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15.00.00 PLANT AUXILIARY SYSTEM

15.01.00 CONTROL AND INSTRUMENTATION FOR MAIN PLANT AUXILIARY SYSTEMS

15.01.01 Bidder shall provide complete Control and Instrumentation system with all accessories, auxiliaries and associated equipments and cables for the safe, efficient and reliable operation of the plant auxiliary systems as indicated under scope part.

15.01.02 All electrical devices like switches/ transmitters/ controller/ analyzer/ solenoid valves which are located in the hydrogen generation plant shall be made intrinsically safe by providing suitable type of transformer isolated barrier/ Zener barrier of standard make in case it is a standard and proven practice of the bidder. Otherwise such instruments shall be provided with explosion proof enclosure suitable for hazardous areas described in National Electric Code (USA), Article 500, Class-I, Division-I or EN60079-14 or shall comply with the essential requirements of ATEX directives. All fittings, cable glands etc. shall be strictly as per NEC recommendation article, 500 to 503.

15.01.03 Bidder shall provide control system for safe, efficient and reliable operation of each of the plant auxiliary systems. The type of control system shall be as indicated under scope part.

15.01.04 It shall be possible to remove/replace online various modules (like any I/O module, interface module, etc.) from its slot for maintenance purpose without switching off power supply to the corresponding rack. System design shall ensure that while doing so, undefined signaling and releases do not occur and controller operation in any way is not affected (including controller trip to manual, etc) except that information related to removed module is not available to controller. Further, it shall also be possible to remove/replace of controller module without switching off the power to the corresponding rack and this will not result in system disturbance or loss of any controller functions for the other controller. The on-line removal/insertion of controller, I/O modules shall in no way jeopardize safety of plant and personnel.

15.01.05 The control system shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is jeopardized. Control system shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuit/short circuit etc.

15.01.06 The Control system shall include on-line self-surveillance, monitoring and diagnostic facility giving the details of the fault on the Human Machine Interface (HMI) as per standard and proven practice of the Bidder. For Fire Protection systems, the faults to be reported shall include fault in main & standby power supplies, sensor fault, Input/ Output card failure, Memory Status, Controller fault, failure of Communication/ Network links to PLCs, LAN etc. The diagnostic system shall ensure that the faults are detected before any significant change in any controller output has taken place.

15.01.07 The Control system shall generally operate in air conditioned area and shall be suitable for sustained operation for limited air conditioning failure.

15.01.08 PLC systems related to Fire Protection systems shall be interconnected with Fire Alarm panels also and interface to DCS from Fire Alarm panels is also envisaged. The alarm signals from PLC system & fire alarm system shall be provided to DCS by interconnection of FAP at CER with DCS.

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15.02.00 MICROPROCESSOR/ PROGRAMMABLE LOGIC BASED CONTROL SYSTEM

15.02.01 Microprocessor/PLC PROCESSOR

The processor unit shall be capable of executing the following functions:-

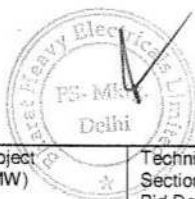
- Binary and analog signals from the field and providing command output to MCC/SWGR/Drive etc. through Input / Output modules and operator initiated commands from HMI / control panel.
- Implementing all logic functions for control, protection and annunciation of the equipment and systems.
- Implementing modulating control function for certain application as specified elsewhere in the specification.
- Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc.
- Performing self-monitoring and diagnostic functions.

15.02.01.01 For each unit, PLC based control system shall be provided. PLC system shall consist of two processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete process operation automatically. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor.

15.02.01.02 Wherever multiple functional groups have been specified/ required, the above requirements are applicable for each functional group.

15.02.01.03 Programmed operating sequences and criteria shall be stored in non volatile semi conductor memories like EPROM. All dynamic memories shall be provided with buffer battery back up which shall be for at least 360 hours. The batteries shall be lithium or Ni-Cd type.

