Indian Institute of Technology, Kanpur
Department of Civil Engineering

Request for Proposal

Sl. No.	Name of Work	Bid Security (in INR)	Last Date and Time for submission of tender	Date and Time for opening of Technical Bid
1.	Supply, guarantee, delivery, site installation, Panel Wiring, testing, training, documentation and commissioning of Programmable Logic Controller (PLC) based control system and accessories as per Scope of supply covered in Part-I and Technical specifications covered in Part-II of this document for National Aerosol Facility at IIT, Kanpur	Rs. 2,00,000/-	30.10.2017 upto 1700 Hrs	31.10.2017 at 1500 Hrs

The firms with at least three years relevant experience in above said work are eligible to participate. The proposal duly completed in all respect should be submitted in sealed cover duly marked, so as to reach undersigned on or before 1700hrs on 30.10.2017. The tender document with eligibility criteria and other details may be downloaded from www.iitk.ac.in. The Institute reserves the right to accept or reject any offer or all the offers without assigning any reasons thereto.

No. CE/2017-18/0137, dated: 16.10.2017

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NATIONAL AEROSOL FACILITY (NAF)

SPECIFICATION NO: NAF-PLC-SPEC-01

TECHNICAL SPECIFICATION

FOR

Programmable Logic Controllers (PLC) Based Control System

SPECIFICATIONS FOR PROGRAMMABLE LOGIC CONTROLLER (PLC)
BASED CONTROL SYSTEM

Part-I   Scope of supply

Supply, Testing, Installation, Commissioning, Training & Guarantee of the following as per the technical specifications covered in Part II of this document.

Following are in the scope of supplier:

1. Supply of of PLC based Control unit and I/O system as per TABLE-1 and as per Technical Spec para 2.0 & 3.0. of technical specifications.

2. Supply of PCs as Operator stations as per Annexure-1. Supply of Interconnecting Cables, Switches Gateways and associated hardware for the complete networked system quoted and Internal cabling within the PLC system as per Technical Spec para 4.0. However, Supplier shall also include in his proposal all hardware and devices, which are needed for the completeness of the plant auxiliary system/equipment, supplied by the Contractor, even if the same is not specifically mentioned.

3. Supply of Rittal make or equivalent Panel with locking arrangement for housing PLC and accessories as per Technical Spec para 7.0 and Control desk for housing large display panel, annunciator,

4. Supply of Furniture for operator station and (SERVER) development station.

5. Supply of UPS 5KVA with One Hour Battery Backup.

6. Development of application software as per para 5.3

7. Training of personnel as per para 8.0 of technical specifications.

8. Inspection, Testing and reports as per para 9.0, testing as per para 12.0 and reports as per para 9.0, and also supply of complete documentation as per para 10.0 of technical specifications.

9. installation and commissioning of the entire integrated system as per para 13.0

10. Guaranty for the system supplied as per para 11.0.

Price break up for the system and spares as mentioned in shall be quoted separately (no lump-sum cost will be accepted) and point to point compliance sheet shall be provided.

TABLE-1: Scope of Supply

S.No	ITEM DESCRIPTION	QTY (No)	UNIT COST (Rs)	TOTAL COST (Rs)
1	PLC with CPU, Power supply and accessories as per para 3.0 & Table-1 PLC a) Analog Inputs (128 Nos.) b) Analog Outputs (32 Nos.) c) Digital Inputs (100 Nos.) d) Digital Outputs with relay (50 Nos.)	1 set		
2	Real time automation and data base software as per para 5.0	1 set		
3	Networking hardware as required	1 set		
4	Panels /Racks as per para 7.0	1 set		
5	Testing, Installation & Commissioning as per attached Specifications	Lumsum		
6	Training as per para 9.0	Lumsum		
7	Spares as per Table-3	1 set		

TABLE-3: Spares

Sr No.	ITEM	QTY (Nos)	UNIT COST (Rs)	TOTAL COST (Rs)
1.	PLC CPU Module	1 modules		
2.	Digital I/P channels	1 modules		
3.	Digital O/P channels	1 modules		
4.	Analog I/P channels	3 modules		
5.	Analog O/P channels	2 modules		

TABLE-5 Questionnaire

S.No	DESCRIPTION	ANSWERED
1.	CPU communication	
2.	CPU to I/O communication	
3.	H/W and S/W required for third party integration	
4.	Communication protocol for third party integration	
5.	Max no. of nodes and I/Os supported	
6	Backplane bus description	
7.	Whether Integration carried out by supplier or third party system Integrator	
7	Third party connectivity (List of products supported enclosed)	Yes/No
8	PLC programming through Functional block diagrams	Yes/No
9	Detailed description for method of connection to third party devices	Yes/No
10	Training as per Specification para 9.0	Yes/No
11	Supply of Rittal Panels as per para 8.0	Yes/No
12	Questionnaire answered as per Table-5	Yes/No

PART-II Technical Specifications

1.0 GENERAL:

A Programmable Automation Controller (PLC) based control system on a high speed data transfer network and with SCADA system, is required for the centralized monitoring & control of an Experimental facility. The entire system shall be located in the same control room. The entire system configured shall support distributed intelligence i.e. multiple CPU for increased reliability, availability and processing power. The control system shall be expandable by interconnecting multiple units to form a distributed system utilizing the peer – to-peer communications. The system shall be designed to communicate over 10/100M Ethernet The system shall provide a scaleable open design and embedded object-based OPC interface that will program, engineer and visualise any other third party products, meet diverse needs for operations, maintenance and plant management. The SCADA shall be user configurable, upgradable and with plug & play user friendly modules. The software shall enable the engineers, supervisors, managers and operators to view and communicate with the workings of entire operation through graphical representations of their production process. The software must provide host of features including distributed alarm handling, distributed historical data, centralized alarm printing, remote tag referencing. The system will have following salient features:

- *Open System Architecture*
- *Connectivity to third party devices*
- *Client Server Architecture*
- *Windows Platform*
- *Programming language confirming to IEC61131-3*
- *Upgradable with 30% spare capacity*

Standard Rittal make or Equivalent panels with locking arrangement shall be used for housing the control units and I/Os with the accessories. The workmanship shall be of high standard and quality. The power supply will be made available to the supplier at site through Uninterrupted Power Supply. *The facility will be housed in an air-conditioned control room*.

The supplier shall supply the PLCs, system networking hardware and the associated Software as a complete package. Any additional Software and Hardware other than the existing Software as mentioned in para 5.0 required to integrate the quoted system shall be in the scope of the supplier. He shall provide the necessary details in a clear document.

Suppliers shall provide list of such installations carried out by him. The supplier shall quote separately for spares and accessories as mentioned in Table-3. The following points shall be strictly adhered to.

The quotation shall be made only in the format given in Table-1. Price break up for each item / unit rate of each item shall be mentioned else the quotation will not be considered. Only those quotations will be considered in which hardware and software for the system shall be supplied in totality. <u>Point to point compliance / deviation</u> between the offer and the specified requirements shall be furnished.

