and/or proceedings to the exclusion of all other Courts, provided that nothing herein stated shall be deemed to anywise authorize any party to seek resolution of any dispute(s) otherwise than the recourse to arbitration in accordance with the provisions of the Arbitration clause herein.

Provided always that an award rendered in any arbitration proceedings arising out of or in relation to the Contract may be enforced or executed in any other country or jurisdiction including without limitation a country in which any party against whom the award is to be enforced or executed is located and a country in which the assets of any such party are located.

36.0 **Limitation of Liability**

The maximum liability shall be limited to 100% of total contract value except in case of fraud, deliberate default, negligence or misconduct by the vendor. The vendor shall not be liable for consequential losses on account of production, revenue or profit.

37.0 **Use of white/ erasing fluid**

In case the bidder has been asked to submit price bid/ price implication in physical form, the use of white/ erasing fluid for correcting the rates is banned. Wherever the rates are corrected with white/ erasing fluid, the bids will be summarily rejected.

* * * *

Annexure – A

FORM OF BANK GUARANTEE IN LIEU OF EARNEST MONEY DEPOSIT
(On non-judicial stamp paper of appropriate value)

BG NO:_____
DATED:_____
VALID UPTO:_____

To,
Indian Oil Corporation Limited
(Refineries Division)

[Address]

Dear Sirs,

In consideration of the Indian Oil Corporation Ltd. [Address]…… , (hereinafter called the "Corporation", which expression shall include its successors and assigns) having agreed interalia to consider the tender of _____(Name)_____ , (Constitution)_____(Address)_____ (hereinafter referred to as the "Tenderer" which expression shall wherever the subject or context so permits include its successors and assigns) for supply of materials to be awarded under Tender No._____ upon the Tenderer furnishing an undertaking from the Bank as hereinafter appearing in lieu of a Demand Draft or Bankers Pay Order for the Earnest Money.

We _____(Name of Bank), a Bank constituted/Registered under the _____ Act, having our Head Office/Registered Office at [Address] _____(hereinafter called the "Bank" which expression shall include its successors and assigns), at the request of the Tenderer and with the intent to bind the Bank and its successors and assigns do hereby unconditionally and irrevocably undertake to pay the Corporation at New Delhi forthwith on first demand without protest or demur or proof or satisfaction or condition and without reference to the Tenderer, all sums payable by the Tenderer as and by way of Earnest Money to the Corporation, for an amount of Rs. _____ (Rupees_____) only or US Dollar_____ (United States Dollars_____)

AND THE BANK DOTH HEREBY FURTHER AGREE AS FOLLOWS:

1. The amount stated by the Corporation in any demand, claim or notice made or given with reference to this Guarantee/Undertaking shall as between the Bank and the Corporation for the purpose of this Guarantee/Undertaking be conclusive of the amount payable by the Bank to the Corporation hereunder.

2. This Guarantee/Undertaking shall not be determined or affected by the liquidation or winding up or dissolution or change of constitution or insolvency of the Tenderer or by any change in the legal constitution of the Bank or the Corporation.

3. Without prejudice to any other mode of service, a demand or claim or any other communication may be made, given and/or transmitted by the Corporation to the Bank either by post or by fax. If transmitted by fax, the transmission shall be

complete and shall be deemed to have been acknowledged as soon as the "OK" facsimile transmission report for the fax message has been received.

4. Notwithstanding anything contained herein:

   i. The Bank's liability under this Guarantee/Undertaking shall not exceed Rs./ US$_____ (Rupees / United States Dollars_____ only).

   ii. This Guarantee/Undertaking shall remain in force upto (fill in date) and any extension(s) thereof; and

   iii. The Bank shall be released and discharged from all liability under this Guarantee/Undertaking unless a written claim or demand is issued to the Bank on or before the midnight of _____ and if extended, the date of expiry of the last extension of this Guarantee/Undertaking.

The Bank doth hereby declare that Shri [designation] is authorised to sign this Guarantee/Undertaking on behalf of the Bank and to bind the Bank thereby.

This_____ day of _____ 20

Yours faithfully,
Signature:_____
Name & Designation:_____
Name of the Branch:_____

NOTES:

1. The Bank Guarantee in lieu of Earnest Money Deposit shall be strictly as per above proforma and shall be through a Scheduled Bank operating in India, including the Indian Branch of a foreign bank recognized as a Scheduled bank in India.
2. The Bank Guarantee shall be typed on stamp paper applicable to an agreement in the State in which the Bank Guarantee is issued.
3. This Bank Guarantee shall be sent by the Bank directly to:- Dy. General Manager (Materials), IOCL (Refineries Division].

Annexure - B

[IRREVOCABLE LETTER OF CREDIT- FORMAT]

To:

This communication is to be considered as our credit instrument and is subject to the Uniform Customs and Practice for Documentary Credit 1993 revision, I.C.C. publication No. 500.

At the request of Indian Oil Corporation Ltd. (hereinafter called "the Corporation" which expression shall include its successors and assignees) we hereby establish our irrevocable Letter of Credit No. _____ dated _____ in favour of :

(Beneficiary)
for a sum not exceeding (Currency in figures and words) which is payable at sight at the counter of [Beneficiary's Bank] in [Address], covering the FOB/CIF/C&F port supply of Material(s) and equipment under Purchase Order No.[ ] for the Unit/Refinery of Indian Oil Corporation Ltd.. (IOCL).

This Letter of Credit shall be valid up till [Date]

TERMS OF PAYMENT

Payments under this Letter of Credit shall be made of _____ % of the value of the Invoice(s) drawn by the Beneficiary on IOCL under the said Purchase Order against presentation of the following documents:

Imported Materials:

i. Invoice;
ii. Clear Bill of Lading/Airway Bill covering the Materials(s) invoiced;
iii. Packing list for the consignment;
iv. Inspector's Certificate covering the invoiced Material(s);
v. Test/Composition Certificate;
vi. Certificate of origin;
vii. Drawing(s)/Catalogue(s) covering the Material(s);
viii. Export Certificate, wherever applicable;
ix. Invoice of Inspector's charges, wherever applicable;
x. Freight Memo(s) if the freight particulars are not shown in the Bill of Lading/Airway Bill.
xi. Copy of faxed/e-mail intimation of the shipment to IOCL certified by the Beneficiary to be a true copy of the faxed intimation of shipment to IOCL

Indigenous Supply:

i. Invoice
ii. Clear Railway Receipt/Truck Receipt/Goods Receipt covering the Material(s) invoiced;
iii. Packing list for the consignment;
iv. Third Party Inspector's Certificate covering the invoiced Material/Release Note;
v. Test/Composition Certificate;
vi. IBR Certificate/CMRS Certificate;
vii. Drawing(s)/Catalogue(s) covering the Material(s);

viii. Guarantee/Warranty Certificate(s), wherever applicable;
ix. Invoice of Inspector's charges, wherever applicable;
x. Freight Memo(s) if inland freight is not included in the Price and the RR/TR/GR does not give the freight particulars.
xi. Copy of faxed/e-mail intimation of the shipment to IOCL certified by the Beneficiary to be a true copy of the faxed intimation of shipment to IOCL.

SPECIAL INSTRUCTIONS

* All Bank charges and commissions outside India shall be borne by the Beneficiary
* Drawing permitted in not more than 3 (three) tranches.
* Partial shipment is not permitted.
* Trans-shipment not permitted.
* Negotiating Bank to reimburse itself after giving 7 (seven) banking days notice to the Issuing Bank from Issuing Bank's account with _____ (Name of the Issuing Bank's correspondent in _____) at maturity under telex/cable advice to the Issuing Bank indicating the amount claimed.
* IOCL to be intimated the shipping details by fax immediately on shipment.
* Documents to be dispatched to Issuing Bank by courier within 7 banking days of receipt by Negotiating Bank.
* Documents must be presented within _____ days after the date of shipment/dispatch to ensure receipt thereof 7 days prior to the arrival of the vessel.

* * * *

Annexure -C

[PROFORMA OF BANK GUARANTEE (PERFORMANCE)]

(On non-judicial stamp paper of appropriate value)

To
Indian Oil Corporation Ltd.
[Address]

Dear Sirs,

In consideration of the Indian Oil Corporation Ltd. (hereinafter called the "Corporation" which expression shall include its successors and assigns) having awarded to [Name], [Constitution] _____ [Address] _____(hereinafter referred to as the "Supplier" which expression shall wherever the subject or context so permits include its successors and assigns) a Supply Contract in terms interalia, of the Corporation(s) Purchase Order No. [ ] dated ..... (hereinafter referred to as the "Contract") upon the condition of the Supplier's furnishing security in lieu of cash deposit for the Performance of the Supplier's obligations and/or discharge of the Supplier's liabilities under and/or in connection with the said Supply Contract upto a sum of Rs./US$ [ ] [Rupees/United States Dollars_____] only amounting to 10% (ten percent) of the total contract value.

We _____ (name) a body corporate registered/constituted under the laws of _____ and having a branch at [Indian branch address] (hereinafter called "the Bank" which expression shall include its successors and assigns) with the intent to bind the Bank and its successors and assigns, hereby undertake to pay the Corporation at [place] on first demand in writing without protest or demur or proof or satisfaction or condition and without reference to the Supplier, any and all amounts from time to time demanded by the Corporation from the Bank with reference to this Guarantee/Undertaking upto an aggregate limit of Rs./US$ [ ] only or [Rupees / United States Dollars _____].

AND THE BANK DOTH HEREBY FURTHER AGREE AS FOLLOWS:

1. This Guarantee/Undertaking shall be in addition to any other guarantee or any other security whatsoever that the Corporation may now or at any time anywise have in relation to the Supplier's obligations and/or liabilities under and/or in connection with the Contract and the Corporation shall have full authority to take recourse to or reinforce this Guarantee/Undertaking in preference to the other guarantee(s) or security(ies) at its discretion, and no failure on the part of the Corporation in enforcing or requiring enforcement of any other guarantee or security shall have the effect of releasing the Bank from its full liability hereunder.

2. The Corporation shall be at liberty without reference to the Bank and without affecting the full liability of the Bank hereunder to take any other security in respect of the Supplier's obligation(s) and/or liability(ies) under/or in connection with the Contract and/or to vary the terms vis-a-vis the Supplier of the Contract and/or to grant time and/or indulgence to the Supplier or to reduce or to increase or otherwise vary the prices or the total contract value or to release or to forebear from enforcement of all or any of the obligations of the Supplier under the Contract and/or the remedies of the Corporation under any

other guarantee(s) or security(ies) now or hereafter held by the Corporation and no such dealing(s), variation(s), reduction(s) or other indulgence(s) or arrangement(s) with the Supplier or release or forebearance whatsoever shall have the effect of releasing the Bank from its full liability to the Corporation hereunder or of prejudicing the rights of the Corporation against the Bank.

3. This Guarantee/Undertaking shall not be determined or affected by the liquidation or winding up or dissolution or change of constitution or insolvency of the Supplier or any change in the legal constitution of the Bank or of the Corporation.

4. The Bank hereby waives all rights at any time inconsistent with the terms of this Guarantee/Undertaking and the obligations of the Bank in terms hereof shall not be anywise affected or suspended by reasons of any dispute or disputes having been raised by the Supplier (whether or not pending before any Arbitrator, Officer, Tribunal or Court) or any denial of liability by the Supplier or any other order or communication whatsoever by the Supplier stopping or preventing or purporting to stop or prevent any payment by the Bank to the Corporation in terms hereof.

5. Notwithstanding anything contained herein:
   a. The Bank's liability under this Guarantee/Undertaking shall not exceed (currency in figures) . . . . . (currency in words only) . . . . . ;

   b. This Guarantee/Undertaking shall remain in force upto _____ (here put the entire period required for the performance of the Contract and the defect liability period plus 3 (three) months) and any extension(s) thereof; and

   c. The Bank shall be released and discharged from all liability under this Guarantee/Undertaking unless a written claim or demand is issued to the Bank on or before the midnight of _____ and if extended, the date of expiry of the last extension of this Guarantee/ Undertaking.

6. The Bank doth hereby declare that Mr. _____ [name & designation of the person authorised to sign on behalf of the Bank] is authorised to sign this Guarantee/Undertaking on behalf of the Bank and to bind the Bank thereby

Yours faithfully,
Signature)
NAME & DESIGNATION
NAME OF THE BANK

NOTES :

1. The Performance Bank Guarantee shall be strictly as per above proforma and shall be through a Scheduled Bank operating in India, including the Indian Branch of a foreign bank recognized as a Scheduled Bank in India.
2. The Bank Guarantee shall be typed on stamp paper applicable to an agreement in the State in which the Bank Guarantee is issued.
3. This bank guarantee shall be sent by the bank directly to:- Dy. General Manager (Materials), IOCL (Address)

Annexure D

PROFORMA OF BANK GUARANTEE
(FULL VALUE OF FREE ISSUE MATERIALS)

(On non-judicial stamp paper
Of appropriate value)

To

Indian Oil Corporation Ltd.
[Address]

Dear Sirs,

In consideration of the Indian Oil Corporation Ltd. [address] (hereinafter called the "Corporation" which expression shall include its successors and assigns) having awarded to _____[Name], _____(Constitution) _____(Address) (hereinafter referred to as the "Supplier" which expression shall wherever the subject or context so permits include its successors and assigns) a Supply Contract in terms, interalia, of the Corporation(s) Purchase Order No. [ ] dated [ ] (hereinafter referred to as the "Contract") and having agreed to provide certain free issue material(s) hereinafter referred to as "Free Issue Material" to the Supplier for incorporation in the materials(s) to be supplied under the Contract) upon the condition of the Supplier's furnishing security in lieu of cash for the said Free Issue Material(s) upto a sum of Rs./US$ ..... (Rupees/ United States Dollars _____ only] being the value of the Free Issue Material(s):

We _____ [name] a body corporate registered/constituted under the laws of [Country] and having a branch at [Indian branch address] (hereinafter called "the Bank" which expression shall include its successors and assigns) with the intent to bind the Bank and its successors and assigns, hereby undertake to pay the Corporation at [place] on first demand in writing without protest or demur or proof or satisfaction or condition, and without reference to the Supplier, any and all amounts from time to time demanded by the Corporation from the Bank with reference to this Guarantee/Undertaking upto an aggregate limit of Rs./US$ _____ (Rupees/ United States Dollars _____ only]

AND THE BANK DOTH HEREBY FURTHER AGREE AS FOLLOWS:

1. This Guarantee/Undertaking shall be in addition to any other guarantee or any other security whatsoever that the Corporation may now or at any time anywise have in relation to the Supplier's obligations and/or liabilities under and/or in connection with the Contract and/or the Free Issue Material and the Corporation shall have full authority to take recourse to or enforce this Guarantee/Undertaking in preference to the other guarantee(s) or security(ies) at its discretion, and no failure on the part of the Corporation in enforcing or requiring enforcement of any other guarantee or security shall have the effect of releasing the Bank from its full liability hereunder.

2. The Corporation shall be at liberty without reference to the Bank and without affecting the full liability of the Bank hereunder, to take any other security in respect of the Supplier's obligation(s) and/or liability(ies) under or in connection with the ContPraacgt eo3r 6thoef F44ree Issue Material and to vary

the terms vis-a-vis the Supplier of the Contract or the Free Issue Material and/or to grant time and/or indulgence to the Supplier and/or to reduce or to increase or otherwise vary the prices or the total contract value or the value of the Free Issue Material or to release or to forebear from enforcement of all or any of the obligations of the Supplier under the Contract and/or the remedies of the Corporation under any other guarantee(s) or security(ies) now or hereafter held by the Corporation and no such dealing(s), variation(s), reduction(s) or other indulgence(s) or arrangement(s) with the Supplier or release or forebearance whatsoever shall have the effect of releasing the Bank from its full liability to the Corporation hereunder or of prejudicing the rights of the Corporation against the Bank.

3. This Guarantee/Undertaking shall not be determined or affected by the liquidation or winding up or dissolution or change of constitution or insolvency of the Supplier or any change in the legal constitution of the Bank or of the Corporation.

4. The Bank hereby waives all rights at any time inconsistent with the terms of this Guarantee/Undertaking and the obligations of the Bank in terms hereof shall not be anywise affected or suspended by reasons of any dispute or disputes having been raised by the Supplier (whether or not pending before any Arbitrator, Officer, Tribunal or Court) or any denial of liability by the Supplier or any other order or communication whatsoever by the Supplier stopping or preventing or purporting to stop or prevent any payment by the Bank to the Corporation in terms hereof.

5. Notwithstanding anything contained herein:

    a. The Bank's liability under this Guarantee/Undertaking shall not exceed [currency in figures]. . . . . [currency in words] . . . . . only.

    b. This Guarantee/Undertaking shall remain in force upto the midnight of (here put the scheduled date of delivery of the Free Issue Material + 3 months) and any extension thereof.

    c. The Bank shall be released and discharged from all liability under this Guarantee/Undertaking unless a written claim or demand is issued to the Bank on or before [ ] and if extended, the date of expiry of the last extension of this Guarantee/Undertaking.

6. The Bank doth hereby declare that Mr. _____ (name & designation of the person authorised to sign on behalf of the Bank) is authorised to sign this Guarantee/Undertaking on behalf of the Bank and to bind the Bank thereby.

Yours faithfully,
(Signature)
NAME & DESIGNATION
NAME OF THE BANK

NOTES:

1. The Bank Guarantee shall be for the full value of the Free Issue Material(s) as specified by IOCL and shall be strictly as per above proforma and shall be through a Scheduled Bank operating in India, including the Indian Branch of a foreign bank recognized as a Scheduled Bank in India.

2. The Bank Guarantee shall be typed on stamp paper applicable to an agreement in the State in which the Bank Guarantee is issued.

3. This bank guarantee shall be sent by the Bank directly to:- Dy. General Manager (Materials), IOCL [Address].

Annexure E

PROFORMA OF BANK GUARANTEE
(FOR THE FULL VALUE OF REJECTED MATERIALS)

(On non-judicial stamp paper
Of appropriate value)

To

Indian Oil Corporation Ltd.
[Address]

Dear Sirs,

In consideration of the Indian Oil Corporation Ltd. (hereinafter called the "Corporation" which expression shall include its successors and assigns) having awarded to [Name], (Constitution) (Address) (hereinafter referred to as the "Supplier" which expression shall wherever the subject or context so permits include its successors and assigns) a Supply Contract in terms interalia, of the Corporation(s) Purchase Order No. [ ] dated [ ] (hereinafter referred to as the "Contract") and having agreed to permit the Supplier to remove certain rejected material(s) for which the Corporation has paid the Supplier (hereinafter referred to as the "Rejected Material(s)") upon the condition of the Supplier furnishing security for the satisfactory replacement of the Rejected Material(s) upto a sum of Rs./US$ [ ] (Rupees/ United State Dollars _____ only) amounting to the full value of the Rejected Material(s).

We _____ [name] a body corporate registered/constituted under the laws of [Country] and having a branch at [Indian branch address] (hereinafter called "the Bank" which expression shall include its successors and assigns) with the intent to bind the Bank and its successors and assigns, hereby undertake to pay the Corporation at [place] on first demand in writing without protest or demur or proof or satisfaction or condition, and without reference to the Supplier, any and all amounts from time to time demanded by the Corporation from the Bank with reference to this Guarantee/Undertaking upto an aggregate limit of Rs./US$ [ ] [Rupees/United States Dollars].

AND THE BANK DOTH HEREBY FURTHER AGREE AS FOLLOWS:

1. This Guarantee/Undertaking shall be in addition to any other guarantee or any other security whatsoever that the Corporation may now or at any time anywise have in relation to the Supplier's obligations and/or liabilities under and/or in connection with the Contract or the Rejected Material(s) and the Corporation shall have full authority to take recourse to or reinforce this Guarantee/Undertaking in preference to the other guarantee(s) or security(ies) at its discretion, and no failure on the part of the Corporation in enforcing or requiring enforcement of any other guarantee or security shall have the effect of releasing the Bank from its full liability hereunder.

2. The Corporation shall be at liberty without reference to the Bank and without affecting the full liability of the Bank hereunder, to take any other security in respect of the Supplier's obligation(s) and/or liability(ies) under or in connection with the Contract and/or the Rejected Material(s) and to vary the terms vis-a-vis the Supplier of the Contract or Rejected Material(s) and/or to grant time and/or

indulgence to the Supplier and/or to reduce or to increase or otherwise vary the prices of the total contract value or the value of the Rejected Material or to release or to forebear from enforcement of all or any of the obligations of the Supplier under the Contract or otherwise in respect of the Rejected Material and/or the remedies of the Corporation under any other guarantee(s) or security(ies) now or hereafter held by the Corporation and no such dealing(s), variation(s), reduction(s) or other indulgence(s) or arrangement(s) with the Supplier or release or forebearance whatsoever shall have the effect of releasing the Bank from its full liability to the Corporation hereunder or of prejudicing rights of the Corporation against the Bank.

3. This Guarantee/Undertaking shall not be determined or affected by the liquidation or winding up or dissolution or change of constitution or insolvency of the Supplier or any change in the legal constitution of the Bank or of the Corporation.

4. The Bank hereby waives all rights at any time inconsistent with the terms of this Guarantee/Undertaking and the obligations of the Bank in terms hereof shall not be anywise affected or suspended by reasons of any dispute or disputes having been raised by the Supplier (whether or not pending before any Arbitrator, Officer, Tribunal or Court) or any denial of liability by the Supplier or any other order or communication whatsoever by the Supplier stopping or preventing or purporting to stop or prevent any payment by the Bank to the Corporation in terms hereof.

5. Notwithstanding anything contained herein:

   a. The Bank's liability under this Guarantee/Undertaking shall not exceed [currency in figures]. . . . . [currency in words only] . . . . . .

   b. This Guarantee/Undertaking shall remain in force upto (put date fixed for replacement of the Rejected Material + 3 months) and any extension(s) thereof;) and
   c. The Bank shall be released and discharged from all liability under this Guarantee/Undertaking unless a written claim or demand is issued to the Bank on or before [ ] and if extended, the date of expiry of the last extension of this Guarantee/Undertaking.

6. The Bank doth hereby declare that Mr. _____ (name & designation of the person authorised to sign on behalf of the Bank) is authorised to sign this Guarantee/Undertaking on behalf of the Bank and to bind the Bank thereby.

Yours faithfully,
(Signature)
NAME & DESIGNATION
NAME OF THE BANK

NOTES:

1. The Bank Guarantee for full value of Rejected Material(s) shall be strictly as per above proforma and shall be through a Scheduled Bank operating in India, including the Indian Branch of a foreign bank recognized as a Scheduled Bank in India.

2. The Bank Guarantee shall be typed on stamp paper applicable to an agreement in the State in which the Bank Guarantee is issued.
3. This bank guarantee shall be sent by the Bank directly to:- Dy. General Manager (Materials), IOCL [Address].

Annexure F

PROFORMA OF BANK GUARANTEE
(ADVANCE)
(On non-judicial paper of appropriate value)

To
Indian Oil Corporation Ltd.
(Refineries Division)
……
……
……

Dear Sirs,

WHEREAS INDIAN OIL CORPORATION LIMITED (REFINERIES DIVISION) (hereinafter called "The IOCL" which expression shall include its successors and assigns) has awarded M/s _____ (hereinafter called "The Supplier" which expression shall include its successors and assigns) the work of designing, manufacturing, fabricating and supply of _____ in terms of a contract as constituted by Purchase Order No._____ dated _____ issued by the IOCL to the Supplier (hereinafter called "The Contract" which expression include all the amendments and/or modifications of the Purchase Order).

AND WHEREAS the IOCL has agreed to advance the Supplier a sum of Currency _____ (Currency _____) hereinafter called "The Advance" as financial assistance to the Supplier under the Contract on the condition, inter alia, that the advance shall be secured by a Bank Guarantee as hereinafter appearing.

We_____ Bank _____ a Bank incorporated/constituted under the laws of _____ and having its registered/principal office at _____ (hereinafter called "The Bank" which expression shall include our successors and assigns) in consideration of the aforesaid promises and at the request of the Supplier DO HEREBY bind ourselves and our successors and assigns, and irrevocably undertake to pay the IOCL on first demand in writing without protest or demur or proof or condition and without reference to the Supplier any and all amounts at any time and from time to time claimed by you, as due to you under or in respect of the said advance, and demanded by you from us, with reference to this undertaking upto an aggregate limit of Currency _____ (Currency _____).

AND, we, the Bank DO HEREBY further agree as follows:

i. The IOCL shall have the fullest liberty without reference to the Bank and without affecting in any way the liability of the Bank under this Guarantee/Undertaking, at any time and/or from time to time to anywise vary the Contract and/or any of terms and conditions thereof or of or relative to the advance and to extend time for the performance of the Contract and/or repayment of the advance or to postpone for any time or from time to time the obligations of the Supplier and to waive or postpone exercise of any of the rights available to the IOCL against the Supplier or to forebear from enforcing any of the terms or conditions of the Contract and/or the advance or any security(ies) available to the IOCL, AND the liability of the Bank shall remain in full force and effect notwithstanding any exercise by the IOCL of the liberty with reference to any or all the matters

aforesaid or by reason of time being given to the Supplier or any forebearance, waiver, act or omission on the part of the IOCL or any indulgence by the IOCL to the Supplier or any other act, matter or thing whatsoever which under the law relating to sureties would have the effect of releasing the Bank from its liability hereunder or any part thereof, AND the BANK DOTH HEREBY waive all rights at any time inconsistent with the terms of this Guarantee/Undertaking.

ii. It shall not be necessary for the IOCL to proceed against the Supplier before proceeding against the Bank and this guarantee/undertaking shall be enforceable against the Bank as principal debtor notwithstanding the existence of any other security for any indebtedness of the Supplier to the IOCL (including relative to the advance) and notwithstanding that any such security shall at the time when claim is made against the Bank or proceedings taken against the Bank be outstanding or unrealised.

iii. As between the Bank and the IOCL for the purpose of this guarantee/undertaking the amount claimed by the IOCL from the Bank with reference to this guarantee/undertaking shall be final and binding upon the bank as to the amount payable by the Bank to the IOCL hereunder.

iv. The liability of the Bank to the IOCL under this guarantee/undertaking shall remain in full force and effect notwithstanding the existence of any difference or dispute between the Supplier and the IOCL, the Supplier and the Bank and/or the Bank and the IOCL, or otherwise howsoever touching or affecting these presents or the liability of the Supplier to the IOCL, and notwithstanding the existence of any instructions or purported instructions of the Supplier or any other person(s) to the Bank not to pay or for any cause withhold or defer payment to the IOCL under these presents with the intent that notwithstanding the existence of such difference, dispute or instruction, the Bank shall be and remain liable to make payment to the IOCL.

v. This guarantee/undertaking shall not be affected by any change in the constitution of the Bank or that of the Supplier or the IOCL, or any irregularity in the exercise of borrowing powers by or on behalf of the Supplier.

vi. This guarantee/undertaking shall be valid for all claims/demands made by the IOCL to or upon us upto midnight of _____ provided always that if for any reason, the Supplier is unable to complete supplies under the Contract, the Bank shall at the request of the IOCL and without recourse to the Supplier extend the validity of this guarantee/undertaking for a further period of six months. For the purpose of this clause, the IOCL's statement that the Supplier is unable to complete supplies under the contract shall be conclusive and final binding on us.

vii. Notwithstanding anything contained herein:

a. The Bank's liability under this Guarantee/Undertaking shall not exceed Currency..... (Currency..... only),

b. This Guarantee/Undertaking shall remain in force upto..... and any extension(s) thereof; and

c. The Bank shall be released and discharged from all liability under this Guarantee/Undertaking unless a written claim or demand is

issued to the Bank on or before..... or the date of expiry of any extension(s) thereof if this Guarantee/Undertaking has been extended.

viii. The Bank DOTH HEREBY declare that Mr. _____ (name of the person signing on behalf of the Bank) who is _____ (his designation), is authorised to sign this guarantee/undertaking on behalf of the Bank and to bind the Bank thereby.

Dated this _____ day of _____

Yours faithfully

For _____

Signature _____
Name & Designation_____
Name of the Branch _____

NOTE

1. This Guarantee/Undertaking is not to be witnessed.
2. This Guarantee is required to be stamped as an agreement according to the stamp duty act.
3. This Guarantee is required to be sent by Vendor's Bankers directly to the IOCL.

S.NO.	ITB CL. NO.	CONTENT
1.	ITB 1.1	Item: **DISTRIBUTION CONTROL SYSTEM**
2.	ITB 2.1	Enquiry Basis is: ***Domestic Limited Basis***
3.		This Enquiry is for refinery of IOCL for following locations: Job No. B568 – BARAUNI REFINERY
4.	**Commitments**	As per technical section of bidding document.
5.	--------	**Payment Terms shall be as per following:** **Supply:** - 5% against approval of drawings, wherever required (identified in PO/ PR) at least in Code-2 and against submission of ABG of equivalent amount. - 10% against identification of raw materials at Supplier's works (to be identified during kick off meeting, if not specified in enquiry) and against submission of ABG of equivalent amount. - 65% against despatch documents (along with copy of LR/GR and IRN) through Bank or directly to IOCL/ CONSULTANT together with full taxes, duties. - 5% against receipt & acceptance of material at site. - 5% on receipt of Final/As built Drawings/Documents/Data/Manual in requisite number of copies/sets/CDs as per VDR specified in Purchase Requisition. - 10% on completion of site work **Mandatory Spares:** - 90% on receipt of spares at site after dispatch of main equipment. - 10% on receipt of materials at site. **Site Work and Pre-commissioning checks:** - 90% against monthly progressive bills (based on agreed billing schedule) duly certified by Engineer-in-charge. - 10% on successful completion of site work and handing over of goods/equipment at site.
6.	ITB 4.1	Additional Document Not Required
7.	ITB 5.2 **(Site Visit)**	Not Applicable
8.	ITB 6.3	i. Last date for submission of pre-bid queries is ***7 DAYS FROM RFQ ISSUANCE.*** ii. The pre-bid meeting is scheduled as following:

S.NO.	ITB CL. NO.	CONTENT
		Schedule: AS MENTIONED IN RFQ.
9.	**ITB 6.2, 11.1.2, ~~16.0 & 19.9~~**	The detail of Contact Persons for any query/ clarification/ communication/ **Postal address including original EMD (Bid Security) submission** is: Mr. Lotavath Thavurya, General Manager (SCM-C&P) Engineers India Limited, Tower-2, 2nd Floor, R&D Complex Sector-16, Gurugram, Haryana-122001 Telephone : +91 (0) -124-289-2509/ 1356/1358 E-mail : anindya.sinha@eil.co.in, sashi.shekhar@eil.co.in, shweta.singh@eil.co.in
10.	**ITB 11.1.2, 19 & 22.1**	The last Date and time of submission of Bids shall be ***AS MENTIONED IN RFQ.*** **EMD / Bid Security: Not applicable** URL for e-tendering portal is https://gem.gov.in
11.	**ITB 11.1.1**	List of Document required in the UNPRICED BID: a) Offer Covering letter (in bidder's letter head) without any deviations/stipulations. b) Power of Attorney in the name of authorized signatory who is submitting the bid with his Digital Signature Certificate & signature and the supporting Board Resolution authorizing the person submitting the bid on behalf of the company as per Clause 1.14 of ITB~~.~~ c) **Annexure-1** to **Annexure-2a** enclosed in Bidding Forms Section d) **Bidder Input Sheet (Indigenous)** enclosed in Bidding Forms Section e) **Annexure-3 to Annexure-4,** enclosed in Bidding Forms Section f) ~~**Annexure-5** (Wherever Pre-Qualification / Bidder's Qualification Criteria is applicable), enclosed in Bidding Forms Section~~ g) **Annexure-6** "Unpriced BOQ" h) **Annexure-7,** enclosed in Bidding Forms Section i) ~~**Annexure-8,** enclosed in Bidding Forms Section - **DELETED SINCE NOT APPLICABLE**~~ j) **Annexure-9 to Annexure-13,** enclosed in Bidding Forms Section k) **Annexure-14 -** Certificate for Declaration of Restriction for Bidders from Countries which share Land Border with India enclosed in Bidding Forms Section l) **Annexure-15** enclosed in Bidding Forms Section m) **Annexure-16**, enclosed in Bidding Forms Section n) **Annexure-17** enclosed in Bidding Forms Section o) ~~**Annexure-18** enclosed in Bidding Forms Section (applicable for foreign bidder in case of services in India is required as per scope of Enquiry Document) - **DELETED SINCE NOT APPLICABLE**~~ p) **Annexure-19**, enclosed in Bidding Forms Section q) ~~Supporting documents for Custom Duty exemption / waiver, if any.~~

S.NO.	ITB CL. NO.	CONTENT
		~~(Applicable for Foreign Bidders)~~ **~~NOT APPLICABLE~~** r) Preamble to Price Schedule and Unpriced copy of Price Schedule (Indicating 'Q' in place of price and 'NQ' for not quoted) s) ~~Latest Complete Audited Annual Financial Year Report including auditor report, Balance Sheet, Profit & Loss Account Statement, Notes and all other schedules. -~~ **~~NOT APPLICABLE~~** t) ~~Duly signed Integrity Pact (duly Witnessed) in accordance with Clause 12 of ITB~~ u) Certified documentary evidence to avail preference for being MSE bidder as per the requirement of ITB. v) Addendum / Amendment (if any) duly signed & stamped. w) Technical Compliance/ datasheets/ documents, required as per Material Requisition. x) Annexure-F to SPC (Undertaking by the Tenderer(s) y) ~~Compliance towards Preference to Domestically Manufactured Iron & Steel Products (DMI&SP) shall be as below:~~ ~~*"Bidders including domestic manufacturers, selling agents/ authorized distributors/ authorized dealers/ authorized supply houses of the domestic manufacturers of Iron & Steel Products shall furnish the Affidavit of self-certification issued by the domestic manufacturers declaring that the iron & steel products is domestically manufactured in terms of the domestic value addition prescribed, along with the bid.*~~ ~~*In case of selling agents/ authorized distributors/ authorized dealers/ authorized supply houses of the domestic manufacturers of Iron & Steel Products, the bidder shall also furnish the authorization certificate issued by the domestic manufacturer."*~~ ~~**Non-submission of requisite documents in r/o compliance to DMIS Policy shall render the bid liable for rejection.**~~ z) Form-1 & Form-2 ~~/ Form-3~~ attached with Annexure-III to ITB, w.r.t. PPP-MII 2017 Policy. aa) ~~Scanned copy of Bid security/ EMD must be uploaded in "FEE FOLDER" in e-tendering portal on or before Bid due date and time.~~ bb) Any other document required as per MR / RFQ Documents.
12.	**STOCKIST/ TRADERS**	**Not Eligible to Bid**
13.	**ITB 12.8**	**Integrity Pact: Not Applicable.**
14.	**ITB 15.1 & ITB 32.0**	The currency of Bid shall be in INR only.
15.	**ITB 16.0**	**BQC documents: Not Applicable**

S.NO.	ITB CL. NO.	CONTENT
16.	ITB 17.0	**Net Worth: Not Applicable**
17.	ITB 18.0	Bid shall remain valid for a period of **04 Months** from bid (Unpriced/techno-commercial) opening date.
18.	ITB 33.4 & 34.1	Purchase preference as admissible under the prevailing procurement policy for MSEs is **applicable** to this Enquiry Document. - **Not Applicable**
19.	ITB 34A (i)	Opportunity to Startup's and Micro & Small Enterprises (MSE'S): **Not Applicable** for this enquiry.
20.	ITB 35.1	Policy for Public Procurement (Preference to Make in India), order 2017 is Applicable to this Enquiry Document. Bidders having **minimum local content of 50% are eligible to participate** but purchase preference is applicable for participating Class-I local Suppliers, as defined in the Public Procurement (Preference to Make in India), order 2017, and such bidders shall submit the required documents as specified in the said policy. Bidder to submit Form-I & Form-II attached with Annexure-III to ITB, w.r.t. Public Procurement (Preference To Make In India), order 2017.
21.	ITB 36.1	Policy for Providing Preference to domestically manufactured iron & steel products in government procurement- revised, 2019 is **Not Applicable** for this Enquiry.
22.	ITB 36A (i)	Policy for Domestically Manufactured Electronic Products (DMEP) is **Not Applicable** for this Enquiry Document.
23.	**Entire bidding document**	Performance Bank Guarantee shall be read as “Contract Performance Bank Guarantee”.
24.	**Clause 40 / Annexure-V to ITB** **[Restrictions for Bidders from Countries which Share Land Border with India]**	Clause 40 of Instructions to Bidders (ITB) stands deleted. Bidder to refer Annexure-V to ITB Office Memorandum (O.M.) NO. F.7/10/2021-PPD (1) dated 23.02.2023 issued by Dept. of Expenditure (Govt. of India) w.r.t Restrictions Under Rule 144 (xi) of General Financial Rules (GFRs). Bidder to submit dully filled, signed and stamped “Bidder's Undertaking” and “Bidder's Undertaking in Case of Transfer of Technology (ToT) Arrangement” formats enclosed in bidding forms.
25.	**Evaluation and Ordering Philosophy**	Evaluation and Ordering shall be done on **Bottomline** basis.

S.NO.	ITB CL. NO.	CONTENT
26.	**Entire bidding document**	Bidder shall ensure that any certificate/ reports issued / attested by a statutory auditor / practicing-chartered accountant /Cost Auditor in India and submitted in the bid shall mandatorily include the UDIN number. Certificate/ reports issued/ attested without UDIN number of practicing chartered accountant in India shall not be considered for evaluation.
27.	**33.5 of ITB & 22.0 of SPC**	**Reverse Auction: Not Applicable.**
28.	**14.0 of SPC**	**Commercial Loading of Offers: Not Applicable**
29.	**17.0 of SPC**	**Part Order: Not** Applicable
30.	**23.0 of SPC**	**Repeat Order:** Not Applicable
31.	**Blacklisting / Holiday Listing**	Provisions of Blacklisting / Holiday Listing / Debarment / Banning stipulated anywhere in the RFQ Document stands replaced with the following Latest Holiday listing guidelines of IOCL: Blacklisting / Holiday Listing / Debarment / Banning Policy of Indian Oil Corporation Limited: The Blacklisting / Holiday Listing / Debarment / Banning policy of Indian Oil Corporation Limited can be accessed from any of the following portals: a. www.iocl.com from the link https://iocl.com/uploads/holiday2023.pdf b. Indian Oil e-tenders website (https://iocletenders.nic.in) under the "Announcement" Section
32.	**10.1, 10.12, 14.1.1 of SPC**	CPBG is APPLICABLE for this enquiry. PBG for 5% of order value, valid till Defect Liability Period plus the claim lodgment period / warranty period plus 6 months or as per requirement of Owner, shall be furnished within 45 days of order. In case of increase in the order value due to an amendment, the PBG value shall be proportionately increased. **Note:** In case a vendor does not furnish PBG, prorata payment of 5% shall be deducted from vendor's invoice and retained for a period of final delivery date plus warranty period plus 6 months. PBG is taken separately, one for supply & installation and other for PWCAMC / PWAMC wherein Post Warranty Comprehensive Annual Maintenance Contract (PWCAMC) / Post Warranty Annual Maintenance Contract (PWAMC) is in vendor's scope. PBG will be released after completion of their respective defect liability period. In absence of a valid PBG, payment for PWCAMC / PWAMC shall not be released. PBG for PWCAMC / PWAMC shall normally be taken @5% of AMC value as per requirement of Owner. As a special initiative to encourage more participation, PBG requirement shall be relaxed by 50% in case of MSEs owned by SC / ST & Women Entrepreneurs.

S.NO.	ITB CL. NO.	CONTENT
33.	ITB 27.0 ZERO DEVIATION	Offers are invited on "Zero Deviation Bid" Basis. Offers submitted with deviations or incomplete offers requiring any queries/correspondence may be liable for rejection without any reference to the Bidder.
34.	ITB 14 & Annexure-E to SPC (PRICE BASIS W.R.T INCLUSION/ EXCLUSION OF TAXES)	Bidder shall quote the prices in GeM Schedule as follows: a) Supply Price on FOT Site basis including Freight & GST b) Site Work including GST c) Mandatory Spares on FOT Site basis including GST d) Charges for Pre and post commissioning Checks, assistance etc. including GST
35.	Financial Document Folder in GeM	Bidder to upload the quotation for Two Years Operation and Maintenance Spares as per Material Requisition/ recommended by Vendor, Breakup for Mandatory Spares, Unit Rates for Addition/ Deletion as per Price Schedule Format available in the Tender in "Financial Document" Folder on GeM Portal.
36.	TPI Agencies SPC 5.1	The TPI agencies listed under SPC Cl. No. 5.1 stands replaced with the following revised TPI agency list: 1. ABS INDUSTRIAL VERIFICATION (INDIA) PVT. LTD 2. BUREAU VERITAS (INDIA) PRIVATE LIMITED 3. CERTIFICATION ENGINEERS INTERNATIONAL LTD. 4. EDILIPSE ENGINEERING GLOBAL PRIVATE LIMITED 5. GULF LLOYDS INDUSTRIAL SERVICES (INDIA) PVT. LTD. 6. INTERNATIONAL CERTIFICATION SERVICES PVT. LTD. 7. INTERTEK INDIA PVT. LTD. 8. IR CLASS SYSTEMS AND SOLUTIONS PRIVATE LIMITED 9. MEENAAR GLOBAL CONSULTANTS LLP 10. RITES LIMITED 11. SGS INDIA PRIVATE LIMITED 12. TUV INDIA PVT LTD 13. TÜV RHEINLAND (INDIA) PVT. LTD. 14. TUV SUD SOUTH ASIA PVT. LTD. 15. VCS QUALITY SERVICES PVT. LTD.
37.	Warranty / Guarantee Period / Defect Liability Period GPC 1.1(d)	Applicable as per GPC 1.1 (d)-i

स्वदेशी सामग्रियों के लिए पैकिंग, मार्किंग, शिपिंग और दस्तावेज विनिर्देश

PACKING, MARKING, SHIPPING AND DOCUMENTATION

SPECIFICATIONS FOR INDIGENOUS MATERIALS

Rev. No	Date	Purpose	Prepared by	Reviewed by	Approved by
1	10-09-2018	ISSUED FOR COMPLIANCE	DDC	DRC	ED (SCM)
0	05-12-2012	ISSUED FOR COMPLIANCE	DDC	DRC	GM (I)

Abbreviations:

CM	-	Centimeters
EIL	-	Engineers India Limited
E-way bill	-	Electronic Way Bill
Kg	-	Kilograms
FTL	-	Full Truck / Trailer Load
KGS	-	Kilograms
L.R.	-	Lorry Receipt / Goods Receipt
mm	-	Millimetre
MT	-	Metric Ton
NO. / NOS.	-	Number / Numbers
P.O.	-	Purchase Order
RCM	-	Resident Construction Manager

Document drafting Committee Members:

Shri. V.S.Krishnaswamy, Manager (SCM-Shipping)

Shri Ashish Mathur, Manager (SCM-Shipping)

Document review Committee Members:

Shri Uttam Kumar, Manager (SCM-C&P)

Shri R K Singh, Sr. G.M (SCM) & Head (Shipping)

Shri Rajeev Kumar, Sr. G.M (SCM-Inspection)

1. GENERAL

1.1 Purpose

This specification details the minimum requirements for the preservation, packing, marking, shipping and documentation of Products, materials and equipment as specified in the respective Purchase Orders or Contracts. This specification forms an integral part of the Purchase Order or Contract issued. However, whenever specific instructions are detailed in the Purchase Order and are in conflict with this specification, particular instructions mentioned in the individual Purchase Order or Contract shall prevail over this general specification.

1.2 Requirements and Conditions

The following requirements are intended as minimum requirements, and compliance to these requirements in no way absolves or relieves Supplier of any responsibility or obligation outlined in the Purchase Order. Equivalent or better packing methods may be deployed wherever supplier's own packing standards are more stringent to the requirements mentioned herein. Supplier shall submit the packing procedure or its equivalent for purchaser's approval during detailed engineering.

In all circumstances, the packing will be designed and constructed in order to support materials during transportation as well as to prevent the materials from damage due to impact, extreme climatic conditions, sun and rain. It must be ensured that the materials and equipments are delivered to the job site by sea, road or air, in good condition.

The Supplier shall, at its own cost, ensure items to be transported are carefully packed and protected in accordance with best practice, having due regard to the climatic conditions encountered during the passage, method of carriage and handling / loading / unloading processes. In addition to any of the measures detailed within this Specification, the Supplier shall apply any other measures that, in its experience, are required to safeguard the particular item. The Supplier shall obtain the approval of EIL / Owner for any variation to the packing, marking and shipping requirements outlined in this Specification.

1.3 Responsibility and liability

Supplier shall be held responsible for any damages and / or losses of all and any kind that may occur by not respecting these specifications. Owner / EIL reserves the right to reject any packing when the packing does not conform to these specifications / instructions and / or when the packing does not ensure perfect protection of the goods and materials. Supplier is responsible for the weights and dimensions declared and the marking of the packages. Supplier will be held responsible in the event goods and materials becoming useless, broken or damaged as a result of poor packing and / or stowing or due to corrosion because of insufficient or inadequate protection. All direct and indirect costs resulting thereof will be back charged to Supplier.

2. CLEANING AND PRESERVATION

2.1 Cleaning

All equipment, materials and parts shall be thoroughly cleaned inside and outside and shall be free from grease, oil, weld spatter, rust and all other foreign matter prior to preservation.

2.2 Preservation

Articles may be exposed to severe environmental or climatic conditions, moisture and dust. All materials and equipment shall be packaged suitable to prevent damage and deterioration during transportation and storage. Where damage occurs due to inadequate packaging of items, the liability for costs associated with rectification of the damage will be to the Supplier's account. All metals subject to corrosion shall be treated with a corrosion preservative suitable for the purpose intended. Products susceptible to corrosion must be packaged in a dry non-corrosive environment for the duration of shipment and storage, for a minimum of 1 year. All bright and machined parts shall be coated with a recognized rust preventative suited to the particular application concerned. All internal parts of machinery shall be treated with lubricant containing rust and oxidation inhibitors to protect equipment from any possible damage. Such lubricants shall be compatible with those which will subsequently be used in service and shall be identified by appropriate tagging. Electrical equipment and instrumentation shall be packed with a suitable desiccant. Delicate equipment such as instruments, electrical switchboards and panels etc. shall be packed for protection to eliminate the effects of vibration.

Wherever necessary, desiccant packs shall be kept to avoid excessive moisture in the packing.

3. PACKING

3.1 General

The instructions herein shall be considered as general directives and minimal requirements, which are applicable to the packing of all equipment and materials. The Supplier is responsible for the correct and adequate packing of the equipment and materials so that these equipment and materials will arrive at destination undamaged and the packing itself in such a condition that, if not otherwise required, it will be suitable for a minimum of 1 year storage.

3.2 Packaging Materials

All packaging together with packaging and protective materials shall be new, maintain its integrity and perform its intended function while being transported, handled and stored.

The quality of packing shall provide maximum protection against damage, breakage and pilferage during transport, storage and multiple handling, including handling by hoisting, lifting devices and / or forklift trucks. Material used for packaging, packing, wrapping, sealers, moisture resistant barriers and corrosion preservatives shall be of recognized brands and grades and shall conform to the best world standards.

Packaged Products showing any damage, defect or shortage resulting from improper packaging, packaging materials or packing procedure or having concealed damage or being short at the time of unpacking shall be subject to rejection and be replaced at the Supplier's cost

3.3 Packing requirements

3.3.1 Wooden Boxes and Crates

Interior support board shall be of strength to withstand multiple handling. Tops of crates shall be one piece wherever possible to avoid seepage through cracks; otherwise a top coating is required. Waterproof lining shall be used for sides, ends and top of crates, proper venting of cargo boxes containing machinery is required, as well as sufficient use

of desiccants. Crates shall be diagonally braced on all faces and suitable for hooks, slings and forklifts. Heavy items shall be secured with wood braces. Fragile items shall be cushioned. Material packed in large boxes shall be layered between plywood sheets to maintain load integrity during transit. Banding shall be used on all boxes to prevent distortion / deformation of the box.

3.3.2 Pallets

When equipment and/or materials are packed on pallets (wood or synthetic), these should be solid double deck pallets that provide adequate load support during transportation and storage (under not always ideal conditions). The pallets should have a dynamic load capacity, enough to carry the mass loaded on the pallet. Where feasible, the top surface of the pallet must be flat. The pallet design must enable safe handling by forklift, cranes etc. and storage on rough surface. Pallets shall be covered with wrapping. All corners, horizontal and vertical shall be protected with cardboard protection strips. The pallet must be tide on all sides with steel or synthetic straps.