15.02.01.04 Priority of different commands shall be as follows:
Manual intervention shall be possible at any stage of operation. Protection commands shall have priority over manual commands and manual commands shall prevail over auto commands.



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15.03.00 HUMAN MACHINE INTERFACE (HMI)

15.03.01 Graphical Interface Unit (GIU) / Operator work station (OWS) shall perform control, monitoring and operation of all auxiliaries/ drives interacting with PLC based/Microprocessor control system. It shall be possible to use the same as programming station of the PLC/ Control system and the Human Machine Interface System. In case the PC based OWS can not be used as programming station of the PLC/ Control system and the Human Machine Interface System, then separate PC based programming station shall be provided.

15.03.02 Operator shall be able to access all control/information related data under all operating conditions including a single processor/computer failure in the HMI.

15.03.03 The operator functions for each OWS shall as a minimum include Control System operation (A/M selection, raise/lower, set point/bias change, on/off, open/close operation, mode/device selection, bypassing criteria, sequence auto, start/stop selection, drive auto selection, local-remote/other multi-position selection etc.); alarm acknowledge; call all kind of displays, logs, summaries, calculation results, etc.;printing of logs & reports; retrieval of historical data; and any other functions required for smooth operation, control & management of information as finalized during detailed engineering.

15.03.04 The display selection process shall be optimized so that the desired display can be selected with the minimum no. of operations. Navigation from one display to any other should be possible efficiently through paging soft keys as well as through targets defined on the displays.

15.03.05 The system shall have built-in safety features that will allow/disallow certain functions and entry fields within a function to be under password control to protect against inadvertent and unauthorized use of these functions. Assignment of allowable functions and entry fields shall be on the basis of user profile. The system security shall contain various user levels with specific rights as finalized by the Owner during detailed engineering. However, no. of user levels, no. of users in a level and rights for each level shall be changeable by the programmer (Administrator).

15.03.06 When any drive or sequence is being controlled from one OWS, the system shall inhibit control access of the same drive or sequence from other OWS or Local Control Panel.

15.03.07 Graphical Interface Unit shall meet the minimum functional requirements of monitoring, operating & controlling the process and displaying information related to process. GIU shall be provided with TFT active matrix display and keypad for operation. GIU shall be ruggedly designed to withstand hard environments like high temperature, shock and vibration.

15.04.00 PROGRAMMING FUNCTIONALITIES

Programming of the PLC/ Control system Processor / controller as well as programming of HMI shall be user friendly with graphical user interface and shall not require knowledge of any specialized language. For example, the programming of PLC/ Control system shall use either of the following:-

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- Flow-chart or block logic representing the instructions graphically.
- Ladder diagrams.

The programming of HMI (like development and modification of data base, mimics, logs / reports, HSR functionalities etc.) shall also be possible through user-friendly menus etc All programming functionalities shall be password protected to avoid unauthorized modification.

15.05.00 **SOFTWARE REQUIREMENT**

15.05.01 All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The Bidder shall provide sufficient documentation and program listing so that it is possible for the Owner to carry out modification at a later date.

15.05.02 The Bidder shall provide all software required by the system for meeting the intent and functional/parametric requirements of the specification.

15.05.03 Industry standard operating system like UNIX/WINDOWS (latest version) etc. to ensure openness and connectivity with other system in industry standard protocols (TCP-IP/ OPC etc.) shall be provided. The system shall have user friendly programming language & graphic user interface.

15.05.04 All system related software including Real Time Operating System, File management software, screen editor, database management software. On line diagnostics/debug software, peripheral drivers software and latest versions of standard PC-based software and latest WINDOWS based packages etc. and any other standard language offered shall be furnished as a minimum.

15.05.05 All application software for PLC/ Control system functioning like input scanning, acquisition, conditioning processing, control and communication and software for operator interface of monitors, displays, trends, curves, bar charts etc. Historical storage and retrieval utility, and alarm functions shall be provided.

15.05.06 The Bidder shall provide software locks and passwords to Owner's engineers at site for all operating & application software so that Owner's engineers can take backup of these software and are able to do modifications at site.