2.0 GENERAL SPECIFICATIONS:

The control system will be housed in an air-conditioned room. Four units of single phase 240VAC supply are provided through isolation transformer and UPS.

2.1 Power Supply Voltage: 240VAC, +/- 10%, 50Hz, single phase.

For separately mounted I/O racks, separate power supplies shall be provided. Power supply module shall be of ample capacity to supply all modules. In addition 30% spare capacity for future shall be provided. All the drives shall be switched ON/OFF through 24V DC coupling relays to be provided in panels. The exact 24V DC power supply scheme shall be as approved by Employer during detailed Engineering stage.

2.2 Ambient temperature: Shall be capable of working in the temperature range 10 to 50 deg. C

2.3 Relative Humidity   :   Up to 95%

3.0 FUNCTIONAL SPECIFICATIONS FOR PLC:

I/Os indicated in Table-1 are to be quoted by the supplier.

<u>Spare Slots</u>: The Control system panels shall each have 30% spare slots to take care of future expansions. The supplier shall discuss the configuration of the racks for the modules and the wiring of all slots in consultation with the indenter.

<u>Spares</u>: Spares as mentioned in the Table-3 shall be quoted giving the unit rate separately.

TABLE-4

	Analog I/P	Analog O/P	Digital I/P	Digital O/P	Power Supply Required
Total	128	32	100	50	Power supply 24V DC,10 A 2nos. load sharing type connected in a redundant manner

The front plane of the system panel shall house the CPUs, and I/O Modules and Power Supplies and field terminations shall be done on the back plane. All the backplanes housing the I/Os shall be connected through solid cabling and connectors. In case of communication failure to the Operator Stations, the process shall remain undisturbed and only the data shall not get displayed.

3.1 **Central Processing Unit (CPU**)

Processor Family : CPU shall be a Power processor. The supplier shall mention the processor family type. _There shall be Single processor only_ . There must be exact tracking of control, logic and sequence databases amongst the processors. Live replacement should be possible for the processor. All module should be rack mounted and Hot Swappable and min IO handling capacity should be for DI/DO 1024 and Analog 256 IO.

CPU required min 1 USB ,1 Ethernet, 1 RS485/232 ,memory min 8 MB.

Execution time 1.16μs for floating points ,0.25μs single-length words, 0.17μs double-length words, 0.12 μs Boolean

The loading of the CPU should be only 60% of its total capacity.

3.1.1 Real time Clock :

The processor shall have a real time clock with battery back up. In case of total power failure, provision for maintaining memory for 10-12hrs to achieve hot start of the processors shall be possible.

The instrument time should be synchronized automatically with the server time available in the network.

3.1.2 <u>Self Diagnostics</u> :

Built-in diagnostics shall be provided for Watchdog timer, RAM check, ROM check, Power & voltage check, Battery voltage check, Status check of all I/O modules, Bus faults, Program Memory, timers, counters, Illegal instructions & front panel indications for Run Error, I/O Error & Communication etc. and the same shall also be clearly documented in the graphic configuration editor easy fault detection. Power supply module shall have an Alarm relay for external annunciation.

3.1.3 <u>Sampling times</u> :

i) For Analog signals: 120 msec. or better
ii) For Digital signals: 50 msec. or better

Memory back-up

Power back-up for volatile memories shall be capable of maintaining stored information for at least 300 hrs under normal use, and 1,000 hrs at a temperature not greater than 25 °C when the energy source is at rated capacity. The manufacturer should specify storage time information relative to volatile memory if different from stated durations. It shall be possible to change or refresh power back-up without loss of data in the backed-up portions of memory. If a memory back-up battery is provided, a warning of "low battery voltage" shall be provided.

3.1.5 <u>Communication</u>:

PLC shall have suitable standard high speed communication bus interfaces for peer communication to Server. Separate ports/Module for SCADA interfaces & PLC programming shall be available so that changes in the PLC program are possible without interrupting SCADA communication. The individual PLCs shall have additional USB/ETHERNET port for programming the PLC and fast data downloading using PC and RS 485 port for multi drop connectivity. The communication between CPU and Server shall be preferably Ethernet. The speed of communication between I/O racks shall be better than 10Mbps. Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc. plus 30% spare capacity shall be available for future expansion.

3.2 **Input (I/P) & Output (O/P) module Specifications**:

Input/Output modules, as per Table-1 required in the Control System for 4-20 mA, and outputs from the control system, non change over/change over type of contact, 24/48 VDC output signals for energizing interface relays, 4-20 mA output etc. are to be provided by the Contractor. All modules shall be individually enclosed in rugged industrial enclosures housed in free-standing panels/racks. These Input/ Output modules shall meet the technical requirements as mentioned in the above clauses. The Input/output system shall facilitate modular expansion in fixed stages. The individual input/output cards shall incorporate indications on the module front panels for displaying individual signal status.

Individually fused output circuits with the blown fuse indicator shall be provided. All input/output points shall be provided with status indicator. Input circuits shall be provided with fuses 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.

All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching of power supply.

Further these Input/ Output modules shall be designed to continuously 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 panels/racks exceeds a distance of 300 meters from the Central PLC, fiber optic data link has to be provided.

3.2.1 Digital Inputs :

These are required for sensing DC proximity switches, push buttons, limit and selector-switches from console or field devices. The I/P circuitry must have I/P filtering circuit to eliminate the effect of voltage transients caused by contact bounces and/or electrical noise. Each I/P should have LED indicator to indicate healthy and faulty state of operation.

Quantity	as per Table-1 (preferable I/Ps per module shall be 8)
I/P voltage	Biasing supply voltage shall be 24V, as per Table-2
Permissible voltage	19 to 30V
Indication	LED for status of each I/P

System Isolation	500 V DC (max) between group of channels
Current consumption	140 mA at 3.3VDC
Input impedance	9600 Ohm
Insulation resistance	> 10 MOhm 500 V DC
Channel Qty in each module	16/ 32
Voltage state 1	>= 11 V
Voltage state 0	<= 5 V
DC Power dissipation in W	<= 3.9 W
DC typical filtering time	Approx. 4 ms
DC maximum filtering time	Approx. 7 ms

3.2.2 <u>Digital Outputs</u> :

The digital O/P modules shall be of DC type to drive console lamps and solenoids. The modules shall have LED for status indication and protection for overload, short circuit & polarity inversion. The facility for O/P paralleling shall be available with potential free contacts. Preferable O/Ps per module shall be 16/32.

Indication:	LED for status of each O/P
Digital output voltage	24 V 19...30 V DC
Current per module	<= 3.2 A
Insulation resistance	> 10 MOhm 500 V DC
Power dissipation in W	<= 3.6 W
Response time on output	1.2 ms or better
Typical current consumption	150 mA 3.3 V DC

Relay required for potential free O/P with min. 5A Rating.