3.4 Packaging

All equipment and materials shall be properly fixed (by bolts, clamps, supporting beams, etc.) in such a way that internal movements and / or loosening is impossible. Under the top cover (roof) depending on the case and crate length, a. sufficient number of strong beams shall be placed and properly fixed in order to allow stacking of the cases and crates avoiding any compression. Equipment parts and materials which may be subject to damage by vibration and /or shock must be protected using shock-absorbing material. All equipment and materials which may be damaged by moisture shall be packed in airtight bags in which sufficient desiccant material (e.g. silica gel) is placed. All openings on the equipment must be closed with wooden / metal or plastic covers to prevent damage to the openings and interiors. Fragile and loose parts easily damageable pertaining to the equipment must be securely and properly packed in a separate case.

3.5 Waterproofing

Cases including the cover shall be internally lined with a strong type of waterproof paper or plastic foil. Equipment and materials shall always be packed in a foil (polyethylene or aluminum) for extra (double) protection against rainfall. Those foils shall be applied in such a way that they are self draining.

3.6 Hazardous cargo

The hazardous materials shall be packed in accordance with and in cognizance to the applicable rules, regulations and tariff of all Governmental Authorities and other Governing bodies. Hazardous materials shall always be packed and documented separately from any other material. It shall be the responsibility of the seller of hazardous materials to designate the materials as hazardous and to identify each material by its proper commodity name and its hazardous materials class code. Safety and emergency procedures shall be displayed outside the package. Any certificates required for transportation or for authorities to be supplied before shipment of the goods

4. GUIDELINES FOR PACKING GOODS

In subsequent paragraphs details of different types of packing for different types of goods are defined. Supplier shall make packing details / procedure based on the guidelines and submit for approval.

Chemicals in powder form, catalysts, refractories & like materials etc. shall be packed in drums only.

4.1 Pipe

All pipes 2" included and below shall be packed in crates. All pipes to be capped and ends sealed with waterproof tape. Pipes over 2" up to 6", shall be bundled and banded in bundles of uniform length. Bundling is carried out with U-IRON or traversal planks, joined with threaded connecting rods with locknuts.. Bundle weight shall not exceed 2,000 kg. All pipes are to be capped and ends sealed with waterproof tape (tape is not necessary if end caps are of the pre-shrunk or self-sealing type).Pipes larger than 6" shall be shipped as single lengths with the ends capped. End caps are to be of the recessed type to enable the use of soft faced hooks, but still completely sealing the end and also protecting the weld. All stainless steel / non-ferrous piping must be packed separately in wooden crates. Any banding of bundles is to be with the same material. The bundling and packing of pipe and instrument tubing shall enable the safe discharge of pipe on site using clamps and forklifts. All pipes shall be supported along their lengths to prevent bending / flexing during transport. During loading / unloading slings shall be applied to the center of the load as well as each end to prevent bowing.

Pipe and rigid conduit smaller than DN50 diameter shall be bundled in units not to exceed 1000 kg. Threaded and coupled pipe shall be equipped with plastic thread protectors. All material shall be segregated and shipped by generic material type to prevent cross contamination. Where wire rope or chains are used, adequate padding shall be used at points of contact with pipe. Care must be taken to prevent any chafing of pipes against each other or against the metal structures of the vehicle during transportation. Where necessary, such metal structures must be padded with planks or plastic tubes. Skids and dunnage must be used between the bundles in transit as well as in the storage of coated pipes.

4.2 Pipe Fittings, Flanges, Valves and Gaskets

All pipe fittings, flanges and valves up to 6", are to be packed in cases / crates. For items over 6", these may be fixed securely to a pallet base and enclosed in a crate, for protection. All flange faces / bevel ends shall be suitable protected with plastic caps / end protectors. Where valves have actuators attached, rigidity must be ensured for the valve and actuator. The vulnerable parts of the actuator are to be completely protected within a wooden crate. Empty spaces shall be filled with expanded PU foam to restrict movement in the crate. All stainless steel fittings, flanges and valves of all sizes, must be packed separately in wooden crates. Any strapping is to be with the same material. Gaskets are considered fragile and shall be treated as such. Individual gasket sizes shall be boxed and labeled separately.

All threaded fittings and pipes should be greased and provided with plastic caps.

4.3 Steel Structure and Plates

Structural steel sections and plates shall be strapped in bundles of convenient size and weight for handling. Rolled and shaped plates shall be provided with suitable bracing to eliminate distortion during transit, and shall be bundled in uniform lengths. Each bundle shall be marked with a metal tag, hard stamped, secured under steel wrapping. A 2000 kg limitation shall be imposed for lifts in this category unless exempted.

4.4 Itemized Equipment

Units or parts belonging to main equipment but separately packed shall be clearly marked for easy identification with the main equipment to which they relate.

All flanges, machined working surfaces and threaded parts of all equipment shall be suitably protected. All flanged connections of vessels shall be protected by metal plates correctly casketed by wooden plugs or plastic caps suitably secured in position.

Vessels shall, where possible, be packed on skid constructions and secured with adjustable steel straps. Manholes and other major openings shall be protected with cover flanges or metallic plates firmly secured. Smaller openings shall be closed with plastic plugs / caps.

All vessel internals and items not installed by Supplier at works including accessories such as small parts, bolts, nuts, gaskets, etc. shall be packed in wooden cases separately for each vessel or apparatus and marked with the same item number as the vessel / apparatus in order to protect all parts from loss or damage in transit. Internals, bolts and gaskets for service / testing operations shall be supplied with the vessels / items by Supplier and all internals shall be boxed separately and marked according to marking procedure; each item shall be supplied correctly and identified for field installation by others.

All vessels / heat exchangers or items of such construction shall be dried, thoroughly cleaned inside and be free of all dirt and loose foreign materials. The equipment shall be filled with Nitrogen. Make up arrangement for loss of Nitrogen along with a pressure gauge shall be installed.

All commissioning spare parts shall be packed separately and marked with the relevant main item number.

Pumps, compressors, rotating equipment, turbines and motors will require specific packing and preservation as per the relevant Technical Specification. For skidded equipment openings, flange faces, threaded connections, wires, valve stems, and other component parts that may be subjected to mechanical damage or corrosion shall be adequately protected. This protection shall be applied to all components, both those removed and boxed and those remaining in place on the skid assembly. Each skid shall have one box strapped to it containing a complete set of drawings together with a manual covering installation and operating instructions and other pertinent instructions required for reassembly of components that were disassembled for shipment.

4.5 Control Panels and Electrical Devices

Equipment such as control panels, instruments and electrical devices shall be packed in an interior moisture / vapor-proof barrier with silica gel or comparable desiccant. Desiccants shall be bagged to avoid dispersing in containers. The quantity of desiccant shall be calculated in accordance with the manufacturer's recommendations. Equipment must be secured to the case with bolts, blocks or straps. Adequate precautions (for example, shaft locks to prevent longitudinal / rotational movement of rotor shafts in motors) shall be included in the packaging of all equipment which has plain, ball or roller bearings so as to minimize the risk of bearing damage.

4.6 Instruments

Instruments shall be thoroughly clean, dry and free from rust and individually wrapped using polythene sheets / U foam / Thermocol sheets depending upon the items and then packed in wooden boxes. The left out spaces and top of the boxes should be filled with rubberized coir to get proper cushioning effect. Special attention shall be paid for arresting movements of their operating mechanism during transportation. Silica gel or

other approved desiccant shall be strapped inside but shall not come into contact with the paintwork.

4.7 Cables

All electric cables to be packed in new cable drums made of steel and painted with epoxy resin paint. Cable ends to be carefully protected before packing. Polythene sheet should be wrapped over the cables and sealed properly. Cable drum can be put in wooden crates for ease in handling and transportation.

4.8 Saddles, Supports, Spiders and Lifting Equipment

All items which cannot be transported without independent supports must be supplied with Shipping saddles suitable for land and / or ocean transit. Such transport saddles are to be included within the scope of supply. Supplier is to advise of any requirement for lifting beams or other specialized lifting equipment and will include provision for use of such equipment for loading purposes. The Supplier is responsible for ensuring that all modules and oversize items are adequately braced and where required, plastic wrapped suitable for transport. Modules and oversize items shall be packaged to prevent damage during transport.

4.9 Assortment Of Package / Spare Parts for Erection and Commissioning

Equipment and / or parts of different item numbers shall not be packed together in the same package. Small goods such as accessories, spare parts for erection and commissioning and special tools shall be packed separately in respective inner boxes with tags or labels attached there being clearly indicating their contents. In case such accessories, spare parts and special tools are packed in separate boxes / crates, item no. of main equipment shall be clearly mentioned in Main Shipping Mark for easy identification.

5. MARKING

5.1 General

The purpose of the marking is to identify the packages and detail the weight and dimensions to assure efficient and correct handling during transport and upon arrival at destination.

5.2 Marking Instructions & dispatch details

Packages and crates will be marked with indelible black paint. Marking must be perfectly legible. All packages shall be clearly and properly marked in English language if not otherwise specified.

The shipping marks, which will be shall be stenciled on two sides and one end in clear characters at least 5 centimeters high (where crate size permits, otherwise use optimum size for each package dimension).

The texts shall be printed by means of stamps, stencil-plates or electronically. The use of stickers is not allowed, unless securely covered by plastic. Bundles shall be marked by embossing on two metal tags bearing the shipping marks and placed on each side of the package and securely attaching them to the goods. Paint shall be used on metal surfaces.

Labels or tags to be clearly visible and shall be of a quality to remain visible and attached during transit, handling and storage for a minimum period of 12 Months.

Crates containing fragile articles must be packed with special precaution against risk of breakage and must be stenciled on all sides "FRAGILE - HANDLE WITH CARE". Where crates are not to be overturned, Supplier must show on the crates, clear and readily visible identification, to ensure they are kept in the correct position.

Packages / equipment of 2,000 kg or more must be marked with slinging points on all sides, in addition to the centre of gravity marks.

Number packages consecutively i.e. 1 of 10, 2 of 10, etc. Do not duplicate package numbers. SUPPLIER is responsible for any loss or damage caused by incorrect marking.

All cases/crates shall also be marked with the appropriate international standard graphic symbols for handling.

As a minimum, all cases/crates are to be marked clearly on all four sides with:

"HANDLE WITH CARE" "RIGHT SIDE UP" "KEEP DRY"

In the case of packages with a single gross weight totaling 2,000 kg and / or a height of more than 1m, the centre of gravity shall be clearly marked with the symbol on two adjoining sides. For all items of equipment with an eccentric centre of gravity this symbol shall be marked at the bottom, side and top of the package.

The slinging and lashing points shall be marked with a chain symbol.

When packing in cases / crates, these packages shall also have metal corners at the slinging points.

External front and rear sides of the boxes shall be planed for writing instructions. To facilitate identification, the required colour coding as per the specifications shall be carried out on each package and on corners of pipes & plates.

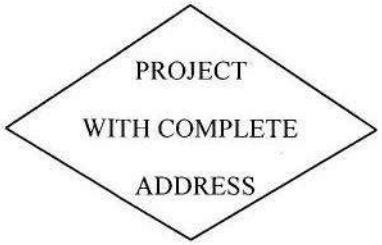
In case of bundles or other packages wherever marking cannot be stenciled, the same shall be embossed on metal or similar tag and wired securely at minimum two convenient points and both ends shall be protected / covered with gunny bags upto 18" (Eighteen Inches). In case of loose pipes, sticker of above markings should be pasted on inner wall corner of each pipe on both sides

Dispatch details such as consignor / consignee address, contract and case details, stacking instructions shall be written on one side of the boxes. One copy of packing slip wrapped in polyethylene bag covered with aluminum packing slip holder to be nailed on the external surface of the box. A packing list and preservation instructions shall be enclosed in a clear weatherproof plastic re-sealable envelope stapled to the box such that the receiver may determine contents without opening the container. An additional packing list is to be enclosed in a clear waterproof plastic re-sealable envelope stapled inside the container. Stapling of the envelopes shall not prevent removal of the documents.

5.3 Shipping Marks

Each package shall be marked on three sides with proper paints / indelible waterproof ink as follows:

(OWNER)



(DESTINATION)

PURCHASE ORDER NO. ----------

NET WEIGHT ---------- KGS. GROSS WEIGHT ---------- KGS.

DIMENSIONS ---------- X ---------- X ---------- CMS

PACKAGE NOS. (SL. NO. OF PACKAGE) OF (TOTAL NO. OF PACKAGES)

TAG / ITEM NO. ----------

SUPLLIER'S NAME----------

The details of the Owner / Project are defined specifically in the Purchase Order / Contract.

5.4 Storage Code

The type of storage required is required to be specified, it will be shown on each packaging in RED colour

X	Crates or packages to be stored outdoor without covers
XX	Crates or packages to be stored under tarpaulin
XXX	Crates or packages to be stored in covered or enclosed premises
XXXX	Crates or packages which must be stored in air-conditioned premises

6. SHIPMENT

Dispatch of material shall be made in accordance with the relevant terms of Purchase Order. Name of the owner, Project, location and other relevant information shall be as per the relevant annexure(s) to the Purchase Order / Contract.

Any change in mode of transport shall be resorted to only after prior approval in writing. Supplier shall ensure dispatch of equipment / materials immediately after they are

inspected and released. All consignments should be booked in the name of 'owner' and not under 'self' basis.

6.1 Dispatch By Road:

a) The Materials shall be dispatched on Door-Delivery basis (smalls or FTL) through a registered transporter.

However, in case, the transporter is nominated by EIL / Owner, the goods shall be dispatched through the same only.

b) The supplier shall ensure with Transport Company the delivery of materials within a reasonable transit period. A complete set of dispatch documents (Delivery Challan / Invoice / Packing List / Test Certificate / L.R. / E-way Bill number etc.) shall be sent to Head (Shipping) at EIL New Delhi and the Resident Construction Manager (RCM) at site.

6.2 Shipment By Air:

Whenever supplier is instructed by EIL/ Owner to airfreight any material, the supplier shall take prompt action for the same. Immediately after air-shipment is effected, the vendor shall intimate by e-mail, the details of Airway Bill number and date, the flight No., Number of packages etc. to Head-Shipping, EIL New Delhi and Resident Construction Manager at EIL (Site).

6.3 Destination:

The consignments should be dispatched to the Consignee / Address as detailed in the Purchase Order.

6.4 Advance Information:

Immediately after a shipment is made supplier shall intimate Underwriter, Head (Shipping) and RCM vide mail regarding particulars of materials, value, Purchase Order No., date of dispatch, L.R. number, E-way Bill No., truck no., name of Transport Company.

6.5 Transmission of Dispatch Documents :

Supplier shall, within 48 hrs. of the dispatch of the materials depending upon the payment terms of the Purchase Order, either negotiate through Owner's / EIL's Bankers or forward directly, by Courier the complete set of dispatch Documents (as detailed in Purchase Order) to Owner / EIL. The supplier shall be responsible for any delay in clearance of the consignment at destination and consequent wharfage / demurrage, if any, due to delay in transmittal of the required documents.

7. TRANSIT RISK INSURANCE

All equipments / materials will be insured for transit risk by (Owners) unless otherwise specified. The insurance cover will be provided from warehouse-to-warehouse.

Annexure-L

TERMS & CONDITIONS FOR SITE WORK

1. The Vender shall perform their jobs in eco-friendly manner and in consonance with the objectives of IOCL Refinery environment management system.
2. Since, it is an existing Complex with various units in operation; the proposed site has constraints of space availability, restriction in movement of over dimensioned / overweight consignments both within & outside the refinery limits. Further, construction / erection work for several other project facilities at various locations within refinery site will be progressing concurrently. It will be the responsibility of vendor to seek approvals from the Owner for working within & outside the refinery limits and also of taking all suitable safety measures as per regulations in force for the safety of existing-refinery.
3. The material shall be collected by the vendor from Owner's stores/Project Site/vendor's own stores (as the case may be) and transported to the erection site at Vendor's cost and risk.
4. All labour (both skilled and unskilled), tools, tackles and consumables, shall be arranged by Vendor at his own cost.
5. Vendor shall arrange for the necessary transport, accommodation, medical, canteen and other facilities for their employees/staff at their own cost and abide by all labour laws, safety codes and statutory regulations and keep Owner indemnified in respect hereof.
6. Vendor shall arrange and pay for all insurances as may be required under the law for their employees/ materials/subcontractor(s) and shall also cover against all risk for the materials issued by Owner. Vendor shall be working at Owner's site along with agencies who will be engaged in the other activities. For this purpose the third party risk shall also be covered by Vendor.
7. The Vendor is responsible for keeping his work place neat and clean and shall always avoid scattering of any materials around the work place. The Vendor shall clear the work site of all debris, materials, tools, tackles etc. immediately upon completion of the job. Any temp. Line/cables etc. laid for the purpose of execution of a particular job shall be immediately removed to an agreed location and the site cleared off all such materials.
8. The Vendor shall not throw out gaskets, used electrode pieces, hand gloves, cotton wastes, gunny bags, polythene bags etc. into open channel, any drains or pipe line system. These are to be collected together and deposited in bins/waste collectors earmarked for the purpose of disposal after consultation with Engineer-in-Charge.
9. Construction Power &water, if available, may be provided on chargeable basis from existing network at one point and further cabling/piping, metering etc. shall be done by the bidder. The bidder shall install their own meters for measuring the units. However, in case power and water cannot be provided by IOCL, the bidder shall make his own arrangements for the same.
10. As per the applicable Factory Act the Labour License if required, shall be taken by Vendor before starting the works.
11. Crane (100 MT tyre mounted) can be given on chargeable basis, if available at the time of execution.

RFQ NO:
ITEM:
OFFER NO:

VENDOR'S SIGNATURE &DATE:
NAME
DESIGNATION

VENDOR'S STAMP

PREAMBLE FOR SUBMISSION OF PRICES ON GEM PORTAL (FOR INDIAN BIDDERS)	
RFQ NO.: SS/B568-304-YE-MR-1501/45	
ITEM : DISTRIBUTED CONTROL SYSTEM	
Name of Bidder : M/s _____	
1	**Bidder to quote price(s) in respective field(s) against respective catalogue(s)/schedules in GeM Portal only . Price(s) quoted any-where else other than in respective fields provided in GeM Portal shall not be given cognizance and shall not be evaluated.**
2	**Currency of Quote shall be INR only**
3	Scope of supply including testing, inspection, documentation etc., shall be strictly as per Material Requisition and other documents which are part of RFQ.
4	Bidders quoted prices are for complete scope of supply as per MR and are inclusive of drawing and documentation charges for all supplies and services as per MR.
5	Bidder to note that evaluation and ordering shall be done on TOTAL VALUE WISE basis. The order shall be awarded on TOTAL VALUE WISE basis to the Lowest (L1) Techno-Commercially Qualified bidder.
6	Following shall be considered for the purpose of Price Evaluation as per provisions of RFQ document. - Supply Price including Mandatory Spares on FOT Site Basis inclusive of Packing and Forwarding (P&F) charges, freight charges, GST and all other Taxes and duties. - Site Work Charges inclusive of GST and all other Taxes and duties. - Pre and post -commissioning checks, assistance charges inclusive of GST and all other Taxes and duties.
7	Bidder to quote per diem Site-Work charges as per MR against respective catalogue/schedule in GeM Portal only. Same shall be considered for commercial evaluation. Quoted site work charges ((for MR Item Sl.no 2) shall be minimum 3 % of the quoted supply (including Mandatory Spares) prices. In case a supplier quotes site work charges lesser than 5% of supply price, the differential charges shall be retained from supply prices and shall be paid along with last 10% payment of supply charges which will be paid after completion of site work
8	Vendor shall furnish Unit Rates of each DCS / PLC / F&G Sub-systems items with its necessary hardware and software required as per MR for addition / deletion purpose which shall include the unit rates of the items as per Annexure-XII. Unit rates furnished by vendor shall be comprehensive i.e., shall include cost of supply (inclusive of all associated cables, I/O chassis, connectors and termination assemblies), engineering, software modification, software licenses (I/O), documentation, transportation, unloading, installation, termination, wiring & testing, pre-commissioning, commissioning, etc. Vendor shall also include the cost of items, which are not listed in annexure-XII but required as per vendor system design /standard, as part of respective main item listed in annexure-XII and insertion of any new items by vendor in annexure-XII (format for unit rate) shall not be allowed.
9	Bidder to upload Unit Rates for Addition / Deletion strictly as per Price Schedule Format (enclosed) in “Financial Document” Folder on GeM Portal. Bidder to note that only the priced copy of above, as per Price schedule format, shall be uploaded in Financial document folder. No other documents including any terms/ deviations/ clarification/ specification/ deviations etc. shall be uploaded in this folder.
10	Bidder to upload quotation for Two years operation & maintenance spares strictly as per Price Schedule Format (enclosed) in “Financial Document” Folder on GeM Portal. Bidder to note that only the priced copy of above, as per Price schedule format, shall be uploaded in Financial document folder. No other documents including any terms/ deviations/ clarification/ specification/ deviations etc. shall be uploaded in this folder.
11	Mandatory Spares: Bidder to quote lumpsum prices for Mandatory Spares as per MR requirments in GeM schedule. However, percentage break-up of Lumpsum Mandatory spares prices (itemwise, if applicable) shall be furnished as per Price Schedule Format (enclosed) in Unpriced bid.
12	Charges for inspection and testing as per MR including Third party inspection charges shall be included by the Bidders in their quoted prices. TPI shall be from any one of the agencies for the project as mentioned in RFQ Documents
13	Bidder shall furnish built-in CIF value, if any, against each quoted ITEM, giving details of description of goods, quantity, rate of Custom Duty etc., in attached FORMAT-CIF/CD. Price of built-in CIF value shall be uploaded to Finance Folder on GeM Portal.
14	Quoted prices are firm and fixed till complete execution of the entire order and no variation on any account is allowed, unless otherwise categorically specified in RFQ documents.
15	In case of any discrepancy in the Item Description/Tag No./ Qty. specified in Price Schedule / catalogue(s) vis-à-vis the corresponding details in MR, the Item Description/Tag No./ Qty.specified in MR shall prevail.

16	Bidder confirms that he has noted the contents of this Preamble, RFQ, Material Requisition, etc. and quoted his prices accordingly without any deviation.
17	Bidder to note that all the prices quoted by bidder on the GeM Portal shall be considered as inclusive of GST and all other taxes and duties. Bidder to quote accordingly.

PRICE SCHEDULE (FOR BREAKUP OF MANDATORY SPARES)

RFQ NO.: SS/B568-304-YE-MR-1501/45

ITEM : DISTRIBUTED CONTROL SYSTEM

NOTES:

1. Bidder shall furnish Percentage breakup of Lumpsum Mandatory Spares price quoted for respective MR Item as per the requirements of MR. Bidder may add/delete rows (if required) to furnish the break-up price.
2. Duly filled, sign/stamped copy this sheet shall be submitted by bidder along with unpriced bid.

BIDDER NAME-

Sl. No.	MR Item No. / Group No.	Mandatory spare name (as mentioned in MR)	Quantity	Unit	Percentage breakup of Lumpsum Mandatory Spares price quoted for respective MR Item / Group
1	4.0001	i)……			____%
2		ii)……			____%
3		iii)……			____%
4		iv)……			____%
5		……			____%
6		……			____%
7		……			____%
8		……			____%
9		……			____%
10		……			____%
11		……			____%
12		……			____%
13		……			____%
14		……			____%
15		……			____%
16		……			____%
17		……			____%
		Sub-Total (for MR Tag no 4.0001 000-SPARE-100):			**100%**

Bidder may add/delete rows (if required)

RFQ No. / Name of Item: SS/B568-304-YE-MR-1501/45 / DISTRIBUTED CONTROL SYSTEM

NOTES:
1. Vendor shall furnish an itemised list of recommended 2 Years Operation & Maintenance Spares, as per MR.
2. Price 2 year Operation & Maintenance spares shall not be considered for evaluation and Purchaser / Owner reserves the right to select and order these spares separately.
3. In case bidder has quoted for any item but not indicated freight for that particular item, in such case freight for that particular item shall be considered NIL.
4. Bidder may add rows, if required.
5. Sign/stamped unpriced copy of the same shall be uploaded along with unprice part of the bid.
6. Sign/stamped Priced copy of the same shall be uploaded on designated Finance Folder on GeM Portal.

Bidder Name :	

PRICE SCHEDULE (FOR TWO YEARS OPERATION AND MAINTENANCE SPARES)

Sl. No.	Item Tag Nos.	Item Description	Quantity	Units	Quoted Currency	Unit Price on FOT Despatch Point Basis	Freight/ Transportation Charges (in %)
					INR		
					INR		
					INR		
					INR		
					INR		
					INR		
					INR		
					INR		
					INR		
					INR		

Unit Rates for Addition/ Deletion

RFQ No. SS/B568-304-YE-MR-1501/45
Item DISTRIBUTED CONTROL SYSTEM
Bidder name:

Sl. No. as per MR	Description	Qty (UOM)	Unit Price on FOT Despatch Point Basis	Freight/ Transportation Charges (in %)
a	b	c	d	e= in % of d
6.0001	Unit Rates of items as per MR.			

Important notes

1. These Unit Rates of Addition/Deletion shall be used in case of Addition/Deletion during execution of the work.
2. Bidder to note that the Unit Rates for Addition/Deletion are to be given in Indian Rupees only. ~~In case of an order, rates of Foreign Bidder/Supplier shall be adjusted for such addition/deletion item in foreign currency as quoted for the main Item/equipment.~~
3. ~~Conversion of the same to equivalent foreign currency as above shall be at the Bill Selling rate of foreign exchange published by State Bank of India (SBI) prevailing on the date of Payment to the Supplier.~~
4. In case of any discrepancy in the Item Description/Tag No./ Qty. specified in this Price Schedule vis-à-vis the corresponding details in MR, the Item Description/Tag No./ Qty.specified in MR shall prevail. Refer MR for details.
5. **Bidder must not quote unit rate as "NIL" or "same as quoted in supply prices" or leave ''blank''. Bidder must clearly indicate rates.**
6. Sign/stamped unpriced copy of the same shall be uploaded along with **unprice part of the bid.**
7. Sign/stamped Priced copy of the same shall be uploaded on designated Finance Folder on GeM Portal.

ENCLOSURE TO PRICE SCHEDULE FOR SUPPLY (INDIAN BIDDERS)

FORMAT-CIF/CD

RFQ NO.: SS/B568-304-YE-MR-1501/45

ITEM : DISTRIBUTED CONTROL SYSTEM

Name of Bidder : M/s _____

DETAILS OF BUILT-IN-CIF VALUE ON MERIT RATE OF CUSTOM DUTY.
DETAILS AND BREAK-UP OF IMPORTS DUTIES CONSIDERED AND INCLUDED IN QUOTED FOT DESPATCH POINT PRICES UNDER PRICE SCHEDULE

DESCRIPTION			CIF value of Import Content included in quoted supply prices for column (2) Qty. (In Rs)		RATE OF IMPORT DUTY INCLUDED IN QUOTED SUPPLY PRICES *(2)				
For Item S. No. as per MR	Description of Imported Items	Qty. (Unit____) *(1)	Rate in Figures	Rate in Words	HSN CODE AS PER GST	BASIC CUSTOMS DUTY (%)	SOCIAL WELFARE SURCHARGE ON CUSTOM DUTY (%)	IGST (%)	TOTAL CUSTOM DUTY (%)
1	2	3	4	5	6	7	8	9	10
TOTAL CIF VALUE									

NOTE:

1 * Unit to be specified by the Bidder.

2 Bidder to furnish the above details separately for each GROUP/ ITEM of MR

3 The Insurance of Built-in Imported Materials (imported raw materials/items) shall be taken by Bidder/ Supplier.

4 Bidder to quote their prices after considering the input credit of IGST on Imports .

5 Bidder to furnish the above details for complete supply ITEMS/ GROUP, as applicable. Bidder may insert rows, if necessary.

MATERIAL REQUISITION (TOP SHEET)

ITEM DESCRIPTION : DISTRIBUTED CONTROL SYSTEM	
ITEM CODE : 16EA	**DESTINATION:** IOCL Barauni
ITEM CATEGORY : II	**DELIVERY PERIOD:**

REQUISITION NUMBER

(Always quote this Number given below as reference)

B568-304-YE-MR-1501	A
JOB NO. — UNIT/ AREA — MAIN COST — DOC. CODE — SR. NO.	REV

07-Nov-2024	16	51
DATE	DIVN.	DEPT.
	ORIGINATOR	

NOTES:

1. This page is a record of all the Revisions of this Requisition.
2. The nature of the Revision is briefly stated in the "Details" column below, the Requisition in its entirety shall be considered for contractual purposes.
3. Vendor shall note the Requisition category and shall submit his offer in line with the requirements included in attached 'Instructions to Bidders'.

REV	DATE	PREPARED BY	CHECKED BY	APPROVED BY	DETAILS
A	07-Nov-2024	BISWANATH ORAON	KAMALESH KANTI PODDAR	SONIA MADAN	Issued For Bids

This is a system generated approved document and does not require signature.

S.No.	TAG NO./ ITEM CODE	DESCRIPTION	QUANTITY	GROUP
1	**Design ,engineering, manufacture, procurement of materials and bought out items/components, assembly at shop, system engineering, integration, Interfacing and integration with Clients existing system ,internal testing, inspection, factory testing and acceptance at manufacturer's works, packing, delivery of the following including supply of commissioning spares, special tools and tackles, consumables, erection materials and documentation as per the enclosed EIL standard specifications, instructions to vendors, job specification, Scope of work ,data sheets etc and other codes and standards attached or referred in the MR.**			
1.0001	000-DCSSYS-00	Augmentation of EPCC-11 DCS system as per MR	1 Lot	
1.0001.01	01-IODCS-100	IO Module, IO cards and accessories for DCS system	1 Lot	
1.0001.02	02-IOPLC-100	O Module, IO cards and accessories for PLC system	1 Lot	
1.0001.03	03-IOFGS-100	IO Module, IO cards and accessories for FGS system	1 Lot	
1.0001.04	04-IOMCC-100	IO Module, IO cards and accessories for MCC	1 Lot	
1.0001.05	05-CAB-100	Cabinets, Panels and Racks	1 Lot	
1.0001.06	06-HWC-100	Hardwired and other Consoles augmentation	1 Lot	
1.0001.07	07-HWI-100	Hardwired Instruments, Barriers, Relays, power supplies etc	1 Lot	
1.0001.08	08-MCT-100	MCT Frames and Blocks	1 Lot	
1.0001.09	09-CIVIL-100	Base Frames and tray	1 Lot	
1.0001.10	10-OTR-100	All interconnecting cables including system cables & FO cables with necessary connectors/ convertors	1 Lot	
1.0001.11	11-NET-100	Networking component including network switch, LIU etc with all accessories	1 Lot	
2	**Unloading, handling at site, transportation to site store and from store to work site, storage at site, assembly at site, completion of erection, Installation of third-party items, installation of all components of the supplied system, testing, cable glanding/terminations, Loop checking etc. and associated site work including residual civil/structural works for the following as per the enclosed EIL Standard Specifications, instructions to vendor, job specifications, datasheets etc of the requisition.**			
2.0001	{2}000-DCSSYS-00	For Item 1.0001	1 Lot	
3	**Transportation from Vendor's shop to site for the following as per the enclosed EIL standard specifications, instructions to vendors, job specification, data sheet etc of requisition.**			
3.0001	{3}000-DCSSYS-00	For Item 1.0001	1 Lot	
4	**Supply of Mandatory Spares , as per enclosed list/instructions to vendor**			
4.0001	000-SPARE-100	Mandatory Spares for Item 1.0001 as per MR	1 Lot	
5	**Supply of two years operation and Maintenance Spares,as per enclosed instructions to vendor**			
6	**Unit Rates**			

S.No.	TAG NO./ ITEM CODE	DESCRIPTION	QUANTITY	GROUP
6.0001	-	Unit Rates for Item No.1.0001for each DCS/PLC/sub systems hardware and software items as per enclosed standard specification, special instructions to vendor, datasheet etc. as specified in requisition	1 Lot	
20	**Pre-commissioning checks, assistance for interlocks and logic checks, providing commissioning back-up, works-completion, commissioning of plant package equipments, Integration with Client's EPCC-11 existing system, completion of SAT, handing over of mandatory spares and post-commissioning back-up.**			
20.0001	{20}000-DCSSYS-00	For Item 1.0001	1 Lot	

NOTES:

Vendors shall quote prices against these items in their price schedule.
Vendor to note that the numbers given in square '[]' and curly '{}' brackets are not for their use and meant for store purpose only.
Items shall be tagged as per main equipment Tag No. only.

Sl. NO.	DOCUMENT TITLE	DOCUMENT NO.	REV / DATE	SHEETS
	(Distributed Control System)			
1.	**SECTION-I (Preamble)**	B568-304-YE-SP-1501	0 / 04-11-2024	2
2.	**SECTION-II Standards and Specifications**	B568-304-YE-SP-1502	0 / 05-11-2024	2
a.	Standard Specification for Distributed Control System	6-52-0055	4 / 22-12-2020	122
b.	Specification for Quality Management System Requirements from Bidders	6-78-0001	2 / 12-06-2020	7
c.	Specification for Documentation Requirements from Suppliers	6-78-0003	2 / 12-06-2020	9
d.	Standard Specification for Health, Safety & Environment Management at Construction Sites	6-82-0001	2 / 18-04-2023	105
e.	Safety Measures for Electrical Installation during construction	7-51-0332	4 / 07-12-2021	2
3.	**SECTION-III (Specific Project Requirements)**	B568-466-YE-SP-1503	0 / 05-11-2024	4
a.	Logistic Support Formats	Annexure-I	0 / 05-11-2024	3
b.	Responsibility Chart	Annexure-II	0 / 05-11-2024	4
c.	Power Consumption & UPS Requirement	Annexure-III	0 / 05-11-2024	4
d.	Ventilation & Air-conditioning Requirements	Annexure-IV	0 / 05-11-2024	5
e.	Air Quality Requirements	Annexure-V	0 / 04-11-2024	2
f.	Proven Track Record	Annexure-VI	0 / 04-11-2024	5
4.	**SECTION -IV (PROJECT SPECIFICATIONS)**	B568-304-YE-SP-1504	0 / 05-11-2024	2
a.	Project Information	B568-304-YE-SP-1507	0 / 04-11-2024	3
b.	Special Instructions to Vendor	B568-304-YE-SP-1508	0 / 04-11-2024	18
c.	MCT specification	B568-304-YE-SP-1509	0 / 04-11-2024	2
d.	Mandatory Spares Part List	B568-304-YE-SP-1510	0 / 04-11-2024	3

e.	RTF Recommendations	Volume -1 dated 2018	--	426
f.	Cyber Security Guidelines for Control Systems -Year 2021	--	--	86
5	**SECTION-V (Specific Requirement for DCS/PLC)**	-	-	-
a.	Scope of Work	B568-304-YE-SP-1505	0 04-11-2024	6
b.	DCS/ PLC Data Sheets	B568-304-YE-DS-1501	0 04-11-2024	53
c.	I/O Summary and sizing consideration	Annexure-VII	0 07-11-2024	7
d.	System Configuration Diagram for DCS System	B568-304-16-51-2201	A 04-11-2024	1
e	110 V AC UPS Power Distribution Diagram	B568-304-16-51-31001	0 04-11-2024	1
f	110 V AC UPS Non DCS Power Supply Distribution List	Annexure-VIII	0 04-11-2024	4
g.	240 V AC Power Supply Distribution Diagram	B568-304-16-51-31002	0 04-11-2024	1
h.	24 V DC Non DCS Power Supply Distribution List	Annexure-IX	0 04-11-2024	2
i.	ATS Scheme	Annexure-X	0 04-11-2024	1
j.	SUPPLIER LIST (INSTRUMENTATION)	Annexure-XI	0 07-07-2024	3
k.	DDCS-III O&MS Control Room Layout	B568-304-81-46-12111	B 02-02-2024	1
l.	EPCC-11 Control Room Layout	EPM24-6373-COO-BLG-DWG-RCBG-2508	02 17-03-2022	1
m.	Overall Plot Plan	B568-000-81-45-0001	1 03-09-2024	1
n.	Unit Rates for Addition & Deletion	B568-304-YE-SP-1511 ANNEXURE-XII	0 07-11-2024	6
o.	Technical Questionnaire	B568-304-16-51-TQS-1501	A 07-11-2024	3
6.	**SECTION-VI (Vendor's Proposal Outline)**	B568-304-YE-SP-1506	0 05-11-2024	5
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SECTION-I
(PREAMBLE)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	04-11-2024	ISSUED with MR	BO	KKP	SM

1.0 **General:**

M/s Indian Oil Corporation Limited (M/s IOCL) is going to set up New Bitumen Manufacturing Unit Unit No. 466 (Biturox® II) for Bitumen production in the IOCL (Indian Oil Corporation Limited) Barauni RefineryThe product shall be stored in offsite Bitumen tank . The same shall be pumped through Product pump .

New Bitumen Bitumen product storage system shall include the following

1. Storage Tank and associated facilities,
2. Product Pump.

1.0 This specification defines the functional requirements of control system of various Sections of bitumen storage along with associated facilities unit which shall be controlled and monitored through existing EPCC -11 Honeywell Make DCS/PLC system located at EPCC-11 Control room . However , the marshalling panels and IO rack shall be placed on DDCS-III control room proposed rack room area..

1.1 This Material Requisition (MR) is for the control system for all the units of the Refinery as stated above. Segregation philosophy is specified in detail in other section of MR. Field-bus based technology is not being implemented for this Project. All open loops, close loops, interlocks & shutdown conventional SMART technology shall be used as defined elsewhere in this MR.

1.2 This MR consists of the following sections: -

1. Section-I (Preamble)
2. Section-II (Standard specifications)
3. Section-III (Specific project requirement)
4. Section-IV (Common Project specification)
5. Section-V (Specific requirement for DCS/PLC)
6. Section-VI (Vendor's proposal outline)
7. Section-VII (Vendor Data Requirement)

1.3 Vendor shall prepare their technical proposal as per section-VI (Vendor's proposal outline) and the item summary of this requisition. Vendor shall categorically state whether their proposal meets all the technical specifications listed in the standard and project specification enclosed with this MR.

1.4 Vendor shall sign and stamp each and every sheet of the following documents: -

1. Project specification
2. Standard specifications
3. Special instructions to vendor
4. Specific project requirements

1.5 The proposal shall be evaluated, as received. Vendors are required to quote strictly as per the requirements of this requisition. Owner/ consultant reserve the right to reject any or all alternatives, if proposed by the vendor, without assigning any reason thereof.

1.6 Vendor shall provide written guarantee for the availability of back-up engineering, maintenance support and spare parts for a period of ten (10) years from the date of expiry of warranty as per the format enclosed for logistic support.

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SECTION-II
(STANDARD SPECIFICATIONS)

0	05-11-2024	ISSUED with MR	BO	KKP	SM
Rev. No	**Date**	**Purpose**	**Prepared by**	**Checked by**	**Approved by**

LIST OF DOCUMENTS

S. No.	Document title	Document no.	No. of sheets
1.	Standard Specification for Distributed Control System	6-52-0055 Rev.4	122 sheets
2.	Specification for Quality Management System Requirements from Bidders	6-78-0001 Rev.2	7 sheets
3.	Specification for Documentation Requirements from Suppliers	6-78-0003 Rev.2	9 sheets
4.	Standard Specification for Health, Safety & Environment Management at Construction Sites	6-82-0001 Rev.2	105 sheets
5.	Safety Measures for Electrical Installation during construction	7-51-0332 Rev.4	2 sheets

वितरितनियंत्रण प्रणाली के लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR DISTRIBUTED CONTROL SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards committee Convener	Standards Bureau Chairman
					Approved by	
4	22.12.20	Revised and Re-issued	HMX/ JJ	AR	MN	SM
3	04.06.15	Revised and Re-issued	HMX/ AR	MN	RG / RP	SC
2	06.08.09	Revised and Reissued	MN	RP	TGM	ND
1	30.03.98	Revised and Reissued as Standard Specification	PM	RK	BRS	AS
0	30.04.85	Issued as Standard Specification	PVS	TSN	AKV	AK

Abbreviations:

AC	:	Alternating Current
API	:	American Petroleum Institute
Baseefa	:	British Approval Service for Electrical Equipment in Flammable Atmospheres
CCE	:	Chief Controller of Explosives
CFF	:	Common File Format
CPU	:	Central Processing System
DA	:	Data Access
DC	:	Direct Current
DCS	:	Distributed Control System
DD	:	Device Description
DDE	:	Dynamic Data Exchange
DLP	:	Digital Light Processing
DVD	:	Digital Versatile Disc
EDDL	:	Electronic Device Description Language
ERTL	:	Electronic Regional Testing Laboratory
EMI	:	Electromagnetic Interference
ESD	:	Emergency Shutdown System
EXIDA	:	Excellence in Dependable Automation
FAT	:	Factory Acceptance Test
FDT / DTM	:	Field Device Tool / Device Type Manager
FF	:	Foundation Fieldbus
FISCO	:	Fieldbus Intrinsic Safe Concept
FNICO	:	Fieldbus Non-Incendive Concept
FSM	:	Functional Safety Management
GPS	:	Global Positioning System
HART	:	Highway Addressable Remote Transducer
HDA	:	Historical Data Access
H1	:	Foundation Fieldbus low speed (31.25kbps) loop powered bus
HSE	:	High Speed Ethernet
I/O	:	Input / Output
IAMS	:	Instrument Asset Management System
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronic Engineers
ISA	:	International Society of Automation
IS	:	Indian Standards
ISO	:	International organization for Standardization
LAN	:	Local Area Network
LAS	:	Link Active Scheduler
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
LCIE	:	Laboratorie Central Industries Electriques
LSB	:	Least Significant Bit
MCC	:	Motor Control Centre
MIS	:	Management Information System
MTBF	:	Mean Time Between Failure
MTTR	:	Mean Time to Repair
OLE	:	Object Linking and Embedding
OPC	:	Open Platform Communications
PC	:	Personal Computer
PFD	:	Probability of Failure on Demand
P&ID	:	Piping and Instrumentation Diagram
PESO	:	Petroleum and Explosives Safety Organisation
PID	:	Proportional, Integral and Derivative

PLC	:	Programmable Logic Controller
PTB	:	PhysikalischTechnischeBundersanstalt
RAID	:	Redundant Array of Independent Discs
RAM	:	Random Access Memory
RDBMS	:	Relational Database Management System
RFI	:	Radio Frequency Interference
ROM	:	Read Only Memory
SER	:	Sequence of Event Recorder
SIL	:	Safety Integrity Level
SPD	:	Surge Protection Device
SPI	:	Smart Plant Instrumentation
SQL	:	Structured Query Language
SRR	:	Satellite Rack Room
STP	:	Single Twisted Pair
TCP / IP	:	Transmission Control Protocol / Internet Protocol
TFT	:	Thin Film Transistor
TUV	:	TechnischeUberwachungsVereine
UHF	:	Ultra High Frequency
UL	:	Underwriter's Laboratories
UPS	:	Uninterrupted Power Supply
UTP	:	Unshielded Twisted Pair
USB	:	Universal Serial Bus
VDU	:	Video Display Unit
VHF	:	Very High Frequency

Instrumentation Standards Committee

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Ms. K. Pratheepa
Ms. R K Gupta (Proj.)

CONTENTS

PART - III

PART – I

GENERAL SPECIFICATION OF DISTRIBUTED CONTROL SYSTEM

1.0 GENERAL

1.1 SCOPE

1.1.1 This specification, together with the Requisition defines the minimum functional requirements for the design, hardware, software and firmware specifications, nameplate marking, testing and shipping of Distributed Control System designed for reliable effective and optimum control and monitoring of a process plant (hydrocarbon and non-hydrocarbon) and captive power plant.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions, unless otherwise specified:-

AG-181	Foundation Fieldbus System Engineering Guidelines	
API	American Petroleum Institute	
	RP 552	Transmission Systems
EEMUA	Engineering Equipment & Material User Association	
	191	Alarm System - A Guide to Design, Management and Procurement
BS EN	British European Standards	
	10204	Inspection Document for Metallic Products
	500820-2	Electromagnetic Compatibility - Generic Immunity Standard Part 2: Industrial Environment
FF	Foundation Fieldbus	
	569	Foundation Fieldbus Host Interoperability Support Test Profile and Procedure
	816	Foundation Fieldbus Specification 31.25 Kbits/s Physical Layer Profile
	890~894	Foundation Fieldbus Specification Function Block Application Process
IS/IEC	Indian Standards / International Electro-technical Commission	
	IS/IEC60079	Explosive atmospheres
	IS/IEC60529	Degrees of protection provided by enclosures (IP Code).
	IEC 60584-2	Thermocouples. Part 2: Tolerances
	IEC 60617	Graphical Symbols for Diagram
	IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors
	IEC 61000-4-3	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.
	IEC 61000-4-4	Electromagnetic Compatibility (EMC) –Part 4-4: Testing and Measurement Techniques – Electrical Fast Transients / Burst Immunity Test
	IEC 61000-4-5	Electromagnetic Compatibility (EMC) –Part 4-5: Testing and Measurement Techniques – Surge Immunity Test

	IEC 61000-6-2	Electromagnetic Compatibility (EMC) –Part-6-2: Generic Standards – Immunity for Industrial environments.
	IEC 61131	Programmable Controllers
	IEC 61158	Industrial Communication Networks – Fieldbus Specification.
	IEC 61511	Functional Safety – Safety Instrumented Systems for the Process Industry Sector
	IEC 61508	Functional Safety of Electrical / Electronic / Programmable Electronic Safety-related Systems
	IEC 61643-21	Low voltage surge protective devices - Part 21: Surge protective devices connected to telecommunications and signaling networks - Performance requirements and testing methods
	IEC 62305-4	Protection against lightning- Part 4: Electrical and Electronics systems within structures
	IEC 62443	Security for Industrial Automation and Control System
	IEC 62561-3	Lightning protection system components (LPSC) - Part 3: Requirements for isolating spark gaps (ISG)
IEEE 802.3	Telecommunication and Information Exchange between Systems – Local and Metropolitan Area Networks – Specific Requirements – Part 3: Carrier Sense Multiple Access with Collisions Detection (CSMA / CD) Access Method and Physical Layer Specifications.	
IS	Indian Standards	
	3043	Code of Practice for Earthing
ISA	International Society of Automation	
	5.1	Instrumentation Symbols and Identification
	5.2	Binary Logic Diagrams for Process Operations
	5.3	Graphic Symbols for Distributed Control / Shared Display Instrumentation, Logic and Computer System.
	5.4	Instrument Loop Diagrams
	5.5	Graphic Symbols for Process Displays
	18.1	Annunciator Sequences and Specifications
	71.01	Environmental Conditions for Process Management and Control Systems: Temperature and Humidity
	71.04	Environmental Conditions for Process Measurement and control Systems: Airborne Contaminants
	TR 50.02 Parts 3&4	Fieldbus Standard for use in Industrial Control Systems, Parts 3 & 4: Technical Report for Fieldbus Data Link Layer - Tutorial
	TR50.02 Part 9	Fieldbus Standard for Use In Industrial Control Systems: User Layer Technical Report
` ANSI/ISA	American National Standards Institute / International Society of Automation	
	TR 99.00.01	Security technologies for Industrial Automation and Control Systems

ISO	International Organization of Standardization	
	216	Writing Paper and Certain Classes of Printed matter-Trimmed Sizes-A& B Series and indication of machine direction
	9241-5	Ergonomic requirements for office work with visual display terminals (VDTs) -- Part 5: Workstation layout and postural requirements
	9241-302	Ergonomics of human-system interaction: Terminology for electronic visual displays
	9241-303	Ergonomics of human-system interaction: Requirements for electronic visual displays

1.1.3 In the event of any conflict between this specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Statutory regulations

b) Job Specifications/ Data Sheets

c) Standard Specifications

d) Codes and Standards

1.1.4 In addition to meeting purchaser's specifications in totality, vendor's extent of responsibility shall also include the following:

a) Purchaser's data sheets specify the minimum acceptable functional requirements for the control system. It shall be vendor's responsibility to select proper hardware, software and firmware to meet the specified functional requirements keeping the integrity of functional blocks specified in the configuration diagram attached with the Requisition.

b) Purchaser's data sheets specify the scan time / cycle time / response time / macro cycle time and loading requirements. Vendor shall be responsible for sizing and selecting their standard product i.e. hardware, software and firmware to meet the requirements specified in the purchaser's data sheets.

c) Fieldbus Segment checking based on the cable schedule and other requirements specified in the requisition and its validation during detailed engineering, site testing and pre-commissioning.

d) Adequacy of Bill of Material selected to meet purchaser's requirements including spares. Vendor to note that bill of material shall not be verified by the purchaser during evaluation stage. Any hardware, software and firmware required to meet the purchaser's specified requirements shall be provided by the vendor without any implication.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the Requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specifications.

b) Detailed specification sheet for each sub-system. The specification sheet shall provide information regarding hardware specifications, software specifications, redundancy requirements, capacity, power consumption etc. of the distributed control system and its accessories. The material specifications and unit of measurement for various items

in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheets.

c) System security features and design details.

d) Proven references for each offered model in line with clause 1.2.4 of this specification whenever specifically indicated in the purchaser's specifications.

e) A copy of approval for intrinsic safe isolators in control room, from local statutory authority, as applicable, like Petroleum and Explosives Safety Organisation (PESO) / Nagpur or Director General of Mines Safety (DGMS) in India along with:

i) Test certificate from recognised house CIMFR (Central Institute of Mines & Fuel Research) / ERTL (Electronics Research and Test Laboratory) etc. for specified protection class as per relevant Indian Standard for all Indian manufactured equipment or for equipment requiring DGMS approval.

ii) Certificate of conformity from agencies like LCIE, Baseefa, PTB, CSA, UL etc., for compliance to ATEX or other recognised standards for all equipment manufactured outside India.

f) Deviations on technical requirements shall not be entertained. In case, vendor has any valid technical reason to deviate from the specified requirement, they must include a list of deviations item wise, summing up all the deviations from the purchaser's data sheets and other technical specification along with the technical reasons for each of these deviations.

g) Certificate for specified SIL requirement (e.g. SIL-3) from Independent Testing Agency (e.g. TUV/EXIDA) listing the firmware and components along with their revision no. / version details which are being offered as part of the PLC sub-system. Also for SIL Certified PLC, FSM certificate for the factory by an Independent Testing Agency (e.g. TUV/EXIDA) shall be provided.

h) Catalogues giving detailed technical specifications, model decoding details and other related information for each item / sub-system covered in the bid.