15.06.00 **INPUT/OUTPUT MODULES**

15.06.01 The PLC/ Control system should be designed according to the location of the input/output cabinets as specified.

15.06.02 Input Output modules, as required in the Control System for all type of field input signals (4-20 mA, RTD, Thermocouple, non change over/change over type of contact inputs etc.) and outputs from the control system (non change-over/ changeover type of contact, 24 VDC output signals for energizing interface relays, 4-20 mA output etc.) are to be provided by the Bidder.

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- 15.06.03 Electrical isolation of 1.5KV with optical couplers between the plant input/output and controller shall be provided on the I/O cards. The isolation shall ensure that any inadvertent voltage or voltage spikes (as may be encountered in a plant of this nature) shall not damage or mal-operate the internal processing equipment.
- 15.06.04 The Input/output system shall facilitate modular expansion in fixed stages.
- 15.06.05 Individually fused output circuits with the blower fuse indicator shall be provided. All input/output points shall be provided with status indicator. Input circuits shall be provided with fuses preferably for each input; alternatively suitable combination of inputs shall be done and provided with fuses such that for any fault, fuse failure shall affect the particular drive system only without affecting other systems. For Hydrogen Generation plant, Bidder's standard and proven practice in this regard shall also be taken into consideration.
- 15.06.06 All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching of power supply.
- 15.06.07 The Bidder shall provide the following monitoring features:
- a. Power Supply monitoring
 - b. Contact bounce filtering
 - c. In case of power supply failure or hardware fault, the critical outputs shall be automatically switched to the fail-safe mode. The fail-safe mode shall be intimated to the successful Bidder during detailed engineering.
- 15.06.08 Binary Output modules shall be rated to switch ON/OFF coupling relays of approx. 3VA at 24 VDC. Analog output modules shall be able to drive an load impedance of 500 Ohms minimum.
- 15.06.09 Output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays etc. without any extra hardware.
- 15.06.10 Only one changeover contact shall be provided in MCC for control and interlock requirement. Further multiplication, if required, shall be done by the Bidder in PLC/Control system.
- 15.06.11 All input field interrogation voltage shall be 24V DC.
- 15.06.12 Wiring Scheme for inputs to control system shall be as per Bidder's standard and proven practice.
- 15.06.13 In case of loss of I/O communication link with the main processing unit, the I/O shall be able to go to predetermined fail safe mode (to be decided during detailed engineering) with proper annunciation.
- 15.06.14 Any single sensor/transducer/transmitter failure alarm shall be provided on programmer station screens for all sensors/transducers/transmitters. Bidder shall provide remote Input/Output modules Housed in free-standing cabinets/racks (with suitable redundant data link to the central PLC system) as specified. These Input/Output modules shall meet the technical requirements as mentioned in the above clauses. Further these Input/Output modules shall be designed to continuously

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work under the environment expected to be encountered in assigned areas without any air-conditioning support. Wherever the cable route distance of these I/O cabinets/racks exceeds a distance of 400 meters from the Central PLC, fiber optic data link has to be provided.

15.07.00 SPARE CAPACITY

15.07.01 Over and above the equipment and accessories required to meet the fully implemented system as per specification requirements, Control System shall have spare capacity and necessary hardware/ equipment/ accessories to meet following requirement for future expansion at site:

15.07.02 10% spare channels in input/output modules fully wired up to cabinets TB.

15.07.03 Wired-in "usable" space for 10% modules in each of the system cabinets for mounting electronic modules wired up to corresponding spare terminals in system cabinets.

15.07.04 Each processor / controller shall have 30% spare functional capacity to implement additional function blocks, over and above implemented logic/ loops.

15.07.05 The Data communication system shall have the capacity to handle the additions mentioned above.

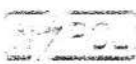
15.07.06 Twenty (20) percent spare relays of each type and rating mounted and wired in cabinets TB. All contacts of relays shall be terminated in terminal blocks of cabinets.