3.2.3 <u>Analog I/Ps</u>:

All analog I/Ps shall be of 4-20mA type. The quantity shall be as mentioned in Table-2
The modules shall have LED for status indication and protection for overload, short circuit & polarity inversion. The facility for O/P paralleling shall be available

Type :	Current0...20 mA
	Current4...20 mA
	Voltage+/- 10 V
	Voltage+/- 5 V
	Voltage0...10 V

Voltage0...5 V

Voltage1...5 V

With driving voltage of 24VDC floating

Analog/Digital conversion   16bits

Nominal read cycle time   9ms for 8 channels

Input range   -30mA to 30mA

Overall Accuracy :   0.1 % of range

CMRR :   >= 80 db

Input impedance :   4 Mohm

Isolation :   Required

Indication :   Each I/P should have LED to indicate healthy/faulty state

System Isolation   300 V DC max

Current consumption: 150mA at 3.3 V D & 45mA at 24 V DC

Ambient Temp.   0……..60 Deg.

Relative Humidity   10….95% Without condensation

No. of I/Ps per module: preferably 4/8

3.2.4 Analog O/Ps:

No. of O/Ps per module: preferably 4/8

Overall Accuracy :   0.1% of range

Common mode

between channels   >= 80 dB

Detection type   +/- 10 V,4...20 mA, 0...20 mA

Resolution: 15 bits + sign

Isolation :   analog O/P channels shall be isolated Channel isolation

                             Functional, 264V ac max

System isolation   300 V DC

LED Indication: status indication for each O/P

Load resistance :   <=500 Ohm 4...20 mA

Current consumption   150mA at 3.3 V D & 45mA at 24 V DC

4.0 SYSTEM ARCHITECTURE:

System Requirements:

The system architecture shall be as per sketch-1. The supplier shall offer a system such that the entire system appears integrated and is expandable. The communication link between PLCs and from individual PLC to Server (Engineering station) shall be by High Speed bus or with an Ethernet network with TCP/IP complying to IEEE 802.3 with high degree of reliability. The operator stations (PCs) will have access to the server via an Ethernet network with TCP/IP complying with IEEE 802.3.

The bus used in the system shall have multi vendor connectivity. The supplier shall supply the details of the standard applicable to communication system including communication protocol structure, security checking and control method etc. The bus shall be capable of receiving and sending information to various nodes, PLCs etc. at a speed of 10 Mbits/sec (min).

Suitable standard hardware interfaces shall be provided for interconnecting the PLCs, Server (Engineering station), Operator stations and Printer as per the given system architecture in Sketch-1. The supplier shall provide the associated software drivers and modules based on the type of connectivity of the network. Networking shall be carried out using suitable high quality cables. If the distances are larger, the supplier shall provide Fibre optic communication. For integration with third party devices, built-in Modbus communication shall be made available. The list of third party PLCs and devices supported by the supplier shall be provided in the offer.

Complete system integration shall be in the scope of the supplier.

5.0 **SOFTWARE FEATURES**:

5.1 System configuration software:

An industry standard Windows graphical configuration package, shall be used to configure the processor in a choice of IEC 61131 configuration languages. It should integrate, configure & set the I/O Parameters & control them in real time when PLC is connected to the process. The instrument programming must support Functional blocks, Instruction lists, Structural text, Sequential charts & Ladder type of programming tools. A wide selection of function block libraries shall be available to provide the different, mathematical calculation, control algorithms, alarms, and other blocks required for the advanced control. It should support functions like set point ramping, totalizers and flow compensations. It should have standard control modules for PID, Boiler drum level control motors, valves, duty standby etc.. The required function blocks are placed on a graphical work sheet and the I/O simply needs parameterising. Relay Ladder editors provide combinational logic and sequencing while Sequence Function Charts can program more advanced sequencing. Geographic addressing of I/O cards should be possible. Address setting by jumpers will not be accepted.

On line configuration:

Modifications like add/deleting function blocks and logical connections in the running process strategy shall be possible. Before finalizing the strategy's suitability to the process shall be confirmed.

The components of the control system viz. I/O and CPU shall have a common database to avoid repeatedly carrying out modifications in different databases and thus saving time and reduces errors. Changes in the PLC program are possible without interrupting SCADA communication.

System software shall be provided in the Server Station for graphically configuring and modifying the entire network and I/Os using standard drag & drop technique. Main network Server/ Engineering Station software should support the database for unlimited I/O count. The configuration software shall be in the form of software blocks. It shall be capable of acquiring and control of data from various sensors and instruments via . Analog and Digital I/O boards, RS232-C etc. Easy integration of additional instruments shall be possible.

Software shall have comprehensive alarm management. The analog inputs shall be configurable for different alarm levels through facilities. The analog inputs shall be configurable for different alarm levels through software.

The supplier shall be fully responsible for providing the necessary drivers for integrating the existing system with the system offered by him.

The Sampling rates shall be:

a) For Analog signals : 125msec or better

b) For Digital signals : 50msec. or better

c) The data updating on the screen: 1sec (min).:

5.2 **SCADA Software**:

Suitable real time data management software in the server shall be provided for receiving data from PLCs & Engineering Station and transferring data to operator station on demand. This software shall be able to process and transmit the data very efficiently whenever required in any specific form (as specified by the operator / client through the network). It shall be programmable to limit the data storage from current month to three months depending on sampling time and data storage capacity. Layered password Control at various levels i.e. system configuration, changing alarm interlocks, Set points etc. shall be possible to prevent unauthorised entry. SCADA should maintain its own standards in displaying information to the operators. Standards should be available as pre- configured modules so that they can be used as it is in any installation. The software shall be compatible with running Windows operating system. The feature should also decrease the maintenance and trouble shooting time once the plant is in operation. English shall be the communication language. The software shall have 32 bit architecture, open connectivity, object oriented graphical programming methods and event driven architecture. It shall read I/Os and assign internal variables (Process tags) and generate internal variables by mathematical operation like assigning special control signal computations as per the standard controller algorithms. The software shall not occupy much disk space. It shall add-in to Microsoft Word and Excel package.

Users shall be able to add, delete and modify PLC I/Os, graphics and supervisory control logic online without shutting down the plant/ experimental facility. The Software Development package shall include Data Acquisition & Control, Data Analysis and Data presentation. All The software listings including Source code for application software, All special-to-project data files etc. shall be submitted by the Contractor.

The software shall have the following features:

5.2.1 Single configuration environment

The SCADA System should have a single configuration environment for configuring the whole project. The project environment should have features like:

- Building mimics
- Creating the network and the instruments under those network
- Creating the configuration files for those instruments
- Creating alarm groups – where tags to those alarm groups can be added by dragging those tags to the groups.
- IO manager for allocation of tags to the instruments
- Deploying the project to the runtime and operator station from the development station.
- Creating the security features and deploying them.