1.2.3 The equipment being offered / supplied shall be of latest proven version available in the current manufacturing range.

1.2.4 The system hardware, software, firmware and any bought-out components as offered, shall be field proven and should have been operating satisfactorily for a period of minimum 6 months continuously on the bid due date in the validly similar size and application specified in the purchaser's data sheet. Items with prototype design shall not be offered or supplied.

1.2.5 The detailed scope of work, specific job requirements, exclusions, deviations, additions etc. shall be indicated in the job specifications of the Requisition.

1.2.6 Whenever specified, vendor shall furnish tested values of failure rates, probability of failure on demand and test intervals for safety integrity level analysis.

1.2.7 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals shall be in English language only.

1.2.8 Vendor shall also quote for the following:

a) Two year's operational spares for each sub-system and their accessories which shall include the following as a minimum:

i) All type of electronic modules e.g. I/O modules, processor modules, communication modules, power supply modules etc.
ii) All type of auxiliary items e.g. barriers / isolators, relays, hardwired instruments, annunciator modules, receiver switches, trip amplifiers, temperature element converters etc.
iii) Switches, lamps, fuses, connectors, terminals, pre-fabricated cables, circuit breaker, relays etc.
iv) Video display units, keyboards, disc drives, PC's, network items (e.g. switches, hubs etc.) etc.
v) Network items (e.g. switches, Firewall Router cards etc.). CAT 6 cables, RJ45 jacks.

b) Any special tools and test equipment needed for the maintenance of DCS, PLC and other items being offered by vendor. This shall also include test equipment for Fieldbus testing and configuration like Fieldbus tester, Fieldbus configurator etc. wherever specified in the Requisition. Vendor must confirm in their offer if no special tools or test equipment are needed for maintenance other than those specifically indicated in purchaser's data sheet.

1.3 Drawing and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design manuals, installation manual, operation and maintenance manual etc., submitted by the vendor after placement of purchase order shall include the following, as a minimum:

a) Specification sheet for each sub-system, auxiliary instrument and bought out item.

b) Certified drawings for complete system including the following:

i) System Configuration Diagram

ii) GA drawings for cabinets, marshalling racks, hardwired consoles, operator / engineering console etc. with complete dimensional details, internal construction and weight in kilograms.

iii) Control room layouts e.g. console room, rack room and engineering room layout with all dimensions in millimeters.

iv) Channel base frame drawing for console room, rack room and engineering room.

v) Input / output assignment

vi) Fieldbus segment drawing

vii) Loop wiring diagram

viii) Power supply distribution diagram

ix) Dynamic graphic diagrams

x) System grounding drawing

xi) SIL certificate for the PLC along with detailed SIL report of the PLC firmware models / versions/ revisions utilized

xii) Safety manual for PLC

xiii) Hazardous area certificates for the items like Intrinsic Safe Isolators

c) Design manuals and functional design specifications, which shall include hardware design manual, software design manual and special software specifications.

d) Copy of type test certificates of all components including test certificates / report for suitability against required Environmental condition and EMI / RFI protection, shock and vibration.

e) Copy of test certificates for all tests indicated in Part II of this specification.

f) Installation manual containing installation procedure for distributed control system and other items covered in the Requisition.

g) Power-on, start-up and internal testing procedures.

h) Software debugging and system configuration procedures

i) Calibration and maintenance manual containing maintenance procedures including replacement of parts, application modification etc.

j) Any other drawings and documents specifically indicated in job vendor data requirement enclosed with the Requisition.

2.0 DEFINITIONS

The various terms used in this specification are defined as follows:

2.1 Distributed Control System

The class of control systems which in addition to maintaining and managing data bases in distributed fashion, also executes the stated control functions and permits transmission of control, measurement and operating information to and from a single or a plurality of user specified locations connected via a communication sub-system.

2.2 Programmable Logic Controller

The class of control systems which can be programmed to execute plant shutdown and / or interlock / sequence logics to the specified safety integrity levels.

2.3 Accessible

A system feature that is viewable by and interactive with the operator and allows the operator to perform user permissible control action e.g. set point change, auto-manual transfers or on-off actions.

2.4 Assignable

A system feature that permits an operator to direct a signal from one device to another without the need for change in wiring, either by means of switches or via other data entry devices like key board commands to the system.

2.5 Configurable

The capability to select and connect standard hardware modules to create a system; or the capability to change functionality or sizing of software functions by changing parameters without having to modify or regenerate software.

2.6 I/O

Input / Output with respect to process / operator.

2.7 Fieldbus

A Fieldbus is a digital, two-way, multi-drop communication link among intelligent measurement and control devices. It serves as a Local Area Network (LAN) for advanced process control, remote input/output and high speed factory automation applications.

2.8 System Size

System size shall be defined as maximum number of process inputs or tags those can be connected to the system and viewable from any one of the VDUs of an operating console in all hierarchical displays without changing the configuration or without operator interaction considering:

a) all inputs as close loops

b) all inputs as open loops

2.9 Operator Console

Operator console is the operator's main plant interface device through which operator can view, monitor and control the plant and can give instructions to peripherals to execute commands, and shall have protective access to configure and maintain the system.

2.10 Engineering Console

Engineering console shall be the engineer's main interface device through which engineer can configure and maintain the system, and shall have protective access to monitor and control the plant, give instructions to peripherals to execute commands.

2.11 Local Level

All those sub-systems, which directly interface with field devices shall be referred to as local level.

2.12 Central Level

Operator consoles and Engineering Console, which present data acquired from local level devices, shall be referred as Central Level.

2.13 Database

Database shall be defined as the information stored temporarily or permanently in the system which can be accessed by various programs to meet all its functional requirements.

2.14 Global Database

Global database is defined as the database that can be accessed by two or more non-nested modules of a program without being explicitly passed as parameters between the modules.

2.15 Loop Integrity

A system shall be said to have loop integrity if the failure of one component in the system/ sub-system does not affect more than one loop.

2.16 Interchangeability

System/sub-systems shall be said to have full interchangeability if the functions and information available on one system/sub-system shall also be available on the other in totality.

2.17 System Loading

System loading for a sub-system is defined as the percentage of time a sub-system spends in carrying out various activities referred to the use of memory, CPU time and communication capacity in the worst case of high sub-system operation out of the designed / designated cycle time of the sub-system.

2.18 Bus Degradation

Bus degradation shall be defined as a change in the system performance from the specified one measured in terms of display update rate while loading the communication sub-system from 10 through 100 percent.

2.19 Redundancy

A system component shall be termed as redundant, if it takes over automatically online the operation, in the event of the failure of the main component, without causing any interruption in the system and upsetting the process. The repaired or replaced device shall be brought in-line only through operator action without upsetting system operation.

2.20 Switchover Time

Time required for a backup instrument / system to come on-line automatically in case of the failure of the main instrument / system.

2.21 Processor Cycle Time (t_{pc})

Processor cycle time is the measure of the processing speed of a processor and is user selectable from the pre-defined discrete values. Processor cycle time for a sub-system shall be defined as follows:-

a) Controller Sub-system

Processor cycle time for controller sub-system shall be defined as the total time taken by the control processor to read inputs supplied by input module, execute control algorithm and write the outputs for the output module.

b) Data Acquisition Sub-system

Processor cycle time for data acquisition sub system shall be defined as the total time taken by the processor to read inputs supplied by input processor, perform calculations for all the open loops configured within the data acquisition sub-system and make data available to the communication sub-system.

c) Programmable Logic Controller

Processor cycle time for programmable logic controller shall be defined as the total time taken by the processor to read input supplied by input module, execute all computations (analog as well as logic as configured) and write the outputs for the output module.

d) The processor cycle time for open and close loops, as specified in the requisition, shall be used for calculating the DCS controller loading.

2.22 Scan Time (t_s)

Scan time is the end-to-end response time of a sub-system and shall be defined as follows:

For Fieldbus based system refer clause 2.26 for close loop response time.

a) Close Loops

Scan time for a close loop shall be defined as the total time taken by a sub-system e.g. controller and data acquisition sub-system to read inputs from the input terminal, process input, perform control algorithms, update control output and write output at the output terminal for all the loops configured within the sub-system.

b) Open Loops

Scan time for an open loop shall be defined as the total time taken by a sub-system e.g. controller and data acquisition sub-system to read input from input terminal, process input, perform calculations and write output for communication sub-system to pick-up the same for all the open loops configured within the sub-system e.g. controller and data acquisition sub system.

c) Logic Loops

The scan time for a logic loop shall be defined as the total time taken by a sub-system e.g. programmable logic controller to read input from the input terminal, process input, execute logic, updating logic output and write output at the output terminal for all the logics configured within the subsystem.

2.23 Control Cycle Time

Control cycle time is defined as the total cycle time taken by the supervisory computer to read data from control system, perform calculations and update the set point of a regulatory loop configured in the control system e.g. controller and data acquisition sub-system.

2.24 Macro Cycle

Macro cycle is defined as a single iteration of a schedule within a Fieldbus device.

2.25 Macro Cycle Time

Macro Cycle time or execution time is defined as the amount of time taken by a Fieldbus device to complete the macro cycle. Macro cycle time can refer to a single field device, the LAS or a complete segment made up of multiple devices.

2.26 Loop Response Time

Loop response time for Fieldbus based system shall be defined as the total time required to perform the following functions in each of the specified loop configuration:

a) Control function in transmitter

Execute the analog input and control (PID) function block in transmitter, publish the output on the Fieldbus, receive the controller out value and perform analog output function block in final control element.

b) Control function in final control element
Execute the analog input function block in the transmitter, publish the process variable on the Fieldbus, receive the process variable and execute the control algorithm (PID) and analog output function block in the final control element.

c) Control Function in DCS

Execute the analog input function block in the transmitter, publish the process variable at DCS, execute the control algorithm (PID) in DCS, publish the controller output value on the Fieldbus and execute the analog output function block in the final control element.

2.27 Display Update Rate

Display update rate shall be defined as the time taken by the system to display the information present at the system input terminals updated on the current display on the VDU of an operator console

2.28 Call-up Time

Call up time shall be defined as the time taken by the system to display a particular display/data on the VDU after getting the corresponding command from the operator.

2.29 User's Memory

Free memory space available after utilisation of memory required for system operation, configuration and implementation of application and other system related functions for implementation of user defined specific programs such as plant calculations, process optimization or MIS (like free formatting of certain logs). The programs shall either be written in high level language or system specific language.

2.30 Event

An event shall be defined as any action taken by the operator via operator keyboard or switches on hardwired console like change of set point, change of control mode, start/stop of motor, open/close of shut down valves, alarm acknowledge etc.

2.31 Sequence of Event (SOE)

Arranging events in the sequence of their occurrence in time with a specified time resolution by a program is defined as sequence of event.

2.32 Sequence of Event Recorder (SER)

System or sub-system which presents and / or records the events in the sequence of their occurrence in time with a specified time resolution utilizing its hardware and software capabilities is termed as sequence of event recorder.

2.33 Real Time Trend

Real time trend shall be defined as a continuously progressing graphical record showing continuously updated parameter with most recent value and a past record of minimum of 10 minutes without pressing any additional key for moving backward in time.

2.34 Windowing

Ability of the software program to break the console screen i.e. video display unit into simultaneous or overlapping zones with separate presentations at the same time.

2.35 Interoperability

Interoperability is the capability for a device from one manufacturer to interact with that of another manufacturer on a Fieldbus network without loss of functionality.

2.36 Acyclic Period

The Acyclic Period is that portion of the communication cycle time, during which information other than Publish/Subscribe data is transmitted. Typical information transmitted during this time includes Alarms/Events, Maintenance/Diagnostic Information, Program Invocations, Permissives /Interlocks, Display information, Trend Information and Configuration.

2.37 Capabilities File

A Capabilities File describes the communication objects in a Fieldbus device. A configuration device can use Device Description (DD) Files and Capabilities Files to configure a Fieldbus system without having the Fieldbus devices online.

2.38 Link Active Scheduler (LAS)

A Link Active Scheduler (LAS) is a deterministic, centralized bus scheduler that maintains a list of transmission times for all data buffers in all devices that need to be cyclically transmitted. Only one Link Master (LM) device on an H1 Fieldbus Link can be functioning as that link's LAS.

2.39 Link Master

A Link Master (LM) is any device containing Link Active Scheduler (LAS) functionality that can control communications on an H1 Fieldbus Link. There must be at least one LM on an H1 Link; one of those LM devices will be elected to serve as LAS.

2.40 Segment

A Segment is a section of an H1 Fieldbus that is terminated in its characteristic impedance. Segments can be linked by Repeaters to form a longer H1 Fieldbus. A segment typically consists of terminators at both ends. Each Segment shall include not more than 16 H1 spur devices including 20% spare spurs, unless specified otherwise.

2.41 Resource Block (RB)

A Resource Block (RB) describes characteristics of the Fieldbus device such as the device name, manufacturer and serial number. There is only one Resource Block (RB) in a device.

2.42 Virtual Communication Relationship (VCR)

VCR is configured application layer channels that provide the transfer of data between applications. FOUNDATION Fieldbus describes three types of Virtual Communication Relationships (VCRs): Publisher/Subscriber, Client/Server, and Source/Sink.

2.43 Link Objects

A Link Object contains information to link Function Block (FB) Input/ Output (I/O) parameters in the same device and between different devices. The Link Object links directly to a Virtual Communications Relationship (VCR).

2.44 Plant Control Network

Communication network within a plant that has control information circulating between various plant units or processing locations.

2.45 Plant Information Network

High-level communication network which serves various users within a plant and transfer information for the purpose of unit / plant monitoring. This network is different than control network and is generally realized using open communication protocol network e.g. OPC etc.

2.46 OPC Node

OPC node is any node in the network that provides OPC interfaces consistent with OPC data access, OPC alarm and event and OPC historical data access interface specifications certified against OPC compliance and interoperability test specification.

2.47 Basic Device

A Basic Device is any device not having the capability to control communications on an H1 Fieldbus segment.

2.48 Tag

A Tag is a collection of attributes that specify either a control loop or a process variable, or a measured input, or a calculated value, or some combination of these, and all associated control output algorithms and alarms.

3.0 SPARES PHILOSOPHY

3.1 The system including programmable logic controller, alarm information management system, sequence of event recorder, hardwired instruments etc. shall meet the following spare philosophy. This philosophy shall also be applicable for items like Fieldbus accessories, barriers, relays, terminals, lamps, push buttons etc.

3.1.1 **Mandatory Spares**

Vendor shall include following mandatory spares in their scope of supply:

3.1.1.1 **Installed Engineering Spares**

Installed engineering spares shall be provided in each sub-system for each type of module to enhance the specified system functional requirements by 20%, as a minimum. The basis of offering installed engineering spares shall include:

a) For a system with conventional and / or smart analog input / output, discrete (contact) input / output, pulse input, 20% spare input / output of each type shall be considered for calculating I/O modules and all other related accessories.

b) For a system with Fieldbus input / output, 20% spare segments of each type of Fieldbus (Foundation Fieldbus, Profibus etc.) shall be considered for calculating Fieldbus interface modules, power supply modules and all other related accessories. When only input / outputs are indicated instead of Fieldbus segments, the installed spare philosophy as specified in 3.1.1.1 (a) shall be followed.

c) For all serial input / outputs to the system, 20% spare serial I/O ports of each type of serial input / output shall be provided.

d) 20% spare accessories like relays, switches, lamps, fuses, circuit breakers, barriers, isolators, terminals etc.

e) The engineering spares shall be wired up to the field cable interface and shall be in ready-to-operate condition when field cable is connected to spare assigned terminals.

f) Spare pairs of the incoming cables shall be terminated on spare terminals in the marshalling / barrier cabinets as applicable.

g) The system shall be fully engineered considering 20% installed engineering spares including processor loading.

3.1.1.2 **Spare Space Requirement**

In addition to installed engineering spares specified in Clause 3.1.1.1 of this specification, the system shall be provided with following spare space:

a) The controller and data acquisition cabinets shall have 10% usable spare space, as a minimum, in the racks for installing additional I/O and Fieldbus segment modules in future. However, the control and data acquisition processor shall have additional 10% capacity to handle these I/O's and Fieldbus segment.

b) Each operator console shall contain 20% usable spare group and related display capability in addition to as specified in para 3.1.1.1 of this specification.

c) The system shall have capability to extend its historical trending, logging and user's memory by 20% to meet future expansion with/without adding additional memory modules.

d) The cabinets of the of the programmable logic controller system shall have 10% usable spare space for installing additional I/O cards of each type in future and the PLC processor shall have additional 10% capacity to handle these I/O's. In addition, provision shall be kept for internal wiring of the same up to the I/O terminals.

e) Processor system of programmable logic controller shall have capability to execute additional 20% logics.

f) The communication sub-system shall have sufficient capacity to handle additional data contributed by addition of 20% I/O / segments over and above installed engineering spares.

g) Usable spare space in cabinets to install 10% spare hardwired items like relays, switches, lamps, fuses, circuit breakers, barriers, isolators, terminals, etc. in future.

3.1.1.3 **Spare Memory Requirement**

a) The system shall be provided with a minimum of 40% spare memory capacity, as required for application program and data base to meet specified functional requirements.

b) For Fieldbus based system, spare memory capacity (and CPU loading) shall be calculated considering all control algorithms being configured in the system and executed at the scan time equal to the specified control loop response time.

c) It shall be possible to extend the memory by at least 20% over and above the actual requirement at a later date.

3.1.1.4 **Spare Software Capability**

a) Sufficient additional software capacity shall be available in the system to take care of spares requirement as specified in para 3.1.1.1 and 3.1.1.2 of this specification to meet all functional requirements as per para 5.0 of this specification.

b) Unless specifically indicated otherwise, the offered system shall have software licenses to cover all the tag numbers indicated in the Requisition, including installed engineering spares and spare space indicated in clause 3.1.1.1 and 3.1.1.2 of this specification. This software spare capability is applicable for bought-out systems also which are supplied by vendor as part of the requisition.

3.1.1.5 **Predefined Mandatory Spares**

a) Mandatory spares shall be ware-house spares and shall be supplied as loose items.

b) Mandatory spare module of 5% rounded-up to next higher whole number must be supplied for each type of modules being used excluding modules used in consoles, large display system, servers, Personal Computers.

c) For items like network components including ethernet switches, converters (like FO to TCP/IP, RS 485 to FO etc.) lamps for large display system, hardwired instruments like barriers, relays, lamps, fuses and circuit breakers, complete item limited to 5% rounded-up to next higher whole number, shall be supplied as predefined mandatory spare.

d) Items like personal computers, operator consoles, servers, engineering consoles, 5% rounded-up to next higher whole number, of complete unit shall be supplied as mandatory spares in line with clause 3.1.1.5(b).

e) Software which needs to be separately loaded in the items specified in clause 3.1.1.5(d) above to define the items personality and can't be uploaded from engineering console or any other network device shall be supplied along with additional software.

3.1.1.6 **Consumable Spares**

Any paper, ribbon, printer heads, toner and ink required for printers, video copier or any other consumable item shall be supplied along with system required for minimum of six months duration after system acceptance.

3.1.1.7 **Commissioning Spares**

Unless otherwise specified, vendor shall be responsible to supply all spares which are found necessary to replace failed modules, failed sub-systems, or corrupted / faulty software while performing pre-commissioning and commissioning activities.

3.1.2 **Two Years Operational Spares**

Two years operational spares shall be as per Clause 1.2.8(a) of this specification and shall be quoted separately.

4.0 SYSTEM CONFIGURATION

The system configuration shall consist of the following major sub-systems:-

4.1 Controller and Data Acquisition Sub-system

Controller and data acquisition sub-system is the main field interface sub-system and is capable of performing control and data acquisition functions as one integrated sub-system.

Controller and data acquisition sub-system shall interface with field instrumentation like transmitters, process switches and final control elements to monitor and / or control process parameters like flow, temperature, level etc. The sub-system shall include a comprehensive set of control algorithms and auxiliaries to provide close loop control and data monitoring capability of the system.

4.2 Operator Interface Sub-system

Operator interface sub-system shall consist of one or more operator consoles for monitoring and controlling process parameters and performing other process related functions.

4.3 Communication Sub-system

Communication sub-system interconnects various sub-systems over which they can communicate with each other to meet all functional requirements.

4.4 Engineer Interface Sub-system

Engineer interface sub-system shall consist of an engineering console primarily for tuning, configuring and maintaining the system.

4.5 Supervisory Computer Sub-system

Supervisory computer, when specified, shall be employed for providing supervisory level plant control, plant and unit optimization and other computer based plant management capabilities.

4.6 Programmable Logic Controller

Plant start-up and safety shutdowns shall be performed by separate programmable logic controller which shall communicate with other sub-systems over the communication sub-system.

4.7 Foreign Device Interface

Foreign Device like programmable logic controllers, gas chromatographs, analyzer systems, gas turbine systems etc. when specified shall communicate with other subsystems over the communication sub system for plant monitoring and control using foreign device interface. The foreign device interface shall be either dedicated or shall be part of controller data acquisition sub-system as specified in the job requirements.

4.8 OPC Server

OPC Server in this specification is used as synonymous with any server on the communication sub-system network which shall allow the user to implement applications, within or outside the system, without providing any special drivers or custom interfaces. OPC server, when specified, shall be used to transfer / receive data to / from applications run in other systems.

4.9 Unit History Node

4.9.1 Unit history node, when specified, shall store the long term historical data of the complete unit and shall interact with owner's central computer system over plant wide network.

4.9.2 Unit history node, when specified shall be a dedicated node and shall be in addition to historical data required for normal plant operation (specified as part of operating interface sub-system).

4.10 Sequence of Event Recorder (SER)

Sequence of event recorder, when specified, shall identify, store and print alarms with the specified time resolution between two events. SER shall also transfer data to operator sub system over communication sub system.

4.11 Alarm Information and Management Sub-system (AIMS)

Alarm information and management sub-system when specified, shall be an alarm management package which shall gather alarm information from various sub-systems and shall present the desired meaningful analysed data for information and further analysis.

4.12 Instrument Asset Management System (IAMS)

Instrument asset management sub-system shall acquire, store, analyse and present meaningful diagnostic and maintenance related data of field devices for efficient plant maintenance.

4.13 Large Display System (LDS)

Large Display System, when specified, shall consist of one or more large video screens which shall display either operator selected operator console screen or any pre-selected screen on a back projected large video screens as real time basis.

4.14 Hardwired Instrumentation

Hardwired instrumentation shall be provided as a back up to the distributed control system for critical process parameters when specified in the requisition.

4.15 Information Network Sub-system

Information network when specified shall interconnect with various plant wide systems like distributed control system/systems, mainframe computers, personal computers, laboratory information and management system (LIMS) etc. over which any information can be exchanged without affecting and disturbing the plant control and operations.

4.16 Documentation Node (DON)

Documentation Node, when specified, shall be provided for storing the complete tag wise engineered data base for each unit of the Plant, for reference by Plant personnel during operation and also for carrying out necessary future modification and upgradation required in the Plant units post commissioning.

4.17 Virtualization Server

Virtualization, when specified, shall be provided for servers in which are placed on the Plant communication and/or TCP/IP network so that optimization of server hardware and software, reduction in power consumption and HVAC load can be achieved. This shall also ensure avoidance of disruption of system operation due to obsolescence of server hardware and software by ensuring server related upgrades are secured with time. Both Platform virtualization for Operating Software (OS) as well as Application virtualization for the application software shall be provided for the virtualized machines. The virtualization solution shall meet the cyber security requirement of the requisition by incorporating necessary firewalls.

Virtualization of servers, when specified, shall be incorporated only for sub-systems like AIMS, OPC, UHN and DON. Virtualization Server sizing shall meet the server sizing considerations of all these sub-systems being virtualized. All Virtualization servers used for such functionalities shall have RAID5 or RAID10 configuration.

5.0 DESIGN AND CONSTRUCTION

5.1 Design Requirements

5.1.1 The system shall be microprocessor based having functional distribution and data base distribution sub-system wise. The extent of sub-system wise data base distribution shall be as specified in the requisition. The system design shall ensure that:

a) All the functions defined in this specification are performed in an integrated manner.

b) The access to the distributed data base is available system-wide.

This system shall also have networking capability with other systems distributed geographically in the various units of a plant, over a plant wide information network such as Ethernet or other industrially recognised open networks.

5.1.2 The system shall be of modular construction and expandable in future by adding additional modules. The type of modules shall be kept to the minimum possible in order to have interchangeability and low inventory.

5.1.3 **System Availability**

a) The system shall be designed ‘fault avoidant’ as a minimum by selecting higher grade components of proven quality and proper design of system electronics.

Redundancy shall be provided, as per this specification as a minimum, to improve the system availability and reliability. Due considerations shall be given to the environmental conditions particularly for field mounted sub-system, if specified in requisition, during system design.

b) The system shall have a high MTBF value and shall have well proven record of operating in hydrocarbon plants.

c) The system shall be designed with 99.995% or greater availability. The availability shall be defined as follows:

$$\text{Availability} = \frac{\text{Meantime Between Failure (MTBF)}}{\text{MTBF + Mean time to repair (MTTR)}}$$

For the purpose of calculations, consider mean time to repairs as eight (8) hours unless the manufacturer recommends higher value for MTTR. It is therefore necessary that Vendor covers all necessary spare parts in 2 years recommended operational spares which shall be necessary to meet specified MTTR time.

5.1.4 **Environmental Conditions**

5.1.4.1 Environmentally controlled location installation

a) All subsystem of Distributed Control System located in Control Room, Local Control Room or in Satellite Rack Room shall be able to operate satisfactorily as per below conditions:-

FOR	TEMPERATURE	NON CONDENSING HUMIDITY
Operation	10-35°C	20-80% RH
Storage & Transportation	(-)30 to 60°C	5-95% RH

b) In addition to above, all such sub-systems shall also be able to operate satisfactorily in case of air conditioning failure with ambient temperature of 50°C and 90% non-condensing humidity until the system safe operating limits are exceeded. The minimum period of continuous operation in such condition shall be 48 hours at least once in a month without any damage or degradation of system performance. Vendor, therefore, shall provide continuous temperature monitoring for each cabinet housing items / equipment generating heat, such as system cabinets, barrier cabinets, relay cabinets, consoles etc. and also provide alarm for operator alert in case the safe operating temperature limits are exceeded. For marshalling cabinets and Power distribution cabinets, temperature monitoring through temperature switches is acceptable.

c) Chemical filters have been provided in the incoming air conditioning air to limit the concentration of contaminants below following limits:

Contaminants (Corrosive Gases)	Concentration
SOx	< 0.01 ppm by volume
NOx	< 0.05 ppm by volume
H_2S	< 0.003 ppm by volume
Cl_2	< 0.001ppm by volume

All sub-systems and system components shall be suitable for operating continuously in the above mentioned corrosive environments.

e) Vendor shall provide continuous corrosion monitoring system consisting of transmitter with 4 – 20mA output with setting as per contaminant level exceeding limits specified in clause 5.1.4.1(c) of this specification. Each Corrosion transmitter shall be 4-20mA DC- 2 channel type with one channel of Copper and the other one of silver sensor. Unless otherwise specified the number of corrosion monitors shall be as follows:

Equipment Type	Room Type	Quantity
Corrosion transmitter Unit	Rack Rooms of Satellite Rack Rooms and Control Rooms	3 Nos.
	Console Room	2 No.
	Engineering Rooms of Satellite Rack rooms and Control Rooms	1 No.

Continuous corrosion monitoring trend and alarms shall be provided on the operator console while one group alarm shall be provided on the hardwired annunciator located on the hardwired console.

e) Shock & vibration: The equipment shall withstand transportation and handling by air, sea and road under packed conditions, conforming to MIL-STD-810F (Military Standard: Environmental Test Methods) specifications for shock (Method 514.3) and vibration (Method 514.5) or their commercial equivalent.

5.1.4.2 **Outdoor Installations**

a) Sub-systems or system components which are installed outdoor shall be able to continuously operate at ambient temperature of 50°C and non-condensing humidity of 90%.

b) Unless otherwise specified, all sub-systems or system components installed outdoor shall have corrosive environmental protection coating meeting the environmental classification class G3 as per ISA-S71.04.

5.1.5 **Transient, Static and EMI / RFI Protection**

5.1.5.1 The system shall be internally protected against system errors and hardware damage resulting from:

a) Electrical transients on power wiring.

b) Electrical transients on signal wiring.

c) Connecting and disconnecting devices or removing or inserting printed circuit boards in the Distributed Control System(DCS) and Programmable Logic Controller (PLC).

5.1.5.2 All sub-systems and system components shall be capable of accepting various signal inputs for its direct use while preventing noise errors due to electromagnetic interference (EMI) or radio frequency interference (RFI) including nearby radio stations, hand held two way radios, solenoids, relays or contactors carrying heavy currents as per levels of Environmental electromagnetic phenomenon defined in IEC-61000-6-2/ EN-50082-2. The system shall have total noise immunity from UHF / VHF radio communication equipment, (RFI) and (EMI) noise generating equipment as per IEC-61000-4/ EN-50082-2.

5.1.5.3 For interplant, inter unit and other system cables routed in the field, the level of surge immunity required for equipment signal ports shall be increased to level 2 as defined in IEC-61000-4-5 and the system shall operate according to performance criterion B as defined in IEC-61000-6-2.

5.1.6 **On-line Replacement**

5.1.6.1 On-line replacement of electronic module shall be possible in such a way that removal and addition of the module shall be possible and safe without de-energising the system.

Furthermore, there shall not be any interruption of the system while replacing a faulty module wherever redundant modules are provided.

5.1.6.2 Apart from system modules, power supply units shall be replaceable on-line without disrupting the process and without affecting the system redundancies.

5.1.7 **Electrical Isolation**

Galvanic or optical isolation shall be provided for all field signals. The isolation levels shall be as follows:

Analog I/O channel to system ground	:	1500 VAC
Discrete I/O channel to system ground	:	500 VAC

External isolation (Isolators for analog I/O channels and interposing relays / isolators for discrete I/O channels) shall be provided to meet the above.

Isolation shall also be provided between Engineering / operator console/PLC programming terminal and related sub-systems connected to it if there is any possibility of high voltage being transmitted to the sub-systems.

5.1.8 **Design Requirements of Equipment in Hazardous Area**

5.1.8.1 Unless specifically indicated, the field devices are beyond the scope of this specification. However vendor shall be fully responsible for integrating these devices with their system including compiling and maintaining the engineering data base of these devices and incorporating the data base into the Integrated Asset Management System.

5.1.8.2 **General requirements**

a) Unless otherwise specified, all instruments in hazardous area shall be intrinsically safe (IS) type. Other concepts shall be used when specified.

b) For conventional instrumentation, entity concept shall be used for selecting proper IS isolators. For electrically hazardous area, 50% rule as per IEC-60079 shall be applied for selecting suitable IS isolators for the field cable distances given in the requisition for the specified Gas Group of each unit. Entity parameter checking and validation of the Intrinsic Safe circuit for use in the specified hazardous area shall be carried out by vendor as part of DCS / PLC engineering.

c) Fieldbus segment in classified area may consist only of the type and number of devices which will not cause the segment current drawn to exceed the rated barrier / isolator parameters.

d) Interfacing of non-Intrinsic safe analog instruments in hazardous area shall be as follows:-
- For DCS, both IS as well as non-IS isolators can be used.
- For PLC, only IS isolators shall be used to ensure same PFD of interfacing devices in analog circuits.

5.1.8.3 **Fieldbus Design in Hazardous Area**

The segment design and equipment solution shall be based on the classified area concept used. The functions and entity / safety parameters of power conditioner, safety barriers / isolator, terminators and field devices shall be considered to verify the compliance to the requirements applicable for the specified concept. Following concepts shall be used depending upon the one specified in the requisition:

a) Entity Concept

Certified entity / safety parameters of each device shall be used to match the entity parameters on entity concept.

b) FISCO

Certified FISCO parameters shall be used and shall be matched like entity parameters. All elements in the hazardous area and their interface module shall be certified FISCO.

c) FNICO

Certified FNICO parameters and equipment shall be used to design loop on the basis of FNICO.

d) High Powered Trunk (Field Barriers)

The safety barriers / isolators shall be installed in the field in an increased safety enclosure. The enclosure shall be of Stainless Steel, Electro polished. The entity / safety parameters shall be matched as in case of entity concept. These barriers shall be duly installed in the junction box.

5.1.9 **System Integration**

The distributed control system shall be a fully integrated control system. Foreign devices like shutdown system (Safety Instrumented System), F&G system, analyser system, third party equipment (like compressors package etc.) etc. shall be fully and functionally integrated with the distributed control system. Fully and functionally integrated system shall meet the following requirements, as a minimum:

a) The foreign devices shall either be configurable from DCS engineering consoles or from the dedicated engineering consoles of each foreign device.

b) Unless specifically indicated otherwise, each foreign device shall be integrated with DCS through MODBUS (RTU / PLUS) or OPC protocol using redundant interface unit.

c) Operator console shall display information in the similar fashion irrespective of source of information. Source of information shall be transparent to the operator.

d) The process alarms and diagnostic alarms shall be presented on the operator console.

e) The time of all foreign devices shall be synchronized with DCS clock or GPS, as specified in the requisition.

f) The data transfer to and fro from other distributed control systems or supervisory computers through information network shall utilize OPC protocol with adequate security such as firewall.

5.1.10 **Surge Protection**

5.1.10.1 Surge protection devices (SPD's) shall be provided on the system to limit the surge voltages reaching beyond the safe limits, under normal, abnormal or lightning strike condition. Unless otherwise specified, SPD's shall be provided at least at the following locations:

a) All serial signal and communication cable except FO going from or to control system and from one location to another outside the control building at both control system end.

b) All Fieldbus segments at control system end.

c) All power incoming cable (110V AC, 110V DC, 240V AC, etc.), UPS or non UPS, at the power supply distribution cabinet.

5.1.10.2 The selection of type and rating of SPD shall be selected such that the introduction of this device shall not change the characteristics or reliability of an application, whether it is for the protection of power system, signal such as Fieldbus or analog or communication signal, as applicable. The SPDs shall comply with the requirements of IEC-61643-21.

In case of Fieldbus system, the SPD shall be selected such that its inclusion in the segment shall not degrade the Fieldbus signal, maximum length of the segment and / or number of devices on a segment significantly.

5.1.11 **System Securities**

5.1.11.1 The system shall have incorporated a fool proof system security feature in its design which would protect its data base and functioning against viruses, trojans and works through integrated antivirus, fire wall and intrusion detection for the system.

5.1.11.2 All devices and / or servers which interface and interact with external application must be supplied with hardware and software firewalls. Vendor shall ensure that security of the system is addressed from both IT and control System perspective. Vendor shall design multiple layers of network, system and application security. Vendor shall ensure that industry, regulatory and international standards are taken into account while designing the security system. Connectivity with Plant LAN, wherever specified in the requisition, shall be achieved through double layered hardware firewalls and the creation of Demilitarized Zones (DMZ).

5.1.11.3 All the security protections, hardware and software, as offered shall provide protection against all sorts of threats and vulnerabilities which include:

a) Positive user authentication and login privileges.

b) Prevention of importation of viruses.

c) Packet filtering, content filtering, URL filtering, protocol filtering and application level filtering to accept only intended data.

d) Strict Access controls like password, hash files, cryptographic material used in confidentiality etc.

e) Hardening of operating system.

f) Firewall proxy.

g) Network sniffers and file integrity checkers

h) Scanning, enumeration and vulnerability scanning tools.

i) Log files analysis tools.

The functionalities indicated above are the indicative security features and shall be provided within and where data import / export utilities apply.

5.1.11.4 Operating system shall be provided with the manufacturer's recommended antivirus software for the warranty period. Also, all required software patches to fix bugs for DCS/ PLC and any other system / application software supplied by vendor shall be provided for the entire logistic support period as part of his firm scope.

5.1.11.5 The use of any unauthorized CDs, DVDs, USB devices or similar removable media on any node that is part of or connected to the system should not be permitted in order to prevent the introduction of malware or the inadvertent loss or theft of data.

5.1.11.6 USB mass storage media drive monitoring software shall be provided on all computers/servers (wherever USB port is given). This shall alert administrator by playing selected sound or by CPU warning beep sound when any USB stick is being connected or removed. Surveillance utility shall explain entire details of connected USB storage device including manufactures company name, hardware ID, storage capacity with client machine name, IP address and save information in txt or html file. USB data protection software enables or disables access permission (read / write) of any storage media in domain. Data theft protection application shall be applicable for all USB storage media devices.

5.1.11.7 The DCS and PLC systems shall be compliant to security Level -1 of IEC-62443-4-1&4-2 / ANSI/ISA TR99.00.01 as a minimum.

5.1.12 **System Software**

5.1.12.1 The system software shall be governed by the operating system running in a real time mode and shall be able to meet all functional requirements specified in clause 5.2 of this specification as a minimum.

5.1.12.2 The operating system and other standard software shall be of latest version.

5.1.12.3 The system shall have software "wizards" to effectively manage the process of decommissioning the failed device, commission the replacement device and reconcile the configuration.

5.1.12.4 All the system application software provided by vendor shall be upward compatible i.e. new enhancements can be incorporated in the system for future upgradation owing the user to migrate to newer revision levels of application software in existing operating software and thereby to take advantage of continuing technical enhancement.

5.1.12.5 Application software shall be designed in a manner that requires no modification to the system operating software. Software design shall be such that future revisions or updates of the system operating software will not affect the successful operation of the system. Any new release of system software shall be backward compatible with files created using the previous software releases.

5.1.13 The system shall have the capability of detecting the open sensors and short sensors. The sensor status reading on failure either upscale or downscale shall be field configurable.

5.1.14 **Emergency Shutdown Switches (ESD Switches)**

5.1.14.1 All Emergency (ESD) switches shall he hardwired and shall be pull type with red coloured knob or push type with protective cover as specified in the requisition. Control room mounted ESD switches shall be installed on hardwired console.

5.1.14.2 The ESD switch contact shall be used in ESD system (PLC etc.) for logic implementation and event history.

5.1.14.3 All ESD Switches shall be provided with at least 2 independent NO contacts and 2 independent NC contacts.

5.1.15 **Alarm Start-up By-pass Switches and Emergency Shutdown Switches**

5.1.15.1 Startup by-pass (SBS) switches for alarms

All SBS's shall be configured in the ESD system (i.e. PLC) and shall be operable from operator console or hardwired console as per requisition. All such by-pass switches shall be alarmed and shall have audit trail.

5.1.16 **Interface with Electrical Inputs / Outputs**

5.1.16.1 All input and output contacts from electrical switch gear panels (MCC / PCC etc.) shall be terminated in dedicated 'Electrical Interface marshalling cabinets' located in control room. All such I/O's shall have intermediate relays.

5.1.16.2 Remote I/O rack shall be provided in sub-station, when specifically indicated in the Requisition.

5.1.16.3 All serial I/O cables from sub-station to control room shall be redundant including remote I/O cable.

5.1.17 **Automatic Loop Tuning Software Package**

5.1.17.1 It shall be possible to tune a control loop or group of control loops on selective basis at a time automatically unless otherwise specified. Tuning parameters computed by the system shall either be loaded automatically or manually by operator.

5.1.17.2 The automatic loop tuning software shall be used to tune PID control loops. The auto tuning technology used shall utilize principles like Ziegler – Nichols, Cohen – Coon or Internal Model Control (IMC).

5.1.17.3 The software package for loop tuning may reside / run on any system hardware including controller sub system, console sub system, engineering sub system, supervisory computer etc. The tuning software must ensure that the process is not disturbed whenever a loop is being tuned.

5.1.17.4 Automatic loop tuning package shall be able to study the dynamics of control loops and shall be able to compute response time, dead time, lead or lag time etc. directly from Engineering / operator console.

5.1.17.5 For Foundation Fieldbus Based system, Automatic Loop tuning feature shall be applicable only when control is specified in DCS.

5.1.18 The system shall be suitable for power supply as specified in para 6.2 of this specification. Suitable battery back-up shall be provided for volatile memory protection only.

5.1.19 **System Upgrade Capability**

5.1.19.1 System shall be scalable and upgradeable by adding additional hardware, over and above the spares specified, without rendering the initial hardware and software investment obsolete within the capability of the system.

5.1.19.2 This is in addition to the system upgrades, hardware and software, available from vendor as standard from time to time.

5.1.20 **Fieldbus Segment Validation**

Fieldbus segment validation shall be carried out by vendor based on the following as a minimum:

a) Voltage drop and current supply limitations.

b) Specified spare capacity as per philosophy defined in the specification.

c) Loop response time.

5.1.21 **Noise Level**

5.1.21.1 Noise level generated by any equipment shall not exceed the following limits:

a) Noise level shall not exceed 55dBA for equipment installed in console room, engineering room and computer room.

b) Noise level shall not exceed 65dBA for equipment installed in rack room and satellite rack room (SRR).

c) For control rooms where consoles and cabinets are installed in the same room, the noise level generated by any equipment shall not exceed 55dBA.

5.1.21.2 The noise level shall be measured in dBA at a distance of 1 meter from the equipment generating noise.

5.1.22 **Equipment Identification**

Unless otherwise specified, all equipment shall be identified by tag numbers indicated in the data sheet / summary sheet attached with the Requisition. The tag number shall be inscribed on a nameplate which shall be fixed with screws.

The nameplate shall be black laminated plastic with core i.e. black with white characters. The size and description shall be subject to purchaser's approval.

5.1.23 **System Furniture**

All system furniture required for mounting and operation of the system including mounting of tabletop equipment shall be supplied. Furniture for operating personnel shall be as defined in the requisition.

5.2 Functional Requirements

5.2.1 The system, as a minimum, shall meet the following requirements without the supervisory computer:

a) Control

b) Data acquisition & monitoring

c) Alarming

d) Logging & report generation

e) Historical data storage

f) Trending

g) System shall have some free memory space available for the user and CPU shall have the additional capability to perform advance control functions, process optimization

programs or generate management reports as specified in the requisition in addition to space requirements as per clause no. 3.0 of this specification. The availability of these features in process control language shall be preferred.

h) System shall support functionalities like remote calibration, remote diagnostics and asset management in case of smart or Fieldbus based instruments.

5.2.2 In addition to above, following functional requirements shall also be complied, when specifically indicated in the requisition:

a) Sequence of event function.

b) Alarm management

c) Long term historisation

d) Open system connectivity

5.2.3 The system when specified with Programmable Logic Controller (PLC) either as integral part of system or as separate third party device it shall perform following functions:

a) Process interlocks

b) Plant safety shutdown

c) Sequence control Functions, when specified

Plant process and safety shutdown shall be independently performed by programmable logic controller (PLC shall be communicating bi-directionally with other sub-systems via the DCS communication sub-system).Where the PLC is not part of the DCS communication sub-system, vendor shall provide dedicated and redundant bi-directional serial interface gateways with OPC communication protocol for each PLC sub-system for interfacing the same with the DCS communication sub-system.

5.2.4 The system when specified along with a supervisory computer, shall meet the following requirements in addition to as specified in para 5.2.1 of this specification:

a) Advanced Control

b) Unit and plant optimization

c) Management information service reports.

5.2.5 Whenever information network along with plant wide interconnectivity is specified, dedicated OPC interface shall be provided. The system shall meet any or all of the following requirements in addition to those specified in Clause 5.2.1 above of this specification, whenever advance process control or any other such requirement is specified:

a) Centralised information system

b) Statistical process control/statistical quality control.

c) Plant optimization, data reconciliation, overall mass balance, etc.

d) Plant planning and scheduling.

e) Computer integrated manufacturing with information transfer to achieve functions like production and preventive maintenance scheduling and plant wide coordination etc.

5.2.6 The system as offered shall be fully and functionally integrated meeting the requirements specified above. In addition, the system shall also have capability and capacity to interact

with smart and Fieldbus instrumentation simultaneously. The system shall also be capable of accepting signals from different type of Fieldbus systems in the same controller and data acquisition sub-system.

5.3 Controller and Data Acquisition Sub-system (CDAS)

5.3.1 Controller and data acquisition sub-system shall primarily be used for plant control and data acquisition and shall interface with physical inputs and outputs from the plant and third party devices.

5.3.2 CDAS shall be microprocessor based and fully programmable sub-system which shall be capable of processing the acquired data from input / output devices utilizing a set of algorithms within its defined processing cycle. The microprocessors utilized in controller and data acquisition sub-system shall generally be of latest generation.

5.3.3 CDAS shall have a multi-processor architecture with each processor responsible to carryout predefined functions like Input / Output processing, control processing, internal communication, external interfaces etc.

5.3.4 The hardware and software capability of this sub-system shall primarily be exploited for processing regulatory close loop and open loop control functions only. Sequencing and interlocking capability shall be utilized whenever specified in requisition.

5.3.5 CDAS shall be capable of accepting signals from various process sensors and devices with linear, non-linear and serial outputs. Typically the inputs shall include 4-20mA DC (both conventional and HART), 1-5VDC, millivolt signal from thermocouples, resistance from resistance temperature detectors (RTD's), pulse input, Fieldbus (Foundation Fieldbus, Profibus PA etc.), serial inputs (example MODBUS) and discrete contacts (powered or potential free), as a minimum. System shall also accept other inputs when specified in requisition.
System shall be able to accept 2-wire, 3-wire and 4-wire signal inputs without any change in the I/O module.

5.3.6 The system shall have capability to generate analog 4-20mA DC (conventional or HART) current signal, 1-5VDC voltage signal, Fieldbus output signal, potential free contacts for discrete outputs and serial (example MODBUS) outputs, as a minimum, apart from others specified in the requisition.

5.3.7 The output from the system shall be capable of driving following loads:

a) Analog outputs shall be able to drive loads of output devices such as I/P converters, smart positioners, recorders / indicators etc. In general, it should have load driving capabilities up to 600 ohms.

b) Contact outputs suitable for driving alarm annunciations, status lamps, relays, converters, solenoid valves, contactors / breakers of motor control etc. In general, contacts rating shall as follows:

Intrinsically safe load	:	30V, 0.5 Ampere
AC powered loads	:	230, V 5 Ampere
DC powered loads	:	110V, 0.2 Ampere
DC powered loads	:	220V, 0.2 Ampere

5.3.8 The system shall be capable of differentiating between out of range measurement (Bad process value) and a failed transmitter signal. In conventional 4-20mA output transmitter and

smart (HART) transmitter, this shall be identified by signal level (i.e.<4mA and >20mA), while for Fieldbus transmitters' data quality indicator from the device shall be utilized.
The detection of device failure alarm and driving output to a pre-defined value shall be configurable within this sub-system.