15.08.00 DATA COMMUNICATION SYSTEM (DCS)

15.08.01 The Data Communication System shall include a redundant Main System Bus with hot back-up. Other applicable bus systems like cubicle bus, local bus, I/O bus etc shall be redundant except for backplane buses which can be non-redundant.

The DCS shall have the following minimum features :

- a Redundant Communication controllers shall be provided to handle the communication between I/O Modules (including remote I/O) and PLC/ Control systems and between PLC/ Control systems and operator work station/HMI device.
- b The design shall be such as to minimize interruption of signals. It shall ensure that a single failure anywhere in the media shall cause no more than a single message to be disrupted and that message shall automatically be retransmitted. Any failure or physical removal of any station/module connected to the system bus shall not result in loss of any communication function to and from any other station/module.
- c Built-in diagnostics shall be provided for easy fault detection. Communication error detection and correction facility (ECC) shall be provided at all levels of communication. Failure of one bus and changeover to the standby system bus shall be automatic and completely bump less and the same shall be suitably alarmed/logged.

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- d The design and installation of the system bus shall take care of the environmental conditions as applicable.
- e Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc.
- f Passive coaxial cables or fiber optic cables shall be employed.

The Bidder shall furnish details regarding the communication system like communication protocol, bus utilization calculations etc.

- 15.08.02 The PLC/ Control system shall be provided with necessary hardware and software for dual fiber optic connectivity & interconnection with station wide LAN (for scope of Station LAN refer Vol-I) for transfer of signals for the purpose of information sharing. The plant information shall be made available through an Ethernet link following TCP/IP standard. The system shall be OPC compliant. The exact data structure shall be as decided during detailed engg. All required plant data shall be transferred to/from through this ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalized during detailed engineering. The Bidder shall provide all assistance to the BOP C&I System Supplier including co-ordination and flow of required information etc. for display of all input points under alarm, connected to PLC/ Control system or generated by PLC/ Control system, on various operating stations on BOP C&I System (for scope of BOP C&I System refer Vol-I) and various client PCs on station LAN.

15.09.00 **SYSTEM REACTION TIME**

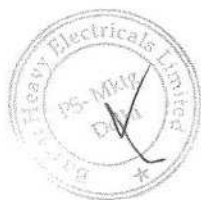
- 15.09.01 The reaction time of the programmable control system from input signals at the input cards to output of the associated signals or commands of the output card inclusive of programmed logic processing, comprising a mixture of logic gates, arithmetic operations and other internal operations shall be less than 100 milli seconds under the most arduous control system operating conditions.

15.10.00 **OPERATOR INTERFACE DISPLAYS/LOGS/REPORTS**

- 15.10.01 Suitable Operator Interface Displays/Logs/Reports for control operation & monitoring shall be provided. The details shall be finalized during detailed Engg. stage taking into account the Bidders standard and proven practice.

15.11.00 **HISTORICAL STORAGE AND RETRIEVAL SYSTEM (HSRS)**

- 15.11.01 The data to be stored in the above system shall include alarm and event list, periodic plant data, selected logs/reports. The data/information to be stored & frequency of storage and retrieval shall be as finalized during detailed engineering. The system shall provide user-friendly operator functions to retrieve the data from historical storage. It shall be possible to retrieve the selected data on OWS or printer in form of trend/report by specifying date, time & period. Further, suitable index files/directories shall also be provided to facilitate the same. The logs/reports for at least last seven (7) days shall be available on the disk. In addition to above, the system shall also have facility to store & retrieve important plant data for a very long duration (plant life) on portable long term storage media). These data will include any data from the database



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as well as processed/computed data based on various calculations/transformation. The retrieved data from long term storage media should be possible to be presented in form of X-T display, X-Y display, logs, reports, etc.