5.2.2 Object oriented graphics

It should be easy to configure and reduce development times. Objects should have features like sizing, moving and animating. Powerful object oriented design tools should be available to create graphics. It should support Microsoft's ActiveX technology. It should support video resolution supported by windows and multi monitor configurations.

5.2.3 Animation Links

Animation links should be available for movement, position changes and more. It should include discrete, analog and string touch inputs.

5.2.4 Distributed Alarming

It should support multiple alarm servers or 'providers' simultaneously, which gives operators the ability to view alarm information from multiple remote locations at the same time. It should also support distributed alarm functions which let users implement 'point-and-click' alarm acknowledgment, alarm scroll bars and many other features for networked use.

Time Stamping: All the alarms and events that occur should be time stamped at source.

5.2.5 Distributed Historical Trending

Operation Server/Viewer should allows you to dynamically specify different historical file data sources for each of the pens on a trend chart. The Operation Server/Viewer should permit minimum of 16 pens per trend chart. The users should be able to view historical data at any given time.

5.2.6 Display navigation

The display should be user configurable. Screen navigation is designed so that the operator can page through displays at different levels. Starting with over view, area displays, group displays, fascia displays, current and historical trend groups etc., A permanent alarm banner provides immediate indication of abnormal plant conditions. Security is achieved via login and password.

5.2.7 Group Display

The system should allow for building graphics comprising of points across groups/areas. The areas are created for efficient alarm management. Group display should contain bar graph display of individual loops, their digital values & status display. In addition to this, one should have access to the tuning parameters, real time trend, historical & event trends. Auto/manual/remote selection for any loops or all loops should be possible from group display. Set point & alarm adjustment of any loop should also be possible from any display. This should be password protected.

5.2.8 Faceplates

Faceplates for all IO tags, control modules should be available by default. It should allow some operator interaction with the device and provide an operational summary of the status of Faceplates should be displayed on a supervisory system as a sub-window.

The operator should be able to control the device by means of pushbuttons (for mode selection or for state selection on a digital device) or numeric values (for analogue values

such as set points). Numerical values can be set either by selecting the displayed value and entering a new value or by selecting the associated bar graph and ramping up or down.

5.2.9 Parametric/Loop Display

The SCADA system should have a faceplate for PID, Pulse Input, Analog Input, Device Control, and Input Selector function blocks etc. It should also contains a detail display for the PID, and Device Control blocks. The loop detail display should provide access to frequently modified parameters for loop module as well as status and diagnostics information.

5.2.10 Trend Display

The SCADA system should be capable of displaying Real time and historical data from the continuous history subsystems as well as from the event chronicle. Trends should be plotted on a graph. On line archiving of trends should be possible. The trend package should allow the operator to carry out the following:

- Move forward and backward in time
- Zoom in on a particular area of the trend
- Select a particular pen (the engineering units range of this pen is then displayed)
- Position a hairline cursor to read off values and timestamp
- Print display charts

5.2.11: Reporting &Alarming Manager:

NOTE:

Software Licenses:

Scada license must be min 1500 Tags

The Contractor shall provide software license for all software being used. The software licenses shall be provided for the project (e.g. organisation 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 Employer to seek a new license/renew license due to upgradation/change of hardware/machine at site. All licenses shall be valid for the continuous service life of the plant.

Software Upgrades

As a customer support, the Contractor shall periodically inform the designated officer of the Employer about the software upgrades/new releases that would be taking place after the system is commissioned so that if required, same can be procured & implemented at site.

5.3 Application Software Development

5.3.1 Operator Interface
The following features shall be possible:

a) On line display of control groups, alarm summary, process mimics with on line data   20 pages minimum. A sample mimic shall be provided. and the manner in which pages shall be displayed shall be described.

b) Trends for selected variables for selected time interval in different windows. The display panels should show X-Y and real time plots, bar graphs, trend graphs.

c) Alarm settings for different levels and alarm generation

d) Controller mode of operation and performance behavior.

e) Configurable O/P states for predictable performance in critical applications.

f) Generation of shift wise log reports on demand log report for programmable time basis for selected process variables which shall be either on hard disk/floppy disk with security privilege and printout shall be routed to Colour LaserJet printer.

g) It shall be possible to generate reports from the data acquired by the system. DDE linkages shall be available through which data can be transferred to packages like Microsoft EXCEL.
Assign / change job for any other station from anywhere.

h) Each graphic Display shall be composed of graphic symbols and alphanumeric characters. The symbols shall be as per the latest revision of ISA standard (S5.5 or equivalent).

i) All displays shall be graphically updated.

j) The **equipment control logic for the various equipments shall be provided** by the user. The supplier **shall develop the software accordingly for each equipment.**

5.3.2 Control Software Development

The control logic and mimic display will be programmable by the supplier. The user shall provide the equipment trip matrix. The user shall also provide skeleton picture of the mimic pages required for running the facility.

In addition to the basic design the following application software can be provided:-

- Configuration of the I/O Process Interface
- Configuration of the software database and mimics
- Preparation of report and alarm manager as per the desired format

The application software includes the following elements:-

- Production of Design Specification
- Production of Test Specification
- Configuration and Programming
- Functional Test of Programmed Instrument
- Production of Operating Description

The supplier shall configure the alarms as process, system, diagnostic alarms for the ease of operators.

6.0 **DOWN TIME**:

In the event of PLC failure, the maximum downtime for the system shall not be more than 15min.

7.0 **PANELS & INTERNAL CABLING**:

7.1 PLC with its accessories will be housed in standard "**Rittal Make or Equivalent Panels**" with of IP-65 protection class. The cabinets shall have glass doors and shall be designed for front access to system modules and rear access to wiring and shall be designed for top entry of the cables.

The panels shall be totally enclosed, free standing type and shall be constructed with 1000mm (W)x800mm(D) , preferred height of the panel is 1800 mm with base. The panels shall be equipped with full height front and rear doors. The floor mounting arrangement for other panels shall be as required by the Employer and shall be furnished by the Contractor during detailed engineering.

The Contractor shall ensure that the packaging density of equipment in these panels is not excessive and abnormal temperature rise, above the panel temperature during normal operation or air-conditioning failure, is prevented by careful design. This shall be demonstrated to the Employer during the factory testing of the system. The Contractor 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 Suitable louvers with wire mesh shall be provided on the panel.

The Panel will have following features:

1. Electrophoretic dipcoat priming and powder coating
2. Sturdy handle & locking arrangement
3. .Highly elastic foamed- in PU gasket for perfect sealing.
4. cooling fans of sufficient capacity and tube light.
5. The actual design & fabrication drawing shall be prepared and got approved by the representative of the purchaser before the commencement of actual fabrication. The wring nomenclature shall be fully approved prior to execution.