5.3.9 It shall be possible to override or force an input measurement or an output in the system while testing or on failure of an input.

5.3.10 Controller and data acquisition sub-system shall have a non-volatile memory for storing configurational data. In case vendor's standard product supports only volatile memory, battery backup shall be provided with a minimum of 3 months lifetime to keep the program storage intact for a period of minimum 48 hours. A battery drain indication shall be provided to alert the operator at least one week before the battery gets drained.

5.3.11 The sub-system shall have sufficient memory to store the program instructions, CDAS data base, data required for real time trending and point trend and any other data required to be stored to meet specified functional requirements.

5.3.12 The sub-system shall incorporate a hardware or software based watch dog timer to monitor the healthiness of the CDAS processor health.

5.3.13 Each controller and data acquisition unit shall have its own dual redundant power supply which can be replaced online. Separate dual redundant power supply unit shall be provided for powering field devices.

5.3.14 Controller and data acquisition sub-system shall be modular in construction with rack mounted modules in general. Input / Output modules shall be either rack mounted or DIN Rail mounted type.

5.3.15 **Input / Output Modules**

5.3.15.1 **General**

a) I/O modules shall communicate with processor modules serially either through back-plane or through I/O communication network. I/O network shall always be redundant. Data transferring through hardwired connections shall not be acceptable.

b) Analog to digital converters for analog 4-20 mA / 1-5 VDC modules shall meet the following minimum requirements:

A/D Resolution	14 bits
Repeatability	± ½ LSB
Accuracy	± 0.1% of full scale
Common mode Rejection	60dB at 50Hz
Normal mode Rejection	40 dB at 50Hz

c) Digital to analog converters for output module shall meet the following minimum requirements:

D/A Resolution	12 bits
Repeatability	± 1 LSB
Accuracy	± 0.25% of full scale

d) Each output channel (conventional and HART) must maintain its own failure mode value, which is automatically executed upon detection of a communication failure between process and output module.

In addition I/O modules shall also meet the specific requirements specified in clauses 5.3.15.2 through 5.3.15.7.

5.3.15.2 Analogue Input / Output modules with HART

The input module shall meet the following requirements:

a) It shall accept 4-20mA isolated input with maximum input resistance of 250 ohms or 1-5VDC isolated input with input resistance more than 500KOhms.

b) The input module shall support field powered transmitter i.e. 2-wire, 3-wire or 4 wire system.

c) Input faults such as open circuit, short circuit and earth fault shall be detected by I/O module. When external isolators / relays are provided for each I/O channel, then detection of these faults in the I/O modules are not applicable.

d) The output module shall provide 4-20mA output driving up to 600ohms of total loop resistance at 24V DC.

e) The system shall provide 24V DC for loop powered 2-wire transmitter and shall also loop power the 2-wire outputs.

f) Input / Output module shall not have more than 16 inputs or outputs.

g) Input / Output shall fully support the HART communication signal i.e. the American Bell 202 standard frequency shift keying signal superimposed at a low level on analogue measurement signal.

5.3.15.3 Foundation Fieldbus (H1) Interface Module

a) Foundation Fieldbus H1 interface module shall be capable of supporting multiple segments and able to operate in full redundancy mode.

b) Foundation Fieldbus H1 interface module shall always be provided in redundant configuration with Link Active Schedulers (LAS) configured in primary and back-up H1 interface modules respectively to ensure that failure of primary LAS shall not cause failure of H1 bus communication. Power for H1 segment shall be provided by power conditioner module which shall be separate from H1 interface module to ensure that failure or removal of H1 interface module does not affect the supply of power to the segment.

c) H1 interface module shall be supplied with link active scheduler (LAS) capability and shall store on the segment the images of the Foundation Fieldbus (FF) function blocks which include PID, PD, Bias, Gain, calculations etc. The manufacturer shall guarantee the interoperability of H1 interface module with any function block residing in the field device.

d) The system incorporating the Foundation Fieldbus H1 interface card shall have Foundation Fieldbus Registered HIST certification.

e) The sub-system shall accept all the dynamic variables transmitted by the Fieldbus device.

5.3.15.4 Temperature Input Module

a) The thermocouple input module shall accept grounded or ungrounded inputs from various thermocouple types i.e. T, E, J, K, R, S and B. The module shall be capable of linearising the thermocouple inputs and provide cold junction compensation. The module shall have 12 bit resolution with digital accuracy of ±1°C.

b) The RTD input module shall accept 100ohm platinum resistance temperature detector (Pt 100) in 3-wire or 4-wire configuration. The module shall be capable of linearising the RTD input. The module shall have 12 bit resolution with digital accuracy of ±0.28°C.

5.3.15.5 Serial Interface Modules

a) Serial Interface modules shall be capable of communicating with RS232C, RS422, RS485, TCP/IP (Ethernet), OPC signals.

b) Unless otherwise specified, all serial interface modules shall be configured in redundant configuration. Spare port of a communication module shall not be used to connect the redundant link from the same foreign device.

5.3.15.6 Discrete Digital Input / Output Module

a) Digital input module shall be capable of detecting close or open status of powered or potential free contacts. The interrogation voltage of the contacts shall be 24VDC or as per selected barrier for barrier powered contacts.

b) The input module shall also be suitable to accept inputs from proximity switches or from open collector output from proximity input barrier.

c) The digital output module shall provide output contact rated for 110V AC, 5 Ampere or 110V DC, 0.2 Ampere.

d) The type of contact output i.e. normally open or normally closed shall be user selectable.

e) Maximum number of inputs or outputs shall not exceed 32.

5.3.15.7 Universal Input / Output Module

a) Whenever Universal I/O modules are specified in the Requisition, following shall be ensured:-
- All I/O modules shall be redundant irrespective of type of I/Os.
- I/O Modules for analog and digital signals shall be separate
- Analog I/O signals shall be limited to 16 channels per module
- Digital I/O signals shall be limited to 32 channels per module.

5.3.16 **Fieldbus Segment Power Supply and Terminators**

5.3.16.1 The power supply used for powering Fieldbus segment shall have an impedance matching network, preferably part of power supply unit. The Fieldbus power supply unit shall be isolated type.

5.3.16.2 Short-circuit protection shall be considered in the wiring / termination block so that short circuit at spur level shall not lead to failure of any Fieldbus segment except the short-circuited spur.

5.3.16.3 Unless otherwise specified, Fieldbus power supply / conditioner shall meet the requirement of type of selected instruments and shall be as follow:

a) Foundation Fieldbus power supply Type 131 non – IS power supply intended for feeding IS barriers. Output Voltage depends on barrier rating.

b) Foundation Fieldbus power supply Type 132 non – IS power supply not intended for feeding IS barriers. Output voltage is 32 VDC max.

c) Foundation Fieldbus type 133 IS power supply compliant with the recommended IS parameters.

d) For Non-Intrinsically safe segment, the Foundation Fieldbus power supply shall be capable of each drawing 20mA current supplying power to at least sixteen field devices including a segment terminator.

e) For intrinsically safe segment, the Foundation Fieldbus power supply shall comply with FISCO or entity concept requirements as specified in purchaser's specifications.

f) For a segment designed with Non-incendive concept, the Foundation Fieldbus power supply shall meet the requirements of FNICO.

5.3.16.4 Each Foundation Fieldbus power supply shall be redundant with current limited outputs to all Foundation Fieldbus segment and surge protection as applicable. Each module of Redundant Foundation Fieldbus power supply shall be fed with redundant power feeders.

5.3.16.5 Individual Foundation Fieldbus power supply modules and input power supply feeders can be replaced without interrupting power or communication Fieldbus segment.

5.3.16.6 Terminators

Terminators shall be provided by vendor at both ends of a Foundation Fieldbus segment. The terminator at DCS side shall be incorporated into the Foundation Fieldbus power supply while field side terminator shall be installed in the junction box.

5.3.17 **Control Functions and Algorithms**

Controller and data acquisition sub-system shall have capability to perform conventional and advanced control algorithms for implementation of regulatory and advanced control strategies. This sub-system shall have real time computational capability and shall be able to perform following algorithms and computations as a minimum unless specified otherwise in the requisition:

a) Control Algorithms
Proportional (P), Proportional – Integral (PI), Proportional – Integral – Derivative (PID), adaptive gain, feed forward, cascade, split-range, etc.

b) Dynamic Functions
Lead-lag, dead time, timers, counters etc.

c) Signal Selector
High selector, low selector, high-low selector.

d) Calculation Blocks
Linearisation, pressure-temperature compensation, polynomial, multiplication / division / addition / subtraction etc.

e) Signal Limiters
Low limiter, high limiter, high-low limiter etc.

f) Logic Blocks
Logic 'GATES' (OR, AND, NOR, NOT, NAND etc.), Flip-flops etc.

5.3.18 Controller shall be able to operate in manual, auto, cascade or computer mode. Mode changeover in either direction shall be procedure-less and bump-less. Following functional capability shall necessarily be possible:

a) In cascade loops, the primary controller shall be able to track the set point of the secondary controller when the secondary controller is not operating in cascade mode.

b) In computer mode, controller shall be able to track computer generated set point and shall hold the last generated value in case of computer failure. In such case, controller shall fall back on auto-mode and continue to operate at the last received set point, in general. Other options like pre-defined set point operation and fail safe condition shall also be possible. On the resumption of computer set point again, the controller shall not return to the computer mode automatically. Computer failure indicator shall be provided at central and local level.

5.3.19 Controller shall accept the change in set point command from central level (as operator interface function) and take action accordingly. It shall have facility for slow and fast ramping of set point as well as output. In addition, it shall have anti-reset wind-up feature as standard.

In addition to above, it shall also be possible to change set point, tuning constant, operating mode, controller configuration from the central level i.e. operator's interface keyboard and engineer's interface keyboard.

5.3.20 **Loop Integrity**

5.3.20.1 Loop integrity shall be maintained in controller functionality in such a way that the single component failure in the sub-system shall not affect more than one control loop (single loop integrity). This shall be achieved in offered sub-system architecture by providing one to one controller back-up. In case failure is detected in the active controller all the loops of the failed controller shall be transferred to the back-up controller.

5.3.20.2 For the close loops, Loop integrity shall be maintained for the I/O modules by providing one to one back-up. For the open loops where non-redundant I/O module is specified in the requisition, loop integrity shall be maintained for the I/O modules such that a single component failure shall not affect more than 16 analog inputs or 32 discrete inputs.

5.3.20.3 Loop integrity shall also be applicable to power supply modules, communication modules and other associated devices as per the philosophy explained in clause 5.3.20.1 and 5.3.20.2 of this specification.

5.3.21 **Sub-system Redundancy**

5.3.21.1 In case of redundant configuration (where back-up components are provided), the design shall incorporate a fail-safe automatic control transfer switching mechanism which shall transfer the entire configuration, data base and loop control of the failed controller to the back-up controller. Design must also ensure that data integrity is maintained during switchover and no portion of data to be transferred is corrupted or lost before and during switch over to the redundant (back-up) controller. The indication of the failed controller / component shall be displayed at the level as well as on the central level.

5.3.21.2 The switchover from primary to back-up component / device shall be bumpless and transparent to the operator i.e. the outputs shall be held at the last value during switchover to avoid any process upset. The switchover time shall be of the order of one (1) second.
In case of redundant H1modules, the back-up module shall maintain connectivity with all publishers and shall subscribe to all publishers to minimise switchover time.

5.3.22 **Sub-system Configuration and On-line Modifications**

5.3.22.1 Controller and data acquisition sub-system shall be configured from the central level i.e. from engineers interface sub-system under password or hardwired key lock protection. Single loop controller when specified shall be configured from the local level.

5.3.22.2 Sub-system shall allow following configurational functions to be performed for each loop:

a) Control function parameters.

b) Processor cycle time for each loop tag wise.

c) Macro-cycle time for Foundation Fieldbus H1 segment as per segment loading.

d) Output status of each control loop in case of processor failure.

5.3.22.3 It shall be possible to carryout online modifications or perform back-up without interrupting the central software or preventing the operator commands. Such modifications shall be possible without any plant upset or process interruption.

5.3.22.4 Downloading of modifications to the respective controller and data acquisition sub-system shall be possible in running condition.

5.3.22.5 Sub-system shall perform saving and back-up of data base as per changes made automatically.

5.3.23 **System Diagnostics**

5.3.23.1 Each module shall have diagnostics for indicating status of the module-on the console.

5.3.23.2 All diagnostic subroutines shall carryout various diagnostic tests to check the healthiness. The test shall include memory test (RAM and ROM), on-board processor test and back-up module communication healthiness test etc. Failure of any of the tests shall be alarmed as module failure.

5.3.24 **Sub-System Performance**

The sub-system response time shall be the indicator for the performance of the sub-system. The control system shall be able to perform control algorithm, calculation function etc. for each loop within the specified response time unless specified otherwise in the purchaser's data sheets, the system response time (scan time) and loop response time (for Fieldbus based system) as defined in clause 2.22 and clause 2.26 respectively of this specification shall be as follows for each individual loop:

-	For flow and pressure close-loops	-	500mS
-	For temperature and level close-loops	-	1000mS
-	For analyser close-loops	-	1000mS
-	For all open loops	-	1000mS
-	For Interlock related inputs	-	500mS

The processor cycle time shall be set to achieve the scan time and loop response time values specified above.

Scan time of multi-variable advanced control loops when implemented in controller and data acquisition sub-system shall be specified in purchaser's data sheets.

5.3.25 **Controller &Data Acquisition Subsystem Loading**

The system loading for controller and data acquisition subsystem shall not exceed 60%. The loading as indicated here is the worst case of high system activity referred to the use of memory, CPU time and communication capacity for this sub-system.

5.3.26 **Sub-system Sizing**

5.3.26.1 Sizing of controller and data acquisition sub-system shall be carried out considering the following parameters, as a minimum:

a) Unit-wise segregation of CDAS as specified in the requisition.

b) Number and type of inputs / outputs specified in each unit in the requisition e.g. analogue I/Os (conventional / smart (HART), Fieldbus segments, discrete I/Os etc.

c) Intrinsically safe and non-intrinsically safe I/Os.

d) Spares philosophy including installed spare IOs and IOs for future spare space..

e) Distribution of spare I/O's in I/O modules.

f) Processor Cycle time specified for each type of I/O.

g) Segment design criteria.

h) Worst-case processor loading specified in the specifications.

i) Calculation blocks specified in the requisition. Following philosophy shall be followed for computing calculation blocks in addition to those indicated:

PID Blocks	-	No of outputs
Calculation Blocks	-	50% of PID Blocks or 130% of specified calculation Blocks whichever is higher.
Logic Blocks	-	150% of specified blocks or 100% of specified Discrete outputs whichever is higher.
Advanced blocks	-	150% of actual numbers specified.

For the purpose of block calculation, consider actual I/O's along with installed engineering spares. Also consider clause 5.3.26.2 for Fieldbus based system.

j) Serial interface modules in redundant and single configuration as specified.

k) Any parameter not specified above but required to be considered for size because of vendor's standard sizing methodology.

l) For Fieldbus systems, the controller sizing shall be carried out considering all PID blocks in DCS even if the job specification specifies control in field.

Processor loading factor / calculation available in standard product guide for sizing shall be utilised else vendor shall reduce the sub-system block handling capability by a factor of loading calculated for the above criteria.

5.3.26.2 In addition to relevant requirements specified in Clause no.5.3.26.1, following process control functionalities and requirement must be considered for Fieldbus segment design:

a) The sensor device and the corresponding actuator in a control loop shall be on the same Fieldbus segment.

b) Control loop that include a cascade type controller, the primary and secondary loop measurement as well as final control element shall be on the same Fieldbus segment.

c) Split range measurement and final control element shall be on the same Fieldbus segment.

d) Discrete Fieldbus device used in an interlock along with a control loop, discrete device shall preferably be on the same Fieldbus segment. Discrete device described here also refers to the devices connected through Fieldbus converter.

e) The default configuration shall be for control (except high level complex calculations) to reside in Fieldbus device.

f) Type of hazardous area philosophy i.e. entity concept, FISCO, FNICO, high power trunk and flameproof.

g) Length of each segment with respect to the physical distance between control system (HOST) and field devices.

h) Loop response time / macro cycle time as specified.

i) Sufficient unscheduled time must be kept in each cycle to transmit a cycle information within defined loop response time. This shall be 50% of the specified loop response time.

5.4 Operator Interface Sub-system

5.4.1 General

5.4.1.1 The operator interface sub-system shall provide the centralized information to the plant Operator/Engineer in the following fields:

a) Indication of all analog and digital process variables of control loops, open loops and all loop related parameters.

b) Manipulation of control loops including changing set point, mode, output, configuration, tuning and computational constants.

c) Alarm displays and annunciation.

d) Graphic displays and status indication.

e) Logging and trending including historical trend recording.

f) Trend recording on assignable trend recorders, wherever specified.

g) Self diagnostic messages.

5.4.1.2 The operator interface sub-system shall consist of a single or multiple operator consoles (VDU's driven by console electronics) and hardwired consoles. The number of consoles for a unit shall depend upon the size and operating philosophy of the plant. The number of console shall be as specified in the requisition.

5.4.1.3 The operator interface subsystem shall have either single tier construction or stacked construction. The type of construction shall be specified in the requisition.

5.4.1.4 The operator station shall comply with ISO 9241-5, 9241-302 and 9241-303. The layout of the operator interface sub-systems shall be as indicated in the Requisition. The consoles required to meet the shape and symmetry indicated in the requisition shall be supplied by the vendor.

5.4.1.5 Unless otherwise specified in the requisition, each VDU shall be of multiple colour21" active matrix TFT type LCD display unit with backlit LED and shall have native resolution of 1280 x 1060 pixels, as a minimum, with a 160° wide viewing angle.

5.4.2 Operator Consoles

5.4.2.1 Each operator console shall consist of the following:

a) Single tier construction shall have three (3) VDU screens with its own dedicated keyboards (a total of three keyboards) each driven by an independent electronics.

b) Stacked construction shall have the two stacks of VDUs with four VDUs (2VDUs / stack) and two sets of keyboards (one keyboard / stack) each stack driven by an independent electronics.

c) The operator console shall also have a logging printer, an alarm and event printer and a hard copy unit, unless otherwise specified in requisition.

d) Each operator console workstation shall have at least two number cursor control devices in addition to keyboard which may include touch screen, mouse, etc. Touch screen facility should be an integral part of the TFT monitor /HMI and shall not be added on to the monitor with the help of any additional hardware.

5.4.2.2 **Hardware Configuration**

The operator console of each operator group, shall meet any one of the following configuration options:

5.4.2.2.1 **Option I**

Each operator video screen shall be driven by a dedicated driver electronics which also keeps the desired data base for various functions defined and termed as workstation. All the operator workstations shall be operationally interchangeable in such a way that all the workstations have similar data base and functionalities.

5.4.2.2.2 **Option II**

One or more number of operator console workstations (consisting of video screens and dedicated keyboards) is driven by a common redundant set of server machines storing a common database for all the workstations (workstations may work like clients to this server). The server switchover time in such case shall not exceed twelve seconds. However, at least one of the operator console workstation shall have direct real time data access from the controllers so that during server switchover, operator functionality is not affected simultaneously in all the console workstations.

Server shall be a multifunction high end server grade machine which may support functionalities such as:

a) Data connectivity between CDAS and other sub-systems (i.e. operator sub-system, engineering sub-system, IAMS etc.)

b) Database storage and engineering functionality as per Clause 5.4.2.3 of this specification.

c) Historisation of data related to associated operator consoles.

For systems where multiple servers are used to support different functions like data connectivity, database storage and historian function, each of the redundant set of servers shall be connected to the workstations to meet the above functionality.
This server shall not be used for functions like:

a) Plant history (UHN)

b) Connectivity to information network or OPC node.

c) Running specific applications like generating advance controls, MIS reports, IAMS, AIMS etc.

5.4.2.3 The system shall have global data available at each operator console electronics and all the functions explained in Clause 5.4 shall be available / executed at operator console. However, in case functionalities are distributed in various intelligent hardware / software or in case of distributed database / console functions is supported by the standard system architecture, each data base electronics / functionality shall be dual redundant. Further any change made in the

database of one operator console shall automatically update the database of other operator consoles.
Following shall apply:

a) History function for the units monitored and controlled from the operator console shall be dual redundant with each node having dual disc drives dedicated for history storage or with history storage available in each of the multiple operator stations of a console group.

b) Data base storage function for the units being monitored and controlled by the unit shall be dual redundant and shall have dual disc drive configuration.

c) All servers used for such functionalities shall have RAID5 or RAID10 configuration.

5.4.2.4 The operator, as a minimum, shall have access to the following through the operator key board at all times:

a) Selection of all the displays including the direct selection of loop in alarm, page turning facility, overview, group view and loop view selection etc.

b) Selection of loop for operation.

c) To acknowledge alarms as and when they are annunciated on the operator console.

d) Facility to enter any changed parameter like set point, manipulated variable, digital commands and to cancel any wrong entry while making such change.

e) Facility for easy positioning of cursor for the selection of any parameter.

f) Selection of hardcopy printout, logging printout and alarm history printout.

g) Auto/manual/cascade/computer mode changeover of each controller.

h) Zooming facility of all history trends with respect to time scale and parameter value shall be possible.

5.4.2.5 In addition, the Engineering keyboard shall have the following capabilities for restricted user/engineer through a Keylock or with password protection:

a) Database configuration including overview, group, loop, multi-loop and multi-variable control configuration.

b) Group or multi-group alarm inhibit from a plant under maintenance.

c) Reconfiguration of alarm settings and their values, addition and deletion of components in a loop.

d) Tuning of control loops including change of P, I, D and dead-time constants.

e) On-line compilation of graphic displays using standard user defined symbols.

f) Changing of parameters to be logged.

g) Setting of real time clock.

h) Assigning of parameters for historical trending.

i) To call detailed self-diagnostic for maintenance.

Any change made for any parameter for an input from any display shall be automatically updated on all displays configured for that input. (For systems, where the activities listed at (a) (e) and (f) above are part of engineering activities, the operator console shall have facility to log onto the engineering station for performing these functions with secured access).

5.4.2.6 Operational Protection

A key-lock switch or software password shall be provided for operational protection. Following minimum level of access and authorisation shall be available:

Operator Level	-	Authorises all commands for plant operation.
Engineers level	-	Authorises all commands for plant operation and system engineering.
Management Level	-	Authorises all operational data and reports to be viewed through operator level access

Other levels of keylock / password protections if available as standard with the system shall also be offered.

5.4.2.7 It shall not be possible to override any process variable or digital status from operator keyboard.

5.4.2.8 Each keyboard either integral or as a separate attachment shall have a set of dual function user configurable keys. These keys shall be configured to access important pages in single keystroke. These keys shall have LEDs which flash on pre-configured alarm conditions. A minimum of 32 numbers of such keys shall be offered with each keyboard. Systems, which do not support dual function keys with their standard keyboard shall offer either one of the following:

i) a dedicated VDU and keyboard with each operator console group configured with an intelligent graphic which would replicate the functionality of dual function keys.

ii) a dedicated keyboard with dual function keys alongwith each standard keyboard.

5.4.2.9 Wherever integration of different process operation groups within the DCS network is required, it shall be possible to exchange data and graphics between one operator console group / server to other operator console group / server within the DCS network for effective control, monitoring and operation purpose. All such data transfer required between the operator console groups / servers shall be of the order of 3 seconds including the update rate on Operator consoles of one group from the other. Vendor shall consider suitable hardware and software to meet this requirement. Moreover, the network connectivity between the various process operation groups within each network shall be redundant including redundant hardware.

5.4.3 **Process Displays**

5.4.3.1 Process information and operational aids shall be presented to the operator in the form of display. These displays shall cover all points related to tag numbers built within the system. The process displays shall include different type of displays and the functionalities associated with each of these displays. Various types of process displays, as envisaged, are detailed out in the clauses to follow. The details provided herein are typical and explain only the functional requirements. The systems as offered must provide displays which meet these functional requirements.

5.4.3.2 Overview Display

5.4.3.2.1 Overview display shall present the overall status of a unit or large segment of the process plant. The analysed data and alarm conditions are displayed with colour changes.

5.4.3.2.2 Overview display shall incorporate a minimum of 128 analog or discrete inputs which can be monitored simultaneously on the VDU screen (Referred as page). Each page shall be

organized into a suitable number of groups. Each group shall be identified separately. Each group shall further incorporate suitable number of inputs (referred as tags). Suitable identification and description shall be shown for each group on the overview display to relate it to a group or loop display.

5.4.3.2.3 Alarms shall be displayed in change of colour against each variable if the variable crosses a set value. Control loops operating in manual mode shall be indicated.

5.4.3.2.4 An input in alarm condition shall be identified by flashing.

5.4.3.2.5 In case, any hard wired instrumentation backup is provided, overview pages shall be assigned indicating the tag number and type of hardwired instrument.

5.4.3.2.6 The operator shall be able to call directly any group display or loop display or any predetermined displays covered in the overview display.

5.4.3.3 Group Display

5.4.3.3.1 Group display shall be limited to the group of inputs as displayed in the overview display. Each group shall preferably include eight (8) numbers of inputs.

5.4.3.3.2 Each input in the group shall be identified by the tag number, unit of measurement and process description which shall be displayed on the VDU screen.

5.4.3.3.3 Display, as a minimum, shall show following degree of details:

a) Process variable in analog form shall show, as a percentage of the transmitter span on a linear scale bar graph of 0-100% or engineering units and in digital form as alphanumeric display in engineering units.

b) Set point value in analog form as a percentage of the transmitter span on linear scale bar graph of 0-100% engineering units and in digital form as alpha-numeric display in engineering units.

c) Output value in analog form as a percentage of linear scale bar graph of 0-100% and digital form as percentage.

d) Controller mode i.e. auto, manual, cascade, computer.

e) Process alarm on process variable, deviation or velocity.

f) Selected loop within the group shall be identified by cursor marking or similar identification.

g) Control valve failure position.

h) The contact input / output shall be represented by simulated graphic lamps and configurable alphanumeric status description.

5.4.3.3.4 It shall be possible to control the process from group views. Following control actions shall be possible:

a) Increase / decrease of set point value.

b) Change of controller mode i.e. Auto/manual transfer.

c) Changing output to the final control element.

d) For digital points, start/stop or open/close command.

5.4.3.3.5 It shall be possible to repeat any tag number in more than one group/console. Moreover it shall be possible to control or change configuration of a tag from any of the group/console display to which the tag is assigned. Audit trail for any such configuration change shall be possible.

5.4.3.4 Loop Display

5.4.3.4.1 Loop display shall provide a separate detailed display for each of the process inputs. The graphic representation of analog and digital points shall be similar to group display. However in addition following information shall also be presented in alphanumeric form as a minimum

a) Controller tuning constants.
b) Process variable zero and span values.
c) Alarm set point on various parameters.
d) Limits on set point, output, etc.
e) Controller action (direct/reverse).
f) Failure position of final control element.
g) Computational constants like ratio or bias.
h) Integrated value.
i) Output to the final control element.
j) Engineering units.

5.4.3.4.2 It shall be possible to change the following through the keyboard of operator console:

a) Tuning constants.
b) Scale, zero and span.
c) Limits on set point, output etc.
d) Alarm set points.
e) Control mode.
f) Output to the final control element.
g) For digital points, it shall be possible to issue start/stop or open/close command.

5.4.3.4.3 Loop control parameter changes as specified in Clause 5.4.3.4.2 (a) to (d) shall be restricted by a key lock control or password.

5.4.3.4.4 The loop display shall also contain a trend displaying process variable, set point and output with a sample interval time of maximum 1 second and full scale time base of minimum 60 seconds for tuning the process control loops.

5.4.3.5 Graphic Display

5.4.3.5.1 It shall be possible to display dynamic graphic of different sections of plant on the operator console VDU screens. Graphic displays shall be field configurable only through engineering key-board with standard / user defined graphic symbols. Dynamic graphic displays of different sections of the plant shall be displayed on different pages.

5.4.3.5.2 The system shall have graphic symbol library as per ISA-5.1 and 5.3. In addition standard industrial symbols like distillation columns, heat exchangers, pumps, compressors, tanks etc. shall also be provided as a standard.

5.4.3.5.3 Graphic displays shall be interactive type through which it shall be possible to control the process. It shall also be possible to send motor start/stop and shutdown valve open/close commands, as specified in requisition, from this display.

5.4.3.5.4 It shall be possible to view the process variable and alarm points and view and change set point value, manipulated variable, controller mode etc. from the graphic display. Also rotating machinery (i.e. compressor / pump) status and valve status shall be displayed on the graphic display with different colours.

5.4.3.5.5 Various colours used in the generation of graphics like colour of the process lines, utility lines, Instrument signal lines and event modifier conditions shall be finalised during detailed engineering. The colours used to identify event modified conditions shall generally be as follows unless otherwise indicated during detailed engineering:-

Green	:	Valve open, pump running.
Red	:	Valve closed, pump stopped.
Flashing Red	:	All points alarm / Shut down valve transition state.

5.4.3.5.6 It shall be possible to go from any graphic page to related graphic pages or any group view or alarm summary in single key stroke using soft key function.

5.4.3.6 Trend Display

5.4.3.6.1 The system shall be capable of displaying the following trends:

a) Real time trends for the parameters specified in requisition displaying current data for a period of minimum one (1) hour as defined in clause 2.33 of this specification. However it shall be possible to assign any parameter for real time trend.

b) Historical trend for number of parameters as specified in the requisition for a period of 30 days with sampling rate of 10 minutes. However, it shall be possible to assign any parameter for historical trending.

5.4.3.6.2 Historical data shall be stored on the nonvolatile memory device like hard disc in such a way that such historical data can be utilized for archival storage and subsequent recall.

5.4.3.6.3 Real time and historical trend shall be possible on any parameter or variable like measured variable, set point, output, calculated variable etc.

5.4.3.6.4 It shall be possible to sample and store data of instantaneous and average value at the intervals mentioned below. However it shall be possible to display by scrolling or expanding the time base for all the trends.

a) At intervals of 1 second or higher for the real time trend.

b) At 1 minute, 10 minute & 1 hour interval for historical trend.

Historical data trends shall be displayed for a period of minimum up to 72 hours for a data sampling rate of 1 minute.

5.4.3.6.5 The requirement of fast trend (trends with sample time faster than Real time trend) if any, shall be specified in the requisition. This shall be in addition to tuning trend requirement specified in this specification.

5.4.3.6.6 Selection of the tag number and sampling time for real time and historical trending shall be possible from operator keyboard.

5.4.3.6.7 The system shall also have a multi trend capability in such a way that it shall be able to display set point, measured variable and output on the same display, the trend of either the same process variable or any other process variable.

5.4.3.6.8 Trend display shall be single line type or bar graph type with additional information like loop tag number, engineering units, span, present value of the trended point, alarm status etc. displayed.

5.4.3.7 Closed Circuit Television Window Display

Wherever specified in the requisition that CCTV shall be integrated with DCS, it shall be possible to display close circuit television (CCTV) video monitor image on the operator console as a CCTV window. A function key on the operator keyboard shall be assigned to select the desired CCTV monitor window.

5.4.3.8 Alarm Monitoring and Display

5.4.3.8.1 Alarm Management

a) It shall be possible to display process as well as system alarms on the operator console for operator's attention and action. Alarms shall appear immediately on the operator console as and when they occur on priority basis.

b) It shall be possible to set process alarm limits from the engineering keyboard i.e. alarm limits on absolute value of measured variable, rate of change of measured variable, high and low deviation set points, high and low points on process variable. In addition, it shall be possible to derive alarm conditions on the basis of few calculations performed by the system.

c) Alarm messages shall be displayed with tag no. and tag description. Alarm messages shall be displayed by flashing the page and group number of the input under alarm irrespective of type of display. It shall be possible to access the group or tag in alarm condition with a maximum of two key-strokes of operator's console keyboard. The plant overview display, in addition to display alarm message, shall also be able to provide warning by changing colour in case of excessive deviation of process variable from their set value.

d) All alarms shall be displayed as and when they occur or generated with change in the colour of display in the following sequence, activating an audio signal:

Continuous flashing	:	Un-acknowledged alarm
Steady display	:	Acknowledged alarm

e) The system shall not put off the audio alarm and visual flashing even after the condition returns to normal unless it is acknowledged by the operator.

f) In order to provide immediate attention to critical alarms, alarms shall be classified in the priority of their criticality.

g) In addition to alarms appearing on the different displays as mentioned in para 5.4.3.1 to 5.4.3.5 of this specification, the system shall also be able to display alarm summary and alarm history as per para 5.4.3.8.2 and 5.4.3.8.3 of this specification.

5.4.3.8.2 Alarm Summary Display

a) It shall be possible to display summary of all alarms in the sequence of their occurrence and shall disappear from display only when they are acknowledged and cleared. The alarm display shall list the following for each alarm as a minimum:-

i) The date and time of occurrence.

ii) Point identification (i.e. Tag number)

iii) Point description.

iv) Type of alarm (absolute value or deviation.)

b) The system shall be able to display on alarm summary a minimum of 100 alarms.

c) Alarms shall preferably be listed in the form of alarm list like current, List I, List II etc. The minimum number of alarms per list shall be 25. Alternately, system may provide a common list of alarms in the sequence of their occurrence (with respect to time).

5.4.3.8.3 Alarm History

a) The history of alarm conditions shall be maintained in the database for alarm history display and printed on shift-wise basis for the parameters specified in the requisition. The alarm display and print out shall list the following for each alarm as a minimum:-

i) The data and time of occurrence.

ii) Point identification (i.e. Tag number)

iii) Point description.

iv) Type of alarm (absolute value or deviation)

v) Time of acknowledgement.

vi) Time of return to normal.

b) The system shall be able to display and print out the alarm history of minimum of 300 alarms.

c) Alarms shall be listed in the form of alarm lists like List I, List II, List III etc. The minimum number of alarm points per list shall be 25. Alternately system may provide a common list of alarm in the sequence of their occurrence.

5.4.3.8.4 System Alarm

a) System shall have capability of on-line self-diagnostics as mentioned in para 5.4.5 of this specification.

b) Any abnormal conditions in system and sub- system or any other functional device shall be displayed as system alarm message on the operator console irrespective of the display selected.

5.4.3.9 Configuration Display

5.4.3.9.1 It shall be possible for the Operator console to access the Engineering console for Configuration display. This access shall be through engineer level password protection. The Configuration display shall provide a separate detailed display for each loop indicating the configuration of that loop. When control requires more than one loop, all interrelated loops shall also be displayed. Following information is required to be available on configuration display:

a) Loop configuration giving designation of each block.

b) Control blocks interconnection showing soft-wiring or hardwiring.

c) Value of each block parameter like P.I.D, ratio, bias, dead-time, lead- time etc.

5.4.3.9.2 It shall be possible to configure & reconfigure the loops from this view using user friendly software.

5.4.4 Logging and Report Generation Function

5.4.4.1 It shall be possible to log all real time data, historical data, computed parameters, operator actions, alarms and events etc. from operator consoles irrespective of data source connected to communication sub-system. In general, the data type shall include:

a) All measured and manipulated variables (inputs as well as output data)

b) System calculated variables

c) Historical data values

d) Alarm and event data

e) Operator data entry and operator actions

f) Equipment status data

g) Data through serial links

h) Data through OPC server

i) Batch related data

j) System clock time

k) System diagnostic data

5.4.4.2 The system shall have a report builder and report scheduler which shall have following capabilities:

a) The system shall be able to generate reports on hourly basis, shiftly basis (8 hourly), daily basis and in some cases weekly or monthly basis, as specified in requisition.

b) The system shall be able to generate reports as per operator command either on-demand or on predefined time.

c) In general, the type of reports shall be:

- On demand report initiated by operator action
- Predefined time initiated report e.g. hourly, shift, daily etc.
- Event driven report
- Shutdown driven report
- Equipment runtime status report

d) The generation of on demand report shall not affect any scheduled report.

e) These reports shall be stored in separate files independent from historical and trend data files.

5.4.4.3 All parameters required for logging shall be stored in the system memory as per data base update rate. The system shall be able to perform following functions on all such stored data prior to logging as per the requirement of the report:

a) Basic arithmetic calculations such as averaging, summing, multiplication, division etc.

b) Advanced calculations like efficiency calculations, conditional calculations etc.

c) Extended log reports such as weekly and monthly reports.

d) Batch Reports

5.4.4.4 The formats used to generate log reports shall be user definable, in general. Typical log formats for hourly, shiftly and daily reports will be provided during detail engineering. System shall have a user friendly structured programming language suitable to generate and access various reports. System may utilize high level language for generating reports with advanced calculations. High level language compiler software shall be supplied as part of standard system function.

5.4.4.5 Number of log reports generated for a project shall be governed by the number and type of log formats defined for a project like hourly report format, daily report format, shutdown report format etc. Number of pages in each log report shall be sufficient to accommodate all the parameters.

5.4.4.6 In addition to the real time and historical data, the report builder programme shall incorporate report title, sub-headings, notes and messages.

5.4.4.7 Hourly report shall be printed only as and when initiated on demand by the operator and shall not be printed automatically after the end of the hour. All other reports shall be printed automatically at the end of the pre-defined time as well as on demand by the operator. The maximum storage time for a log information shall be 15 minutes after the pre-defined print out time for a format, within which time log report must be printed. In case report could not be printed within the scheduled defined time, data shall remain stored till the report is finally printed.

5.4.4.8 Data required to be logged shall be finalised during log report finalisation stage. However, typically following shall apply:

a) All tag numbers, analogs as well as digitals, shall be available for hourly log.

b) All flow tag numbers and other selective tag numbers shall be available for daily log report.

c) Only selective tag numbers shall be available for weekly and monthly report.

d) Average (over the defined period) for flow and instantaneous shall be used for log printing with maximum and minimum value as defined in log formats.

5.4.4.9 Logging Hardware and Software

5.4.4.9.1 The system shall be supplied with all hardware and software necessary to meet functional requirements specified in Clause 5.4.4.1 to 5.4.4.8 of this specification. Log reports shall be generated, compiled and printed using system standard hardware and software. No separate computer / server shall be used.
Separate server, if necessary, may be utilised, to generate extended logs or reports requiring advanced calculation.

5.4.4.9.2 It shall be possible to archive log reports on an external computer. Facility shall also be available to retrieve these reports as an external latest electronic media for future reference.

5.4.4.9.3 In the event of printer failure, the system shall maintain the data in the buffer memory of the report originating device with a printer failure alarm.
It shall also be possible to print the report at an alternate printer without any data loss, whenever necessary.

5.4.4.9.4 System Printers

a) In addition to configuration and maintenance (C&M) printing, printers shall be used for printing reports like log reports and alarm and event reports.

C&M printers shall be dedicated for each machine whenever such a function is required.

b) All printers shall be low noise industrial type and shall be suitable for continuous duty.

c) Logging Printer

Logging printer, if specified as a separate printer, shall be A3 size colour laser printer and shall be able to meet the following requirements:

i) Logging printer shall be able to print the following reports:

- Printing of hourly, shift-wise, daily and weekly log.
- Shut down report printing.
- Any other report defined in the requisition.

ii) In addition to above, logging printer shall also be used for printing hard copy of any video screen, whenever necessary.

d) Alarm and Event Printer

Alarm and event printer shall be capable of meeting the following requirements:

i) Alarm and Event printer shall be able to print out following reports:

- Log the process and system alarm messages with a time stamp as and when they occur
- Print the alarm history for every shift of operation or on demand from operator console.
- Log events such as operator actions as defined in para 2.30 of this specification, as and when they are initiated.
- System alarms as per self-diagnostic reported alarms.

ii) Alarms and Events shall be clearly distinguishable on the report, preferably by colour.

iii) Print out shall show as a minimum the tag number, description, date and time of occurrence, time of acknowledgement and time of return to normal.

iv) The time stamp shall include month, day, hour and minute.

e) Multifunction Printer

Multifunction printer shall be a colour laser printer which shall be able to print out log reports as well as alarm and event reports. Multifunction shall be specified either common for a unit or a group of units. The functionality of multifunction printer shall be same as (a) through (d) specified in clause 5.4.4.9.4 of this specification. Alarm & Event printing should be 'On demand' rather than "As and when they occur".

The command for printing of any report shall be generated from any operator and / or engineering console. The reports shall be generated in the priority of which shall be as per request time for printing report.

f) Hard-copier

i) Hard-copier shall be a coloured heavy duty A3 laser printer. The command for copying shall be initiated from any operator console.

ii) The screen display may be changed on the console after the copy command is initiated for any screen. This video copier shall have buffer memory storage for at-least two screen pages.

iii) VDU page shall not be locked for more than 5 seconds while taking the video copy.

g) Configuration & Maintenance Printer

It shall be coloured A3 laser printer and it shall meet the requirements specified in Clause 5.5 of this specification.

5.4.5 Self Diagnostics

5.4.5.1 The self diagnostic message for a subsystem failure shall appear on the operator console irrespective of display selected. The detailed self diagnostic displays shall be available on the operator console only when called.

5.4.5.2 The system shall have an extensive set of self-diagnostic routines which shall locate and identify the system failure at least up to module level including redundant components.

5.4.5.3 Failure of a module in a sub-system shall be identified in the operator consoles.

5.4.5.4 Failure of a subsystem shall be annunciated with the change in colour. To aid system maintenance and for effective fault location, following displays shall be provided as a minimum.

5.4.5.4.1 Communication System Status Display

The display shall show an over view of different sub-systems connected over the communication sub-system showing status of each sub-system. When a failure is detected by the system self diagnostic routine, the display shall indicate the location and nature of malfunction. Display shall as a minimum have:

- Type of sub-system.
- Failure of communication bus/link with the sub-system.

5.4.5.4.2 Sub-system Diagnostic Display

One display page shall be available for each sub-system on the communication sub-system which can be called on demand.

The display as a minimum shall contain:

- Sub-system number and type
- Error code and description
- Details of failed module

5.4.6 **Data Storage, Archival and Retrieval**

5.4.6.1 Historical data shall be stored on a non-volatile memory device like hard disc which can be subsequently recalled by operator on any screen. System must support multiple historical data discs in order to avoid data loss in case of disc crash.

5.4.6.2 It shall also be possible to store and retrieve this data on external electronic mass storage media.

5.4.7 **System Servers Sizing Criteria**

5.4.7.1 The servers provided as part of standard system architecture shall have fault tolerant architecture with a minimum availability of 99.999%. The design requirements of each server shall be dependent on its functional requirements such as:

a) Guaranteed throughput performance.

b) Continuous and consistent data connectivity even during fault.

c) Continuous and consistent processing of data even during fault.

d) Fault tolerant operating system.

The fault tolerant configuration of server shall include synchronised redundant processors such that failure, if any, is transparent to the user and server applications.
Transparent to the user implies that the data display on the graphic of any VDU shall not be lost for more than three (3) seconds in case of failure of the main server.

5.4.7.2 In case of redundant server configuration, the maximum switchover time shall be of the order of ten (10) seconds.
System servers which have switchover time exceed 3 seconds, shall ensure that real time data is available on at least two of the three operator console VDU's even during switch over.

5.4.7.3 All server machine used shall be high end server grade machines. General purpose machines/ servers shall not be acceptable.

5.4.7.4 Server Sizing

5.4.7.4.1 Unless otherwise specified, following criteria shall be considered while sizing the server / servers used for driving operator console:

a) Number of Operator Workstation (clients)

Consider 1.2 times the specified number of operator workstations rounded-up to next higher whole number for each type.

b) Number of Engineering Workstations (clients)

Consider 1.2 times the specified number of engineering stations rounded-up to next higher whole number.

c) Number of Controller and Data Acquisition Nodes

Consider 1.4 times the specified number of CDAS nodes.

d) Maximum number of nodes / sub-systems on the network should be less than 60% of the system capacity specified in the standard printed catalogues of manufacturers.

e) Maximum History Storage Tag Numbers per second.

Consider 1.4 times the specified number of tag points in the Requisition with storage rate of 1 second.

f) Maximum Number of Trends

Consider 1.4 times the specified number of trend points. Where no separate trend points are indicated consider all analog inputs and outputs as required trend points.

g) Maximum Number of Reports

Maximum number of log reports (formats) shall be 50 with 1000 points in each log report.

h) Maximum Number of Tag data

Consider 1.4 times the total number of tags and associated parameters i.e. process variable, set point, manipulated variable, auto-manual-computer status, alarm values, diagnostic data from field devices with HART or Fieldbus protocol, serial data (process and diagnostics) from third party devices, SOE data etc.

i) Maximum Number of Process Alarms, Operator Events and Operator Messages

Consider 1.4 times the maximum specified parameters. Where no operator-events or operator messages are indicated in Requisition, consider a total of 1000 points for sizing.

j) Number of Peripheral devices

Consider 1.4 times the maximum number of peripheral devices specified in the configuration diagram.

k) Maximum Number of Fieldbus Segments

Consider 1.4 times the maximum number of Fieldbus segments specified or computed by the vendor, as applicable.

l) Maximum Number of Data for UHN and OPC Node

Consider 1.4 times the maximum number of tag data specified in the requisition. Where no separate data is given in the requisition consider through put requirements specified for UHN and OPC node sizing in this specification. The polling rate shall be considered as 1000 tags per second.

m) Maximum Amount of Asset Management Data

Consider 1.4 times the maximum data available from field devices with HART or Fieldbus protocol for asset management.

5.4.7.4.2 While sizing the server / system consider the following operational features:

a) Number of Operator Console VDU (WS) with over view display. : 33% of 'A'

b) Number of operator console VDU's (WS) with : 33% of 'A'

trend displays.

c) Number of operator console VDU's (WS) with graphic displays. : 33% of 'A'

Consider 'A' as number of workstations specified in clause 5.4.7.4.1(a) of this specification.

5.4.8 **System Operational Response Time**

The system shall meet the following response times beyond which the delay may have detrimental effect on the operator's performance:

System activation or Logging-on of a terminal	:	1 sec.
Display call-up time		
- Simple pages like menu display	:	0.5 sec.
- Graphic page	:	1 sec.
Command execution response	:	4 sec
Data entry error reporting	:	1 sec.
Response to mouse / keyboard commands	:	0.5 sec.

5.5 Engineer Interface Sub-system

5.5.1 Engineer interface sub-system shall be primarily an engineer's interface which shall normally be used for configuring, tuning and maintenance of the Distributed Control System. This sub-system shall also be used as operator console whenever necessary (e.g. during start-up etc.).

5.5.2 It shall consist of an Engineering console which shall be able to perform all engineering functions related to each operator console and other sub-systems e.g. controller and data acquisition sub-system, foreign device interface device etc. (except PLC for which dedicated programming terminal shall be provided). It shall also be possible to configure Fieldbus function blocks on any segment from engineering console.

5.5.3 Each Engineering console shall consist of multiple colour 21" active matrix TFT LCD with backlit LED video display with specifications same as operator console as a minimum. Each engineering video screen shall be provided with one operator key-board and one engineering keyboard. This, as a minimum, shall also have one configuration and maintenance printer unless otherwise specified in the requisition.

5.5.4 Engineering console shall have all the capability of an operator console. However, the operation of the plant shall be restricted from this console. All the operator console displays as specified under clause 5.4.3 of this specification shall also be available on engineering console.
The engineering console shall also have configuration display to provide a separate detailed display for each loop indicating the configuration of that loop. It shall be possible to display and perform all functions related to configuration display as described under clause 5.4.3.9.

5.5.5 Engineering console like any other sub-system shall be capable of communicating with all other sub-systems over the communication sub-system.

5.5.6 Engineering console shall have individual dedicated electronics with RAID 5 / RAID 10 disk configuration.

5.5.7 It shall be possible to perform all system configuration functions and configuration modification functions from the Engineering console typically:

a) Data base configuration including overview, group view, loop view, trend view, sequential programming, multi-loop multi-variable control configuration for smart and Fieldbus based inputs and outputs.

b) Group or multi group alarm inhibit for the plant under maintenance.

c) Configuration or re-configuration of alarm settings, their values, addition or deletion of any control block or component in a loop.

d) Compilation of graphic displays.

e) Setting of real time clock.

f) Compilation of logs/reports/historical trend points.

g) To call detailed self diagnostic displays for maintenance aid.