15.12.00 **CONTROL & POWER SUPPLY SCHEME**

15.12.01 **General Requirements**

The requirements of Electrical Power Supply system are specified herein on system basis. The Bidder shall be responsible for engineering and furnishing a complete and operational system fully meeting the intent and requirements of this specification including tender drawings. All equipment and accessories required for completeness of this system shall be furnished by the Bidder whether these are specifically mentioned herein or not. All the equipments and sub systems offered shall be from reputed experienced manufacturers. All system cabinets, enclosures, & distribution boards shall be manufactured, assembled, wired and fully tested as a complete assembly as per the requirements of this specification at the manufacturer's works. 24 V DC power supply system shall be provided as below:-

(A) 24V DC power supply system for PLC based control system shall comprise of two sets, each set shall consist of 1 x 100% Chargers, 1 x 100% Nickel - Cadmium batteries for one (1) hour duty, 1 X 100% DC distribution board.

(B) All interconnection hardware including cables to be provided.

15.13.00 **CONTROL CABINETS / PANELS**

15.13.01 The cabinets shall be IP-22 protection class. The Bidder shall ensure that the packaging density of equipment in these cabinets is not excessive and abnormal temperature rise, above the cabinet temperature during normal operation or air conditioning failure, is prevented by careful design. This shall be demonstrated to the Owner during the factory testing of the system. The Bidder shall ensure that the temperature rise is limited to 10 deg. C above ambient and is well within the safe limits for system components even under the worst condition as specified in Sub-section-basic Design criteria and specification requirements for remote I/O cabinets. Ventilation blowers shall be furnished as required by the equipment design and shall be sound proof to the maximum feasible extent. If blowers are required for satisfactory system operation, dual blowers with blower failure alarm shall be provided in each cabinet with proper enclosure and details shall be furnished with proposal. Suitable louvers with wire mesh shall be provided on the cabinet.

15.13.02 The cabinets shall be designed for front access to system modules and rear access to wiring and shall be designed for bottom entry of the cables.

15.13.03 The cabinets shall be totally enclosed, free standing type and shall be constructed with minimum 2 mm thick steel plate frame and 1.6 mm thick CRCA steel sheet or as per supplier's standard practice for similar applications, preferred height of the cabinet is 2200 mm. The cabinets shall be equipped with full height front and rear doors. The floor mounting arrangement for other cabinets shall be as required by the Owner and shall be furnished by the Bidder during detailed engineering.



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15.13.04 Cabinet doors shall be hinged and shall have turned back edges and additional braking where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is more than 800 mm, double doors shall be provided.

15.13.05 Two spray coats of inhibitive epoxy primer-surface shall be applied to all exterior and interior surfaces. A minimum of 2 spray coats of final finish color shall be applied to all surfaces. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2 mm and 50 microns for sheet thickness of 1.6 mm. The finish colors for exterior and interior surfaces shall conform to following shades:

(a.) Exterior:- As per RAL 9002 (End panel sides RAL 5012), to be finalized during detailed engineering.

(b.) Interior:- Same as above.

15.13.06 Paint films which show sags, checks or other imperfections shall not be acceptable.

15.13.07 As an alternative, single coat of anodic dip coat primer along with single textured powder coating with epoxy polyester meeting the thickness requirement is also acceptable.

15.13.08 Refer Subsection Basic Design Criteria, Vol-II D for grounding requirements.

15.13.09 The mimic shall be configured on the OWS and it shall be possible to control, monitor and operate the plant from the same.

15.13.10 The technical specification covering panel fabrication details, wiring and termination details etc. shall be as described under Sub-Section INST CABLE of this specification.

15.14.00 **ANNUNCIATION SYSTEM**

15.14.01 Only OWS based alarm system shall be provided with audio alarm facility (beep/tone generator). No facia annunciation is envisaged in the control room. Hooters are to be provided.

15.14.02 The system shall display history of alarms in chronological order on any of the OWS. The system shall have all alarm functions and related function keys like alarm acknowledge, reset, paging, summaries etc. The alarm display/report format shall be as approved by the Owner.

15.14.03 Facility of audio annunciation shall be provided in OWS upon the occurrence OWS alarms irrespective of whether alarms are displayed or not. Facility to disable the audio annunciation shall be provided.