7.2 Control Desk

The control desk for dimension   3000(L)X1800(H)X400(D) shall be supplied to accommodate 16 Window Alarm Annunciator with push button accessories and Large Display Unit of 55" dimension and mushroom type emergency push buttons ETBs of 10 Nos for tripping the equipments manually in case of failure of PLC system/any malfunction in the plant. The control desk table (Control Console) shall be of suitable dimension to accommodate the server/developer station and the operator station along with colour laserjet printer. The system architechture is shown in sketch-1.

The drawing of the control desk and PLC rack shall be submitted for approval before fabrication.

7.3 Specifications for alarm annunciator

General:

Alarm Annunciator is required for instant alarming of any abnormal condition occurring in the process parameters. The annunciator shall be based on latest single chip micro processor based and designed using the latest technology with plug-in modules for Sequence card,

Flasher Card and Push button module. All connectors shall be gold plated and of "Amphetronix" make or equivalent. The operating sequence shall be **AUTO RING BACK ALARM SEQUENCE** as per the prevailing standard of ISA – 2A and common ring back audible. The compact design shall ease troubleshooting and installation, i.e. all plug-in cards shall be front accessible. Suitable circuit arrangement for maintenance shall be provided. *A 16 window fascia of size 40X40 mm with eight super bright LED's per window, hooter and power supply is available.*

2.0 **Functional Specifications:**

2.1] Input voltage range: 240 V AC, +/- 10%, 50Hz 1 phase.

2.2] No. of windows 12 per unit each of size 40x40mm each arranged in 3 rows

2.3] No. of LED's / window 8/9

2.4] Scan Time 200 milli sec. or better

2.5] Response Time 40 milli sec

2.6] a) Sequence card This card shall contain the solid state circuitry with RING BACK ALARM SEQUENCE as per ISA-2A ISA - S18.1 –1979 (R 1985) and common ring back audible and as per the Table-1

b) Flasher card This card shall be an integral part of the annunciator but the bidder shall provide the push buttons and accessories to be installed on the existing mimic panel.

2.7] Interrogation voltage 24 V DC

2.8] Flash rate 50 flashes/min- fast flashing
25 flashes/min- slow flashing

2.9] Fault Input contacts Potential free contacts NO/NC site selectable by DIP switches

2.10] Output connections For test, Accept & Reset operations on specific demand

2.11] Output relay contact Potential free contact for internal Hooter/Bell
< 5 % for non-linear load

2.12] Output contact rating 5 Amp. At 230 V AC

2.13] In built hooter With 6 window model having audio discrimination

2.14] Noise Less than 45 db at 1mt. distance

2.15] Enclosure The cards shall be assembled in a rugged MS enclosure and the enclosure shall be clamped inside the mimic panel. The annunciator installed in this position could be accessible only by opening the front door of the mimic panel. There shall be no projections / terminations on the rear side of the annunciator. The dimensions shall be specified

2.16] Service Conditions   The annunciator shall be able to function properly in the mounting position as described. Shock and vibration shall not damage the annunciator system.

3.0] **Performance Specifications**

3.1] Operating Temperature 40deg C (max)

3.2] Relative Humidity 95% at 35 Degree Centigrade non condensing

5.0] **Documentation:**

2 copies of the original manual alongwith the working shall be supplied along with the despatch. The circuit diagram shall be sufficient for installation and troubleshooting. They shall include proper identification of components.

Ring Back Annunciator Sequence

CONDITION	Manual Action	Audio	Visual	Ring Back Alarm
Normal		Off	Off	Off
Abnormal		On	Fast flash	Off
Normal before accept		On	Fast flash	Off
Normal	Accept	Off	Steady	Off
Ab-Normal	Accept	Off	Steady	Off
Normal before reset		Off	Slow flash	On
Normal	Reset	Off	Off	Off
Ab-normal	Reset	Off	Steady	Off
Normal	Test	On	Slow flash	Off

8.0 **TRAINING:**

Training of 4 engineers for Three Days, before the delivery of the equipment, in maintenance of hardware, software and preparation of application software for processor, Communication Processor and PID Controller and other standard controller. i.e. for the entire system mentioned in the document. The supplier will provide necessary guidance for a mutually agreed period.

Training would be provided for Engineers and Operators at site.

Process Operator / Engineer Course

Instrumentation Engineer Configuration / Maintenance Course

Operations Staff Training

1. System architecture.
2. Functions of each node.

3. Display hierarchy, access methods for various displays, switching between different types of displays etc.

4. Control of plant from various displays.

5. Alarm -handling.

6. Developing special programmes for plant control and their debugging (Restricted to supervisory staff only).

7. Logging software.

Maintenance Staff Training

1. System architecture.

2. Functions of each node.

3. Hardware in each node.

4. Complete application software.

9.0 **INSPECTION, TESTS & REPORTS:**

The supplier shall be conducting all the tests as per the Quality Assurance Plan(QAP). Supplier shall prepare the detailed fabrication drawings, final QAP and a detailed test Procedure covering all the tests while QAP in Annexure as well as other tests necessary to meet the requirements and the test procedure. The supplier shall submit three copies of these documents for approval before commencement of Fabrication & Integration.

Following Predespatch Inspection of the above mentioned items shall be carried out in an integrated form at the supplier's premises prior to despatch by authorized engineers from BARC.

1. Visual inspection

2. Functional check of all I/O modules, PLCs, Network, Database,

3. Computers & Printer

4. Accuracy performance of Signal conditioning and control algorithm

5. Throughput check of data acquisition and data transmission

6. I.R. Value

7. Reliabilty of system performance

8. Functional verification of softwares

The panels shall be inspected prior to fixation of PLC and accessories and later after the fittings are made.The supplier shall demonstrate third party connectivity and shall Show the well-documented drivers of the same. Supplier shall provide all the inspection, testing facilities and test reports of the tests conducted on the modules in a detailed manner as

claimed in the specifications. **Shipping release will be issued only after satisfactory test results.**

10.0 DOCUMENTATION:

The supplier should supply the following documents:

Details of associated I/O cards, interconnecting wiring and terminal strip details, detail of network architecture and 3 copies of original manuals of the entire system and test reports in English.

Original technical manuals of network operating system, data base server software, system configuration software, application development tools, application software and data acquisition software.

Two sets each of Panel Drawings, termination details in the PLC panels and Field termination panels and Detailed test report shall be provided.

Three sets of the following shall be provided;

1. Panel layouts
2. General arrangement drawings
3. Specification sheets
4. Termination drawings
5. Alarm schematic drawings
6. Computer configuration drawings
7. System interconnection drawings
8. Equipment specification and Operation Manuals
9. Configuration manuals

The supplier shall furnish all the information required of him for making a system as mentioned. Additional information regarding hardware and software not mentioned here, but required for making this type of system shall also be required to be submitted and cost break up for the same shall be indicated in a tabular manner.

11.0 GUARANTEE:

The system in the scope of the supplier should be guaranteed for overall performance. If the system becomes defective under proper use due to faulty material or workmanship within 24 months from the date of delivery, the supplier has to repair it free of cost.