5.5.8 **Configuration Requirements**

5.5.8.1 It shall be possible to configure conventional, smart (HART) and Fieldbus I/Os and control strategies in the same way. The device configuration application for HART and Fieldbus devices shall utilize EDDL or FDT / DTM as specified in data sheet. It shall include the following:

a) Capability to display all device parameters directly from the device itself.

b) Modify and download device configuration directly to device.

c) Separate display of process values and device alarms.

d) Capability to modify multi-device and download all at the same time.

5.5.8.2 Fieldbus H1 interface configuration

a) The configuration software shall have capability to configure all H1 Fieldbus interfaces such as:

- LAS assignment and management
- LAS scheduling
- Macro cycle time calculations / optimisation

b) Interface configuration software shall support multiple LAS in a segment. Graphical tool shall be provided which shall provide sequence of execution, execution time of each Fieldbus device and overall macro-cycle time.

5.5.8.3 Fieldbus Function blocks

a) The configuration software shall be able to configure all Fieldbus functional blocks available in Fieldbus devices.

b) Function block configuration shall be downloaded from engineering console to field devices on-line.

c) Downloads that will result in change in segment macro-cycle shall proceed with a positive confirmation before the download is allowed.

5.5.8.4 Segment Scheduling
The engineering software shall have capability to carryout segment scheduling against the scheduling constraints such as number of parameters which LAS can transmit during the single cycle.

5.5.8.5 Automation Configuration Tool

5.5.8.5.1 The configuration software shall be capable of auto-detection of following I/O devices:

a) Identification of I/O ports and all types of I/O modules with software configuration defined. If mismatch is detected, an alarm message shall be generated.

b) Function block configuration tool shall be capable of identifying the installed field devices. An alarm message shall be generated in case of mismatch.

c) Automatic address and tag name assignment for Fieldbus devices. These capabilities shall also include handling of any Foundation Fieldbus registered device using the device DD and CFF files.

5.5.8.5.2 The system shall be pre-configured to identify the attributes of all I/O interface ports and general characteristics of any connected field device, which comply with EDDL (of latest version) or FDT / DTM or as specified in the requisition.

5.5.9 Tuning of a control loop shall be possible from Engineering as well as from operator console, the location for tuning shall be selected by the operator.

5.5.10 **On-line Configuration**

The system shall have the capability to copy, store, modify and restore the configuration data on-line without shutting the system partly or completely. The system shall be capable of downloading controller configuration from engineering console without taking controller off-line.

5.5.11 **Off-line Configuration**

5.5.11.1 It shall be possible to generate system configuration i.e. controller and data acquisition sub-system and display configuration including graphics from an independent PC with windows operating system loaded. System engineering features like continuous control, advanced controls, displays, alarm, historical functions, logging functions etc. shall be configurable from above station. The configuration shall be possible without the availability of actual engineering station. Configuration generated off-line shall be loaded on to engineering station without any limitation.

5.5.11.2 Fieldbus engineering software tool shall be able to perform offline Fieldbus engineering by accessing CFF and DD files of field devices without connecting the field devices.

5.5.12 During the normal operation, the Engineering console, in no case, shall interfere with the process operation or system software. However any change in the configuration shall be down loaded into the system with proper knowledge of the operator.

5.5.13 All detailed diagnostics of the system shall appear on the Engineering console with a print out on the Configuration and Maintenance (C & M) printer. A common diagnostic message on the operator console shall indicate the need of the maintenance.

5.5.14 To aid the system maintenance and effective fault identification, following displays shall appear on the engineering console:

a) Communication system status display

b) Device diagnostic display and System diagnostics upto module level should be possible from the diagnostic software. The details of system diagnostics are described under para 5.4.5 of this specification.

5.5.15 Any special diagnostic package, in addition to as mentioned under para 5.4.5 of this specification, if available with the system, shall also be offered. Detailed description and capability of this package shall be furnished.

5.5.16 C&M Printer shall be used for printing the configuration or configuration changes, printing system alarms as and when they appear and to print out any engineers command from Engineering console. Hard copy unit, when specified, shall be used to take hard copy of the engineers console screen.

5.5.17 The system shall have adequate security features to secure plant operation and DCS data base. Engineering console shall have the following security features, as a minimum:

a) Key-lock or password protection for accessing operator functions and engineering functions.

b) Redundant disc and RAID 5 / RAID 10 controller configuration.

c) Disc interface to enable 'disc down loading' / database or configuration data back-up.

d) De-functioning / inhibiting all functions other than those functions which are required for engineering and operation as defined above.

5.5.18 System Back-up and Re-initialization

a) The entire control software including control database (application program), system software, source code, schematics etc. shall be backed up on system hard disc automatically at regular intervals.

b) It shall be possible to have a complete back-up of system including the historical data on-demand without interrupting the system normal function.

c) It shall be possible to have back-ups on external electronic mass storage media.

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d) The maximum time acceptable for reloading a device like console is five (5) minutes.

5.5.19 Global Database Management and Configuration

5.5.19.1 System configuration software shall provide a common database configuration environment and shall support the following data management facilities, as a minimum:

a) System design shall follow the data centric approach and shall manage entire system data in global manner. Paths and connections between data objects shall be automatically maintained when configuration is changed.

b) Whenever the offered system maintains multiple data bases, the design must ensure a close coordination between these data bases such as management of cross reference table and data reconciliation algorithms.

c) Configuration of operator graphics including management of change tools so that the changes made in graphics are updated uniformly throughout the system.

d) All control, historical, trend function configuration and interconnection between data elements in the system without any need to maintain user based cross references.

5.6 Communication Sub-system

5.6.1 The communication shall be a digital communication network bus, that provides a high speed data transfer rapidly and reliably between the operator consoles, process I/O devices and other devices connected to it. Each network node shall be capable of communicating with other nodes over the communication network.

5.6.2 The Communication network topology shall preferably be bus structure. Other vendor standard topologies shall also be acceptable provided these meet all the functional requirements specified in this specification.

5.6.3 The communication over the communication network shall not be affected even if a node connected to network is powered down or fails to respond. It shall be possible to connect or disconnect a device from the system without disturbing the operation.

5.6.4 The communication sub-system shall be dual redundant, consisting of two separate communication networks and two separate communication system interfaces for each device. The systems requiring traffic directors shall be avoided. However, if unavoidable, dual redundant traffic directors shall be provided.

5.6.5 Design shall ensure that there is no cause of common mode failure in communication sub-system.

In general, both the communication networks / devices shall be active at all the times in such a way that either they shall take the communication data load or switch the communication path at regular interval whenever vendor standard data transfer technique allows data transfer to one network while redundant network takes control on the failure of the main network. Vendor shall ensure that there shall not be any system degradation or data loss before, during and after the changeover.

Redundant communication network and communication components / modules shall be continuously checked for their availability and healthiness. In case of main bus failure or any communication device failure, the transfer to the back-up device or bus shall be automatic without interrupting the system operation and without any operator's intervention. Information about the failed device / bus shall be displayed on the operator console.

5.6.6 Communication network protocol used within the system shall safeguard against false data transfer and allow error detection, recovery failure detection and initiatives of switchover to the redundant network / network component / module.

5.6.7 In addition to automatic switchover of communication network on detection of failure of active / one of the network / network device, it shall be possible to switch over the communication from main bus to the redundant bus manually without disturbing the system operation. Manual switchover shall be effected whenever the network integrity and switchover is to be verified during testing.

5.6.8 The mechanism used by the communication system for error check, parity error, over-run error etc. and other advanced codes shall be transparent to the application information.

5.6.9 In general, the transmitting message shall identify the receiving device. The transmitting device shall receive a reply from the receiving device on the receipt of correct message. Lack of response shall be considered as a receiver failure. There shall be positive acknowledgement of all messages transmitted over the communication network.

5.6.10 Communication speed on the communication bus shall be sufficient to update the operator console data base once in every second. The overall system performance shall not be degraded whether communication sub-system is 10% loaded or 100% loaded. Degradation of communication bus shall be as defined under para 2.18 of this specification. Failure of one or more nodes shall not degrade the communication performance in any way.

5.6.11 **Network Diagnostics**

5.6.11.1 Network management software shall be resident on all the network modules in order to ensure reporting of node status to other network nodes and reporting node failure alarm within one second.

5.6.11.2 Communication network diagnostics shall run continuously so that the failure of any network / network component / communication module is alarmed without any delay.
The diagnostics sub-routines shall detect and isolate faulty network component and noisy network cables. Communication shall automatically transfer to the redundant component/ module / network whenever the failure is detected without interruption of system operation and loss of data.

5.6.11.3 Diagnostic sub routines shall be available to monitor the network performance and errors shall be reported.

5.6.12 **Network Components and their Requirements**

5.6.12.1 All hardware like network cables, connectors, media converters, network switches, network hubs and fibre-optic patch-cards required for completing communication network shall be supplied by the vendor.

5.6.12.2 Network can be either screened twisted pair copper and / or fibre optic cable. All network cables shall be fibre optic and armoured type when routed outside the control room buildings. All network cables within the control room shall preferably be armoured. In case of un-armoured cables within control room, the same shall be provided with physical protection like covered ducts/ trays or conduits as specified in the requisition.
Fibre optic cable in addition shall be jelly filled for protection against ingress of moisture.

5.6.12.3 Communication network if routed outside the control room shall be fibre optic type only and shall support the use of media converters for fibre optic network. The system design shall allow the use of unequal network lengths in case of redundant network configuration to make-up for the difference in routing lengths.

5.6.12.4 Type and specifications of the fibre-optic cable shall be decided by vendor based on the distance, band-width required for data transfer and allowable signal attenuation. Minimum two numbers of spare fibres shall be provided in fibre optic cable. The outer sheath colour of the fibre optic cables shall be orange.

5.6.12.5 Fibre optic cable shall always be routed in enclosed HDPE conduit with matching fittings. HDPE conduit shall be as per IS-4984 or equivalent IEC code. The outer sheath colour of HDPE conduits shall be orange with black for the fittings throughout the fibre optic cable run.

5.6.12.6 The network devices such as network switches, media converters, connectors etc., utilized in communication sub-system shall be of industrial grade managed type and of rugged design with cable diagnosis and LEDs for power, fault & link failure features. These components shall be selected as per the make and model number listed in the standard vendor document.

5.6.12.7 The network switches used shall have multiple speed ports (10/100/1000/ 10000 Mbps) and shall have:

a) Multi-processor design for high performance operation.

b) Routine diagnostics to detect and isolate noisy cables and jabbering nodes.

5.6.13 **Network Loading and OPC Server**

Worst-case network loading for the systems supporting deterministic protocol shall not exceed 50% while for non-deterministic protocol shall not exceed 15%.

5.7 Open System Connectivity

5.7.1 The system shall be capable of interacting with other plant systems and computers over a well established communication network like Ethernet (HSE) conforming to IEEE 802.3. This connectivity with the other systems shall always be made via a firewall.

5.7.2 The system software shall be support industry standards like Windows, OSF/ MOTIF, TCP/IP etc. as applicable.

5.7.3 The method of data access by any user on this network shall be by I/O Tag name and not by any physical or logical address.

5.7.4 Whenever the communication network is required to connect to any other system network or to plant information network, fire-wall (hardware and software) and routers shall be used.

5.7.5 The system shall be capable of acting as a Dynamic data Exchange (DDE) or OPC client or server to exchange real time data with DDE or OPC compliant application.

5.7.6 When OPC is used for interfacing, system shall exchange the data with any client's application in the standard OPC format. Design shall ensure that OPC connectivity tools are fully integrated within the standard product providing seamless integration. Following shall be ensured:

a) System shall provide alarm and event information with no point building from other OPC alarm and event server directly into DCS system alarm summary.

b) Allows OPC data access clients to view DCS system data, hierarchical area, point and parameter structure.

c) Allows access to historical data from DCS.

d) Allows third party OPC server information to be mapped, displayed, alarmed, get historical data and controller data into the system server.

e) Integrates supervisory monitoring, alarming and control data between two or more OPC servers.

f) All graphic applications and all control function blocks supported by operator console software shall have direct access to data integrated with DCS via OPC.

g) OPC data groups, items and tags shall be viewable in any browser function provided in graphics, devices or control configuration tools as if these were data native to the controller sub-system.

5.7.7 **OPC Server**

5.7.7.1 Unless specified otherwise, vendor shall offer a dedicated full-fledged OPC server compliant to and registered with OPC Foundation Specification. This node in no way restricts the data transfer. In any case, the device shall be intelligent with adequate memory and software capabilities.

5.7.7.2 OPC Data Access (DA) Server

a) OPC data access server functionality shall allow bi-directional data transfer between multiple OPC data access servers for monitoring, alarming and control. DA server shall read and write process data using item ID as identifier.

b) Rate of data transfer in case of DA server is typically 1000 tags per second.

5.7.7.3 OPC Historical Data Access (HDA) Server

a) OPC client shall access DCS data by connecting to HDA server. It shall also automatically save instantaneous data acquired from DA server and A&E server to a historical database in HDA server.

b) HDA server shall be able to receive and publish data timely and efficiently whether online or from archived source. System shall be able to read raw data at the rate of 1000 tags per second and read manipulated data at the rate of 100 data per second.

5.7.7.4 OPC Alarm and Event (A&E) Server

a) OPC A&E server shall publish DCS alarm and events to OPC clients. The server shall support event types such as conditions, tracking and simple events (e.g. component failure). It shall also publish DCS alarm and event such as system and process alarms, alerts, Mode change and status change message, events, sequence of events and operator changes Operator guide message. Engineering maintenance messages.

b) OPC A&E server shall write OPC server alarms and errors messages to DCS operator console as well as OPC Clients.

c) The maximum number of alarms and events received by OPC A&E server shall be of the order of 1 A&E per second.

5.7.7.5 **OPC Batch Server**

OPC batch server shall read and write the batch related data and information of DCS.

5.7.7.6 The OPC server software shall have the following features, as a minimum:

a) It shall support standard OPC interface functions such as DA, A&E, HDA, Batch and security as specified by OPC foundation.

b) The software shall be able to interact with another OPC compliant software loaded in another server machine associated with different make of DCS or control system without the need of any additional hardware or / and software.

c) The software shall support automatic data back-up in such a way that process data acquired by DA / A&E server are automatically saved as back-up data on a disc without client having requested to save the data by server.

d) The software shall allow viewing of contents of OPC server from OPC client.

e) The software shall have capability to restrict the access of OPC server to its client to avoid exceeding the maximum accessible data and to avoid load concentration which may slow down the data access.

5.7.7.7 System Sizing

Following criteria shall be followed for sizing OPC nodes:

a) Number of third party OPC servers / nodes (This shall include UHN connected to other DCS systems) shall be minimum 10. Ten (10) concurrent licenses shall be supplied as part of OPC node.

b) In addition to third party servers, consider the following:

Number of client per OPC node	:	10
Number of third party OPC devices Such as RTU's	:	10 (when specified)

c) Following rate of data read / write shall be considered for sizing:

OPC client data read (cache read)	:	1000 per second
OPC client data read access (Device)	:	500 per second
OPC client write	:	500 per second

d) Maximum number of read and write data for OPC node : 2000 tags (unless otherwise specified).

Each tag is unique and complete with data points which shall include:

a) Process Variable (PV), Manipulated Variable (MV), Set point, Sum, Mode, Alarm Status, PID constants for analog control loop.
b) PV, Sum, Alarm status for open loops.
c) Status for digital inputs.

5.7.7.8 System Performance

OPC node shall meet the following performance requirements:

Data read and write on client machine (This includes data display update for real time data)	:	max. 5 seconds
Data read and write on server machine	:	max. 5 seconds
Maximum server loading	:	50%

5.7.7.9 OPC Node Configuration

5.7.7.9.1 OPC node system hardware shall be of latest version machine as specified in the requisition and shall meet the following requirements:

a) VDU shall be 21" active matrix TFT type coloured LCD screen with backlit LED.

b) QWERTY keyboard.

c) Mouse or Track ball control.

d) Memory as 8GB RAM and 500 GB hard disc with DVD drive as a minimum.

5.7.7.9.2 OPC node shall be supplied with operating system and other software to meet functional requirements specified herein.

5.7.7.9.3 Whenever OPC node is specified with historisation, it shall have RAID 5 / RAID 10 configuration.

5.7.7.9.4 The system when specified with redundancy, shall offer a standalone software application that provides OPC server redundancy by transparently redirecting client requests to secondary OPC server when primary OPC server is unavailable or fails.

5.8 Time Synchronisation

5.8.1 The system shall have capability to synchronise the time of all the sub-systems within the system either by internal or external clock as specified in the requisition.

5.8.2 **Time Synchronisation with Internal Clock**

Unless specified otherwise, all the sub-system node clocks shall be synchronised with designated system master clock. Master clock shall either be assigned automatically by system or assigned manually during system configuration. In both the above cases, whenever the master clock node fails, an alternate sub-system clock assumes the charge of time synchronisation. In no case, the system shall operate without time synchronisation.

5.8.3 **Time Synchronisation with External Clock**

a) When specifically indicated, the time shall be synchronised with external time reference e.g. GPS. This shall ensure that data acquired by all sub-systems will have the same and common global time reference. All hardware and / or software required to meet this requirement shall be supplied by the vendor.

b) In general, redundant system shall be provided with external GPS antenna connected to master clock server. This server shall synchronise all DCS clocks and also provide time synchronising outputs to synchronise all non DCS sub-system clocks. The node shall not exceed 30 millisecond time differences between GPS and any node clock.

c) In case of failure of master clock server, the time synchronisation shall be carried by the designated DCS master clock.

d) Additionally the GPS shall be provided with minimum 8 nos. NTP ports and 2 nos. IRIG ports for connection to external third party devices which are not part of the vendor supplied system. Each port shall be with unique IP / port address.

e) Each control room (console and rack room) building shall be provided with 1 no. LED/ LCD clock which shall be synchronized with GPS.

5.9 Shutdown Sub-system-Programmable Logic Controller (PLC)

5.9.1 Programmable logic controller shall be microprocessor based system which shall be used to execute all the process and safety shut-down logic of the plant when specified, it shall also execute plant interlock and sequence logics as well. Programmable logic controller shall be an independent unit and shall not depend on any of its functionality on any other system including Distributed Control System.

In case of common engineering database for DCS and PLC, engineering data for DCS and PLC shall be segregated and the data access shall be through respective engineering stations of DCS and PLC only. Such configuration shall meet the SIL3 compliance by third party certifying agency like TUV/ EXIDA etc.

Moreover, wherever exchange of safety parameters between the different PLC sub-systems are required for interlock execution, separate secured communication network shall be provided between these PLC sub-systems. For SIL certified PLCs, this secured communication network between PLC nodes shall also be SIL certified.

5.9.2 The system shall be designed fault tolerant and shall utilize high quality components of proven quality. Any single system fault shall not degrade the system safety or functionality or affect operation. The system shall have certified Safety Integrity Level as per IEC-61508 / 61511 as applicable and specified in requisition. Unless otherwise specified, it shall meet the availability requirement specified in Clause 5.1.3 of this specification.

5.9.3 The system shall have very high noise immunity in order to ensure safe and reliable operation when subjected to electrical radio frequency interference and Electro-magnetic disturbances expected in a plant.

5.9.4 Unless otherwise specified in the requisition, the scan time of programmable controller shall be less than 250 milliseconds for SIL certified PLCs. Scan time for a PLC shall be as defined under Clause 2.22(c) of this specification. The PLC processor sizing shall be done considering the PLC scan time for the units as mentioned in the requisition. The PLC processor sizing shall meet the specified scan time taking into consideration all the I/Os specified in the requisition including installed spare IOs and IOs for future spare space. Other activities like diagnostics routines, output / dump of data to peripherals, development of sequence blocks or any other activity which consume processor time shall also be accounted while computing scan time. This shall also be in line with SIL certification for SIL3 certified PLCs.

5.9.5 Operation of PLC shall be completely unaffected by a momentary loss of power of the order of 20 milliseconds. This shall be demonstrated during FAT.

5.9.6 On line replacement of any module of programmable logic controller shall be governed by Clause 5.1.6 of this specification in general. However, in case of Triple Modular Redundant, Quad or dual PLC configuration, there shall not be any process upset during replacement of failed module.

5.9.7 It shall be possible to Hot swap any faulty system module without degrading the system safety or operation or freezing the output status. The switchover to the healthy module shall be bumpless. The swapped module shall take over the function of the failed module without any manual programming.

5.9.8 The system shall be programmed in principle as per the logic diagrams. Owner / Consultant reserve the right to revise or review the logic diagrams even after acceptance of any offer. The programming language of offered PLC shall be as per IEC 61131.

5.9.9 Whenever the requirement of SIL is specified, it shall meet the requirements of SIL level specified and shall be certified by an independent body (e.g. TUV/ EXIDA) for complying requirements of IEC-61508 / 61511 as specified. For shutdown application requiring SIL certification, PLC shall always meet SIL 3 requirements. Also for SIL Certified PLC, assembling and engineering shall be done from a factory certified for FSM by an Independent Testing Agency (e.g. TUV/EXIDA).

5.9.10 Power supplies in the system shall be provided as follows:

5.9.10.1 Each I/O rack shall have be provided with redundant power supply system. The power supply for the I/O racks shall be sized to take full load of the I/O racks.

5.9.10.2 The processor rack shall be provided with separate power supply for each processor or redundant power supply module for the processor rack such that failure of one power supply does not affect the system operation.

5.9.11 **System Configuration**

5.9.11.1 General

a) PLC system configuration shall be as specified in the requisition. For emergency shutdown system application specified with SIL classification, the system configuration shall be TMR or Quad or DMR as per the job specification and shall be certified by independent agency e.g. TUV/ EXIDA.

b) Regardless the action feature selected (except for single architecture), the failure of single component shall not result in a failure of correctly executed safety function. The degradation mode for the selected configuration e.g. 3-2-0 or 4-2-0 or 3-2-1-0 etc. shall be documented in SIL certification report.

c) In general, the PLC system shall comprise of various sub-systems as described in the subsequent clauses of 5.9.11.

5.9.11.2 Input/ Output system

5.9.11.2.1 Each I/O module shall have its own processor. I/O modules configured in redundant configuration, shall have their processors properly synchronised.

5.9.11.2.2 Unless otherwise specified, system shall accept analog 4 – 20mA inputs and contact inputs. The maximum number of Input/ Output per I/O module shall be limited as per the following table.

Sl. No.	Type of Configuration	Maximum No. of I/Os
1	Single I/O system	8
2	Dual I/O system	16
3	Triple Modular Redundant system (TMR)	32
4	Quadruple Modular redundant System (Quad)	16

In case of PLC certified for SIL requirements, the maximum number of I/O's shall be governed by the SIL certification applicable for specified SIL level.

5.9.11.2.3 Each I/O shall be protected against the reversal of polarity of the power voltage to I/O.

5.9.11.2.4 Each input shall be provided with filters to filter out any noise in the input line and contact bouncing noise, as applicable.

5.9.11.2.5 All the inputs shall be double ended i.e. two wires per input and not with common return for all inputs upto the I/O module.

5.9.11.2.6 The interrogation voltage to the inputs and power supply for 2-wire instruments shall be powered from separate redundant power supply / supplies and shall not be a part of PLC, unless otherwise specified. This power supply shall be supplied at one point and shall be distributed by the vendor.

5.9.11.2.7 a) Each I/O module channel status shall be represented on the operator console.

b) When specified, input module shall be capable of monitoring the input contacts for any wire open fault.

5.9.11.2.8 Analog Input Module

a) Input module shall be able to accept 4~20 mA DC input from smart transmitters (e.g. 4 – 20mA HART).

b) The module shall have 14 bit A/D resolution accuracy of ±0.25% of full scale over the entire range, unless otherwise specified.

5.9.11.2.9 Output contacts

a) Output contacts from the PLC shall be potential free dry contacts with contact rating as per clause 5.9.11.2.10 b) of this specification. Wet contacts/ powered contacts / TTL outputs etc. shall not be acceptable.

b) The output contact rating shall be as follows:

Sl. No.	APPLICABLE FOR	VOLTAGE RATING	CURRENT RATING
1.	All output cards driving solenoid valve and alarm annunciator system unless otherwise specified Category – I Category – II	 110 V AC/ DC 24 V DC	 0.5 A 2 A
2	All motors/pumps/compressor output cards unless otherwise specified. Category – I Category – II	 240 V AC 110 V DC 220 V DC	 5.0 A 0.2 A

The category of contacts shall be specified in the Requisition.

c) Each output shall be short circuit proof and protected by fuse. Visual indication of fuse blown must be provided for each module.

d) When specified contact output module shall have monitored output features like that specified in clause 5.9.11.2.8(b).

5.9.11.2.10 Where inputs or outputs have multiple field devices for the same measurement or device, the corresponding inputs / outputs shall be configured in separate I/O modules.

5.9.11.2.11 Where single input signal is available for Quad or TMR configuration, inputs shall be multiplied to feed inputs to each input modules.

5.9.11.3 Processor System

5.9.11.3.1 The processor shall have capability to implement all the control functions required to implement the logic scheme as logic/ladder diagram.

5.9.11.3.2 The size of the memory shall be sufficient for storage of the program instructions required by the logic schemes and other functional requirements. Offer shall indicate the amount of memory capacity occupied by the actual program and spare capacity available for future program modifications or additions.

5.9.11.3.3 Memory shall be non-volatile. However in case volatile memory is provided, battery backup shall be provided with a minimum of 3 months lifetime to keep the program storage intact for a period of minimum 48 hours. A battery drain indication shall be provided to alert the operator at least one week before the battery gets drained.

5.9.11.3.4 Watchdog timer shall be a software device. The healthiness of processors shall be continuously monitored by watchdog timer. Any hardware or software problem in the

processor system, which shall include, CPU, memory, power supply, communication interface etc. shall cause the watch dog timer to report processor failure.

5.9.11.3.5 Wherever dual redundant processor is specified, redundancy shall be provided in such a way that in case of failure of the main processor, the standby shall take over automatically online. The changeover shall be bumpless. Redundancy shall be provided for complete processor system including processor, power supply and communication sub system.

5.9.11.3.6 In case of triple redundant system all the three processors shall execute the same instructions/ programs and check their results and majority vote to correct any faulty result. The faulty processor diagnostic shall be made available.

5.9.11.3.7 In case of Quad system, individual processors shall execute the same instructions/ programs and check their results within same CPU module and vote to correct any faulty result. The faulty processor diagnostic shall be made available.

5.9.11.3.8 Failure of a single processor in dual redundant, triple redundant system and two processors in quad system shall not affect the system. In case of failure of complete processor system i.e. both processors in case of dual configuration, two or more in case of triple redundant system and more than two in case of quad system, outputs shall take failsafe state automatically unless otherwise specified in the data sheets.

5.9.11.3.9 In case multiprocessor configuration is offered, the processors must be able to communicate with each other over the interconnecting data link. Vendor must ensure that system performance shall not be degraded by any means when such a system is offered.

5.9.11.3.10 It shall be possible to generate the first out alarm contact by the PLC in case where a group of parameters are likely to trip a system.

5.9.11.4 PLC Console (Engineering)

5.9.11.4.1 The PLC engineering console shall be used for programming, program storing, fault diagnostics and alarm monitoring. Whenever specified, it shall also be possible to use this for plant operation. The functionality to operate as engineering terminal or operator terminal or both shall be as specified in the requisition.

5.9.11.4.2 It shall consist of at least one coloured 21" size TFT LCD screen with backlit LED and one programming / operating keyboard and printer unless specified otherwise.

5.9.11.4.3 The keyboard shall be easy to operate with each key clearly identified.

5.9.11.4.4 All illegal entries shall be rejected by the terminal and shall be identified by warning signal on VDU.

5.9.11.4.5 Manual forcing of any input or output contact connected to PLC shall be possible from keyboard. Forced functions shall have an associated audit trail.

5.9.11.4.6 It shall be possible to modify, add or delete the application program on line without affecting the outputs.

5.9.11.4.7 PLC Console shall display logic and/or ladder diagram indicating power flow and shall show description and status of each contact. It shall also be possible to display process alarms and diagnostic messages as and when they appear. Further it shall also be able to display I/O map in a user defined format.

5.9.11.4.8 It shall be possible to print out the ladder/logic diagram on the dedicated PLC printer. The printer in addition shall also print out:

a) The diagnostic messages as and when generated and diagnostic reports, when called for.

b) Process alarms connected to the programmable logic controller as and when they appear and alarm report whenever initiated. The choice of printing alarms on this printer shall be operator selectable from a key lock / password protected switch on PLC console.

c) The I/O maps showing status of all inputs and corresponding outputs in a user defined format.

5.9.11.4.9 The PLC console shall be provided with self diagnostics feature which shall display error messages and initiate an audible alarm if the fault is detected. Wherever specified, a potential free contact for diagnostic group alarm shall be provided which shall be connected to the hardwired alarm annunciator system.

5.9.11.4.10 The system shall be able to identify the failure at least up to the module level including I/O system and redundant processor and report print out.

5.9.11.4.11 PLC console when used for plant operation shall also meet the following functional requirements.

a) At least two number cursor control devices shall be provided in addition to keyboard which may include touch screen, mouse, track ball etc.

b) PLC operator console shall have complete graphic capability and shall be able to display process dynamic graphics, overview and group view displays. It shall be possible to operate the plant i.e. start and stop of rotating machinery, opening and closing of valves etc. from dynamic graphics and group displays available on PLC operator console.

c) It shall be possible to monitor, historise and print out all process alarms, diagnostic alarms and alarm reports.

d) The time stamping of all alarms shall be as per PLC processor time stamping or I/O module stamping.

e) The system shall be able to store and display stored data wherever required. The minimum storage capacity shall be for 30 days at 1 minute sample rate for all the inputs specified, diagnostic alarms, process and first out alarms, manipulation data etc.

f) The system shall be able to generate shiftly, hourly, daily, weekly and monthly reports. The log format shall be furnished during detailed engineering.

g) The system shall be supplied with first out alarm generation capability. The resolution of alarm shall be as per processor cycle time, as a minimum.

5.9.11.5 PLC Communication Subsystem

5.9.11.5.1 The PLC communication subsystem shall be a digital communication bus that provides a high speed data transfer rapidly and reliably between the processor, I/O sub-system, PLC console and other devices connected in the PLC system.

5.9.11.5.2 Redundancy in PLC communication subsystem shall be provided as follows unless otherwise specified.

a) For single architecture, the communication subsystem between PLC processor and I/O subsystem shall be single unless otherwise specified. This shall include single communication bus and single interfaces/buffers.

b) For dual I/O configuration, each I/O sub set shall have separate communication interface and bus for connecting to PLC processors.

c) For the triple redundant system, each processor shall have a separate set of PLC communication subsystem.

d) For the Quad systems each I/O subset shall have redundant communication interface and bus for connecting to the redundant CPU modules.

e) The communication subsystem between processor subsystem and PLC console shall be dual redundant, consisting of two separate communication interfaces and two buses, each one configured in redundant mode, unless this is only used as programming aid.

5.9.11.5.3 In case of redundant PLC communication sub system, on the failure of the active device, the redundant device shall take over automatically without interrupting the system operation. Information about the failed device shall be displayed at local as well as on PLC console. It shall be possible to manually switch over the communication from main bus / device to redundant bus / device without interrupting any system function.

5.9.11.5.4 The mechanism used by the system for error checks and control shall be transparent to the application information / program. Error checking shall be done on all data transfers by suitable codes.

5.9.11.5.5 Wherever remote I/O is specified in the requisition, it shall be redundant and SIL3 certified (for SIL3 PLCs).
Segregation for the remote I/O shall follow the same philosophy of group wise PLC segregation specified in the requisition. Moreover, separate PLC in remote I/O location with peer to peer communication with Host PLC through third party (TUV/ EXIDA etc.) certified SIL3 redundant network is also acceptable for remote I/O requirement. However, separate PLC shall be considered for each of the Remote I/O subsystem within each location.

5.9.11.6 Interface with Distributed Control System

5.9.11.6.1 The PLC shall be required to be interfaced to the offered Distributed Control System bus. A suitable interface shall be offered in order to achieve the following functions:

a) Display of all input points under alarm/first out alarm connected to PLC or generated by PLC on the main operator console.

b) Generate shutdown reports on the logging printer of Distributed Control System.

c) To receive certain operational commands from the operator console for the operation of certain output devices connected to PLC.

d) To display diagnostic messages of PLC.

5.9.11.6.2 In general, PLC shall provide data in a well-established protocol format. If DCS and PLC are not of same family, then PLC shall be serially interfaced with DCS through dedicated redundant serial interface gateway and protocol shall be preferably be MODBUS.

5.9.11.6.3 The interface shall be dual redundant unless otherwise specified meeting all requirements as specified under para 5.9.11.5.3 and 5.9.11.5.4 of this specification.

5.9.12 **System Software**

5.9.12.1 The system software shall include all programs for the PLC and PLC console which are required to perform all PLC functions including communication and self diagnostics.

Whenever PLC is specified for shutdown application with SIL classification, the system shall be designed and engineered in full compliance with the requirement of IEC-61511.

Whenever different functional logics are combined within a common PLC, the safety related I/O's of each functionality shall be kept segregated within the system.

5.9.12.2 Logic program shall also be recorded on the external electronic mass storage media which shall be delivered in duplicate together with the system.

5.9.12.3 The PLC programming language for implementation of logic operations shall be based on the following representations:

a) Logic diagrams - Binary logic symbols such as AND, OR, NOT Gates, Timers and Flip-Flops.

b) Ladder diagram - Series / parallel connection of relay contacts.

c) Combination of (a) & (b) above.

5.9.12.4 It shall be possible to print out the ladder/logic diagram on a dedicated printer. The printer shall also print out all diagnostic reports. The software package shall enable the owner to modify/add/delete any part of program both on-line as well off-line and for documentation.

5.9.12.5 Software for the generation of various displays including dynamic graphics, whenever specified, to be provided as per para 5.4.3.5 of this specification.

5.9.12.6 The software for printing alarms, system as well as process, and events on the PLC printer must be provided. All alarms must be printed as and when they appear.

5.9.12.7 Software package for displaying I/O map showing status of inputs and corresponding output as per logic shall be offered. The I/O map format shall be user definable.

5.9.12.8 The system shall have an extensive set of self diagnostic routines which shall be able to identify all permanent and transient system faults / failures at least up to module level including redundant components and power supplies through detailed VDU displays and report print out. Diagnostic software shall have the capability to provide information about the failed module/system either in the form of a system configuration display or provide information in the form of a statement.

5.9.12.9 System for the following functionalities shall be supplied when specified:

a) Long storage historisation

b) Log report generation

c) First out alarm generation

5.9.12.10 System diagnostics shall be capable of identifying, locating and reporting the following faults, as a minimum:

a) Processor fault

b) Communication fault

c) I/O module fault

d) Power supply fault

e) Over temperature monitoring

f) Permanently close / open (stuck on or off) fault

g) Memory fault

h) Signal redundancy fault

Any other additional diagnostic alarm if available as a standard shall also be provided by vendor.

5.9.12.11 Self diagnostic software shall have capability to detect faults which make the system permanently close/open in the I/O modules or I/O signal conditioning modules (in case of triple redundant system). This shall be achieved by automatically running the self diagnostic software at cyclic intervals. However, system performance shall not be degraded during the running of this diagnostic software.

5.9.12.12 In case of dual I/O or dual signal conditioning modules for triple redundant system or quadruplicate system, whenever output module testing software detects any faulty channel, the power supply to that particular module in that particular bank is removed automatically and further testing on the corresponding module in the other mirror image bank is stopped. However, the testing continues uninterruptedly in other output modules.

5.9.12.13 Feedback must be provided in case of triple redundant system and quadruplicate system from the output voter system to detect any latest faults of the system in addition to other diagnostic software as per para 5.9.12.8 through 5.9.12.10 of this specification.

5.9.12.14 Diagnostic package and its related equipment and software shall be supplied. A list of additional diagnostic packages available and the packages provided, including the description and capabilities, shall be provided with separate quote, wherever asked.

5.9.13 **Sequence of Event (SOE) Function Requirement**

Sequence of Event for analog and digital inputs shall be generated and time stamped in PLC. The maximum resolution between two events shall not exceed specified PLC scan time unless specified otherwise. A separate SOE PC with 21" size TFT with backlit LED screen and printer shall be provided for PLC sub-system unless specified otherwise.

5.9.14 Unless specified otherwise, one no. Maintenance override switch (MOS) shall be provided on the hardwired console for each PLC sub-system. On activation of MOS, any particular interlock input shall be able to be selected for bypass through the DCS Operator Console. MOS once activated will be automatically de-activated within a user selectable specified time. MOS shall not be applicable for interlock inputs from field in 2oo3 configuration.

5.10 Foreign Device Interface

5.10.1 Foreign device interface shall be capable to transfer data from the foreign devices like analyser systems, gas chromatographs, gas turbine system etc. to other sub-systems connected to communication sub-system and vice versa wherever specified in the requisition.

5.10.2 Each device interface shall be redundant unless otherwise specified in requisition.

5.10.3 Interface hardware and software shall be suitable to match the foreign device communication requirements like hardware interface, communication protocols etc.

5.10.4 While writing software or mapping the input/output in the interface device it must be ensured that integrity of the data to be transferred like resolution, correctness etc. shall be maintained.

5.10.5 Redundant interface switchover shall be designed based on the type of redundancy available in the foreign devices.

5.10.6 The total responsibility of selection of hardware, writing of software, switchover of redundant interface etc. shall be of distributed control system vendor only. All necessary information, assistance and help shall be rendered by the Foreign device vendor.

5.10.7 For foreign device interface, wherever redundant serial interface is specified in the requisition, each link shall be connected to separate serial interface module / interface device.
The number of serial interfaces per serial interface module / device shall be as per the requisition.

5.11 Hard-wired Instrumentation

5.11.1 Hardwired instruments, when specified in the requisition, shall be stand-alone type and shall meet their functional requirements fully without depending on DCS system. Even power supply and input/output circuits of hardwired instruments shall be totally independent of DCS system.

5.11.2 Hard wired instruments shall be microprocessor based. Each instrument shall have as a minimum the necessary firm-ware to meet its functional and operational requirements.

5.11.3 Each device shall have its own analog to digital/digital to analog converter.

5.11.4 The display of each device shall preferably be bar graph type.

5.11.5 Single loop Controller shall be digital type capable of performing automatic control based on the set points given locally or from a remote device like another controller or Distributed Control System or Supervisory computer. The controller as an instrument shall also have provision for manually controlling the process by means of a manual loader and cascade-computer auto-manual transfer switch. The operation of the transfer switch shall be procedure-less and bumpless while changing mode from computer to cascade to manual and from manual to auto to cascade to computer. During such a change the output shall not change by more than 1% of span. Controller shall have a facia giving continuous indication of process variable, set value, controller output and controller mode. It shall be possible to remove an instrument for maintenance without upsetting the process by use of device like service station. Operation of the controller like set point change, manual control, controller mode change shall be possible from the front of the controller. Controller shall be flush panel mounting type on the hard wired console. Configuration and tuning of controller shall be possible through a portable and pluggable configurator.

5.11.6 Temperature transducers and trip amplifiers shall accept inputs from standard industrial thermocouple and resistance temperature detector (RTD). Linearization of the thermocouple and RTDs shall be done inside each instrument. Transducers and amplifiers shall be suitable for rack mounting.

5.11.7 Alarm cards shall accept standard outputs and shall produce changeover contact output. Each alarm card shall have one continuously adjustable blind setting device. Alarm cards shall be suitable for rack mounting.

5.11.8 **Alarm Annunciator system**

5.11.8.1 The alarm logic shall be executed in single input plug in type logic modules. Where integral logic has been indicated, the logic module shall be accessible from the front of the annunciator after opening the swing door. The design of each module shall be such that by simply

jumpering suitable point, it may be changed from normally open mode of operation to a normally closed mode of operation and vice versa.

5.11.8.2 Alarm Annunciator shall have clustered LED type display per alarm.

5.11.8.3 The initiation of alarm condition in the annunciator shall take place approximately 330 millisecond after the condition sensing contact has assumed the off- normal state.

5.11.8.4 Hooter, in general, shall be solid state type with audibility of the order of 80 dBA at a distance of 3 meters.

5.11.8.5 An interruption of power supply for a duration of 20 milliseconds or less shall not affect the functioning of the annunciator.

5.12 Instrument Asset Management System (IAMS)

5.12.1 Instrument Asset Management System shall facilitate the maintenance management of all smart, Fieldbus based and conventional field instruments. Unless otherwise specified, the system shall manage the maintenance of following:

a) All smart and Fieldbus based instruments connected to Distributed Control System and Programmable Logic Controller.

b) Conventional (non-smart / non Fieldbus) instruments connected to DCS and PLC or any other dedicated instruments.

5.12.2 The system shall include all hardware and software to meet specified functional requirements. IAMS shall be an integral part of Distributed Control System and shall acquire the data from the controller and data acquisition sub-system and PLCs. Inputs which are connected to programmable logic controller and do not have digital pass through features as a standard, shall be parallely connected to IAMS in such a way that the hardware used shall allow unrestricted transfer of digital signal without degrading the analog signal.

5.12.3 A dedicated IAMS console with following features consisting of one video display unit along with a laser printer shall be provided:

a) Display all data related to device diagnostics and complete configurational data base.

b) Provide historical data for calibration and device configuration / reconfiguration etc.

c) Generate event and other device reports.

d) Manual data entry with password / key lock.

The VDU shall be 21" colour TFT LCD with backlit LED monitor along with a keyboard.

5.12.4 The system shall support multiple authorisation levels for carrying out configuration changes and calibration adjustment.

5.12.5 The Instrument Asset Management System shall meet the following requirements:

a) Instrument Configuration

It shall be possible to configure, verify the configured parameters, reconfigure, re-range and calibrate / recalibrate the smart and Fieldbus devices from IAMS console.

b) Device Status Monitoring

The system shall monitor the status of all field devices and shall report any maintenance alarm generated by these devices. In general, following shall apply:

- Diagnostic alarms from smart and Fieldbus devices shall be classified into device failure and device diagnostic categories.
- Out of limit alarm shall be generated to indicate device failure alarm for conventional devices.

The system shall be capable of displaying and generating maintenance report listing all devices currently under alarm. The report may be generated unit-wise / area-wise or for complete plant.

c) Maintenance Database

The system shall be able to maintain maintenance database for all the instruments which shall include date of commissioning, last calibration date and next calibration due. The system software shall have capability to manage and track scheduling of all such maintenance related activities.

The IAMS software shall also provide data as predictive maintenance such as list of transmitters experiencing excessive drift, list of control valves loosing on shipped parameters etc. when the IAMS is loaded with the device DTM files, valve advanced diagnostic software etc.

d) Audit Trail

The system shall have capability to provide an audit trail for a complete historical record of all configuration, calibration and device alert data. This shall include tracking of maintenance history for all instruments in the plant, typically recording the type of maintenance work done, smart and compilation times of activity, person responsible for the activity etc.

e) Advanced Diagnostics

The system shall be able to provide advanced diagnostics such as device step response, device signature, dynamic error band etc. Special device diagnostic software whenever required (like for smart / Fieldbus positioner) shall also run in the system.

f) Documentation

System shall generate documentation like trend reports, diagnostic reports, pre-detective maintenance report, audit report, historical data and device specification sheet etc. through the diagnostic software of the Smart/ FF device loaded in the IAMS system. Definition, engineering, configuration, loading and compilation of all reports whether specifically indicated are available as standard and shall be supplied as part of vendor scope of supply.

g) Partial stroke testing for on-off valves with partial stroke testing positioner shall also be carried out from the IAMS. For this, DCS HART pass through analog output modules shall be considered by the vendor which shall be connected to the Partial stroke testing positioners of the valves.

h) It shall be possible to show the control valve position status, received from Smart positioner through HART signal, on the DCS Operator console.

i) The IAMS shall be pre-loaded with all the DD files published in https://fieldcommgroup.org/ so that the HART/FF instruments are detected

automatically and manual mapping of the DD file for each instrument is not required during system commissioning.

5.13 Alarm Information Management System (AIMS)

5.13.1 The purpose of Alarm Information Management System (AIMS) is to provide a centralised Alarm information over and above the requirements specified in Clause 5.4.3.8 of this specification and shall be used for acquiring, sorting, add value and provide redistribution platform, so as to streamline and transform the raw alarm data into intelligent and actionable information for plant operation personnel.

5.13.2 The system shall acquire inputs from various systems such as:

- Distributed Control System / Systems and Programmable Logic Controllers.
- ESD and F&G Systems
- Package unit control systems, wherever specified.
- Electrical control system / systems, wherever specified.
- Electrical numerical relays, wherever specified.
- Any other system defined specifically in the requisition.

5.13.3 Unless otherwise indicated, the AIMS shall have high speed data transfer OPC link connectivity with the systems. Where OPC link is not available, the data transfer shall be through dedicated serial links. In addition, AIMS shall also have capability to accept hardwired inputs.

5.13.4 Unless otherwise specified, the following type of data shall be acquired by the AIMS software for further analysis:

- Process and utility alarms
- System diagnostic alarm
- Sub system status alarms
- Operator activities
- Maintenance alarms

The AIMS shall offer a variety of alarm handling feature for processing and presenting alarms in most efficient way. The package shall be a comprehensive tool with capabilities of:

a) Logical filtration of alarms during normal and special operating conditions such as start-up, process upset and turndown conditions.

b) Logical processing of events and sequence of events for facilitating quick assessment of normal or emergency situation based on pre-defined rule-sets.

c) Generation of different levels of alerts, based on type of alarms, sequence of alarms, logical processing of alarms etc. and propagation of the same to different groups and categories of personnel's, based on pre-defined alarm distribution matrix.

5.13.5 AIMS shall meet the following functional requirements, as a minimum:

5.13.5.1 Data Acquisition

The data acquired from the various sub-systems and other control systems shall be stored in a dedicated AIMS server. The data shall be stored in a structured format and shall contain tag number, time of occurrence, text information like service description, event type, alarm priority, alarm group priority etc.

5.13.5.2 Alarm Computing

The package shall have capability to generate / compute alarms based on a logical combination of states, conditions and events.

5.13.5.3 Information Analysis

The package shall have capability to analyse and present only the meaningful information. This shall include the following:

a) Analyse the alarm frequency within the predefined period and its repetition period.

b) Analysis of various alarms to identify nuisance, chattering and redundant alarms and eliminate them, if necessary.

c) Analysis of various alarms to identify serious alarms and monitor their frequency of occurrence.

d) Monitoring Operator actions.

5.13.5.4 Expert Alarming

i) The system shall be able to carry out statistical analysis on the alarm data gathered and perform:

- Real-time frequency analysis
- Alarm frequency break-up
- Alarm frequency monitoring
- Standing alarms
- Time elapsed between two alarms / events

ii) The system shall have capability of implementing rule sets to analyse various alarms / data and inform plant operator the probable reason, make recommendations for the action to be taken and provide operational alternatives.

iii) System shall also be capable of analyzing and recommending maintenance requirements based on preset rules.

iv) The system shall have advanced search and sort features to provide quick access of alarm data to operator.

5.13.5.5 Alarm Prioritisation

The system shall have the capability to segregate the alarms as per their criticality and operational importance, which may be defined as per the severity with respect to its:

- Production losses
- Human and equipment safety
- Environmental safety
- Process reaction time like run-down reactions

The alarms shall be differentiated in different displays by allocating different colour codes.

The system shall be able to be configured with different priority levels which shall be defined based on the process criticality and operational requirements. As a minimum following priority levels shall be definable:

Level 1 - Alarms directly related to human safety – leading to heavy casualties
Level 2 - Alarms directly leading to total plant shutdown – personnel, environmental and equipment safety hazard.
Level 3 - Alarms leading to partial plant trip conditions.

Level 4 - Maintenance alarms not leading to immediate plant trip.
Level 5 - Status or low priority alarms for operator information.

Other priorities shall also be user definable. It shall also be possible to set priority for each and every alarm point. Assignment or change of level of priority shall be possible only under password protection.