15.14.04 At least three levels of alarm priority shall be available which will be displayed in different color. It shall be possible to display & print alarms of any of the three levels.

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15.14.05 Alarm boxes shall be provided in each display to alert the operator about an alarm when he is viewing some other picture. No of alarm boxes shall be finalized during detailed engineering for each process area & each priority therein.

15.15.00 **CONTROL DESK**

15.15.01 For Fire Protection system, Industry standard Control desk shall be provided to keep the TFT monitors at top and computers inside. Control desk shall consist of vertical, horizontal and base supports with their coverings for work surface, keyboard trays, mouse pads, monitor shelf and concealed cable and wire way management, perforated trays with covers in both horizontal and vertical directions. PA system handsets, telephone sets, any PB stations and lamps required shall be mounted on the control desk on mosaic grid structure and same shall be decided during detailed engineering. ASCII Keyboard shall be capable of being pulled out through a tray.

15.15.02 The cabling / wiring between OWS & CPU'S, power supply cables etc. shall be aesthetically routed and concealed from view.

15.16.00 **FURNITURE**

Chairs - Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge & other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back. Chair pedestal shall be made of 5mm thick MS plate covered with poly-propylene cladding. Arm-rests in one piece shall be of poly-urethane and twin wheel castor of glass filled nylon. The exact details shall be finalized & approved by Owner during detailed engineering.

Tables -- Industry standard tables shall be provided for printers.

15.17.00 **SOFTWARE DOCUMENTATION AND SOFTWARE LISTINGS**

15.17.01 All technical manuals, reference manuals, user's guide etc., in English required for modification/editing/addition/deletion of features in the software of the PLC/ Control system shall be furnished. The Bidder shall furnish a comprehensive list of all system/application software documentation after system finalization for Owner's review and approval.

15.17.02 All The software listings including source code for application software, All special - to-project data files etc. shall be submitted by the Bidder.

15.18.00 **SOFTWARE LICENCES**

The Bidder shall provide software license for all software being used in Bidder's System. The software licenses shall be provided for the project (e.g. organization or site license) and shall not be hardware/machine-specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for Owner to seek a new license/renew license due to up gradation/change of hardware/machine in Bidder's System at site. All licenses shall be valid for the continuous service life of the plant. As a customer support, the Bidder shall periodically inform the designated officer of the Owner about the software

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upgrades/new releases that would be taking place after the system is commissioned so that if required, same can be procured & implemented at site.

15.18.01

(A) SPECIFICATIONS OF OWS

The minimum requirement for PC based OWS shall be as below:

CPU	Latest generation CPU
Removable bulk storage drive (MOD / DVD / DAT)	6 GB (minimum)
Monitor	Minimum 22" Full Flat TFT Resolution 1600 x 1280, refresh rate min 85 Hz.
UPS	1 no. on-line Interactive UPS with 30 mins. Battery backup on machine load (for PC & its printer)

Software	a	General MS Windows latest version, MS-Office, Microsoft Visual Studio, Adobe Acrobat, anti-virus McAfee or equivalent, etc.
	b	Application software - to suit project specific requirement
Accessories		Required furniture for mounting of HMI peripherals shall be provided.

(B) GRAPHICAL INTERFACE UNIT

The minimum requirement of Graphical Interface Unit are as follows:

Sl. No.	Description	
1.	Power supply	24 V DC/ 240 V AC
2.	Display Type	10.4" Colour, TFT screens with keypad
3.	Humidity & Operating Temperature	5-95%, 0-50 deg C
4.	Protection class	IP-65 for extremely dust prone area, otherwise IP-55. Enclosure shall be provided to prevent ingress of dust
5.	Keys	Function keys and numeric keys
6.	Interfacing requirements	Interface with PLC system
7.	Functional requirements	Ability to operate drives locally using function keys. Graphics display including alarms and operator guidance messages.

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15.19.00 PRINTER

15.19.01 One number A4 size color laser printer shall be provided as a part of the HMI system. It shall print out all alarm/trip conditions and event changes in plant status along with date and time of occurrence.



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