12.0 Testing

For each test, the manufacturer shall

1. specify how this configuration shall be installed and externally connected;
2. provide the suitable test programmes which shall be run during the test;
3. provide the proper operation verification procedure including the way to measure accuracy and temporary deviations of analogue I/Os.

During the type tests, there shall be no

1. modification of the operating system and test programs and/or alteration of their execution;
2. unintended modification of system and application data stored or exchanged;
3. erratic or unintended behavior of the system;
4. deviation of the analogue I/Os out of the limits

All external and internal product status information reporting means, such as displays, lamps, alarm signals, self-test result registers, shall be exercised. The test procedures shall include conditions to verify the related activities.

All various PLC-system operation modes significant for the user's implementation such as start-up and shut-down, cold/warm/hot restart, "normal run", "normal stop", "programme/ monitor", etc., as applicable, shall be verified for performance and behavior.

Initialization and reset conditions of all system components shall be checked for controlled start-up and shut-down. The various modes, such as "run", "programme", "monitor", shall be verified for performance and behavior.

Any special feature/performance not covered in this standard but necessary for the proper operation of the basic PLC-system shall be exercised and tested.

12.1 PLC-system self-tests and diagnostics requirements

The manufacturer shall provide means for self-tests and diagnostics of the PLC-system operation. Such means shall be built-in services of the PLC-system and/or recommended ways to implement the intended application.

The following shall be provided:

1. a means for monitoring the user's application programme (i.e. watchdog timer, etc.),
2. a hardware or software means to check the memory integrity,
3. a means to check the validity of the data exchanged between memory(ies), processing unit(s) and I/O modules (such as an application loop-back test),
4. a means to check that the power supply unit(s) do(es) not exceed the current and voltage limits allowed by the hardware design,

Verification:

The PLC system should be able to diagnose the problems inside it and report in proper manner. It shall be able to monitor-at system start-up and while running-the health of the processor, the peripheral devices, memory, software and power supply. The health check routine on start-up should ensure that the states of all hardware devices are proper and they are correctly initialized.

12.1.1 Start-up test

When the external supply is applied for a time specified by the manufacturer, the PLC-system shall start again according to the specifications of the manufacturer (automatic or manual restart, initialization sequence, etc.). During the start-up, there shall be no erratic or unintended condition.

12.1.2 Shut-down test (sudden supply interruption)

Test description: during shut-down due to the supply interruption, the system behaviour shall be observed. The test is repeated twice.

Performance criteria: The requirement given above shall be met. In addition, from the start of interruption to shutdown, there shall be no change not caused by the normal test programme and no erratic or unintended condition of any kind.

12.2 External energy supply variation tests (immunity tests)

At voltages below the minimum normal service conditions limits and/or frequencies beyond the normal service condition limits, the PLC-system shall "either maintain normal operation or go to a predefined state and have a clearly specified behaviour until normal operation is resumed". Performance criteria: during the tests, the PFVP (2.5) shall ensure that the behaviour of the basic PLC-system is as specified by the manufacturer and that there is no change not caused by the PFVP test programme and no erratic or unintended conditions of any kind.

12.3 Verification of input/output requirements

General

Test procedures are not defined in detail hereinafter. Detailed procedures shall be agreed upon by the user and the manufacturer. Though test procedures are not defined in detail, all tests which are referenced shall be performed.

All tests shall be carried out on all the Analog and Digital I/O channel(s.)

12.3.1 Verification of digital inputs

Reversal of signal polarity test (withstand test)

Test procedure: A signal of reverse polarity for digital inputs shall be applied for 10 s.

Verification:

The results shall be as stated by the manufacturer. Protective devices such as fuses may be reset prior to verification.

Operating range test

Connect a fast changing digital input signal (which changes from open to close and then to open position in less than 10msec) to any of the digital input terminals. Verify that the corresponding LEDs are actuated and the same shall be confirmed from the SCADA package.

12.3.2 Verification of digital outputs

Test procedure:

A small test program may be written so that the digital output is activated through the software strategy. Verify each digital output by verifying the actuation of the LED in the output card.

12.3.3 <u>Verification of Analog Inputs</u>

Operating range tests

Connect a 4-20mA source to the analog input channels. Inject signals at 25%, 50%, 75% and 100%. Check the visibility of the same in SCADA and verify the same from the LED on the front panel.

Analogue input overload withstand test

Test procedure:

To be informed by the manufacturer.

Verification:

During the application of specified maximal overload, no physical damage or abnormal phenomenon shall be detected. After the test, the accuracy shall be verified for the minimal and the maximal value of the input range

12.3 4 <u>Verification of Analog O/Ps</u>

Operating range tests

Connect a 4-20mA source to the analog output channels. Force signals at 25%, 50%, 75% and 100%. Check the visibility of the same in SCADA and verify the same from the LED on the front panel.

Short-circuit test (voltage output) and open-circuit test (current output)

When the short circuit (for a voltage output) or the open circuit (for a current output) is realized, no physical damage or abnormal phenomenon shall be detected. After the test, perform the proper functional verification procedure.

Voltage supply variation test

This test shall be performed when the analogue I/O modules are externally energized by an independent power supply (i.e. independent from the other I/O modules power supply(ies) of the PLC-system).

The power supply is replaced by a variable power source. The voltage is adjusted to the extreme values of the specified range of voltage supply. The module shall then pass the PFVP and the output variations shall be inside the specified range.

Reversal of signal polarity test (withstand test)

If the equipment is designed to prevent confusion of signal polarity, the withstand test may not be carried out and replaced by proper visual inspection.

Test procedure:

A signal of reverse polarity for unipolar analogue inputs shall be applied for 10 s.

Verification:

The results shall be as stated by the manufacturer. The device shall pass the PFVP

Protection devices such as fuses may be reset prior to verification.

Response time test

This test verifies the effect on transfer time(s) introduced to provide input information and status to the application programme and to transmit its logical decisions to outputs.

Procedure:

An application test programme consisting of copying input status to outputs is run.

Pass/fail criteria:

The total system response times and the subsequent variations of transfer time(s) shall conform to the manufacturer's published specifications.

Loss of communication test

When communication is removed, outputs shall assume a manufacturer's specified state within a manufacturer's specified interval without erratic or unintended behaviour, and the communication error shall be signalled to the user.

Procedure:

The test is performed by disconnecting a) the link, b) the external power supply and observing the behaviour of the basic PLC.

Pass/fail criteria: According to requirements.

Safety test for PLC

On PLC CPU the analog outputs can be selected to give any current between 0-20mA. On failure, the channels should output their predefined values.