Number of alarms under each level of priority shall be user definable. However, for the purpose of internal assignment, following numbers may be considered

Priority Level	No. of Alarms
Level 1	10 Nos. minimum per unit
Level 2	70 Nos. minimum per unit
Level 3	5% of balance alarms per unit
Level 4	20% of balance alarms per unit
Level 5	75% of balance alarms per unit

5.13.5.6 Alarm Display

a) AIMS shall display alarms gathered from all Nodes / subsystems seamlessly and shall be displayed on any display irrespective of source or location.

b) Alarm display shall be sorted out in the form of alarms groups in the following categories:

- Priority level sorting
- Sorting as per type, frequency, unit-wise, area wise and operating area wise.

c) AIMS displays shall be in graphic form with user friendly displays, color modifiers etc.

d) The system shall process alarms using well proven analysis techniques, directly related to specific alarms, which are trendable.

The system shall have advanced Rule-based and latest abnormal condition management tool which shall provide prediction and anticipation of plant deterioration with sufficient lead time for operation action. The system shall also have real time root cause analysis.

5.13.5.7 Operator Actions

The system shall be able to acquire and analyse Operator action required during plant operation such as:

- Time to alarm acknowledge
- Controller mode changes
- Controller set point changes
- Analogue output changes (in manual mode)
- Discrete output changes (in manual mode)
- Alarm level of priority changes
- Range changes
- Tuning constant changes
- System configuration changes e.g. control algorithm, cycle time changes etc.
- Manual time adjustment
- Alarm acknowledgement
- ESD switch actuation (full or partial)

- Any other operator action not specifically indicated above but required during operation. The operator actions shall also be categorised based on their criticality in various levels.

  Level – 1 - Most critical operator actions leading to plant shutdown in full e.g. ESD switch action.

  Level – 2 - Configuration changes or set point changes which may lead to mal-operation or partial plant shutdown e.g. set point changes, range changes, time adjustment etc.

  Level – 3 - Changes which may affect control but rarely could lead to plant Shutdown full or partial e.g. controller mode change, range changes, tuning constant changes etc.

  Level – 4 - Actions which are for mere operation but does not lead to plant shutdown.

  The system shall also able to provide information like:

  i) Time to acknowledge alarms

  ii) Alarm acknowledge time exceeding a pre-set value.

5.13.5.8 Report Generation Printing

The package shall have capability to:

a) Store alarm messages for a period of minimum one year and shall have facility for data archival on external electronic portable media.

b) AIMS shall be capable of generating and printing reports in user defined formats. The data in each report shall be raw, manipulated, calculated, compressed or analysed.

c) The alarm shall be possible to be printed as and when required, as a user defined formats. These formats shall be defined during engineering.

5.13.5.9 System Diagnostics

The AIMS shall have extensive set of diagnostic subroutines running in real time basis and shall provide at least the following diagnostic alarms:

- System software failure
- Disc / Disc drive failure
- Application software failure
- Network failure
- Communication software failure
- Disc full
- Power supply failure

These diagnostic alarms shall also be made available at DCS operator and engineering consoles.

5.13.5.10 Data Storage and Archival

AIMS shall store alarms and events indicated in Clause 5.4.6 for a period of minimum 1 (one) year in the hard disc. Multiple disc configurations, if required, shall be provided. For the purpose of calculating data storage capacity, consider occurrence of 30% of alarm and events per day apart from other system defined functionalities.

5.13.5.11 Alarm Notification and Audio Messaging

The system shall be capable of performing following alarm notification and messaging functions:

a) Dial Telephone
In case of predefined alarm or alert condition the system shall automatically dial a telephone number and plays a pre-recorded message. All hardware and software for auto-dialing shall be included.

b) Dial a Cell phone
The system shall have facility to dial up mobile cell phone. When an alarm occurs, the system shall be able to send a text (SMS) message also.

c) E-mail
When a predefined alarm occurs, the system shall be able to send message through an e-mail to the predefined user. This facility shall also be utilised to send e-mails to the manufacturers of various system oriented items like DCS, PLC etc. in case of occurrence of a critical system diagnostic alarm.

d) Audio Messages
Whenever specified, the system shall be capable to play a pre-recorded message in case of predefined critical alarms on the plant public address system. For example, this shall be useful for alerting plant personnel on gas / fire alarm in a particular area.

e) Emergency Hooters
The system shall be capable of generating input such that in case of an emergency condition emergency hooters can be initiated along with audio messages on the public address system.

5.13.6 **System Hardware & Software**

5.13.6.1 AIMS shall have all the hardware and software to meet the following major functional requirements:

a) Efficient storage and archiving of acquired and manipulated data to allow retrieval of reports or alarm analysis information.

b) Retrieval of important information on-line to a network drive disc or dedicated device.

c) Remote access to more than one client on the network.

d) Export alarm, events or other information to other applications like Excel.

e) Advanced diagnostic techniques for analysis of acquired data.

f) Log the time between specified alarms / messages.

g) Assignment of various levels of passwords.

h) Multiple clients accessing different data or data screens simultaneously.

i) Disc mirroring for data storage over the network.

j) Automatic Triggering of alarm reports and messages on devices like mobiles, telephones, computer networks etc.

k) Data search facilities with efficient search engines like SQL.

l) Data sorting facility as per defined rule-set.

m) Time stamping of data as per AIMS clock wherever required.

5.13.6.2 AIMS can be realised on either the DCS platform or as a standalone system. In either case the offered solution shall meet all the requirements specified.

5.13.6.3 In case AIMS functionality is realised on DCS platform a separate dedicated AIMS station shall be provided. This station shall have same hardware and software configuration as operator console and shall have redundant storage disks (for bulk data storage.

5.13.6.4 In case stand-alone system is considered, the same shall meet the following requirements:

a) The system shall be capable of interaction with DCS via a serial port or by OPC connectivity.

b) The system shall have a minimum of one dedicated server with monitor and cursor control devices capable of meeting all functional requirements for AIMS. If the system demands more than one server to meet job requirements, the same shall be supported and provided.

c) The AIMS console shall be server based machine of latest version and shall have 21" TFT LCD with backlit LED screen with keyboard, mouse and read / write DVD drive.

d) The system shall support client server architecture with minimum of 4 clients. Detailed functionalities of these clients shall be finalised during engineering. Wherever supply of client PCs is specified as part of DCS scope, it shall be of latest version and shall have 21" TFT LCD with backlit LED screen with keyboard, mouse and read / write DVD drive.

e) AIMS server shall be RAID5 / RAID 10 having redundancy in storage discs for bulk-data storage.

5.13.6.5 In general, all alarms and events shall be transferred to AIMS with time stamped by the originating devices. AIMS shall maintain this time for further analysis. AIMS shall time stamp the acquired data only when this data is not transferred by the originating device with time stamp.

5.13.6.6 The AIMS connectivity to the systems shall be either from the control network (i.e. communication sub system) or from the serial ports available in these devices. For third party systems direct connectivity from the station having master database is preferred.

5.13.6.7 When multi drop serial link connectivity is considered, not more than four (4) devices shall be multi-dropped on one serial link to server.

5.13.6.8 AIMS server memory shall be sized suitably to display and printout the alarm history of all the tags of all the systems and sub-systems connected to it.

5.14 Unit History Node (UHN)

5.14.1 UHN shall primarily be used to carry out the following activities:

a) Store automatically gathered data from control system (DCS, PLC, etc.), other DCS systems over OPC and manually entered data.

b) Present data in a meaningful manner for performance enhancements and fault analysis.

c) Long term historisation of data for future reference and decision making.

d) Carryout calculations on the real time and stored data, as necessary.

5.14.2 The UHN shall be a high capacity data storage device where data from various process units shall be stored in a fast access database. The node shall support standard open system interfaces like OPC, SQL, OLE, DDE and shall provide Active X facility.

5.14.3 UHN shall Collect Data from

a) Distributed Control system of which this UHN is a node.

b) UHN's of other control systems

c) Nodes other than UHN's connected on information network.

d) Manually entered data.

The data collected shall be of various types like process variable, set point, computed variable, manipulated data, outputs, alarms, events, which shall be used for long term storage, trending and report generation.

5.14.4 UHN shall have capability of storing real time data in real time database and shall perform functions like:

a) Identification of bad data (algorithm to run in UHN when necessary)

b) Specify dead band and data sampling rate (or collection rate) as user definable parameter.

c) Calculate maximum, minimum, average, summation, and integrated values of collected data. The time period of calculating average shall be user definable.

d) Specify high / low, high – high / low – low alarm limits for triggering an event or message or alarm as applicable.

e) Specify damping parameter, delay parameter etc. to reject unwanted data.

f) Specify data storage / sampling rate and period of storage necessary for historical storage of data.

g) Mathematical functions and application program as specified in Requisition which are necessary for report generation. (This does not include advanced control functions but do include MIS reports)

All the parameters indicated or functions performed shall be definable tag number wise.

5.14.5 **Data Management and Data Presentation**

5.14.5.1 UHN shall act as a network server and shall support two way data communication between:

a) DCS and UHN for real time data transfer. UHN shall acquire real time data from DCS and provide derived and calculated data to DCS.

b) UHN and information network to transfer data from other systems on information network to UHN and vice versa.

UHN shall be a separate and independent node and is in addition to any History node or History server provided as part of DCS functionality.

5.14.5.2 UHN provides the user with current raw and calculated / manipulated data on predefined graphic screens or pre-defined report formats. The graphic screens and report formats are user configurable.

5.14.5.3 UHN performs long-term historization of raw and calculated / manipulated data.

5.14.5.4 The data received or sent from the UHN shall have time stamp associated with it from the originator of the data. The data update is effected in case the data value has changed by more than the configured dead band since the last update.

For manually entered data, the time stamp shall be time of entering data (by default) or the time entered with the data as applicable.

5.14.5.5 UHN time shall be synchronized with DCS time clock. For time synchronization refer clause 5.8 of this specification.

5.14.5.6 UHN shall maintain relational database and shall support RDBMS tool.

5.14.5.7 All data raw, manipulated or manually entered acquired or calculated by UHN shall be stored, as unit-wide historian. Historian can be accessed to retrieve the data from specified period in the past. Historian should have capability to store data for a period of one year (365 days) with a sampling rate of 30 seconds, as a minimum. Other sampling rates such as 1 minute, 5 minutes, 10 minutes and 1 hour shall also be possible. The duration of on-line storage shall be controlled by the archiving facilities which in turn shall be dependent on specified sampling rate.

5.14.5.8 The data shall be presented to the user in a well structured hierarchically configured user displays. User shall be able to navigate down to any detailed data displays without any system configuration knowledge.
The display structure may include:

a) Overview display or main menu display, displaying key process parameters and performance indicators like real time data, snap-shot, calculated variables, real time trend, historical trends, manual data entry, function block, alarm and events, reports etc.

b) The reports generated shall include both tabular and graphical type (i.e. trend and bar graph). The reports as a minimum shall include shiftly, daily, weekly, monthly and yearly reports. The report formats and specific data shall be finalised during system configuration stage.

5.14.6 **System Administration and Security functions**

5.14.6.1 The system shall perform the following administration functions:

a) System start-up and shutdown

b) System configuration and configuration changes

c) System diagnostic alarm management

d) Archiving and storing history data.

e) System back-up and system restoration from back-up.

f) Manning user and security files.

g) Maintenance sub-routines and manipulation of data in the database with Audit.

5.14.6.2 UHN shall provide a full data security guarantee and shall be equipped with proper firewall security features. For details refer clause 5.1.12 of this specification.

5.14.7 **System Configuration**

5.14.7.1 UHN shall be industrial grade RAID 5 / RAID 10 high end server machine. The selected UHN hardware platform shall meet system throughput and capacity requirements. As a minimum, the system hardware shall meet the following requirements:

a) VDU shall be 21" TFT type coloured LCD with backlit LED screen.

b) QWERTY keyboard.

c) Mouse or track-ball control

d) Memory as 8GB RAM and 500GB hard disc (HDD) and shall support DVD drive.

e) Clock speed as 2.4 GHz minimum.

f) Coloured laser printer

5.14.7.2 The system shall be supplied with a robust operating system and all supporting software necessary to meet functional requirements specified here including RDBMS with TCP / IP as network protocol.

5.14.8 **System Sizing**

Following criteria shall be followed for sizing UHN:

a) UHN shall interact concurrently with minimum 20numbers of users in addition to DCS (of which UHN is the node) and client's main computer. Unless otherwise specified, ten concurrent user licenses shall be supplied along with UHN node. For the purpose of sizing consider at least 20 concurrent users.

b) The data shall be accessed from remotely located data sources through information network or through auto-dialing with proper ID address and password protection. The rate of data access from / to this network shall be considered as 1000 tags per second.

c) The data access from DCS shall be 1.4 times of all the analog (PV, MV, SV) and digital tags accessed at the rate of 1000 tags per second.

d) UHN historian shall be sized considering following factors:

Storage data	:	2 times the total analog (PV, MV, SV) and digital data of all DCS connected tag number (through hardwiring, serial ports, Fieldbus etc.)
Storage time	:	1 year (365 days)
Storage rate	:	30 seconds for all data
Storage interval on RAM	:	20 minutes

5.14.9 **System Performance**

5.14.9.1 The response to all online enquiries and actions from any user shall be complied with 95% confidence level from any client with a minimum of 20 concurrent users as defined in clause 5.15.8(a) of this specification shall be as follows:

a)	A data query to display on graphic or report	:	5 second
b)	Pre-defined trends up to 1hour data	:	5 seconds
c)	A data query to present a 24 hours report	:	10 seconds

5.14.9.2 Average loading shall not exceed 50% when averaged over 15 minutes with peak loading at any time not to exceed 70%.

5.14.9.3 All securities shall be positioned while evaluating system performance.

5.15 Sequence of Event Recorder (SER)

5.15.1 Sequence of event recorder, when separately required, shall be provided for recording sequence of alarms / events for shutdown inputs.

5.15.2 The inputs for sequence of event recording shall be handled as follows:

a) The maximum number of inputs for I/P module shall be 32.

b) The contact inputs (either open or close on alarm) shall be multiplied using dual output contact barrier one of which shall be connected to PLC while the other is routed to SER. Wherever necessary, fast response multiplying relays may be used (certified by SER manufacturer).

c) For analog input, the signal shall be connected in parallel across the conditioning resistance to PLC or dual output barrier and to a dedicated alarm card, the contact of which shall be routed to SER.

In case analog inputs are to be routed to different physical locations or more than two devices, analog isolators shall be used.

5.15.3 SER shall be capable of providing demonstrable alarm resolution of 1millisecond between the events and shall also be able to print out the same with similar resolution.

5.15.4 The contacts or alarm may be close or open on failure and must be configurable for close / open on failure.

5.15.5 The SER system shall be capable of providing alarm monitoring, printing and inputs for management packages. The configuration of inputs and other functions mentioned above shall be carried out using a dedicated terminal, which is also provided with a printer. Once configured, the access to configuration shall be denied except with 3 levels of password protection.

5.15.6 All the trip / alarm settings should be same as that of PLC in all respects. The accuracy and resolution of measurements and settings are to be equal or greater than that of PLC.

5.15.7 Vendor shall make a provision to connect PLC outputs to SER recorder whenever necessary and decided during engineering with proper isolation.

5.15.8 There must be 20% installed and wired spare input channels up to the marshalling cabinet for each type of input / output of PLC, DCS and other systems.

5.15.9 The system must have facility of keeping at least 96 hours of record at the time with last in and first out facility.

5.15.10 It shall be possible to configure / modify / reconfigure the system online through a dedicated programming unit. Any addition and deletion of inputs should be menu driven only and should be possible to be done during running condition.

5.15.11 It shall be possible to archive data from the SOE recorder on external electronic mass storage media along with all necessary hardware & software which shall be part of system supply by the vendor.

5.15.12 The system shall have an extensive set of diagnostic package, which shall be able to provide the fault alarms up to the module level. The same shall be also printable on the printer.

5.15.13 The system shall be able to generate an audit report, which can be printed on demand. The audit report shall be able to provide shutdown area, time of shutdown and reason for shutdown.

5.15.14 Sequence of events shall also record PLC shutdown outputs.

5.16 Large Display System

5.16.1 The Giant Screen (Large screen) in the control room is primarily used for:

a) Display important operational data of the plant /unit for ready reference like daily production, shutdown required /requested etc.

b) Display operational situations like start up or shutdown to enable mangers / operators to discuss without disturbing the unit operator.

c) Display any operator screen on the large screen.

d) To provide real time clear luminous view of the unit to share information between operators, unit managers and refinery manager.

e) To hold demonstrations to visitors for ready impressive and effective plant overview and plant highlights.

5.16.2 The giant screen shall be installed in the console room.

5.16.3 The giant screen system shall have the following specifications:

i) The screen design shall be based on single chip DLP technology.

ii) Optical system shall have a minimum resolution of 1024 pixels X 768 pixels Colour pixels per cube. Each cube shall have a screen diagonal of minimum 65 to 70 inches with 16.7 million colours.

The lamp shall be pre-adjusted in lamp module, which shall not require any readjustment after replacement. Giant screen Optical system shall be provided with low power LED lamps with operational life of minimum 60,000 Hrs.

They shall be able to provide uniform brightness of 95% with a contrast 1200:1, which shall be able to provide high contrast even in bright ambient light.

iii) The display screen shall be seamless and flicker less. It shall be black or grey in colour. The brightness and contrast shall remain uniform irrespective of the number of cubes used.

iv) The control of screen displays shall be carried out from a dedicated workstation (PC) connected to Giant screen control station, however the functionality shall be made available from the operator console. The signal transfer shall provide guaranteed disturbance free operation, which shall not affect sharpness and colour quality.

v) The giant screen shall be lightweight and low thickness type, which can be supported from the control room wall. The front or rear access, as specified in the requisition, shall be provided for any maintenance.

vi) The system shall perform satisfactorily in ambient conditions with maximum temperature of +40 degree Celsius and 80% non-condensing humidity.

vii) Provision of automatic switching off of Giant screen if temperature in the console room increases above the maximum permissible limit.

viii) Workstation shall be provided with the Giant screen Control station. Ethernet card shall be provided in Giant Screen to connect it with Ethernet port for necessary functionality.

5.16.4 The giant screen system shall be interfaced with the system such that any operator display of any screen could be displayed on the Giant screen suitably. It shall meet the following requirements:

i) Any operator console display or all operator console displays shall be able to be displayed or switched as desired.

ii) Priority of displays should be assignable.

iii) The system shall be supplied complete with all hardware and software as necessary for the specified application including interface software for DCS.

5.17 Documentation Node (DON)

5.17.1 Documentation Node (DON), when specified, shall be used for storing the complete tag information and the engineered data base, unit wise, for the Plant. The system shall be supplied with completely engineered nodes including necessary hardware of proper size and the software necessary to meet the requirements of the node for the assigned units shown in the System Configuration diagrams. The relational data base shall be generated by the vendor to display and printout all unit documentation on the documentation node. The DON software shall have requisite RDBMS tool to ensure data change for one tag getting updated in all related documents uploaded as native files in the DON machine.

5.17.2 Each node shall comprise of a workstation or a PC with storage and archival facility.

5.17.3 The documentation PC(s) shall be connected to TCP/IP network.

5.17.4 Separate documentation node shall be provided as per the configuration diagram. The sizing of the node shall be carried out based on the following requirements as a minimum:

a) Store complete unit documentation for the system for entire assigned units.
b) Store all instrument specification sheets including for field devices for all the units.
c) The specifications will essentially consist of tag number, location, service and major attributes to uniquely identify the instruments in the plant.
d) Documentation provided by DCS vendor shall be properly organized for storage and retrieval.
e) Capacity should be expandable for future use.
f) Link DCS documentation with unit documentation and instrumentation specification.
g) Updation & maintenance of documentation file.
h) Generation of new drawings and document and load these in the system if required.
i) Provision of transferring/ accessing information to/from Access/ Spreadsheet formats from/to other PC's on network
j) Print out various documents as required.
k) Following documents should be possible to be printed from the documentation node, as a minimum. Vendor shall indicate the capability of their offered system and shall engineer the same as per Purchaser’s requirements:
    i) Loop wiring diagram for every input and output.
    ii) Loop schematic and instrument hook-up drawing.

iii) Alarm and trip settings (software and hardware along with field settings) for DCS and PLC tag numbers in tabular form, in total or in part, as per requirements based on type of instruments/ parameters.
iv) Instrument specification sheets.
v) DCS/ PLC input/ output tag list with location.
vi) The document relation document containing all information attributed to the particular tag number like its loop wiring diagram, cable schedule number, tubing hook-up number, installation standard number etc.
vii) Provision for viewing/ printing logic diagrams, PLC configuration (if possible).
viii) Generate any report in the user definable format.

5.17.5 It shall be possible to add/ delete/ modify any attribute, data, specification, parameter etc from the system with proper protection, pass word protection may be provided.

5.17.6 All documentation can be archived attached to documentation node and also can be printed on the printer attached. Provision for printout shall be possible in a suitably segregated manner for:

a) DCS/ PLC input/ output tags
b) Tuning parameter tag wise
c) Loop wiring diagram
d) Cable Schedule
e) Any table containing any set of parameters/ specifications for any number of DCS/ field tags based on data base

5.17.7 Any information should be accessible from the system in a menu driven program only.

5.17.8 Purchaser's document shall be provided in SPI soft file for the Instrument Index and instrument data sheets. Other documents like drawings, cable schedules, Bill of Material shall be provided in formats like Autocad, Excel, pdf which shall be informed during detailed engineering. The DON node shall be suitable for uploading / downloading the Purchaser's data in these formats and meeting the DON functionalities stated in this requisition.

5.17.9 The system shall be supplied with complete application engineering of documentation node including for package & sub-package items. Any modification or revision necessary because of as-built documentation shall be carried out by vendor during Site commissioning.

6.0 MISCELLANEOUS REQUIREMENTS

6.1 Safety Requirements

6.1.1 Unless otherwise specifically indicated in the requisition, all the equipment covered in this specification shall be located in general purpose non-hazardous area, normally in control room or / and satellite rack room. However transmitters, process switches and final control elements including smart positioners, solenoid valves etc. I/P converters (not forming part of this specification) shall be located in the field and shall be specified as per the electrical area classifications.

6.1.2 Unless otherwise specified, intrinsically safe certified transmitters, smart positioners, Fieldbus devices and I/P converters shall be used when located in hazardous area.

6.1.3 Intrinsic Safety Protection

6.1.3.1 I/O modules of DCS / PLC shall have external isolators for intrinsic safety.

6.1.3.2 The system as a whole shall be intrinsically safe based on entity concept, unless otherwise specified. It may be noted that the field instruments are being bought separately and can be of different make and models by different recognised statutory body. These details shall be furnished during detailed engineering. Safety barriers selection shall be carried out based on the entity (safety) parameters which shall be properly matched. Fieldbus segment terminator shall be considered for evaluating intrinsic safety of a segment. Any limitation or special requirements for cables to meet the intrinsic safety requirements shall be brought out in the offer.

6.1.3.3 Conventional or Smart Instrumentation

a) Whenever intrinsic safety is specified for conventional and smart instrumentation entity parameters of the elements in loop shall be matched with the barrier safety description parameters (i.e. loop design as per entity concept).

b) In case of smart transmitter, the entity parameters of the hand held terminals shall also be considered while selecting proper barriers.

c) All intrinsically safe barriers shall be isolating type only providing galvanic isolation between:

i) Input and output (non-hazardous to hazardous side of barriers)

ii) Power supply and input

iii) Power supply and output

The minimum isolation level for the above barriers shall be 250VDC. In case of I/O modules have built in barriers, I/O modules shall also meet the requirements specified in Clause 6.1.3 of this specification.

d) Only single channel barriers shall be selected. Following shall apply:

i) Dual input barriers shall not be selected.

ii) Single input and single output barriers shall be selected.

iii) Single input dual output shall be selected when specifically indicated.

6.1.3.4 Fieldbus Instrumentation

a) Whenever intrinsically safe Fieldbus system is specified with Entity concept, safety parameters of various items in the segment shall be matched with the selected barrier.

b) Whenever FISCO system is specified, all components in the segment is FISCO complied as per IEC 60079-27, segment power supply selected shall also meet FISCO compliance. Segment design shall also meet FISCO requirements.

6.1.4 All intrinsically safe barriers shall be of the isolating type only, shunt diode type of safety barriers shall not be used.

6.1.5 Line monitoring

Line monitoring of digital field signals shall be provided in the system through the interface devices as per the following considerations:-

a) For non-Intrinsic Safe digital outputs used in non-fail safe logics like energized to trip/ actuate, Line monitoring relays shall be provided.

b) For digital outputs utilizing digital output Intrinsic Safe barriers/ isolators, Line monitoring facility shall be activated in the barriers/ isolators for all non-fail safe logics and also where dual Solenoid valves or TMR Solenoid Valves are utilized for On-Off valve trip action.

c) Line monitoring status of all above cases shall be alarmed in Operator Console.

6.1.6 All the interposing relays shall be low power continuously rated type and shall have integral LED for status.

6.2 Power Supplies and Distribution

6.2.1 System Power Supply

6.2.1.1 Unless specified otherwise, the system shall operate on uninterrupted power supply (UPS). The DCS and PLC incoming power supply feeders shall be earthed and isolated from Non-DCS loads. The system shall be capable of operating satisfactorily at the following power supply specifications:

Voltage:		110/ 240 V ±10% (as specified in requisition)
Frequency	:	50 Hz ±3 Hz
Harmonic contents	:	Less than 5%
Power interruption	:	20 millisecond

Various main load centers of Distributed Control System may be sequentially started whenever the starting currents are high. The requirement of sequential starting shall be as specified in requisition. The sequential starting circuit shall be designed using hardware timers and contactors of adequate rating.

6.2.1.2 The system shall be supplied with dual power supply feeders each capable of handling 100% of the total power supply load requirements. The system shall be engineered such that:

a) The redundant systems / sub-systems shall be powered such that main and redundant components are powered from separate UPS feeders.

b) Separate set of redundant power supply feeders shall be provided for DCS and PLC unless otherwise specified in the requisition.

c) In case of failure of one feeder, redundant feeder shall supply the total load.

6.2.1.3 Each power feeder shall be monitored for its voltage and current in DCS, the transducers required for the measurement shall be located in power supply distribution boards/ cabinets (PDB).
In addition to above, following indication / alarms shall also be provided for each feeder:

a) Voltmeter, ammeter and power-on-lamp on the cabinet front of respective power supply distribution cabinet.

b) Power failure Alarm contacts for such feeder for DCS monitoring.

c) One common power failure alarm contact for alarm shall be made available.

6.2.1.4 Automatic Transfer Switch (ATS) shall be provided in Power Distribution Boards/ cabinets (PDBs) for power supply to non-redundant feeders of non DCS loads and also for power supply to non-redundant DCS equipment like consoles. The ATS shall be connected to both primary and secondary incomer of the PDBs and power distribution to non-redundant loads shall be from the ATS output bus bar. Each ATS shall have serial communication for incomer switchover status and diagnostics reporting in DCS.

6.2.2 **DC Power Supply**

6.2.2.1 DC supply shall be generally used for ESD devices and shall be either 110V DC or 24V DC as specified in requisition. In general, DC supply shall have the following specifications:

Voltage : 110V± 10% or 24V ±10%

6.2.2.2 Each DC power supply feeder shall be monitored for its voltage. The voltage transducer shall be installed in the DC supply distribution cabinet.

6.2.2.3 In addition to above, following indications and alarms shall also be provided for each DC supply feeder:

a) Voltmeter installed on the respective DC power supply distribution cabinet.

b) Power failure alarm contacts for each feeder for DCS monitoring.

c) One common power failure alarm contact for alarm shall be made available.

6.2.3 **Non-UPS Power Supply**

6.2.3.1 Non-UPS power supply shall be generally used for cabinet / console lighting, power sockets. The voltage shall be 240V,50Hz power supply. In general, 240V, 50Hz Non-UPS power supply shall follow the following specifications:

Voltage : 240V ± 10%
Frequency : 50Hz ± 3 Hz

6.2.3.2 All cubicles lighting shall be on 240 V, 50 Hz normal power supply.

6.2.4 Power supply shall be made available at one place in the Power Distribution Cabinet. Further Power distribution network shall be designed such that a single power fault in any instrument branch system shall not cause a trip of the entire system. Power distribution network shall use bus bars of adequate capacity with MCB in each branch network. Vendor may alternately select DPDT switches with HRC fuses of required short circuit characteristics. Each consumer shall be provided with a separate switch and fuse unit or MCB for isolation and protection of the system. For current rating 100 amperes and above, MCCB shall be used in place of MCB.

6.2.5 Each transmitter shall preferably be powered with individual power supply. However when several transmitters are powered by a common DC source, each power supply branch shall have a separate switch and fuse. The distribution network shall be designed in such a way that overload in any branch shall not trip the main power supply. Enough redundant power supplies/battery banks shall be provided which shall take over automatically in case of main common power source failure. All power supplies shall have one to one redundancy and shall be sized for full load.

6.2.6 **Bulk Power Supply**

6.2.6.1 Power supply distribution other than 110V AC UPS and 240V AC non UPS shall be provided using dual redundant Bulk Power Supply (BPS).

Each Bulk power supply shall be fed from UPS and the primary and secondary UPS feeders shall independently source the primary and secondary BPS of each redundant BPS set respectively.

Separate sets of BPS shall be used for each application i.e. DCS controller and data acquisition subsystem, PLC subsystem and conventional instrumentation / input interrogation.

Moreover, BPS shall be considered controller / processor wise for DCS / PLC and shall be located in the marshalling / system cabinets pertaining to the controllers/ processors.

6.2.6.2 Each Bulk Power Supply (BPS) shall be provided in redundant configuration and with surge protection capability. Each BPS in a redundant set shall be sized considering 70% of its maximum loading capacity.

6.2.6.3 Redundant MOSFET based OR-ing modules shall be provided at the BPS output for balanced load sharing between two BPS in redundant configuration.

For each redundant set of BPS and their MOSFET OR-ing modules, any one BPS / MOSFET OR-ing module failure shall generate an alarm in DCS graphics. Digital I/Os required for this error contact of each set shall be considered as part of system diagnostics.

6.2.6.4 The BPS used for powering the 3-wire gas detectors shall at least have 28V DC power supply output.

6.2.6.5 Isolators/ relays shall be fed individually from the BPS supply without any looping between adjacent isolators/ relays. For DIN rail mounted Isolators of DCS, Redundant power feed module can be provided for powering not more than 50 nos. Isolators on a single rail. However, power feed module shall not be used for DIN rail mounted isolators of PLC.

6.3 Equipment Assembly

6.3.1 General

6.3.1.1 All system equipment like instruments, electronic modules, power supplies, barriers, relays etc. shall be installed in either of the following enclosures / cubicles as specified in purchaser's requisition. The layout of these enclosures shall be prepared considering proper accessibility and maintainability:

a) System Cabinets

All system hardware (excluding consoles) shall be installed in system cabinets. This shall include system racks, system modules, communication modules, power supply modules etc.

System Cabinets shall be free-standing type and shall be freely accessible from front and / or back as required. Following cabinets shall be required for the system, in general and their specification shall be same as system cabinets:

i) Power distribution cabinet (for AC and DC distribution).

ii) Controller and data acquisition sub-system cabinet.

iii) Shutdown system cabinets (PLC processor and I/O cabinets)

iv) SER Cabinet (when separate SER required).

v) Marshalling cabinets for field cable termination, FF Power supplies, barriers/ isolators, relays and other accessories for DCS and PLC systems with segregation philosophy as defined elsewhere.

vi) Free issue items mounting cabinet (for mounting items which are free issued to vendor).

vii) Annunciator Cabinets.

viii) Network Cabinets for housing Network Switches/ LIUs etc.

ix) Any other as per Job requirement

b) Hardwired Console

All indicating type of dedicated instruments like alarm annunciators, lamps, manual switches and push buttons, Emergency Shutdown switches etc. shall be installed on hardwired console when hardwired console is the operator interface or whenever specifically indicated in the requisition.
In order to reduce number of hardwired consoles, vendor may utilize back-lighted switches and miniature instrumentation and annunciator windows.
Terminals of the switches and push buttons on HWC shall preferably be pre-wired modular type fixed with Terminal blocks for ensuring reliable cable termination and connectivity.
Hardwired consoles form the part of main operator console and shall have same design, dimensions, colour, and shape as operator consoles.

6.3.1.2 The marshalling cabinet segregation shall be as follows:-

a) Separate for DCS and PLC.

b) Separate for Process PLC and Gas Detection PLC.

c) Separate for analog, digital and FF signals.

d) Separate for MCC inputs / outputs. (Where no. of signals are few, segregation of inputs and outputs at front and rear respectively of the same cabinet shall be acceptable).

e) Separate for MCC outputs for breaker driven motors (>55 KW) and contactor driven motors (≤55 KW) (Where no. of signals are few, segregation for these two type of outputs for MCC at front and rear respectively of the same cabinet shall be acceptable).

f) Marshaling Cabinets shall not be combined with any Controller and Data acquisition Cabinets.

6.3.1.3 Mechanical Design

6.3.1.3.1 As far as possible, cabinets / consoles shall be manufactured using standard modular design and standard equipment. Vendor may follow their standard manufacturing procedures, however following points must be ensured:

a) All nuts, bolts, screws, washers (lock or flat) and hinges shall be of stainless steel. All fastening links shall also be of stainless steel.

b) Document pocket / wallet shall be provided on the inner side of front and rear doors of each cabinet and on the inner side of the door of each cabinet.

6.3.1.3.2 Cabinets

a) All the cabinets shall be free standing, enclosed type and shall be designed for bottom entry for cable connection. Cabinet structure shall be sound and rigid.

b) Cabinets shall be equipped with front and rear access doors. Doors shall be equipped with lockable handles and concealed hinges with pull pins for each door removal.

c) Each cabinet shall have the following dimensional details:

Height : 2000mm

Width : 800mm / 1200mm (maximum)

Depth : 800mm

Cabinets shall be rigidly mounted on 100mm high channel base. Construction shall be modular preferably. All racks shall be of same height.

Maximum swing out for doors and drawers shall be limited to 800 mm.

Also regarding cabinets having overall depth of 800mm, wherever the cabinets are required to be mounted on false flooring as indicated in requisition, the centre to centre bolt hole distance of the cabinet base frames shall be 725mm unless otherwise specified.

d) Cabinets shall be fabricated from cold rolled cold annealed (CRCA) steel sheet of minimum 1.5 mm thickness for sides and Top and 2 mm thickness for doors and suitably reinforced to prevent warping and buckling. The rack/ rail mounting plates inside the cabinets shall be of 3 mm thickness. Cabinets shall be thoroughly deburred and all sharp edges shall be grounded smooth after fabrication. Cabinet frame shall be of 9 fold profiled CRCA steel sheet or of Angle iron frame using minimum section of 50 x 50 x 4 mm angle.

e) Unless otherwise specified, the cabinet shall be straight face type. Desk type cabinet shall be supplied where specified. Care shall be taken to ensure that the face of the cabinet is truly flat and smooth. For a group of cabinets in each row having inter-panel wiring, walk through cabinets can be provided with side cover for the end cabinets on each side.

f) Cabinet painting procedure shall include blast cleaning, grinding, chemical cleaning, and surface finishing by suitable filler and two coats of high grade lacquer with wet blasting wherever required. Two coats of paint in the cabinet colour shall be provided for non-glossy high satin finish. Final coat shall be given after assembly at site. Colour of the cabinets shall be as per Requisition.

g) Door locking arrangement

All doors of cabinets / consoles shall have flush mounted handles with key operated mechanical door locking arrangement. The locking arrangement shall be interchangeable and shall have common key for locking / unlocking all locks (master keying arrangement).

h) Internal lighting arrangement

Internal illumination shall be provided for all cabinets to ensure proper illumination level of 250 lux for performing maintenance activities.

LED Lamps shall be provided in each cabinet which shall be activated individually by door operated switches. The lamps shall activate when door is opened and deactivate when the door is closed. The door lock switches selected shall have undergone life cycle cyclic test of at least 1000000 operations and test certificate for the same shall be provided from the manufacturer. A manual over-ride switch shall be provided inside the cabinet which shall keep the lamp deactivated even when the door is open.

The cabinet lighting shall operate on 240V AC Non-UPS power supply.

i) Utility Sockets

Each cabinet / console shall have at least one number each of Non-UPS and UPS power sockets. The sockets shall be rated for 10A as a minimum.

j) Ventilation

In order to effectively remove dissipated heat from the cabinets / consoles, ventilation fans along with vent louvers backed by wire fly screen shall be provided in all cabinets and consoles having PC hardwire drives. Ventilation fans shall be provided in dual configuration. A temperature element (resistance temperature detector or

semiconductor type sensor) shall be provided in each System cabinets and temperature switch as a minimum in each marshalling / PDB cabinet for temperature measurement..

Each fan shall have a separate dedicated assembly and shall be replaceable on-line without shutting down any equipment / cabinet / console in part or in complete.

Ventilation fan assembly shall operate on UPS power supply for system cabinets and on 240V AC power supply Non-UPS for other cabinets, unless otherwise specified. Each fan shall have its own dedicated circuit breaker.

Each ventilation fan shall be fitted with a protection type finger guard. Whenever, the numbers of cabinets / consoles are compacted (supplied in mechanical joined conditions), each cabinet / console shall be provided with separate ventilation fan assembly.

The maximum noise level with all fans operating and cubicle doors open shall not exceed 85dBA.

Fan failure device and temperature detection / switch with alarm shall be provided for each cabinet.

Following signals and alarms shall be provided separately as follows:

i) Fan failure alarm for each system cabinet in DCS.

ii) Temperature indication of each system cabinet in DCS.

iii) A common high temperature and fan failure alarm in the DCS for each marshalling / PDB cabinets / consoles for a group of maximum 10 nos. adjacent cabinets / consoles as per the requisition.

iv) These fan failure alarm and temperature indication/ alarm shall be made available on the DCS console graphics.

k) Earthing

Each cubical (cabinet / console) shall be provided with earth bus bars of at least 15 x 5 square mm cross-section for the following:

i) Electrical earthing (non-isolated earth) where all metal components of the cabinet body, doors etc. shall be connected.

ii) System earthing (isolated earth) where cable shielding of all cables shall be earthed. System earth bus bar shall be isolated from electrical earth and also from metallic doors, cabinet body etc.

iii) DC earth (isolated earth) where cable shielding of all 110V DC shall be earthed. DC earth shall be isolated from electrical earth, system earth and also from metallic doors, cabinet body etc.

l) Lifting lugs

All the cabinets shall be provided with removable lifting lugs to permit lifting of cabinets. The cabinet structure / frame shall be designed to permit cabinet lifting without deformation. The normal working load of the lifting lugs shall be more than 1.5 times the cabinet load. The eye bolts shall be certified for their normal working load.

Cabinets shall also be supplied with plugs which can be fitted after the lifting lugs are removed after their placement so as not to leave any opening in the cabinets.

m) Name Plates

All cabinets / consoles shall have name plates fixed on the front, back and inside with following details:

Front and Back	:	Tag number and description
Inside	:	Manufacturer's name, purchase order number and year of manufacture, part number of manufacture.

All other details shall be as per clause 5.1.23 of this specification.

n) No components and terminals shall be mounted on the sides of the cabinets except utility sockets and fan failure and temperature detection devices.

6.3.1.3.3 All servers shall be rack mounted type and kept in the rack room of the Control Rooms / SRRs with keyboard and monitor on the console in engineering room. KVM (keyboard video mouse) switches shall be provided by vendor for connectivity between the rack mounted servers and console mounted workstations. Similarly all network switches shall also be mounted in free standing cabinets only. Metallic consoles shall be considered in the engineering rooms of the CRs/ SRRs for all the PCs to maintain the aesthetics.

6.3.1.3.4 Electrical Wiring

All the cabinets and consoles shall be completely wired and/or tubed, as required. Interconnections shall preferably be done with the help of pre-tracked cables. Vendor may follow their standard wiring practices, however the requirements specified herein must be complied.

6.3.1.3.4.1Terminals and Terminal Blocks

a) All terminal / terminal blocks shall be DIN Rail mounted type and shall be easily removable. The size of the terminal blocks / terminals of different types shall be consistent and identical.

b) All terminal blocks shall be mounted on suitable anodised metallic or plastic stand-off.

c) Terminal strips shall be arranged group-wise for incoming and outgoing cables separately. Terminal blocks for intrinsically safe wiring shall be separate. 20% spare terminals shall be provided, as a minimum, preferably in each terminal strip.

d) Terminal housing shall be strictly sized with considerations for accessibility and maintenance. Minimum distance required between various components is listed below. These distances are clear distances, and are excluding the width of the raceways or any other component / item mentioned herein. Following clearances should be considered:

i) Distance between terminal strip and side of the cabinet parallel to the strip, up to 50 terminals, shall be minimum 50mm.

ii) Distance between terminal strip and, top and bottom of the cabinet shall be minimum 75mm.

iii) Distance between two adjacent terminal strips shall be minimum 100mm.

iv) Additional distance for each additional 25 terminals shall be minimum 25mm.

v) Distance between cable gland plate and the bottom of the strip shall be minimum 300mm.

6.3.1.3.4.2Terminals

a) Terminals shall be non-hygroscopic type made up of unbreakable, fire-retardant, safe extinguishable, halogen free polyamide compound.

b) Terminals shall be suitable for wires up to 2.5 sq. mm base solid or stranded conductor in general. For power cables, higher size terminals shall be used.

c) The metal parts of terminals shall be of high quality (pure electrolytic) copper and shall be tin or nickel plated (of thickness up to 15 micron).

d) The spring material for all terminals shall be chrome nickel spring steel of high tensile strength and of excellent corrosion resistance.

e) Field side terminal blocks in marshalling cabinet shall be cage clamp interruptible (i.e. disconnect) terminals providing necessary polarity distribution, protection, test point and earthing.

f) For field signals getting interfaced with DCS /PLC through isolators (IS / non-IS), cable termination can be done in the isolators directly without the use of separate Terminal blocks. However, in such cases, terminal blocks shall be provided only for terminating the spare pairs of the field cables.

g) Terminals for all digital outputs with powered contact from DCS/PLC end shall be provided with fuses on the positive terminal. Fuse blown indication LED shall be provided for all such fused terminals. Terminals for digital outputs to MCC shall be potential free and without fuses.

6.3.1.3.4.3Wiring Requirements

a) All wiring shall conform to API RP 552- Transmission Systems. Different signal level cables shall be routed under false flooring with separation distances as recommended by this code.

b) All wiring inside racks including front and rear of the cabinets shall be housed in covered, non-flammable plastic raceways arranged to permit easy assembly to various instruments for maintenance, adjustments, repair and removal.

c) All wiring in the raceways shall be properly clamped. All cables entering the cabinets shall be glanded through cable glands or MCT blocks including supply of cable glands/ MCT block and shall be terminated by vendor. Total wiring cross-sectional area shall not exceed 50% of the raceway cross sectional area.

d) Separate wiring raceways shall be used for power supply wiring, DC and low level signal wiring, and intrinsically safe wiring. Parallel runs of AC and DC wiring closer than 300mm shall be avoided.

e) Vendor can alternately offer prefabricated cables for interconnection between different cabinets.

f) Wire termination shall be done using self-insulating crimping lugs. More than two wires shall not be terminated on one side of single terminal. The use of shorting links for looping shall be avoided.

h) No splicing is allowed in between wire / cable straight run.

i) For external wiring from interposing relays to powered field output devices like solenoid valves, it shall be ensured that the negative terminal of the power supply is connected to the field side and the positive to the relay side so that positive shutdown / de-energization of solenoid valve is ensured on relay contact open.

6.3.1.5 Console Design

a) Console shall be non-graphic, self supported free standing cubicle with back doors and shall be designed for bottom cable entry for connections. Console structure shall be sound and rigid. The Consoles shall be metallic type, unless otherwise specified in the

requisition and designed complying with the ergonomic requirements of ISO 9241-5, 9241-302 and 9241-303.

b) The consoles shall be of modular design, facilitating future equipment retrofits and full reconfigurations without requiring any major modification to the structure or exterior elements.

c) For consoles that are bayed, flexible path shall be allowed for the cables going from one console to other console.

d) The continuity of structure of consoles shall be maintained through corner module kits etc. so that change of direction may be achieved easily.

e) All the consoles shall have mat finish that prevents glare and reflections. The console finish shall be resistant to rubbing and corrosive liquid impact.

f) The material of the working surface of the console i.e. the horizontal portion shall be high pressure laminate, minimum 25 mm thick, insulated and pre-treated for providing good thermal protection. This horizontal portion of the console shall be spill proof, as well as scratch proof with rigid, hard, flat and smooth surface. Material for the console surface shall be as specified in the requisition.

g) The Consoles shall have proper ventilation arrangement for the various heat dissipating equipment mounted inside the consoles and shall have provision for air flow opening for cooling and heat dissipation effect. The airflow openings shall be fitted with filter to avoid accidental entry of foreign objects and to prevent dust accumulation.

h) Monitor Holder Arm

- The consoles shall be supplied with suitable holder arm on which monitors shall be positioned or fixed.
- It shall be suitable with adequate weight bearing capacity for mounting of the HMI display using suitable adapter for ease of replacement of the HMI display.
- It shall allow the operator to tilt the monitors as well as fix their adjustment in a quick and easy manner.

i) Console body shall be fabricated from 1.5 mm (minimum) thick cold rolled steel sheet. Rigid frames shall be of cold rolled steel or extruded Aluminium of minimum 2 mm thickness.

j) Painting procedure of the console body shall be similar to that of the cabinets.

k) For designing hardwired console, following points must be ensured:

- No instrument or switch shall be installed on the horizontal portion of console.
- Hardwired console shall be of mosaic finish design for ease of adding/ deleting any hardware on the console. It shall be possible to add or remove any item from console front by removing or adding mosaic tiles.

6.4 Earthing

6.4.1 All system equipment such as marshalling cabinets, system cabinets and other powered equipment shall be provided with following type of grounding system:

a) Protective Earth / Electrical Earth

b) System earth / signal earth

6.4.2 **Protective earth / Electrical earth**

a) Earth metallic enclosure / cabinet / console etc. shall be provided with electrical earth lug, as a minimum.

b) All earthing lugs of metallic equipment indicated in Clause 6.4.2(a) above shall be connected redundantly to electrical protective earthing system bus-bar / earthing station using a minimum of 6 sq mm solid copper conductor PVC insulated wires. For this purpose, earth looping with permanent shorting link cables shall be acceptable for a maximum of 10 nos. adjacent cabinets in the same row for connecting to protective earth station / bus-bar.

6.4.3 **System Earth**

a) System earth shall be totally noise free dedicated earthing system and shall be fully isolated from electrical protective earth. This earth must be very high integrity system and shall be used to ground zero volt references and signal cable grounds.

b) System earth shall be less than one (1) ohm grounding system with its own dedicated earth pits. The earth pits shall be suitably located outside the control room and away from any heavy noise plant equipment.

The earth pit design shall be as per IS-3043 code of practice for earthing. A minimum of two (2) number of earth pits, in redundant configuration, shall be provided in each Control room / SRR / Remote IO cabinet location for System earth. In case number of pits required to meet system earth resistance are more than one (1) number, the number of system earth pits shall be two times the actual number of pits required to meet the redundancy requirement specified above. All these system earth pits shall be securely connected with each other to form a one homogeneous system earth grid. System Earth Pit shall be by Purchaser unless otherwise specified in requisition.

c) Each marshalling / system cabinet etc. shall be provided with system earth bus-bar which shall be insulated from the metallic body frame. This bus-bar shall be used to earth also signal zero volt references and signal cable screens. Terminals used for termination of spare conductor pairs / cores of multi-pair signal / control cables shall be connected to system earth bus-bar. Shorting links shall be used for spare terminal looping.

d) System bus-bars in the multiplexed cabinets can be joined together by permanent shorting links. System bus-bars of other cabinets can also be connected together provided they are permanently joined using 35 sq. mm stranded copper conductor cable.

e) The redundant System earth pits at each location shall be connected to the Electrical protective earthing system through suitable surge isolation and protection device for lightning equipotential bonding. These lightning surge isolation and protection devices, provided by the vendor, shall comply to the requirements of IEC 62561-3and shall be suitable for rated impulse spark over voltage of upto 1.25 KV.

6.4.4 Other than Fieldbus marshalling cabinets, all other cabinets having SPDs shall be connected to separate earth bus bars in the cabinets. The SPD earth bus bars of these cabinets shall be connected through dedicated redundant cable to electrical protective earthing system.

6.4.5 For Fieldbus segments, the earthing of each FF segment comprising of all FF segment components shall only be at one point i.e. at the Marshalling Cabinet end as per Class A shielding recommendation of AG-181 and the same shall be connected to the system earth. However the SPD earthing shall be as per manufacturer's recommendation.