Verification

This can be verified by monitoring the digital output when the CPU failure is simulated.
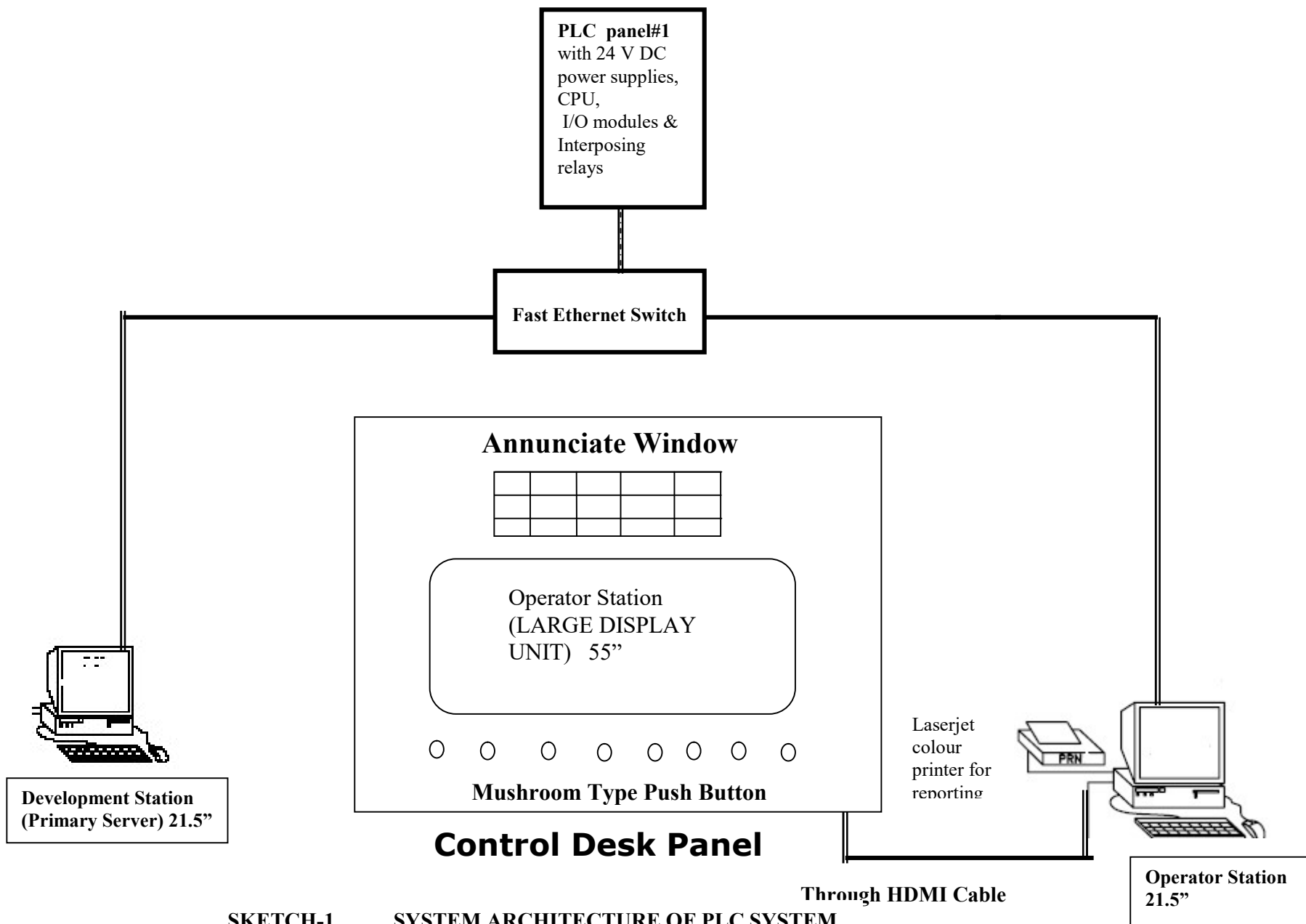
13.0 Installation and Commissioning

The Control System shall be installed and Commissioned by the supplier at IIT, Kanpur. Field signals shall be terminated on the PLC end terminations. The terminations of cables related to PLC, Ethernet switches and the Operator Station shall be in the scope of the supplier. Following shall be the scope:

- Deputation of a team of experienced engineers, technicians and other staff as the case may be for the purpose of installation, pre-commissioning and commissioning of the system at site.
- Routing of all data highway cables/internal bus cables. Termination of system cables.
- Powering up the system, loading the system configuration and carry out internal loop checks for correctness of wiring.

Step by step commissioning sequence from cold condition to fully operational condition shall be furnished in detail. Supplier shall clearly indicate wherever deemed necessary alternate courses of actions to maintain full or partial operations under fault conditions without compromising on safety aspects.

After installation and commissioning, supplier shall extend all the necessary help in resolving various operation and maintenance problems faced by site. This includes visit to site by the manufacturer's engineer to resolve the problems as and when required.

PLC panel#1 with 24 V DC power supplies, CPU, I/O modules & Interposing relays

Fast Ethernet Switch

Annunciate Window

Operator Station (LARGE DISPLAY UNIT) 55"

○ ○ ○ ○ ○ ○ ○ ○

Mushroom Type Push Button

Development Station (Primary Server) 21.5"

Laserjet colour printer for reporting

Control Desk Panel

Through HDMI Cable

Operator Station 21.5"

SKETCH-1   SYSTEM ARCHITECTURE OF PLC SYSTEM

General terms and conditions:

1. The Bidder shall bear all costs associated with the preparation and submission of its bid, and in any case IIT, Kanpur (IITK) will not be responsible or liable for these costs, regardless of the conduct or outcome of the bidding process.

2. It is in the bidder's interest to visit the site and understand the local conditions. IITK shall not be held responsible for any cost implications because of local conditions or for bidder not visiting site.

3. The bid prepared by the bidder and all correspondence and documents relating to the bid exchanged by the Bidder and IITK shall be written in English language.

4. Bidder is advised to note that the prices are to be quoted in a separate price Bid (sealed in a separate envelop) attached with the main Bid along with Technical details. The price quoted anywhere else other than the price bid, (**sealed in a separate envelope)** shall result into disqualification of the bids.

5. The bid and all attached documents should be signed by the bidder as a token of acceptance.

6. IITK has to finalize its purchase within a limited time schedule. Therefore, it may not be feasible for IITK to seek clarifications in respect of incomplete offers. Prospective bidders are advised to ensure that their bids are complete in all respects and fulfil IITK's terms, conditions and bid evaluation criteria of the tender. Bids not complying with IITK's requirement may be rejected without seeking any clarification.

7. Bidder has to sign a **Non-Disclosure Agreement** with IITK. Any technical document, drawings in the form of soft or hard copy shall not be disclosed to anybody outside the working team. All the hard copies shall be destroyed immediately after the use.

8. The bidder should **submit a declaration** to the effect that neither the bidder themselves, nor any of its allied concerns, partners or associates or directors or proprietors involved in any capacity, are currently serving any banning orders issued by IITK debarring them from carrying on business dealings with IITK.

9. Bidders should quote prices in Indian rupee only. Prices quoted in any other currency shall not be considered.

10. The **Bid shall be valid for acceptance for the period of 90 Days** and shall not be withdrawn on or after the opening of bids till the expiration of the validity period or any extension agreed thereof.