6.5 I/O Assignment Philosophy

6.5.1 The I/O assignment philosophy for DCS/ PLC shall be considered as given below:

a) Process Unit – Area wise segregation including packages

Within a process unit, the I/O of a particular process area shall not be shared between different controller/ processor subsystems.

b) The I/O of redundant process signals (in 2oo3, 1ooN etc. configuration) shall not be configured in the same I/O module and shall be distributed among different I/O modules

c) Analog and digital signals shall be assigned to separate modules.

Input modules capable of being configured for various type of signals (i.e. Analog 4-20mA, RTD, mV and Digital in the same module) shall maintain the segregation of Digital signals in separate modules.

d) I/O involved in close loops and interlock/sequence of DCS as identified in Requisition shall be connected to redundant I/O modules. I/Os for open loops shall be connected to non-redundant or redundant I/O modules as specified in the requisition.

e) I/O assignment of tags shall match with the cable schedule.

f) Complex loop signals shall preferably be configured in same controllers. It shall be ensured that all the related input/ output signals of a complex loop are preferably in the same I/O card.

g) Spares as per requisition shall also be considered for each sub-system.

6.6 Cloud Based Detailed Engineering

6.6.1 When specified in the requisition, vendor shall carry out DCS /PLC detailed engineering (System / Marshalling cabinet detail design, I/O allocation, configurations of system including I/O, Logic / cause & effect implementation, control narrative implementation, graphics preparation etc.) through cloud based system which shall be accessible to Purchaser for their review and comments (without necessarily visiting Vendor's Engineering Office).

6.7 The Operating System of all PCs shall be provided with office documentation software package (Word, Spreadsheet etc.).

6.8 For all printers specified in the requisition to operate on 110 V AC UPS, necessary step-up transformers mounted inside the printer furniture shall be provided by vendor for printer models operating on 220 V AC.

PART - II

TESTING, INSTALLATION, COMMISSIONING AND ACCEPTANCE OF DISTRIBUTED CONTROL SYSTEM

1.0 SCOPE

1.1 This specification defines the basic guidelines to Distributed Control System vendor for factory testing and acceptance, installation, commissioning and field acceptance of the fully integrated system.

1.2 These guidelines shall also be applicable to all sub-systems and hardware bought by DCS vendor.

1.3 On the basis of this specification, vendor shall submit detailed testing and acceptance procedures specifically applicable for their system. The procedure shall include both hardware as well as software testing and acceptance methodology covering following details:

a) Hardware Testing:

The procedure shall include:

i) Test name
ii) Purpose of Test
iii) Test equipment
iv) Test set-up (Block diagram)
v) Input definition
vi) Test procedure
vii) Results expected
viii) Acceptance criteria.

b) Software Testing:

The procedure shall include:

i) Test name
ii) Purpose of Test
iii) Test equipment
iv) Test set-up
v) Sequence of Execution
vi) Results expected
vii) Acceptance criteria

The procedure shall not omit any column as indicated above in the procedure submitted. Indicate 'NA' whenever any column is not applicable. Additional requirement, if any may be included, as applicable.

1.4 The testing and acceptance of the system shall be carried out on the approved testing procedures and criterion based on this specification and vendor's standard testing requirements and procedures.

2.0 FACTORY TESTING AND ACCEPTANCE

2.1 General

2.1.1 Vendor shall test and demonstrate the functional integrity of the system hardware and software. No material or equipment shall be transported until all required tests are successfully completed and certified "Ready for Shipment" by the owner/consultant.

2.1.2 The purchaser reserves the right to be involved and satisfy himself at each and every stage of inspection. The purchaser shall be free to request any specific test on any equipment considered necessary by him although not listed in this specification, as a part of approval of factory testing procedure. The cost of performing all tests shall be borne by the vendor.

2.1.3 Vendor to note that acceptance of any equipment or the exemption of inspection or testing shall in no way absolve the vendor of the responsibility for delivering the equipment meeting all the requirements specified in Requisition.

2.1.4 It shall be vendor's responsibility to modify and/or replace any hardware and modify the software if the specified functions are not completely achieved satisfactorily during testing and factory acceptance.

2.1.5 **Failure of components/ modules/ sub-systems during Testing**

2.1.5.1 Vendor shall not replace any system component/module/sub-system unless it is failed. A log of all failed components/modules in a sub- system shall be maintained which shall give description of the failed component/module, effect of failure on the sub-system, cause of failure and number of hours of operation before it failed.

2.1.5.2 If malfunction of a component/module in a sub-system repeats, the test shall terminate and vendor shall replace the faulty component/module. Thereafter the test shall commence all over again. If even after this replacement, the sub-system fails to meet the requirements, vendor shall replace the full sub-system by the one meeting the requirements and the system shall be tested all over again.

2.1.5.3 If a sub-system fails during the test and is not repaired and made operational within four hours of active repair time after the failure, the test shall be suspended and restarted all over again only after the vendor has replaced the device in the acceptable operation.

2.2 Testing Details

The factory testing and acceptance shall be carried out in two phases i.e. Phase I and Phase II. The schedule for the testing shall be submitted by the vendor for both Phase I and Phase II separately. The minimum requirements for testing during these two phases are as follows:

2.2.1 **Phase I**

2.2.1.1 Vendor shall perform tests at his works to ensure that all components function in accordance with their respective specifications. A test report shall be submitted to the owner/consultant for review within one week of completion of testing giving details. Phase II testing (witness inspection) shall start only after this.

2.2.1.2 All sub-systems shall undergo a minimum of 15 days (360 hours) burn-in period (un-interrupted power on) and this can include FAT duration. Should there be a failure noted during FAT, this duration shall be extended. It may include any such time for which the system has been kept powered on even for system generation and Phase-I testing
The requirements of burn-in test shall be as follows:

a) The burn-in time shall start after the sub-system is fully assembled and is powered up. It may include any such time for which the system has been kept powered on even for system generation and Phase I testing.

b) Burn-in period log report shall be maintained by the vendor clearly recording sub-system (Tag No. / Identification No.), date and time of power-on, date and time of power-off, failed component (if any) with identification, communicative power-on time and sign-off. In case power to the sub-system is switched off because of any reason, the same shall be recorded in this log report.

c) Vendor shall submit burn-in period log report as part of Phase I test report for purchaser's review.

2.2.1.3 All the test results shall be recorded in the test log report. The test logbook shall contain the following information about the tests:

a) Date/time

b) Assembly /loop tag number

c) Test input

d) Test results and sign off with personnel name

e) Action required (if deficiency is detected)

f) Action taken, date of completion and sign off

g) Special test methods (including special equipment requirement, bypasses used etc.)

2.2.1.4 Test Details

Following tests shall be performed by the vendor and report shall be forwarded to the owner/consultant.

2.2.1.4.1 Quality Control Test

a) Quality control tests shall be carried out to assure quality of all components and modules in accordance with vendor's quality control and assurance procedures. QA / QC test methodology shall be in accordance with relevant international standards and practices. Vendor shall forward the details of these procedures for purchaser's review.

b) The sampling procedures for all purchased components or components manufactured by the vendor shall be in accordance with the vendor standard quality assurance / quality control procedures. The same shall be submitted for Purchaser' review.

c) All assemblies shall be aligned and adjusted before conducting tests. All tests shall be carried out as per manufacture's published / established testing methods and shall be recorded in a test logbook. The test logbook shall be duly signed by the QA / QC manager. The same shall be submitted for Purchaser' review.

d) Test certificates of all components, Manufacturer's Test Certificates (TCs) of all bought -out items and Statutory Certificates shall be submitted for Purchaser' review.

e) Internal Test report or Type Test reports for the system components suitable for function in temperature of 50°C and 90% non-condensing humidity for 48 hours.

2.2.1.4.2 System Power-up Tests

All sub-systems shall undergo complete functional testing as part of Phase I power-up testing. Testing shall include, but not limited to, the following:

a) System hardware functional testing including redundancy, wherever applicable, as per vendor standard testing procedures

b) System software testing as per vendor standard testing procedure including builder functionality.

c) System performance on power supply variations as per vendor standard procedures.

d) Application, Software testing:

Complete application programme generated by the vendor specific to the job shall be tested by simulating inputs. This shall include the following, as a minimum:

- Database verification including loop configuration as per approved functional schematics.
- Display verification including dynamic graphics and hierarchical displays.
- Trending, real time and historical, functionality and assignment.
- Logging and report generation
- Serial port assignment and its proving
- Security functionalities, as applicable e.g. password functionalities, fire-wall protection
- Testing of third party equipment (if applicable)
- Verification of logic diagrams
- Alarm management verification
- Any other software verification necessary for the offered system, as per vendor standard.

e) System Diagnostic Verification

f) Internal Test report or Type Test reports for the system components suitable for function in temperature of 50°C and 90% non-condensing humidity for 48 hours

All the test results shall be recorded as per Clause 2.2.1.3 of this specification and shall be submitted to Purchaser for their review as part of Pre-FAT reports before commencement of FAT.

2.2.2 **Phase II (Witness Inspection)**

2.2.2.1 During Phase II testing, all the hardware and software shall be systematically, fully and functionally tested in the presence of purchaser representative.

All the sub- systems shall be interconnected to simulate the totally integrated system as close as possible. Vendor purchased items (third party equipment) e.g. programmable logic controller, sequence of event recorder, alarm information management system etc. shall also be integrated with the system. Free issue item, if any supplied by purchaser to the vendor for integrated factory acceptance test, shall also be integrated with the system. Barrier cabinets shall be used as the connecting points for the test inputs and outputs. In case of FF I/Os, one sample FF junction box with corresponding FF Hardware& sample field devices to be hooked up & simulated during each FAT. However, complete Database for FF configuration shall be verified for correctness.

2.2.2.2 The duration of Phase II testing shall be communicated by the vendor along with day wise testing schedule to the purchaser. System shall be shipped to site only after the successful completion of this testing and the system is certified 'ready for shipment' by purchaser.

2.2.2.3 Data Review

Purchaser shall review the following documents before starting the witness Inspection (Phase II)):

a) The latest document revisions, based on which vendor has generated the system, to the current data. Any revision or changes required shall be informed to the vendor before starting the witness inspection.

b) Test reports of all bought-out items by their respective manufacturers.

c) The test report/log book forwarded by vendor after Phase I testing. Owner / consultant has right to witness any test performed in Phase I, if found necessary.

2.2.2.4 Testing Record

a) During testing of Phase II, each test carried out shall be recorded. Any deficiency or problem observed during testing shall be clearly recorded and corrected thereafter.

b) Vendor shall prepare a punch list report listing out all the action points. All punch list actions must be completed before system dispatch.

c) Any change in the data or configuration etc. informed to the vendor during testing by purchaser shall be recorded and modifications required shall be carried out by the vendor.

2.2.2.5 Visual and Mechanical Testing

Visual and mechanical testing shall be carried out in principle to assure correct, proper, good and neat workmanship by the vendor. This testing shall include the following, as a minimum:

i) Dimensional verification

ii) Sheet thickness

iii) Layout verification as per approved GA drawings

iv) Quality of painting (outer and inner)

v) Nameplates, identifiers and tag plates

vi) Adherence to ferruling philosophy.

vii) Dressing of wires / prefabricated cables and clearances

viii) Locks and handles

2.2.2.6 Verification of Bill of Material (BOM)

Hardware and software including bought-out items shall be available for verification with the bill of material (BOM) document submitted by the vendor during engineering. Vendor must obtain purchaser's prior approval if any sub-system or bought-out equipment / item can't be made available during Phase II testing i.e. witness inspection. The verification of BOM shall include the following:

a) Hardware verification
The verification shall include verification of all hardware including mandatory spares as per the model numbers and quantities indicated in bill of material document. Items

which can't be identified with model numbers shall be verified with manufacturer's serial numbers. In all such cases, vendor must ensure that the serial number has been indicated against all such items in the BOM document.

b) Software verification
The verification shall include verification of licenses and their numbers for all software as listed in bill of material document. All licenses shall be in the client's name. Number of copies of as built application programmes shall be verified at the time of site acceptance test and not during factory acceptance test.

2.2.2.7 Functional Testing

All system hardware including network interfaces and all software including operating system, console software, network software, complete application software etc. shall be installed and tested as part of function testing.

Functional testing shall include the simulation of inputs and outputs to verify proper system response for both analog and discrete signals. Unless otherwise specified, at least 20% of I/O's shall be simulated in controller and data acquisition sub-system while all I/O's shall be simulated and corresponding logics shall be verified in case of Programmable logic controllers. The I/O sampling shall be at random and shall be selected by the purchaser during testing. The testing, as a minimum, shall include the following:-

a) Complete system configuration loading.

b) Controller and Data acquisition Sub-system

Demonstration of all controller functionalities verification and data acquisition sub-system functions from local as well as from central level including:

- Changing control algorithms
- Changing control mode and controller action
- Changing alarm limits
- Controller tuning using tuning trend.
- Controller tuning using auto-tuning package and change in tuning parameters either automatically or manually.
- Output status on controller failure.
- Setting of macro-cycle time for Fieldbus segment.

c) Scan time verification of scan time values for controllers and data acquisition sub-system and PLC testing shall be carried out by simulating the inputs as follows:

i) Open or close the contact input as per logic execution requirements.

ii) Step input or slow ramp input (typical frequency of 4 cycles / second) with amplitude corresponding to 16mA (4mA to 20mA or vice versa) for all conventional analog and smart (HART) inputs from a signal generator.

The processor cycle time setting and the processor loading shall not exceed the specified limits while verifying scan time.

Checking of scan time values for controllers and data acquisition sub-system and PLC.

The inputs to the system shall be:

- Step input i.e. 0 or 1 for all contact inputs. Step input can be generated by wiring back a digital output configured for the purpose.

- Step input or ramp input for all analog inputs. However, for PLC, the scan time check with analog inputs shall only be for record purposes.

- The output responses shall be verified using a suitable oscilloscope.

The processor cycle time setting and the processor loading shall not exceed the specified limits while verifying scan time.

Control cycle time shall be measured by simulating a Fieldbus segment (with 8 spurs connected through 7 transmitters and one positioner) with DCS controller configured as LAS. This shall be verified by monitoring the scheduled communication updates in fieldbus monitor to verify subsequent updates to be within set macrocycle time.

d) Checking of correct change-over of the back-up units in case of main unit failure. This shall include the following:-

i) Uninterrupted controller operation shall be verified even during and after switchover of back-up device. The failed controller Database, point records, inputs and outputs of the failed main controller shall be transferred to the backup controller without any interruption. The same shall be repeated for transfer back from back up controller to the main controller. Maximum transfer time shall not exceed the specified value. The test shall be repeated for controller all redundant devices including input /output modules.

ii) Uninterrupted data transfer from main communication network and communication interfaces to the redundant ones shall be checked. The transfer back from back-up device or back-up communication network to main network or interface shall not be automatic (automatic transfer from back-up device / network to main device / network shall also be acceptable in case the changeover procedure is flawless and smooth). This test shall be repeated for all interface units in the system including foreign device interfaces.

iii) Uninterrupted operation of system shall be checked on failure and resumption of any of the power supplies where redundant power supplies are provided.

iv) Uninterrupted operation of the system in case of redundant H1 module, power supply conditioners and LAS functionality.

e) Checking of controller loading

Controller loading shall be verified as displayed by the system by simulating as many as inputs to simulate worst case data transfer condition with specified scan time set in the controller.

f) Simulation of Fieldbus segment

At least one Fieldbus segment of each type (e.g. Foundation Fieldbus, Profibus etc.) shall be simulated as applicable. The segment shall include at least one device of each make and model number being used in the project (purchaser shall identify and provide the device to vendor for segment simulation). Following minimum tests shall be carried out:

i) Inter-operability test to ensure correct data transfer between devices of different makes and host (i.e. DCS).

ii) Loop response time verification as per specifications.

iii) Control loop functionality when control algorithm is configured in DCS and in a field device i.e. positioner and in transmitter.

iv) Verification of functionality of control input data transfer along with Fieldbus converter by simulating inputs.

vi) Verification of Fieldbus device displays in Host (DCS).

vii) Verification of range adjustment and alarm settings of field devices from host (IAMS)

g) Functional verification of cursor movement devices

Verification of correct functioning of all keyboards, mouse, touch screens, light pen etc. shall be carried which shall include:

i) Smooth functioning of all devices.

ii) Functional commands verification

iii) Dual function key configuration.

The devices shall include those attached to operator console, engineering console, PLC console, personal computers, other sub-systems / accessories.

h) Verification of loop configuration

Data base and the configuration of all the loops shall be verified for their correctness with respect to range, limits, engineering units, alarm set points, software configuration, output status of controller / control block failure etc. with respect to latest revisions of instrument details and functional schematics / P&ID's supplied by purchaser.

i) Verification of Displays

All types of displays, process as well as system, configured on operator console, engineering console and PLC console shall be verified with respect to correct display configuration, colour scheme, colour modifiers, engineering units, windowing feature, alarms, flags, restricted operation etc.

j) Verification of functionality of accessories

All the accessories like printers and hard copiers shall be verified for their proper operation by printing either test data or actual data.

k) System Diagnostics

System diagnostics shall be thoroughly checked for all sub-systems on local level as well as on operator/engineering console. These shall include diagnostics of failure of main as well as redundant items such as a sub-system, sub-system module, H1module, LAS functionality, power supply, interface unit, network and network module, consoles, third party device interfaced with DCS, printers, hard copier, server failures, key-board / cursor movement devices, disc and disc drives, Fieldbus devices, Fieldbus segment, network devices, diagnostic features of Fieldbus advanced diagnostic module, wherever used with Fieldbus power supply, other detailed diagnostics and their corresponding displays. Diagnostic alarms for any ventilation fan failure, cabinet temperature high and corrosion monitor shall also be verified.

l) Verification of Application programme

Following application programming shall also be verified thoroughly in addition to the complete loop operation by simulation:

i) Verification of trending and trend displays.

ii) Verification of historisation functionalities

iii) Verification of alarm management

iv) Verification of data retrieval functionalities.

v) Verification of all dynamic graphics.

vi) Verification of interchangeability between various video screens of a console.

vii) Synchronisation of system clocks.

viii) Verification of various log formats and log reports including MIS reports as applicable.

ix) Complete (100%) verification of interlock and shutdown logic by simulating inputs and verifying outputs preferably using simulator, other related functions like forcing, first out shall also be verified.

x) Verification of third party device (like PLC, analyser system, computers, Machine Monitoring Systems, Fire &Gas systems etc.) interfaces for complete data transfer between device and DCS and vice versa. Where third party devices are not supplied by vendor (and cannot be provided by purchaser for conducting factory testing), the complete address mapping shall be verified and the link shall be proved using third party device simulation.

xi) Verification of data and reports related to instrument asset management system.

m) Verification of other specific requirements when specified like:

i) Large screen functionality and display solution shall be verified along with large screen controller. Where large screen is not available during factory acceptance test, vendor may utilize a PC in place of display unit for application verification.

ii) Verification of all functionalities of alarm information and management system including report generation.

iii) Verification of functionalities of unit history node and its verification. The verification shall include configuration verification, sample rate versus storage time verification (by extrapolated method for extended time period), throughput, report formats and report generation.

iv) OPC node verification with respect to its configuration, data structure and throughput.

v) Sequence of Event Recorder functionalities verification by verifying identification of events with the specified resolution. The input shall be generated using pulse generator of suitable frequency.

vi) Functionalities of other items when specified shall also be verified.

n) Verification of hardwired console and its functionality. All functions shall be 100% verified such as operation of hardwired instruments, hardwired annunciator, switches, ramps, pushbuttons, instruments like controllers, indicators, recorders etc. Hardwired consoles must be present during factory acceptance test and shall be interconnected for functional verification. All hardwired instruments like alarm cards, barriers and relay shall also be verified for their proper operation.

o) Verification of all system builder functions and engineering console functionalities.

p) Verification of Fieldbus simulator functionalities when specified and purchased along with the system.

q) Verification of display update rate and call-up time under worst loading conditions. Network performance shall also be verified by verifying display update rate of an analog tag number when other inputs in the system are powered.

2.2.2.8 The vendor shall notify the owner/consultant at least three weeks prior to final system testing. In the event that representatives arrive and the system is not ready for testing, the vendor will be liable for back charges for any extra time and expenses incurred.

3.0 INSTALLATION, TESTING AND COMMISSIONING

3.1 Vendor shall offer the services of the installation team which would install the equipment in the control room, lay the interconnecting cabling inside the control room, check out, test and commission the system.

All technical personnel assigned to the site by the vendor shall be fully conversant with the supplied system and software package, and shall have both hardware and software capability to bring the system on line quickly and efficiently with a minimum of interference with other concurrent construction and commissioning activities.

3.2 Vendor's responsibility at site shall include all activities necessary to be performed to complete the job as per Requisition including:

a) Receipt of hardware/software and checking for completeness of supplies.

b) Installation of the system including free supply equipment and field cable termination in the system.

c) Check out of the equipment installation.

d) Checking of interconnection, hardware & software configuration, overall system functioning etc.

e) Loop checking.

f) Liaison with vendor's home office.

g) Field tests

h) Commissioning and on-line debugging of the system.

i) Performance of final acceptance test.

3.3 The only exclusion from vendor's responsibility shall include the following:

a) All civil works in the control room including false flooring, control room lighting and air conditioning ducting.

b) Laying and identification of field cables.

c) Field instrument installation and calibration.

3.4 Field Inspection

3.4.1 All equipment shall be inspected thoroughly by vendor after its receipt at site. The tests, as a minimum, shall include:

(a) Hardware verification as per packing list.

(b) Visual and mechanical checking.

(c) Complete System Configuration loading.

(d) Functioning of all VDUs, keyboards, disc drives, printers, hardcopy units etc.

(e) Checking of correct change-over of redundant devices.

(f) Checking of hardwired instruments.

(g) Any other checking.

3.4.2 The testing defined in para 3.4.1 shall be carried out to ensure functional integrity of all hardware being supplied. Vendor must initiate the remedial action in case unsatisfactory operation of any equipment or item is observed during this testing with an intimation to Engineer-in charge.

3.4.3 Vendor must document all observations including details of malfunctions observed, if any. Items/ equipment requiring total replacement must document reasons for the same.

3.5 Loop Checking

3.5.1 Vendor shall be responsible for loop checking which shall also include checking of the interconnection, at control room end, configuration and ensuring overall system functioning.

3.5.2 Calibration and installation of field instruments, installation of junction boxes, interconnection between instruments and junction boxes, laying of single, multi pair cables upto control room, tagging all field cables, performing continuity/ insulation test of cable, core identification of field cables etc. shall not be in the vendor scope. This work shall be carried out by the field contractor.

3.5.3 Vendor's scope of work, as a part of system installation and loop checking shall include termination of all field cables in control room, checking of interconnection between instrument and equipment, glanding, ferruling and tagging of interconnecting cables in control room, ferruling of field cables in control room and performing overall loop performance check.

3.5.4 Loop checking shall be carried out to check the functional performance of all elements comprising the loop and thereby ensuring proper configuration, functioning and interconnection.

For Fieldbus devices the loop checking shall include the checking of complete Fieldbus segment connectivity with its devices including noise, device configuration, waveform checking. The complete device configuration shall be downloaded to all field devices from DCS prior to the start of loop checking. DCS vendor shall ensure the availability of an application engineer to work closely with field technicians while connecting each device to the Fieldbus network. This activity is required for smooth and rapid commissioning of each FF loop.

3.5.5 Vendor shall co-ordinate with the field contractor for smooth and proper loop checking. Any discrepancy found during checking shall be brought to the notice of Engineer-in-Charge. Complete loop checking shall be performed in the presence of Engineer-in Charge or his authorised representative. All readings shall be recorded on a suitable format which shall be handed over to the vendor by the field contractor after completing calibration record of each field device. On the completion of loop checking, remaining information related to loop checking shall be filled by the vendor. Completely filled format duly signed shall be submitted for approval, to Engineer-in Charge.

3.5.6 a) All the components of the loop shall be checked for proper functioning. All field instruments connected to control room shall be loop checked at 0%, 50% & 100% of FS (for both increasing and decreasing signals). The mode of generating signal from the field by field contractor shall be as follows for different instruments types:-

	Type of Instrument	Mode of Signal Generation
a)	Differential pressure/ flow instruments/ DP type level instruments	By applying impulse to the primary by squeeze bulb or regulator at field
b)	Pressure instruments	By applying impulse to the instrument using instrument air, regulator & standard gage or using portable hydraulic pump and standard gage.
c)	External Displacer	Cage shall be filled with water for different levels and specific gravity correction shall be applied
d)	Other type of tank level instruments	By lifting the float of the level instruments for 0% and 100% of range
e)	Temperature loops with thermocouple	Appropriate mV signals shall be fed from thermocouple head
f)	Temperature loops with RTD	Appropriate resistance shall be fed from RTD head
g)	Field switches for Alarm & Shutdown	Abnormality shall be simulated by disconnecting and connecting the wires at field instruments end
h)	Owner supplied items	As per Engineer-in-Charge's Instructions

	Type of Instrument	Mode of Signal Generation
i)	Special instruments & any other type of instruments	As per Engineer-in-Charge's Instructions

b) Receiver alarm cards shall be checked by the vendor for different settings on both increasing and decreasing signals.

c) Shutdown schemes shall be checked for proper functioning, configuration and actuation.

d) Performance of individual loops may be accepted for an overall accuracy of ± 1.0% unless otherwise specified. Where deviation exists, re-calibration of instruments, based on the scope of work, shall be carried out either by field contractor or by vendor.

e) Signal from controllers/shutdown schemes to control valves/shutdown valves shall be checked at the respective valves. The stroke checking including checking of time of operation of control valves/shutdown valves also forms a part of loop checking. Vendor shall coordinate this activity with field contractor and record the same in the loop checking format.

f) For the loop checking of loops connected to substation, vendor shall be responsible to coordinate with the Electrical Contractor.

g) After loop checking is completed, vendor shall connect back any terminals and connections removed for loop checking.

4.0 SYSTEM ACCEPTANCE

4.1 The owner shall provisionally takeover the system from vendor after System acceptance test. System acceptance test shall be started only after the satisfactory performance of loop checking and verification of all loop checking records by Engineer-in-charge.

4.2 The system acceptance test shall be carried out in the presence of owner's representative and Engineer-in-charge or his authorised representative. The tests carried out in System acceptance test shall be fully recorded and duly signed by all representatives participating in the System Acceptance Testing.

4.3 Vendor shall carry out the following functional tests on the fully integrated system as a part of System acceptance test, as a minimum:

a) Hardware verification as per final Bill-of-material.

b) Visual and mechanical checking for proper workmanship, identification, ferruling, nameplates etc.

c) System configuration as per approved configuration diagram.

d) Checking of correct functioning of all keyboards and dual function keys.

e) Checking of proper operation of hardcopy unit and all printers including printing of Alarms and Events on the Alarm & Event (A&E) printer.

f) Demonstration of all system diagnostics.

g) Checking of correct changeover of redundant devices.

h) Checking of redundancy for LAS functionality for Fieldbus segments.

i) Checking of communication between DCS, PLC and other foreign devices.

j) Checking of proper functioning of all disc drives, historical trend-points, alarm summary and alarm history.

k) Printing of Configuration and Configuration changes on C&M printer.

l) Proper information transfer on the information network by verifying system displays and printouts.

m) Checking of implementation of all recommendations mentioned in PLC safety manual.

n) Checking of implementation of all recommendations mentioned in cyber security manual in the total system.

5.0 FINAL ACCEPTANCE TEST

5.1 The owner will take over the system from the vendor after the final acceptance test, which is defined as successful uninterrupted operation of the integrated system for three weeks for all units of the plant. Vendor's personnel shall be present during the test. Any malfunctioning of the system components shall be replaced/repaired as required. Para 2.1.5 of this specification shall be applied for failure of components & re-adjustments. Once the system failure is detected, the acceptance test shall start all over again from the beginning. The warranty period commences from the day owner takes over the system.

6.0 TESTING/CALIBRATION EQUIPMENTS

6.1 Vendor shall make available all consumable, instruments, and equipment necessary for testing, calibration, maintenance etc. as required by the defined scope of works. All instruments and equipment used for the above purpose shall be of standard make with accuracy better than the accuracy expected from the calibrated/tested instruments, and certified by National Physical Laboratory or other equivalent agencies. These instruments/equipments are necessary only during testing/calibration/maintenance.

PART - III

GENERAL REQUIREMENTS

OF

DISTRIBUTED CONTROL SYSTEM

1.0 SCOPE

1.1 This specification defines the general requirements expected to be fully complied by Distributed Control System vendor including logistic supports, documentation, warranty, maintenance contract and shipping instructions etc.

1.2 The requirements defined in this specification shall also be applicable for all sub-system and hardware bought and supplied by vendor from manufactures other than his own.

2.0 LOGISTIC SUPPORT SERVICES

2.1 The hardware maintenance engineers shall be trained for module level and optionally component level diagnostics of the system. Vendor is required to quote separately for these training facilities. It is also necessary to include in the proposal the details of diagnostic software package for isolating the fault at module level for all the sub- system of Distributed Control System.

2.2 Training

2.2.1 The requirements of training for owner/consultant personnel (one group consisting of operators and other group consisting of hardware/software maintenance engineers) in the operational software and diagnostic programs, are set forth herein.

2.2.2 Vendor shall be responsible for furnishing details of course outlines, manuals of training, equipment necessary to conduct the training, exercises to evaluate trainees' progress. Vendor shall also be responsible for any other requirements necessary to train the engineers deputed by owner within a time limit so that they acquire the necessary expertise to operate and maintain the programs and the equipment supplied.

2.2.3 Owner/consultant or his authorised representatives shall select personnel for training on the basis of his requirements and will review all materials furnished for adequacy of teaching aids and time tables.

2.2.4 **Training Personnel**

Each instructor designate shall have the following minimum qualifications for his area of instructions:

a) Six months of formal class-room instructor experience.

b) Complete and thorough technical knowledge of the equipment and system supplied under the contract and skilled experience in their programming, maintenance and operation.

c) Complete and thorough knowledge of the test and laboratory equipment maintaining, diagnosing, programming, operating and troubleshooting the hardware and software system.

2.2.5 **Course Contents**

2.2.5.1 The outline of each course shall give the subject matter, a short resume of the pre-requisite subjects (if applicable), the position of the course in the training programme, the aim and yardsticks for evaluation and other topics which will add to the usefulness of the program. In order that the selected trainees shall have time to participate in the course, sufficient advance notice of minimum 8 weeks shall be given by the vendor. The course outlines shall be submitted 10 weeks ahead for review.

2.2.5.2 The training exercise shall be designed to be objective in nature and shall include trouble shooting exercises on similar equipment.

2.2.6 **Training Manuals**

2.2.6.1 All training manuals shall be prepared by the vendor and submitted for review 10 weeks ahead of the commencement of the course. After course completion, these manuals shall become the property of the owner. Any change in equipment, manuals and other material shall be informed to the owner during the guarantee period. In addition to vendor documentation, the following minimum requirements shall be adhered to for the training manuals:

a) Functional flow-charts, descriptive material for all operating and application software as well as diagnostics programs and program source listings for application software.

b) Schematic drawings of each assembly of the hardware for the course on maintenance.

c) All manuals pertaining to procedures, specifications and operation for each equipment.

2.2.7 **Hardware and Software Maintenance Training**

2.2.7.1 Vendor shall conduct a course in hardware (module level and optional component level) maintenance, software maintenance and diagnostic of the system for owner at vendor's facility. The course shall be conducted prior to the factory system performance tests so that trained personnel can participate effectively in the final testing.

2.2.7.2 The hardware maintenance training course shall cover every equipment item supplied as part of the Distributed Control System. This course shall include:

a) Actual operation, detection and correction of faults in equipment.

b) Familiarisation with maintenance procedures for the system offered. This shall also include training program to ensure specified MTTR time of the system.

2.2.7.3 Some of the topics covered in the course shall include:

a) Fundamentals of the system

b) Equipment logic diagrams

c) Diagnostic procedures

d) Peripherals maintenance

e) Preventive maintenance procedures

2.2.7.4 Software maintenance training shall cover all software supplied with the system. The trained personnel shall be able to write and debug the application and system software.

2.2.7.5 The vendor is required to quote for in-house and on-site training separately and man-hour rate for additional training, if required by the owner.

2.2.8 **Site Training Facility and Training Kit**

2.2.8.1 The training kit, where supplied, shall be used for refresher and training courses for process engineers, operating and instrument maintenance staff. The training kit shall be simple control system with process simulator for a group of loops and shall include:

a) An operator console with a VDU, operator key board and engineering keyboard.

b) Controller with auto backup facility.

c) One each of the varieties of PCBs used in data acquisition.

d) Signal simulator.

2.2.8.2 Vendor to provide the details of the kit offered along with the proposal.

2.2.8.3 Training kit system shall be stand alone with respect to hardware and software and in no way be lined with the main system.

2.3 Spare Parts

2.3.1 Vendor shall include in the proposal, provisions for special tools, test equipment and initial stock of maintenance spares for a period of two years after commissioning as are essential for proper maintenance and operation of the equipment. In addition, estimated requirements of spares consumption per annum should also be indicated. Full particulars of the tools, test equipment and spare parts shall be provided separately. The list should also include the item wise price.

2.3.2 The successful vendor shall warrant that spare parts for the system would be available for a minimum of fifteen years. After this period, if vendor discontinues the production of spare parts, vendor shall give at least twenty four (24) months' notice prior to such discontinuation so that the owner may order his requirements of spares in one lot.

3.0 DOCUMENTATION

Vendor shall furnish all the manuals and engineering drawings necessary to test, operate and maintain Distributed Control System hardware and software.

The number of hard copies and / or soft copies of each manual and drawing required to be submitted by vendor to owner/ consultant shall be as per the Requisition.
Where hard copies are required as per requisition, all system manuals shall be supplied in hard cover loose ring folders in 'A4' size as per ISO 216 i.e. of size 210mm x 297mm and all drawings and sketches shall be in multiple of 'A4' size like 'A3' (297mm x 420mm) or 'A2' type (420mm x 594mm) etc. but folded to 'A4' size.

3.1 Hardware Documentation

3.1.1 The following documentation for all hardware supplied and as built under this contract shall be submitted for review based on the mutually agreed drawing / document submission schedule during kick-off meeting:

a) The specifications for all off-the-shelf hardware manufactured by vendor, his sub-contractors or suppliers.

Supplier's name and identification of ordered hardware and expected delivery data to vendor's premises shall also be supplied along with this.

b) Documentation relating to off-the-shelf hardware and hardware developed by vendor including description, specifications, theory of operation, maintenance procedures, installation information and drawings. This information shall exclude all non-applicable information.

c) Where more than one size, rating or type of construction appears on the submitted catalogue data, those characteristics applicable shall be identified. Non applicable information shall be suppressed.

d) Test plans and test reports as specified in Part II of this specification for each item of hardware, to be supplied.

e) Bill of material listing all hardware to be supplied including manufacturer part numbers, name plates data, approximate volume, weight and overall dimensions.

f) Spare parts catalogue for all items (at component level) to be supplied.

g) Recommended spare parts for two years.

3.2 Software Documentation

The following documents shall be submitted for review before 90 days of the shipment of the system, for the software packages included in the supply:

a) The specifications for all software to be obtained in-house or from subcontractors or suppliers. The details supplied shall also include the name of the suppliers, software identification including latest modification data.

b) Reference manuals, operating manuals, programming manuals and other software manuals (if any).

c) Description of the function of each program. This shall include the logic, configuration requirements and constraints and sub-programs used, memory map and special characteristics.

d) Input and output details for each program.

e) Listing of assembled programs with label and symbol tables in assembler/compiler language.

3.3 System Manuals

3.3.1 Manuals shall be submitted for assuring satisfactory operation and maintenance of the system. Detailed literature for installation and maintenance of all hardware should be provided to the owner.

3.3.2 Instruction Manual

The information submitted shall preferably be in three parts.

Part-I

First part shall give the following information:

a) A general functional description of the whole system.

b) General software description.

c) General Instructions and start up procedures.

Part-II

Second part shall describe the system software in detail including its interaction with application programs and other programs used as supporting software.

Part-III

The third part shall include detailed maintenance information including all data pertaining to equipment required for maintenance of the system.

3.3.3 **Maintenance Manuals**

3.3.3.1 The maintenance manual shall include details of

a) Preventive maintenance procedures.

b) Trouble shooting procedures including failure analysis.

3.3.3.2 A section on repairs shall provide enough information on repairs including removal, repairs, adjustment and replacement.

3.3.3.3 The maintenance manuals shall contain a list of all maintenance parts to facilitate quick identification of the parts for replacement and ordering. Standard hardware structural parts, or other parts not requiring maintenance shall not be included here. At the end of the list of parts requiring maintenance, a list of special tools required for the maintenance of each unit shall be given. List of manufacturers of each part shall also be included.

3.3.4 The final system manuals shall be furnished to owner within a month of completion of final satisfactory field testing. All field modifications shall be incorporated and system as built drawings and documents shall be included.

3.3.5 **Engineering drawings**

3.3.5.1 The vendor shall provide a complete set of drawings covering each part of the supply for the owner/consultant record. The vendor is required to include owner's project number on each of his drawings in order to ease owner/consultant's record keeping.

3.3.5.2 Vendor shall develop loop wiring diagrams, containing full information of each loop (one drawing per loop) including field termination, junction box details, cables numbering, rack number, bus address code, device address code, power supply connections, final actuating device details including positioner etc. and furnish these before the installation of system.

3.3.5.3 All field modifications shall be carefully recorded by the vendor's commissioning personnel and change shall be incorporated into final drawings.

4.0 WARRANTY

4.1 Vendor shall be fully responsible for the manufacture in respect of proper design, quality, workman-ship and operation of all the equipment, accessories etc. supplied by the vendor for a period specified in commercial terms and condition of the requisition.

4.2 It shall be obligatory on the part of vendor to modify and/or replace any hardware and modify the operating, application and diagnostic software free of cost, in case any malfunction is revealed even during on line operation after taking over within the warranty period.

4.3 Vendor shall also provide the total maintenance of the system during warranty period. The cost for warranty maintenance, if any, shall be included in the proposal separately in 'vendor proposal outline and pricing details'.

5.0 POST WARRANTY MAINTENANCE CONTRACT

5.1 Vendor shall quote separately for post warranty maintenance contract after warranty period for five years for the complete system as per commercial terms and condition of the requisition and the type (i.e. comprehensive or non-comprehensive) of post warranty maintenance shall

be as specified in the requisition. The personnel deployed during post-warranty maintenance shall have thorough knowledge of the system and at least two years of experience on the maintenance of similar system. Any other conditions of contract required by vendor shall be explained in the offer.

6.0 PACKING AND SHIPPING INSTRUCTIONS

6.1 All the material used for packing, wrapping, sealers, moisture resistant barriers and corrosion preventers shall be of recognised brands and shall conform to the best standards in the areas for the articles which are packaged.

6.2 Workmanship shall be in accordance with best commercial practice with the requirement of applicable specifications. There shall be no defects, imperfections or omissions which would tend to impair the protection offered by the package as a whole.

6.3 The package shall be suitable for storing in tropicalised climate, the ambient conditions being specified in the requisition.

6.4 Shipment shall be thoroughly checked for completeness before final packing and shipment.

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SPECIFICATION FOR QUALITY MANAGEMENT SYSTEM REQUIREMENTS FROM BIDDERS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
2	12.06.20	General Revision	QMS Standards Committee	QMS Standards Committee	SKB	SKS
1	12.03.15	General Revision	QMS Standards Committee	QMS Standards Committee	MPJ	SC
0	04.06.09	Issued as Standard Specification	QMS Standards Committee	QMS Standards Committee	SCT	ND

Abbreviations:

ISO	-	International Organization for Standardization
MR	-	Material Requisition
PO	-	Purchase Order
PR	-	Purchase Requisition
QMS	-	Quality Management System

QMS Standards Committee

Convener: Mr. S.K. Badlani

Members: Mr. Sanjay Mazumdar (Engg.)
Mr. R.K. Singh (SCM)
Mr. B. Biswas (SCM)
Mr. Ravindra Kumar (Const.)
Mr. Vinod Kumar (CQA)
Mr. Swapnil Vaishnav (Projects)

CONTENTS

1.0 SCOPE

This specification establishes the Quality Management System requirements to be met by BIDDER for following purpose:

- QMS requirements to be met by suppliers / contractors after award of work / during contract execution.

2.0 DEFINITIONS

2.1 Bidder

For the purpose of this specification, the word "BIDDER" means the person(s), firm, company or organization who is under the process of being contracted by EIL / Owner for delivery of some products (including service). The word is considered synonymous to supplier, contractor or vendor.

2.2 Project Quality Plan

Document tailored from Standard Quality Management System Manual of BIDDER, specifying how the quality requirements of the project will be met.

2.3 Owner

Owner means the owner of the project for which services / products are being purchased and includes their representatives, successors and assignees.

3.0 REFERENCE DOCUMENTS

6-78-0002	Specification for Documentation Requirements from Contractors
6-78-0003	Specification for Documentation Requirements from Suppliers

4.0 QUALITY MANAGEMENT SYSTEM – GENERAL

Unless otherwise agreed with EIL / Owner, the BIDDER proposed quality system shall fully satisfy all relevant requirements of ISO 9001 "Quality Management Systems – Requirements." Evidence of compliance shall be current certificate of quality system registration to ISO 9001 or a recent compliance audit recommending registration from a certification agency. The quality system shall provide the planned and systematic control of all quality related activities for execution of contract. Implementation of the system shall be in accordance with BIDDER'S Quality Manual and PROJECT specific Quality Plan.

5.0 QUALITY SYSTEM REQUIREMENTS

5.1 BIDDER shall prepare and submit for review / record, Project Quality Plan / Quality Assurance Plan for contracted scope / job. The BIDDER'S Quality Plan shall address all of the applicable elements of ISO 9001, identify responsible parties within BIDDER'S organization, for the implementation / control of each area, reference the applicable procedures used to control / assure each area, and verify the documents produced for each area. The Project Quality Plan shall necessarily define control or make reference to the relevant procedures, for design and engineering, purchase, documentation, record control, bid evaluation, inspection, production / manufacturing, preservation, packaging and storage, quality control at construction site, pre-commissioning, commissioning and handing over (as applicable) in line with contract requirement and scope of work.

5.2 BIDDER shall identify all specified or implied statutory and regulatory requirements and communicate the same to all concerned in his organization and his sub contractor's organization for compliance.

5.3 BIDDER shall deploy competent and trained personnel for various activities for fulfillment of PO / contract. BIDDER shall arrange adequate infrastructure and work environment to ensure that the specification and quality of the deliverable are maintained.

5.4 BIDDER shall do the quality planning for all activities involved in delivery of order. The quality planning shall cover as minimum the following:

- Resources
- Product / deliverable characteristics to be controlled.
- Process characteristics to ensure the identified product characteristics are realized
- Identification of any measurement requirements, acceptance criteria
- Records to be generated
- Need for any documented procedure

The quality planning shall result into the quality assurance plan, inspection and test plans (ITPs) and job procedures for the project activities in the scope of bidder. These documents shall be submitted to EIL / Owner for review / approval, before commencement of work.

5.5 Requirements for sub-ordering of outsourced items / sub-contracting / purchasing of services specified in MR / contract / tender shall be adhered to. In general all outsourced items will be from approved vendors of EIL. Wherever requirements are not specified, or approved sub vendors do not exist, the sub-contractor shall establish and maintain a system for purchasing / sub-contracting to ensure that purchased product / service conforms to specified requirements in concurrence with EIL / Owner. Criteria for selection of sub-contractor, evaluation, re-evaluation, maintenance of purchasing data and verification of purchased product (sub-contractor services), constitute important components of this requirement.

5.6 BIDDER shall plan and carry production and service provision under controlled conditions. Controlled conditions shall include, as applicable

a) the availability of information that describes the characteristics of the product
b) the availability of work instructions
c) the use of suitable equipment
d) the availability and use of monitoring and measuring devices
e) the implementation of monitoring and measurement
f) the implementation of release, delivery and post-delivery activities

5.7 BIDDER shall validate any processes for production and service provision where resulting output cannot be verified by subsequent monitoring and measurement. This includes any process where deficiencies become apparent only after the product is in use or service has been delivered.

5.8 BIDDER shall establish a system for identification and traceability of product / deliverable throughout product realization. Product status with respect to inspection and testing requirements shall be identified.

5.9 BIDDER shall identify, verify, protect and safeguard EIL / Owner property (material / document) provided for use or incorporation into the product. If any Owner / EIL property is lost, damaged or otherwise found to be unsuitable for use, this shall be reported to the EIL / Owner.

5.10 BIDDER shall ensure the conformity of product / deliverable during internal processing and delivery to the intended destination. Requirements mentioned in the MR/ tender shall be adhered to.

5.11 BIDDER shall establish system to ensure that inspection and testing activities are carried out in line with requirements. Where necessary, measuring equipment shall be calibrated at specified frequency, against national or international measurement standards; where no such standard exists, the basis used for calibration shall be recorded. The measuring equipment shall be protected from damage during handling, maintenance and storage.

5.12 BIDDER shall ensure effective monitoring, using suitable methods, of the processes involved in production and other related processes for delivery of the scope of contract.

5.13 BIDDER shall monitor and measure the characteristics of the product / deliverable to verify that product requirement has been met. The inspection (stage as well as final) by BIDDER and EIL / Owner personnel shall be carried out strictly as per the approved ITPs or ITPs forming part of the contract. Product release or service delivery shall not proceed until the planned arrangements have been satisfactorily completed, unless otherwise approved by relevant authority and where applicable by Owner / EIL.

5.14 BIDDER shall establish and maintain a documented procedure to ensure that the product which does not conform to requirements is identified and controlled to prevent its unintended use or delivery

5.15 All non-conformities (NCs) / deficiencies found by the BIDDER'S inspection / surveillance staff shall be duly recorded, including their disposal action shall be recorded and resolved suitably. Effective corrective actions shall be implemented by the BIDDER so that similar NCs including deficiencies do not recur. The BIDDER shall take appropriate actions to address the Risks and Opportunities in the project.

5.16 All deficiencies noticed and reported by EIL / Owner shall be analyzed by the BIDDER and appropriate corrective actions shall be implemented. BIDDER shall intimate EIL / Owner of all such corrective action implemented by him.

5.17 BIDDER should follow the standards, specifications and approved drawings. Concessions / Deviations shall be allowed only in case of unavoidable circumstances. In such situations Concession / deviation request must be made by the BIDDER through online system of EIL eDMS. URL of EIL eDMS is http://edocx.eil.co.in/vportal.

5.18 BIDDER shall have documented procedure for control of documents.

5.19 All project records shall be carefully kept, maintained and protected for any damage or loss until the project completion, then handed over to EIL / Owner as per contract requirement (Refer Specification Nos. 6-78-0002 - Specification for Documentation Requirements from Contractors and 6-78-0003 - Specification for Documentation Requirements from Suppliers), or disposed as per relevant project procedure.

6.0 AUDITS

BIDDER shall plan and carry out the QMS audit for the job. Quality audit programme shall cover design, procurement, construction management and commissioning as applicable including activities carried out by sub-vendors and sub-contractors. This shall be additional to the certification body surveillance audits carried out under BIDDER'S own ISO 9001 certification scheme.

The audit programmes and audit reports shall be available with bidder for scrutiny by EIL / Owner. EIL or Owner's representative reserves the right to attend, as a witness, any audit conducted during the execution of the WORKS.

In addition to above, EIL, Owner and third party appointed by EIL / Owner may also perform Quality and Technical compliance audits. BIDDER shall provide assistance and access to their systems and sub-contractor / vendor systems as required for this purpose. Any deficiencies noted shall be immediately rectified by BIDDER.

7.0 DOCUMENTATION REQUIREMENTS

BIDDER shall submit following QMS documents immediately after award of work (Within one week) for record / review by EIL / Owner/ TPIA, as applicable.

- Organization chart (for complete organization structure and for the project)
- Project Quality Plan / Quality Assurance Plan
- Job specific Inspection Test Plans, if not attached with PR
- Job Procedures
- Inspection / Test Formats

In addition to above QMS documents, following documentation shall be maintained by the BIDDER for submission to EIL / Owner on demand at any point of time during execution of the project.

- Quality Manual
- Certificate of approval for compliance to ISO: 9001 standard
- Procedure for Control of Non-conforming Product
- Procedure for Control of Documents
- Sample audit report of the QMS internal and external audits conducted during last one year
- Customer satisfaction reports from at least 2 customers,
- Project QMS audit report
- Technical audit reports for the project
- Corrective action report on the audits

Documents as specified above are minimum requirements. BIDDER shall submit any other document / data required for completion of the job as per EIL / Owner instructions.

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SPECIFICATION FOR DOCUMENTATION REQUIREMENTS FROM SUPPLIERS

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by: Standards Committe Convener	Approved by: Standards Bureau Chairman
2	12.06.20	General Revision	QMS Standards Committee	QMS Standards Committee	SKB	SKS
1	12.03.15	General Revision	QMS Standards Committee	QMS Standards Committee	MPJ	SC
0	04.06.09	Issued as Standard Specification	QMS Standards Committee	QMS Standards Committee	SCT	ND

Abbreviations:

DCI	-	Document Control Index
eDMS	-	Electronic Document Management System
FOA	-	Fax of Acceptance
IC	-	Inspection Certificate
IRN	-	Inspection Release Note
ITP	-	Inspection and Test Plan
LOA	-	Letter of Acceptance
MR	-	Material Requisition
PO	-	Purchase Order
PR	-	Purchase Requisition
PVC	-	Polyvinyl Chloride
QAP	-	Quality Assurance Plan
QMS	-	Quality Management System
RPO	-	Regional Procurement Office
TPIA	-	Third Party Inspection Agency
URL	-	Universal Resource Locator
V-Portal	-	Vendor Portal

QMS Standards Committee

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Mr. Vinod Kumar (CQA)
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CONTENTS

Attachments

Format for completeness of Final Documentation : Format No. 3-78-0004

1.0 SCOPE

This specification establishes the Documentation Requirements from Suppliers.

All documents / data against the PO / PR / MR shall be developed and submitted to EIL / Owner by the suppliers for review / records, in line with this specification.

2.0 DEFINITIONS

2.1 Supplier

For the purpose of this specification, the word "SUPPLIER" means the person(s), firm, company or organization who has entered into a contract with EIL / Owner for delivery of some products (including service). The word is considered synonymous to bidder, contractor or vendor.

2.2 Owner

Owner means the owner of the project for which services / products are being purchased and includes their representatives, successors and assignees.

3.0 REFERENCE DOCUMENTS

6-78-0001	Specification for Quality Management System Requirements from Bidders

4.0 DOCUMENTATION REQUIREMENTS

4.1 Order Acknowledgement and Assigning Project Manager

After placement of order, Supplier shall acknowledge order through V-Portal within 7 days of receipt of FOA / PO. Supplier shall assign a Project Manager for that order though online portal and provide requisite details. Project Manager details shall include e-mail address, mailing address, mobile/telephone nos., fax nos. and name of Project Manager. All the system generated emails pertaining to that order shall be sent to the assigned Project Manager.

4.2 Documents / Data to be submitted by the Supplier

4.2.1 The Supplier shall submit the documents and data against the PO / PR / MR as per the list given in respective PO / PR / MR.

4.2.2 Review of the supplier drawings / documents by EIL would be only to review the compatibility with basic designs and concepts and in no way absolve the supplier of his responsibility / contractual obligation to comply with PR requirements, applicable codes, specifications and statutory rules / regulations. Any error / deficiency noticed during any stage of manufacturing / execution / inspection/ installation shall be promptly corrected by the supplier without any time and cost implications, irrespective of comments on the same were received from EIL during the drawing review stage or not.

4.2.3 Unless otherwise specified, submission of documents for Review / Records shall commence as follows from the date of Fax of Intent / Letter of Intent / Fax of Acceptance (FOA) / Letter of Acceptance (LOA):

QMS	- 1 week
Document Control Index	- 2 weeks
Other Documents / Drawings	- As per approved Document Control Index

4.2.4 Documents as specified in PO / PR / MR are minimum requirements. Supplier shall submit any other document / data required for completion of the job as per EIL / Owner instructions.

4.3 Style and Formatting

4.3.1 All Documents shall be in ENGLISH language and in M.K.S System of units.

4.3.2 Before forwarding the drawings and documents, contractor shall ensure that the following information are properly mentioned in each drawing:

Purchase Requisition Number
Name of Equipment / Package
Equipment / Package Tag No.
Name of Project
Client
Drawing / Document Title
Drawing / Document No.
Drawing / Document Revision No. and Date

4.4 Review and Approval of Documents by Supplier

4.4.1 The Drawing / Documents shall be reviewed, checked, approved and duly signed / stamped by supplier before submission. Revision number shall be changed during submission of the revised supplier documents and all revisions shall be highlighted by clouds. Whenever the supplier require any sub-supplier drawings to be reviewed by EIL, the same shall be submitted by the supplier duly reviewed, approved and stamped by the supplier. Direct submission of sub-supplier's drawings without contractor's / suppliers' approval shall not be entertained.

4.5 Document Category

4.5.1 **Review Category**

Following review codes shall be used for review of supplier Drawings / Documents:

Review Code 1	-	No comments. Proceed with Manufacture / Fabrication as per the document.
Review Code 2	-	Proceed with Manufacture / Fabrication as per commented document. Revised document required.
Review Code 3	-	Document does not conform to basic requirements as marked. Resubmit for review.
R	-	Document is retained for Records. Proceed with Manufacturing / Fabrication as per PR / Tender requirements.
V	-	Void

4.6 Methodology for Submission of Documents to EIL/Owner

4.6.1 Document Control Index (DCI)

Supplier shall create and submit Document Control Index (DCI) for review based on PO / PR / MR along with schedule date of submission of each drawing / document on EIL Vendor Portal. The DCI shall be specific with regard to drawing / document no. and the exact title. Proper sequencing of the drawings / documents should be ensured in schedule date of submission.

4.6.2 Submission of Drawings / Documents / Data

Drawings / documents, data and DCI shall be uploaded on the EIL Vendor Portal as per approved DCI. The detailed guidelines for uploading documents on EIL Vendor Portal are available on following URL

http://edocx.eil.co.in/vportal

4.6.3 Statutory Approvals

Wherever approval by any statutory body is required to be taken by Supplier, the Supplier shall submit copy of approval by the authority to EIL.

4.6.4 Manufacturing Schedule

Supplier shall prepare manufacturing schedule for the order, with key milestone activities (such as document submission, sub ordering, manufacturing, Inspection, dispatches, etc) to meet delivery as per FOA / PO terms. Supplier shall submit manufacturing schedule to concerned Regional Procurement Office (RPO) of EIL / Owner for review within 2 weeks from date of FOA / PO.

4.6.5 Schedule and Progress Reporting

Supplier shall submit monthly progress (MPR) report and updated procurement, engineering, manufacturing status, Inspection and dispatch status (schedule vs. actual) and highlight constraints, if any, along with action plan for mitigation, to the concerned Regional Procurement Office (RPO) of EIL / Owner by 1st week of every month., First MPR shall be submitted within 2 weeks from FOA / LOA. In case of exigencies, EIL / Owner can ask for report submission as required on weekly / fortnightly / adhoc basis depending upon supply status and supplier shall furnish such reports promptly without any price implication. Format for progress report shall be submitted by the Supplier during kick off meeting or within 2 weeks of receiving FOA / LOA, whichever is earlier.

4.7 Inspection and Testing

4.7.1 Quality Assurance Plan / Inspection and Test Plan

If Inspection and test plans (ITP) are attached with MR / PR same shall be followed along with additional tests requirement (if any) mentioned in MR/ PR. However for cases wherein EIL Standard ITPs not available / have not been attached with MR / PR, Supplier shall submit within one week of receiving FOA / LOA, the Quality Assurance Plan for inspection & testing at various stages of production, quality control records for critical bought out items / materials and site assembly & testing as may be applicable to the specific order and obtain approval from concerned Regional procurement Office of EIL / third party inspection agency, as applicable.

For Package equipment contracts, the supplier shall prepare a list of items / equipment and their inspection categorization plan for all items included in the scope of supply immediately after receipt of order and obtains approval for the same from EIL. The items shall be categorized into different categories depending upon their criticality for the scope of inspection of TPIA and / or EIL.

4.7.2 **Inspection Requisition:**

Supplier shall perform internal inspection as per ITP/ approved QAP at their works based on approved documents / drawings. Upon satisfactory internal inspection, supplier shall raise inspection call to concerned Regional Procurement Office (RPO) of EIL / TPIA / Owner with advance notice as per contract along with Internal test reports.

All changes w.r.t. PR shall be recorded through agreed variations or Concessions & Deviations. Conflict, if any, between PR / Job specifications and approved drawings, shall be brought to the notice of EIL / owner by the supplier / contractor. Decision of EIL / owner will be binding on the supplier and to be complied without time and cost implications.

Identified bought out items/ raw material shall be procured under TPIA as per ITP.

4.7.3 **Inspection Release Note (IRN)/ Inspection Certificate (IC)**

IRN / IC shall be issued by EIL Inspector / third party inspection agency on successful inspection, review of test reports / certificates as per specifications & ITP / agreed quality plan (as applicable) and only after all the drawings / documents as per DCI are submitted and are accepted under review code-1 or code R. Supplier shall ensure that necessary documents / manufacturing and test certificates are made available to EIL / TPIA as and when desired.

Note 1: Non fulfilling above requirement shall result into appropriate penalty or with- holding of payment as per conditions of PO / PR / MR.

Note 2: For items where IRN/IC is issued by TPIA, supplier to ensure that following as a minimum must be mentioned by TPIA in IRN / IC

a) PR document number
b) List of drawings / documents with EIL approval code
c) Tests witnessed, documents reviewed
d) Compliance statement by TPIA that product meets the requirement as specified in EIL PR, standard specifications, Inspection Test Plan / QAP and approved documents.

4.8 Transportation Plan

Transportation Plan for Over Dimensional Consignments (ODC), if any, shall be submitted within 2 weeks of receiving FOA / LOA, for approval. Consignment with parameters greater than following shall be considered as over dimensional.

Dimensions: 4 meters width x 4 meters height x 20 meters length

Weight : 32 MT

Dimensions and weight provided above are inclusive of all nozzles, attachments, transportation saddles etc.

Physical Rout survey for ODC movement shall be submitted to EIL within 8 weeks of receiving FOA / LOA.

4.9 Dispatch Details

Upon receipt of IRN / IC from EIL inspector / TPIA, supplier shall dispatch items within 2 days. Supplier shall submit dispatch details to concerned RPO of EIL / Owner within a day of dispatch. Dispatch details shall include Lorry Receipt (LR) number / Dispatch Number, Transporter Name, Date of dispatch, Packing list, Invoice copy etc.

4.10 Final Documentation

4.10.1 Supplier shall prepare final documents in line with VDR (Vendor Document Requirements) attached with PR/Tender. A copy of final document along with filled in Format for Completeness of Final Documentation (Format No. 3-78-0004) to be submitted to EIL Inspector / TPIA for review & approval within 2 weeks from dispatch. Upon receipt of EIL/TPIA endorsement on Completeness of Final Documents, supplier shall submit soft / hard copies of Final documents to EIL / Owner in requisite quantity as per PO / PR details, along with covering letter. A copy of covering letter to be submitted to the concerned Regional Procurement Office (RPO) of EIL/Owner.

4.10.2 **As Built Drawings**

Minor Shop changes made by Supplier after approval of drawings under 'Code 1' by EIL and deviations granted through online system ,if any, shall be marked in hard copies of drawings which shall then be stamped 'As-built' by the supplier. These 'As-built' drawings shall be reviewed and stamped by EIL Inspector / TPIA. Supplier shall prepare scanned images files of all marked – up 'As – built' drawings. Simultaneously Supplier shall incorporate the shop changes in the native soft files of the drawings also.

4.10.3 **Packing / Presentation of Final Documents**

Final Documents shall be legible photocopies in A4, A3 size only. Drawings will be inserted in plastic pockets (both sides transparent, sheet thickness minimum 0.1 mm) with an extra strip of 12 mm wide for punching so that drawings are well placed.

Final Documentation shall be bound in Hard board Plastic folder(s) of size 265 mm x 315 mm ($10^1/_2$ inch x $12^1/_2$ inch) and shall not be more that 75 mm thick. It may be of several volumes and each volume shall have a volume number, index of volumes and index of contents of that particular volume. Where number of volumes are more, 90mm thickness can be used. Each volume shall have top PVC sheet of minimum 0.15 mm thick duly fixed and pressed on folder cover and will have 2 lever clip. In case of imported items documents, 4 lever clip shall also be accepted. All four corners of folders shall be properly metal clamped. Indexing of contents with page numbering must be incorporated by supplier. Spiral/Spico bound documents shall not be acceptable. As mentioned above, books should be in hard board plastic folders with sheets punched and having 2/4 lever clips arrangement.

Each volume shall contain on cover a Title Block indicating package Equipment Tag No. & Name, PO / Purchase Requisition No., Name of Project and Name of Customer. Each volume will have hard front cover and a reinforced spine to fit thickness of book. These spines will also have the title printed on them. Title shall include also volume number (say 11 of 15) etc.

4.10.4 **Submission of Soft Copies**

Supplier shall submit to EIL, the scanned images files as well as the native files of drawings / documents, along with proper index.

In addition to hard copies, Supplier shall submit soft copies of all the final drawings and documents in pen drive or any other specified medium with proper identification tag, all text documents prepared on computer, scanned images of all important documents (not available

as soft files), all relevant catalogues, manuals available as soft files (editable copies of drawings/text documents, while for catalogues / manuals / proprietary information and data, PDF files can be furnished).

All the above documents shall also be uploaded on the EIL Vendor Portal and if applicable on Client Server also.

4.10.5 **Completeness of Final Documentation**

Supplier shall get the completeness of final documentation verified by EIL / TPIA, as applicable, and attach the Format for Completeness of Final Documentation (Format No. 3-78-0004) duly signed by EIL Inspector or TPIA as applicable to the final document folder.

COMPLETENESS OF FINAL DOCUMENTATION

Name of Supplier/Contractor	:	
Customer	:	
Project	:	
EIL's Job No.	:	
Purchase Order No./ Contract No.	:	
Purchase Requisition No./ Tender No.	:	Rev. No. :
Name of the Work/ Equipment	:	
Tag. No.	:	
Supplier's / Contractor's Works Order No.	:	

Certified that the Engineering Documents / Manufacturing & Test Certificates submitted by the supplier (as per Index sheet mentioned in Annexure-1) are complete in accordance with the Vendor Data Requirements of Purchase Requisition / Tender.

Signature	: …….	Signature	: …….
Date	: …….	Date	: …….
Name	: ……..	Name	: ……..
Designation	: ……	Designation	: ……
Department	: ……	Department	: ……
	Supplier / Contractor		EIL / TPIA

Annexure-1

Final Documentation Index Sheet			
PR/PO/Tender No.		Rev. No.	
Serial No.	Document Title	Page/ Folder No.	No. of Pages

Signature	: …….	Signature	: …….
Date	: …….	Date	: …….
Name	: ……..	Name	: ……..
Designation	: ……	Designation	: ……
Department	: ……	Department	: ……

Supplier / Contractor

EIL / TPIA

निर्माण स्थल पर स्वास्थ्य, सुरक्षा एवं पर्यावरण प्रबंधन हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR HEALTH, SAFETY & ENVIRONMENTAL MANAGEMENT AT CONSTRUCTION SITES

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	18/04/2023	REVISED & UPDATED	BT	RK	JPV	SM
1	07/06/2022	REVISED & UPDATED	BT	RK	JPV	SM
0	23/12/2020	REVISED & UPDATED	BT	RK	AKK	S Mazumdar

Abbreviations:

AERB	:	Atomic Energy Regulatory Board
ANSI	:	American National Standards Institute
BARC	:	Bhabha Atomic Research Centre
BS	:	British Standard
BOCW	:	Building and other construction workers
BOO/BOOT	:	Build, Own, Operate/Build, Own, Operate, Transfer
EIL	:	Engineers India Limited
EIC	:	Engineer In charge
ELCB	:	Earth Leakage Circuit Breaker
EPC	:	Engineering, Procurement and Construction
EPCC	:	Engineering, Procurement, Construction and Commissioning
ESI	:	Employee State Insurance
GCC	:	General Conditions of Contract
GM	:	General Manager
GTAW	:	Gas Tungsten Arc Welding
HOD	:	Head of Department
HSE	:	Health, Safety & Environment
HIRAC	:	Hazard, Identification Risk Assessment & Control
HMV	:	Heavy Motor Vehicle
HV	:	High Voltage
IS	:	Indian Standard
ISO	:	International Organization for Standardization
IE	:	Indian Electricity
LTI	:	Lost Time Injuries
LMV	:	Light Motor Vehicle
LOTO	:	Lock Out & Tag Out
LPG	:	Liquefied Petroleum Gas
LSTK	:	Lump Sum Turn Key
MV	:	Medium Voltage
OH&S	:	Occupational Health and Safety
OISD	:	Oil Industry Safety Directorate
PPE	:	Personal Protective Equipment
PUC	:	Pollution Under Control
RC	:	Registration Certificate
RCCB	:	Residual Current Circuit Breaker
RCM	:	Resident Construction Manager or Site-in-Charge, as applicable
SCC	:	Special Conditions of Contract
SLI	:	Safe Load Indicator
SWL	:	Safe Working Load
TPI	:	Third Party Inspection
TBT	:	Tool Box Talks

Construction Standards Committee

Convenor: Sh John Paul V, ED(Construction)

Members: Sh.Janak Kishore, ED (Projects)
Sh.Biswajit Mandal, CGM (SCM)
Sh. Udayan Chakravarty, Sr.GM (Piping)
Sh.Ravindra Kumar, Sr.GM (Construction)
Sh.Debasish Ghosal, GM(Construction)
Sh. Pankaj Kumar Rai, DGM (Construction)

CONTENTS

1.0 SCOPE

This specification establishes the Health, Safety and Environment (HSE) management requirement to be complied by Contractors/Vendors including their sub-contractors/sub vendors during construction.

This specification is not intended to replace the necessary professional judgment needed to design & implement an effective HSE system for construction activities and the contractor is expected to fulfill HSE requirements in this specification as a minimum. It is expected that contractor shall implement best HSE practices beyond whatever are mentioned in this specification.

Requirements stipulated in this specification shall supplement the requirements of HSE Management given in relevant Act(s)/ Legislations, General Conditions of Contract (GCC), Special Conditions of Contract (SCC) and Job (Technical) Specifications. Where different documents stipulate different requirements, the most stringent shall apply.

2.0 REFERENCES

The document should be read in conjunction with following:

- General Conditions of Contract (GCC)
- Special Conditions of Contract (SCC)
- Building and other construction workers Act, (Refer Appendix-D)
- Indian Factories Act,(Refer Appendix-D)
- Job (Technical) specifications
- Relevant International/ National Codes (refer Appendix-A for standards/codes on HSE)
- Relevant State & National Statutory requirements.
- Operating Manuals Recommendation of Manufacturer of various construction Machineries
- Occupation Health and Safety Management System (OHSAS 18001:2007/ISO 45001) and Environmental Management System (ISO 14001:2015)

3.0 REQUIREMENTS OF HEALTH, SAFETY & ENVIRONMENTAL (HSE) MANAGEMENT SYSTEM TO BE COMPLIED BY BIDDERS

3.1 Management Responsibility

3.1.1 HSE Policy & Objectives

The Contractor should have a documented and duly approved HSE policy &objectives to demonstrate commitment of their organization to ensure health, safety and environmental aspects in their line of operations.
The Contractor's senior management shall provide strong visible leadership and continuously demonstrate commitment to develop, operate and maintain, review and continually improve a HSE culture at site which empowers individuals to take responsibility for their safety and embrace and accept nothing but responsible HSE behaviour.
Contractor shall refer in clause No. 3.3.23 for Key Performance Indicator (KPI).

3.1.2 Management System

The HSE management system of the Contractor shall cover the HSE requirements & commitments to fulfill them, including but not limited to what have been specified under clauses 1.0 and 2.0 above. The Contractor shall obtain the approval of its site specific HSE Plan from EIL/ Owner prior to commencement of any site works. Corporate as well as Site management of the Contractor shall ensure compliance of their HSE Plan at work sites in its entirety in true spirit.

3.1.3 Indemnification

Contractor shall indemnify & hold harmless, Owner/EIL & their representatives, free from any and all liabilities arising out of non-fulfillment of HSE requirements or its consequences.

3.1.4 **Deployment &Qualifications of Safety Personnel**

The Contractor shall designate/deploy various categories of HSE personnel at site as indicated below insufficient number. In no case, deployment of safety Supervisor / Safety Steward shall substitute deployment of Safety Officer / Safety Engineer what is indicated in relevant statute of BOCW Act i.e. deployment of safety officer/Safety Engineer is compulsory at project site. The Safety supervisors, Safety stewards/Observer etc. would facilitate the HSE tasks at grass root level for construction sites and shall assist Safety Officer /Engineers.

Contractor shall appoint safety personnel as given below for every work shift:

(i) Safety Observer/Steward: Contractor shall depute one Safety Observer/Steward for every 100 workers or part thereof

(ii) Safety Supervisor: In addition to above(i), contractor shall depute one Safety Supervisor for every 250 workers or part thereof

(iii) Safety Engineer: In addition to above (i&ii), one safety engineer/ officer for every 1000 workers or part thereof.

Contractor shall intimate/obtain prior permission from EIC before demobilizing any safety personnel. The Contractor shall mobilize suitable safety personnel as replacement.

a) Safety Steward/Observer

As a minimum, he shall possess class XII pass certificate and trained in fire-fighting as well as in safety/occupational health related subjects, with minimum two year of practical experience in construction work environment and should have adequate knowledge of the local language spoken by majority of the workers at the construction site.

b) Safety Supervisor

As a minimum, he shall possess a recognized graduation Degree in Science (with Physics & Chemistry) or a Diploma in Engg. Or Tech. with minimum Two years of practical experience in construction work environment and should possess requisite skills to deal with construction safety & fire related day-to-day issues.

c) Safety Officer / Safety Engineer

Safety Officer/Engineer should possess following qualification & experience:

(i) Recognized degree in any branch of Engg. or Tech. or Architecture with practical experience of working in a building or other construction work in supervisory capacity for a period of not less than two years, **or** possessing recognized diploma in any branch of Engg. or Tech with practical experience of working in a building or other construction work in supervisory capacity for a period of not less than five years.

(ii) Recognized degree or one year diploma in Industrial safety(from any Indian Institutes recognized by AICTE or State Council of Tech. Education of any Indian State/Union territory) with at least one paper in construction safety (as an elective subject).

(iii) Preferably have adequate knowledge of the language spoken by majority of the workers at the construction site.

Alternately

(i) Person possessing Graduation Degree in Science with Physics **or** Chemistry and degree or one year diploma in Industrial Safety (from any Indian institutes recognized by AICTE or State Council of Tech. Education of any Indian State/ Union Territory) with practical experience of working in a building, plant or other construction works (as Safety Officer, in line with Indian Factories Act, 1948) for a period of not less than five years, may be considered as Safety Officer.

d) HSE In-Charge

In case there is more than one Safety Officer at any project construction site, one of them, who is senior most by experience (in HSE discipline), may be designated as HSE In-Charge. Duties & responsibilities of such person shall be commensurate with that of relevant statute and primarily to coordinate with top management of EIL/Client and contractors.

In case the statutory requirements i.e. State or Central Acts and / or Rules as applicable like the Building and Other Construction Workers' Regulation of Employment and Conditions of Service- Act,1996 or State Rules (wherever notified), the Factories Act, 1948 or Rules (wherever notified), etc. are more stringent than above clarifications, the same shall be followed.

Contractors shall ensure physical availability of safety personnel at the place of specific work location, where Hot Work Permit is required/granted. No work shall be started at any of the project sites until above safety personnel & concerned Site Engineer of Contractor are physically deployed at site. The Contractor shall submit a HSE Organogram clearly indicating the lines of responsibility and reporting system and elaborate the responsibilities of safety personnel in their HSE Plan.

Upon fulfilling the basic requirement of qualification and relevant experiences, the performance of contractor HSE personnel's is to be monitored.

The good performing contractor's HSE personnel at site shall be rewarded upon assessment of performance by EIL/Owner. The non-performing HSE personnel shall be counselled by EIL/Owner & suitable action may be taken for suspension from site for 3-6 days. Contractor shall arrange training for non performing HSE personnel.

HSE In –Charge of the contractor shall be given the status at par with the other heads of department and shall report to Head of Project.

The Contractor shall verify & authenticate credentials of such safety personnel and furnish Bio-Data/Resume/Curriculum Vitae of the safety personnel as above for EIL/Owner's approval, at least 1 month before the mobilization. The Contractor, whenever required, shall arrange submission of original testimonials/certificates of their Safety personnel, to EIL/Owner (for verification/scrutiny, etc.)

Imposition/ Realization of penalty shall not absolve the Contractor from his/her responsibility of deploying competent safety officer at site.

Adequate planning and deployment of safety personnel shall be ensured by the Contractor so that field activities do not get affected because of non-deployment of competent & qualified safety personnel in appropriate numbers.

3.1.5 Implementation, Inspection/Monitoring

a) The Contractor shall be fully responsible for planning, reporting, implementing and monitoring all HSE requirements and compliance of all laws & statutory requirements.

b) The Contractor shall also ensure that the HSE requirements are clearly understood & implemented conscientiously by their site personnel at all levels at site.

c) The Contractor shall ensure physical presence of their field engineers / supervisors, during the continuation of their contract works / site activities including all material transportation activities. Physical absence of experienced field engineers / supervisors of Contractor at critical work spot during the course of work may invite halting / stoppage of work.

d) The Contractor shall regularly review inspection report internally and implement all practical steps / actions for improving the status continuously.

e) Contractor skilled workmen like riggers, scaffold erectors, welders, crane operators etc. should have sufficient past experience and skill on the relevant job.

f) The Contractor shall ensure important safety checks right from beginning of works at every work site locations and to this effect format No. HSE-10 "Daily Safety Check List" shall be prepared by field engineer & duly checked by safety personnel for conformance.

g) The Contractor shall carry out inspection to identify various unsafe conditions of work sites/machinery/equipment's as well as unsafe acts on the part of workmen/supervisor/engineer while carrying out different project related works.

h) Adequate records for all inspections shall be maintained by the Contractor and the same shall be furnished to EIL/Owner, whenever sought.

i) To demonstrate involvement/commitment of site management of Contractor, at least one Monthly Safety Walk through in a month shall be carried out by Contractor's head of site (along with his area manager/field engineers)and a report shall be furnished to EIL/Owner as per format No: HSE-1" Safety walk through report" followed by compliance for unsatisfactory remarks.

j) As a general practice lifting tools/tackles, machinery, accessories etc. shall be inspected, tested and examined by competent person(approved by concerned State authorities) before being used at site and also at periodical interval (e.g. during replacement, extension, modification, elongation/reduction of machine/parts, etc.) as per relevant statutes. Hydraulic Mobile Crane, cranes, lifting machinery, mobile equipment's/ machinery/ vehicles, etc. shall be inspected regularly by only competent / experienced personnel at site and requisite records for such inspections shall be maintained by contractor. Contractor shall also maintain records of maintenance of all other site machinery (e.g. generators, rectifiers, compressors, cutters, etc.) & portable tools/equipment's being used at project related works (e.g. drills, abrasive wheels, punches, chisels, spanners, etc.).The Contractor shall not make use of arbitrarily fabricated 'derricks' at project site for lifting/ lowering of construction materials.

k) Site facilities /temporary. installations, e.g. batching plant, cement godown, DG-room, temporary electrical panels/distribution boards, shot-blasting booth, fabrication yards, etc. and site welfare facilities, like labour colonies, canteen/pantry, rest-shelters, motor cycle/bicycle-shed, First-aid centers, urinals/toilets, etc. should be periodically inspected by Contractor (preferably utilizing HR/Admin. personnel to inspect site welfare facilities) and records to be maintained.

3.1.6 **Behaviour Based Safety**

a) The contractor shall develop a system to implement Behavior-Based Safety (BBS) through which work groups can identify, measure and change the behaviors of employees and workers towards construction safety aspects.

b) The BBS process shall include the following:
- Identify the behaviors critical to achieve required safety performance.
- Communicate the behaviors and how they are performed correctly byall
- Observe the work force and record safe/at risk behaviors. Intervene with workers to give positive reinforcement when unsafe behaviors are observed. Provide coaching/correction when at risk behaviors are observed
- Collect and record observation data
- Summarize and analyze observation data
- Communicate observation data and analysis results to all employees
- Provide recognition or celebrate when safe behavior improvements occur
- Change behaviors to be observed or change activators or change consequences as appropriate.
- Communicate any changes to workforce

c) Contractor through its own HSE committee shall implement the above process.

d) The necessary procedures and Monthly reporting formats shall be developed by the contractor for approval by EIL/Owner.

e) The HSE committee of contractor shall observe individual's behavior for safe practices adapted for utilization/execution of work for followings a minimum:-
- PPE
- Tools & equipment's
- Hazard Identification & control
- House keeping
- Confined space entry
- Hot works
- Excavation
- Loading & unloading
- Work at height
- Stacking & storage
- Ergonomics

f) EIL/Owner and Contractor's site staff at all levels shall monitor the behavior of contractor employees that create and/or contribute to the unsafe situations at work place.

g) Contractor shall arrange Behavior Based safety (BBS) training of their employees at site on yearly basis.

3.1.7 **Awareness and Motivation**

a) The Contractor shall promote and develop awareness on Health, Safety and Environmental protection among all personnel working for the Contractor.

b) The contractor shall display safety statistics board at all prominent location .Also shall provide dedicated notice board for displaying of safety alerts or any other safety related notices for awareness site workforces.

c) Regular awareness programs and fabrication shop/work site meetings at least on monthly basis shall be arranged on HSE activities to cover hazards/risks involved in various operations during construction.

d) Contractor's workmen & supervisory staff shall participate in common Tool Box Meeting as & when organized/required at site to avoid any incident/accident or occupational disease arising out of multidisciplinary jobs/activities being performed by various contracting agencies in the same location at different elevation.

e) Contractor to motivate & encourage the workmen & supervisory staff by issuing/ awarding them with tokens/ gifts/ mementos/ monetary incentives/ certificates etc. The motivational program shall be organized on regular basis.

f) Contractor shall assess & recognize the behavioral change of its site engineers / supervisors periodically and constantly motivate / encourage them to implement HSE practices at project works

g) Life Saving Rules (refer Appendix-I for details) are to be displayed at prominent location of site.

3.1.8 **Fire Prevention & First-Aid**

The Contractor shall deploy First aider & suitable First-aid measures such as First Aid Box (Refer Appendix-B for details), stand-by Emergency Vehicle. Additionally separate ambulance with trained personnel/male or female nurse to administer First Aid shall be provided by the Contractor beyond deployment of 500 workmen during day/night working hours.

a) The Contractor shall arrange installation of fire protection measures such as adequate number of steel buckets with sand & water and adequate number of appropriate portable fire extinguishers (Refer Appendix-C for details) to the satisfaction of EIL/Owner.

b) The Contractor shall arrange EMERGENCY MOCK DRILL like fire, bomb threat, gas leakage, earth quake, etc. at each site at least once in three months, involving site workmen and site supervisory personnel & engineers. The Contractor shall maintain record of such mock drills at project site.

c) The contractor shall require to tie-up with the hospitals located in the neighborhood for attending medical emergency.

3.1.9 **Documentation**

The Contractor shall evolve a comprehensive, planned and documented system covering the following as a minimum for implementation and monitoring of the HSE requirements and the same shall be submitted for approval by owner/EIL.

- HSE Organogram
- Site specific HSE Plan
- Safety Procedures, forms and Checklist. Indicative list of HSE procedures is attached as Appendix :H
- Inspections and Test Plan
- Risk Assessment & HIRAC for critical works.
- HIRAC Register as per Format no: HSE-19 to identify, assess, analyze & mitigate the construction hazards& incorporate relevant control measures before actually executing site works.
- Environmental Aspect Impact Register as per Format no: HSE-18 (identify, assess, analyze & mitigate the environmental impact & incorporate relevant control measures).
- Legal Register to identify and comply to all applicable HSE related legal requirements.

The monitoring for implementation shall be done by regular inspections and compliance of the observations thereof. The Contractor shall get similar HSE requirements implemented at his sub-contractor(s) work site/office, if applicable. However, compliance of HSE requirements shall be the responsibility of the Contractor. Any review/approval by EIL/Owner shall not absolve contractor of his responsibility/liability in relation to fulfilling all HSE requirements.

3.1.10 **Audit**

Safety Audit shall be conducted at initial stage by EIL/Owner to understand the readiness to start the job after mobilization of contractor's RCM at site& Suitable action shall be taken by contractor to comply the audit observation(s).

The Contractor shall submit an Audit Plan to EIL/Owner indicating the type of audits covering following as minimum:

a) Internal HSE audits regularly on six monthly basis by engaging internal qualified auditors (viz. safety officers/Construction personnel having 5years experience in construction safety and Lead Auditor Course: OHSAS 18001/ISO 45001 certification).However, minimum two internal HSE audit will have to be conducted irrespective of time period of the contract.

b) External HSE audits regularly on yearly basis by engaging authorized auditing agencies (viz. National Safety Council etc.)or qualified external auditors (viz safety officers/Construction personnel having 10years experience in construction safety and Lead Auditor Course: OHSAS 18001/ISO 45001certification). However, minimum one external HSE audit will have to be conducted irrespective of time period of the contract.

c) EIL/Owner may participate in Opening and closing meeting of external audits and provide inputs to the external auditor. Outcome of external audit shall be discussed during HSE Meeting with EIL/Owner.

All HSE shortfalls/ non-conformances on HSE matters brought out during review/audit, shall be resolved forthwith(generally within a week) by Contractor& compliance report shall be submitted to EIL/Owner.

In addition to above audits by contractor, the contractor's work shall be subjected to HSE audit by EIL/Owner at any point of time during the pendency of contract. The Contractor shall take all actions required to comply with the findings of the Audit Report and issue regular Compliance Reports for the same to OWNER/ EIL till all the findings of the Audit Report are fully complied.

Failure to carry-out HSE Audits& its compliance (internal & external) by Contractor, shall invite penalization.

3.1.11 **Meetings**

i. The Contractor shall ensure participation of his top most executive at site (viz. Resident Construction Manager / Resident Engineer/ Project Manager / Site-in-Charge) along with safety officer in Safety Committee/HSE Committee meetings arranged by EIL/Owner usually on monthly basis or as and when called for. In case Contractor's top most executive at site is not in a position to attend such meeting, he shall inform EIL/Owner in writing before the commencement of such meeting indicating reasons of his absence and nominate his representative – failure to do so may invite very stringent penalization against the specific Contractor, as deemed fit as per Contract. The obligation of compliance of any observations during the meeting shall be always time bound. The Contractor shall always assist EIL/Owner to achieve the targets set by them on HSE management during the project implementation.

ii. In addition, the Contractor shall also arrange internal HSE meetings chaired by his top most executive at site on fortnightly basis and maintain records. Such internal HSE meetings shall essentially be attended by field engineers / supervisors including safety personnel of the Contractor and its associates. Records of such internal HSE meetings shall be maintained by the Contractor for review by EIL/Owner or for any HSE Audits.

iii. Agenda of internal HSE meeting should broadly cover: -

a) Confirmation of record notes /minutes of previous meeting
b) Discussion on outstanding subjects of previous points / subjects, if any
c) Incidents / Accidents (of all types) at project site, if any
d) Current topics related to site activities / subjects of discussion
e) House keeping
f) Behavioral Safety
g) Information / views / deliberations of members / site sub-contractors
h) Report from Owner / Client
i) Status of Safety awareness, Induction programs & Training programs

The time frame for such HSE meeting shall be religiously maintained by one and all.

3.1.12 **Intoxicating drinks & drugs and smoking**

a) The Contractor shall ensure that his staff members & workers (permanent as well casual) shall not be in a state of intoxication during working hours and shall abide by any law relating to consumption & possession of intoxicating drinks or drugs in force.

b) The Contractor shall not allow any workman to commence any work at any locations of project activity who is/are influenced / effected with the intake of alcohol, drugs or any other intoxicating items being consumed prior to start of work or working day.

c) Awareness about local laws on this issue shall form part of the Induction Training and compulsory work-site discipline.

d) The Contractor shall ensure that all personnel working for him comply with "No-Smoking" requirements of the Owner as notified from time to time. Cigarettes, lighters, auto ignition tools or appliances as well as intoxicating drugs, dry tobacco powder, etc. shall not be allowed inside the project / plant complex.

e) Smoking shall be permitted only inside smoking booths, if any, exclusively designated & authorized by the Owner/EIL.

3.1.13 **Penalty**

The Contractor shall adhere consistently to all provisions of HSE requirements. In case of non-compliances and also for repeated failure in implementation of any of the HSE provisions, EIL/Owner may impose stoppage of work without any cost & time implication to the Owner and/or impose a suitable penalty.

The amount of penalty to be levied against defaulted Contractor shall be up to a cumulative limit of

2.0% (Two percent) of the contract value for Item Rate or Composite contracts with an overall ceiling of 1,00,00,000(Rupees One Crore).

0.5% (Zero decimal five percent) of the contract value for LSTK, OBE, EPC,BOO/BOOT, EPCC or Package contracts with an overall ceiling of 10,00,00,000(Rupees Ten Crores.)

This penalty shall be in addition to all other penalties specified elsewhere in the contract. The decision of imposing stop-work-instruction and imposition of penalty shall rest with EIL/Owner. The same shall be binding on the Contractor. Imposition of penalty does not make the Contractor eligible to continue the work in unsafe manner.
The amount of penalty applicable for the Contractor on different types of HSE violations is specified below:

Sl. No.	Violation of HSE Norms	Penalty Amount
1.	For not using personal protective equipment like Helmet, Safety Shoes, and other safety gadgets as applicable as per nature of work.	Rs.500/- per day/Item / Person
2.	Working without Work Permit/Clearance	Rs.20,000/- per occasion
3	Execution of work without deployment of requisite field engineer / supervisor at work spot	Rs.5,000/- per violation per day
4.	Unsafe electrical practices (not installing ELCB, using poor joints of cables, using naked wire without top plug into socket, laying wire/cables on the roads, electrical jobs by incompetent person, etc.)	Rs.10,000/- per item per day

Sl. No.	Violation of HSE Norms	Penalty Amount
5.	Working at height without full body harness, using non-standard/ rejected scaffolding and not arranging fall protection arrangement as required, like hand-rails, life-lines, Safety Nets etc.	Rs.10,000/- per case per day
6.	Unsafe handling of compressed gas cylinders (No trolley, jubilee clips double gauge regulator, and not keeping cylinders vertical during storage/handling, not using safety cap of cylinder).	Rs.1,000/- per item per day
7.	Use of domestic LPG for cutting purpose / not using flash back arresters on both the hoses/tubes on both ends.	Rs.5,000/-per occasion
8.	No fencing/barricading of excavated areas / trenches.	Rs.5,000/- per occasion
9.	Not providing shoring/strutting/proper slope and not keeping the excavated earth at least 1.5M away from excavated area.	Rs.5,000/-per occasion
10.	Non display of scaffold tags, caution boards on erected scaffolds.	Rs.1,000/- per occasion per day
11.	Traffic rules violations like over speeding of vehicles, rash driving, talking on mobile phones during vehicle driving, wrong parking, not using seat belts, vehicles not fitted with reverse horn / warning alarms / flicker lamps during foggy weather.	Rs.3,000/-per occasion per day
12.	Absence of Contractor's RCM/SIC or his nominated representative (prior approval must be taken for each meeting for nomination) from site HSE meetings whenever called by EIL/Owner& failure to nominate his immediate deputy for such HSE meetings.	Rs.10,000/- per meeting
13.	Failure to maintain HSE records by Contractor Safety personnel, in line with approved HSE Plan/Procedures/Contract specifications.	Rs.10,000/- per month
14.	Failure to conduct daily site safety inspection (by Contractor's Site Engineer &safety officer), internal HSE meeting, internal HSE Awareness/Motivation Program and Site HSE Training at predefined frequencies (as approved in HSE Plan).	Rs.10,000/- per occasion
15.	Failure to fill online/submit the monthly HSE report by 5th of subsequent month to Engineer-in-Charge/ Owner	Rs10,000/-per occasion and Rs.1,000/-per day of further delay
16.	Poor House Keeping	Rs.5,000 /- per occasion per subject
17.	Failure to report &follow-up accident (including Near Miss) reporting system within specific time-frame.	Rs.20,000/- per occasion
18.	Degradation of environment (not confining toxic spills, spilling oil/lubricants onto ground)	Rs.10,000/- per occasion

Sl. No.	Violation of HSE Norms	Penalty Amount
19.	Not medically examining the workers before allowing them to work at height / to work in confined space / to work in shot-blasting / to work for painting / to work in bitumen or asphalt works, not providing ear muffs while allowing them to work in noise polluted areas, made them to work in air polluted areas without respiratory protective devices, etc.	Rs.5,000/- per occasion per worker
20.	Violation of any other safety condition as per job HSE plan / work permit and HSE conditions of contract (e.g.using crowbar on cable trenches, improper welding booth, not keeping fire extinguisher ready at hot work site, unsafe rigging practices, non-availability of First-Aid box at site, not providing dead man handle switch for blasting, whiplash arrestor for the compressor line, not using hood with respiratory devices by blaster for shot//grit blasting, etc.)	Rs.5,000/- per occasion
21.	Penalty for non-deployment of ambulance in case of man-power more than 500 or not providing dedicated emergency vehicle in case of man-power less than 500.	Rs.3,000 per day
22.	Failure to carry-out Safety audit in time (internal & external),close-out of identified shortfalls of Observations of Safety Aspects(OSA),etc.	Rs.20,000/- per occasion (for internal audit &OSA). Rs.30,000/-per occasion for external audit
23.	Carrying out sand blasting instead of grit/shot blasting	Rs.50,000/- per day
24.	Failure to deploy adequately qualified and competent Safety Officer	Rs.10,000/- per day per Officer
25.	Utilization of Hydraulic Mobile Crane /back-hoe loader for material shifting or any other unauthorized /unsafe lifting works	Rs.25,000/- per occasion
26.	Any Fatal Accident	Rs.10,00,000/-per fatality
27.	Any violation not covered above	To be decided by EIL/Owner.

Note: Penalty amount deducted from the contractor shall be utilized by owner/EIC for the promotion of the safety during the currency of the project.

The Contractor shall make his field engineers/supervisors fully aware of the fact that they keep track with the site workmen for their behavior and compliance of various HSE requirements. Safety lapses / defects of project construction site shall be attributable to the concerned job supervisor / engineer of the Contractor, (who remains directly responsible for safely executing field works). For repeated HSE violations, concerned job supervisor / engineer shall be reprimanded or appropriate action, as deemed fit, shall be initiated (with information to EIL & Owner) by the concerned Contractor.

Contractor shall initiate verbal warning shall be given to the worker/employee during his first HSE violation. A written warning shall be issued on second violation and specific training shall be arranged / provided by the Contractor to enhance HSE awareness/skill including feedback on the mistakes/ flaws. Any further violation of HSE stipulations by the erring individuals shall call

for his forthright debar from the specific construction site. A record of warnings for each worker/employee shall be maintained by the Contractor, like by punching their cards / Gate passes or by displaying their names at the Project entry gate. Warnings, penalizations, appreciations etc. shall be discussed in HSE Committee meetings by site Head of the Contractor.

3.1.14 **Accident/ Incident investigation**

All accidents/incidents shall be informed to EIL/Owner at least telephonically by Contractor immediately and in writing within 24 hours on Format No. HSE-2 as applicable, by Contractor. Thereafter, a Supplementary Accident/Incident investigation Report on Format No. HSE-3 shall be submitted to EIL/Owner within 72 hours. Near Miss incident(s), Dangerous accidents/incident shall also be reported on Format No. HSE-4 within24 hours. The accident/ incident shall be investigated by a team of Contractor's senior Site personnel (involving Site-in-Charge or at least by his deputy) for establishing root-cause and recommending corrective & preventive actions. Findings shall be documented and suitable actions taken to avoid recurrences shall be communicated to EIL/Owner. Owner/EIL shall have the liberty to independently investigate such occurrences and the Contractor shall extend all necessary help and cooperation in this regard. EIL/Owner shall have the right to share the content of this report with the outside world.

3.2 House Keeping

The Contractor shall ensure that a high degree of housekeeping is maintained and shall ensure inter-alia; the followings:

a) All surplus earth and debris are removed/disposed-off from the working areas to designated location(s).

b) Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas are removed to identify location(s).

c) All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).

d) Roads shall be kept clear and materials like pipes, steel, sand, boulders, concrete, chips and bricks etc. shall not be allowed on the roads to obstruct free movement of men & machineries.

e) Fabricated steel structural, pipes & piping materials shall be stacked properly.

f) Water logging on roads shall not be allowed.

g) No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.

h) Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.

i) Protective measures to be ensured with projected rebar by suitable means.

j) Trucks carrying sand, earth and pulverized materials etc. shall be covered while moving within the plant area/ or these materials shall be transported with top surface wet.

k) The contractor shall ensure that the atmosphere in plant area and on roads is free from particulate matter like dust, sand, etc. by keeping the top surface wet for ease in breathing.

l) At least two exits for any unit area shall be assured at all times – same arrangement is preferable for digging pits/ trench excavation/ elevated work platforms/ confined spaces etc.

m) Welding cables and the power cable must be segregated and properly stored and used. The same shall be laid away from the area of movement and shall be free from obstruction.

n) Upkeep/cleaning of site to be carried out on regular basis by the contractor. Contractor shall earmark the area for waste/scrap disposal and ensure that all waste/scrap arising out of the day's work is properly disposed to the earmarked area.

o) Hazardous waste shall be segregated and shall be kept separately at designated place.

p) Contractor shall present the status of housekeeping in HSE meeting.

The Contractor shall carry-out regular checks (minimum one per fortnight) as per format No. HSE-11 for maintaining high standard of housekeeping and maintain records for the same. The Contractor shall provide supervisor for housekeeping exclusively for management of day-to-day housekeeping activities.

3.3 HSE Measures

3.3.1 Construction Hazards

The Contractor shall ensure identification of all Occupational Health, Safety & Environmental hazards in the type of work he is going to undertake and enlist mitigation measures. Contractor shall carry out HIRAC specifically for high risk jobs/critical jobs like

a) Working at height (+2.0 Mts height) for cold (incl. colour washing, painting, insulation etc.) & hot works.
b) Work in confined space,
c) Deep excavations &trench cutting (depth > 2.0 mts.)
d) Operation & Maintenance of Batching Plant.
e) Shuttering / concreting (in single or multiple pour) for columns, parapets & roofs.
f) Erection & maintenance of Tower Crane.
g) Erection of structural steel members / roof-trusses / pipes at height more than 2.0 Mts. with or without crane.
h) Erection of pipes (full length or fabricated) at height more than 2.0 Mts. height with Crane of 100T capacity.
i) All lifts using 100T Crane plus mechanical pulling.
j) All lifts using two cranes in unison (Tandem Lifting).
k) Any lift exceeding 80% capacity of the lifting equipment's (Hydraulic Mobile Crane, crane etc.).
l) Laying of pipes (isolated or fabricated) in deep narrow trenches – manually or mechanically.
m) Maintenance of crane / extension or reduction of crane-boom on roads or in yards.
n) Erection of any item at >2.0 Mts. height using 100T crane or of higher capacity
o) Hydrostatic test of pipes, vessels & columns and water-flushing.
p) Radiography jobs (in-plant & open field)
q) Work in Live Electrical installations / circuits
r) Handling of explosives &Blasting operations
s) Demolishing/ dismantling activities
t) Welding/ gas cutting jobs at height (+2.0 Mts.)
u) Lifting/placing roof-girders at height(+2.0 Mts.)
v) Lifting & laying of metallic / non-metallic sheet over roof/structures.
w) Lifting of pipes, gratings, equipment's/vessels at heights (+2.0 Mts.) with & without using cranes
x) Calibration of equipment, instruments and functional tests at yards / work-sites.
y) Operability test of Pump, Motors (after coupling) & Compressors.
z) Cold or Hot works inside Confined Space.
aa) Transportation & shifting of ODC consignments into project areas.
bb) Working in "Charged/Live" elect. Panels
cc) Stress Relieving works (Electrically or by Gas-burners).
dd) Pneumatic Tests
ee) Card board blasting
ff) Grit Blasting activity
gg) Catalyst loading/unloading
hh) Erection/dismantling of scaffolding
ii) Chemical cleaning