11. The earliest period by which the job can be executed in total should be clearly stated in the quotation and such period should be strictly adhered to in the event of a work-order.

12. Bids qualified by vague and indefinite expressions such as "Subject to availability" etc. will not be considered.

13. The bid along with all technical details, appendices and copies of documents should be submitted to IITK. The Technical bid shall contain all details without indicating prices of the quoted items. The prices are to be quoted in a separate Price Bid.

14. In case the bidder needs to clarify and/or understand the full scope of his work before submitting the quotation, he may do so by taking prior appointment or by writing email to **Prof. S. N. Tripathi, CE Dept., IIT Kanpur** (e-mail id snt@iitk.ac.in).The Client will respond by email to such requests and copies of the response (including an explanation of query but without identifying the source of enquiry) will be sent to all invited bidders who intend to submit the proposal, and also posted at Tenders link of IITK website (if found necessary).

15. The successful bidder shall be responsible for the correctness and accuracy of the drawings, documents and reports prepared by him. Approval of the drawings and documents by IITK/their representative shall not relieve him of his responsibility for correctness and accuracy of such drawings and documents. No compensation or extra payment shall be made by IITK for any correction or changes made in the execution work.

16. Bidders should ensure that they qualify for all the items of the Assignment. The bidders shall have experience and expertise in the scope of work as detailed in this tender.

17. Bidder must have atleast three similar jobs executed, and the name of the organization for which the work were carried out should be furnished with the Bid. Copy of Completion Certificate may be furnished.

18. The acceptance of bids will rest with Director, IITK who does not bind himself to accept the lowest bid and reserves to himself the authority to reject any or all the bids received without assignment of any reason. Also, Director, IITK reserves to himself the right to accept the whole or any part of the bid and the bidder shall be bound to perform the same at the rate quoted.

Commercial terms & conditions:

1. A two-stage procedure will be adopted in evaluating the bids: i) Technical evaluation and ii) financial evaluation. The weightage of technical evaluation will be 60% and of financial evaluation will be 40%.

2. Technical and price bids properly superscribed 'Technical Bid' and 'Financial Bid' respectively to be sealed and kept in a large envelope giving reference of our enquiry. The bid should be addressed to **Prof. S. N. Tripathi**, Department of Civil Engineering, IIT-Kanpur, Kanpur-208016 on **or before the due date as mentioned in the cover page.**

3. Price bids should clearly mention the detailed price break-up of scope of work as given in Part-I of tender and taxes separately for supply and installation jobs. **If the tax value differs for different items, these shall be mentioned separately.**

4. Technical evaluation will be based on the mentioned criteria detailed in the General Terms and Conditions and the scope of work as given in Technical Specifications. If required, evaluation of the bidder's resources would be undertaken by the client by visiting the bidder's premises.

5. IITK is partially/fully exempted from payment of customs/excise duty, if applicable. As the above statutory provisions are frequently reviewed by the Govt., the bidders are advised to check the latest position in their own interest and IITK will not bear any responsibility for any incorrect assessment of the statutory levies by any bidder.

6. Government of India's guidelines on **GST** shall be complied.

7. The Bid Security is required to protect the IITK against the risk of Bidder's conduct which would warrant the security's forfeiture. **The value of bid security shall be Rs. 2.0 Lac of the overall quoted price excluding taxes.**

8. Central Government Departments and Central Public Sector Undertakings are exempted from payment of Bid Security. MSEs units (and not their dealers/distributors) who are themselves, manufacturer of the items/ provider of services, they intend to quote which are themselves registered with District Industry Centers or Khadi and Village Industries Commission or Khadi and Village Industries Board or Coir Board or National Small Industries Corporation or Directorate of Handicrafts and Handloom or any other body specified by Ministry of MSME are also exempted from payment of Bid Security irrespective of monetary limit mentioned in their registration certificate provided they are registered for the Services they intend to quote.

9. The Bid Security shall be acceptable in any of the following forms:

    9.1 Bank Draft in favour of '**REGISTRAR, IIT Kanpur**', payable at Kanpur.

10. The bidders shall submit Bank draft / Bank Guarantee from any scheduled bank incorporated in India.

11. The Bid Security shall be forfeited by IITK in the following events:

    11.1   If Bid is withdrawn during the validity period or any extension thereof duly agreed by the Bidder.

    11.2   If Bid is varied or modified in a manner not acceptable to IITK during the validity period or any extension of the validity duly agreed by the Bidder.

    11.3   If a Bidder, having been notified of the acceptance of its bid, fails to furnish **Performance Bank Guarantee (PBG)** within 30 days of notification of such acceptance.

    11.4   In case at any stage of tendering process, it is established that bidder has submitted forged documents/certificates/information towards fulfillment of any of the tender/contract conditions.

12. The Bid Security of unsuccessful Bidders will be returned after finalization of the bid.

13. The Bid Security of successful bidder will be returned on receipt of **Performance Bank Guarantee (PBG). The validity of PBG would cover the period starting from the acceptance of the contract to the end of the warranty period.**

14. If the contract is awarded, the bidder shall furnish the **Performance Bank Guarantee (PBG) for the value of 10% of the overall cost (excluding taxes) to IIT, Kanpur.** This PBG will be released after the guarantee period is over by IITK based on the satisfactory performance of supplied system/item.

15. **80% funds (installation and commissioning cost excluded) may be released** after delivery of items and balance **20% on completion of the scope of work**. All the payments for installation & commissioning will be paid **only at the completion of the job.**

16. IITK shall make payments only through Electronic Payment mechanism (viz. NEFT/RTGS/ECS). A successful Bidder should invariably provide the required bank details as and when required by IITK.

General Notes to Bidder/Supplier:

1. **Pre-dispatch inspection at supplier's factory is needed. Post supply inspection is not permitted.**

2. *The facility for pre-dispatch inspection / testing for the indented item shall be available with the supplier. Inspection of all the items ordered shall be carried in presence of purchaser's representative at the supplier's factory. The inspector shall approve the test results, after witnessing the test. This includes the tests for all the requirements mentioned in the indent specifications. Supplier shall provide all the inspection, testing facilities and test reports. Shipping clearance will be issued only after the satisfactory test results.*

3. All the relevant catalogs, manufacturer's test certificates in standard format and Operation & Maintenance Manual shall be submitted along with the material.

4. The material shall conform strictly to the relevant specifications and standards.

5. The supplier shall submit a certificate for guarantee of the material/service against any defects **for 18 months from the date of supply or 12 months from the date of installation.**

6. The material shall be properly packed to avoid damage of any kind during transit. IITK is not responsible for any damage during transit. The safe door delivery at IITK is in the scope of supplier.

7. All the work mentioned in the tender document shall be executed at **National Aerosol Facility (NAF), IIT-Kanpur, Kanpur-208016, UP**.