

INSTRUMENTATION

JOB SPECIFICATIONS

GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE

(MR No:B240-910-KA-MR-5010)

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S. No.	Requirement	Description
1.0	GENERAL	
1.1	Location of field equipments/ instruments	Hazardous area
1.2	Area classification	As per Electrical Area Classification
1.3	Operational requirements	Local gauge board and Unit control panel in Control Room
1.4	Type of interlock & shutdown system	Programmable Logic Controller
1.5	Type of instrumentation	Electronic
1.6	Logic representation	ISA
1.7	Distance between field equipments and Control Room	Approx. 500 meters (However bidder shall calculate the exact cable laying distance as per indicative Plot plan and equipment layout drawings of Compressor Station attached elsewhere in this requisition)
1.8	Order of priority in case of any conflict between MR documents	In the event of any conflict between this specification, data sheets, standard specifications, related standards, codes etc: the following order of priority shall govern: a) Statutory Regulations b) Job Specifications c) Job Standard Specifications, Standard Specifications d) Codes & Standards However, Bidder shall inform EIL/ owner for any discrepancy for resolution before proceeding and Client's/PMC decision shall be final & binding.
2.0	TYPE & LOCATION OF CONTROLS & INSTRUMENTS	
2.1	Type of control system (For monitoring and control)	PLC based Integrated gas turbine compressor control system. Including panel mounted HMI and control room mounted HMI with colour monitor, mouse, along with all required software and configurations to make the HMI fully operational so that the necessary operations and functions such as configuration and viewing of compressor performance curves can be carried out from the HMI. The monitor shall be 21" TFT type. (Bidder's Scope)
2.2	Type of control system (For Interlock & shutdown)	PLC based Integrated gas turbine compressor control system including. (Bidder's Scope)
2.3	Signals to / from purchaser's Station PLC.	Hardwired for the main suction & discharge and depressurizing valves and

S. No.	Requirement	Description
	Existing Purchaser control system(RTU/SCADA/DCS). All other signal shall be connected to DCS through serial link.	other signals required for Gas turbine compressor train startup, shutdown & depressurization sequence, as specified in P&ID, equipment data sheets and elsewhere in this MR. Also redundant serial link from GTC PLC to Station PLC shall be provided for repeat of all signals from GTC PLC to station PLC/RTU.
2.4	Status signals of drives from MCC	Shall be wired to UCP marshalling cabinet in control room.
2.5	Antisurge controller, Load sharing / Performance / Master Controller	Antisurge controller for compressor along with a dedicated Load Sharing / Performance (if required) Master Controller mounted in unit control panel.
2.5.1	Location (Note1)	Anti surge controller/ Performance / Master / Load Sharing controller in UCP in Control Room.
	Note-1: Bidder to refer System Interface Schematic B240-910-16-51-SK-0001 and B240-910-16-51-SK-0002 attached with this specification.	
2.5.2	Transmitters	Only transmitters suitable for use with anti-surge controller shall be used
2.6	Vibration & temperature monitoring system	Required(Shall be provided as per Compressor datasheet attached elsewhere in the bid package. Refer B240-910-16-51-SK-0001 and B240-910-16-51-SK-0002 attached with this specification.
2.6.1	Monitors/ racks mounted in UCP	Located in Control Room
2.6.2	Display Unit	On UCP
2.6.3	Requirement of future Connectivity with Purchaser's Machine monitoring System	Bidder shall ensure the following for future Connectivity with Purchaser's System or equivalent in case required at later date by Purchaser: (i) Bidder shall provide hardware like communication processors in each rack. (ii) Individual monitors shall have provision for giving raw data to the Machine Monitoring system (iii) Enabling software required if any for connecting to Purchaser's Machine Monitoring system for acquisition of raw data from various monitors with respect to each sensor shall be provided by bidder.
2.6.4	Process instrument type for alarm/ shutdown	Transmitter (Switch action soft generated through control system. Process switches shall not be used, even though indicated in P&IDs).

S. No.	Requirement	Description
2.6.5	Ingress protection for instruments and enclosures in field	Weatherproof to IP55 as a minimum. IP65 for transmitters, solenoid valves, junction boxes and field switches (wherever applicable)
2.8	Hazardous area protection for instruments (Note-2)	All electronic/electrical instruments and equipments shall be suitable for area classification as per IEC codes and shall be tested by any recognised authority like Baseefa, FM, PTB, CMRI etc. and shall be certified by Petroleum And Explosives Safety Organisation (PESO)/ Chief Controller of Explosives (CCE), Nagpur or Director General of Mines Safety (DGMS) in India. Intrinsically safe in general. Solenoid valves shall be flameproof.
	Note-2: Certification for use in hazardous area shall be as follows: All instruments shall be suitable to Area classification Zone-1 Gr IIC T3 (minimum requirement for instruments). For all intrinsically safe / explosion / flameproof equipment / instruments which are manufactured abroad and certified by any statutory authority like BASEEFA, FM, UL, PTB, ATEX, LCIE etc. should also have the approval of PESO(Petroleum Explosives safety organizer) / CCE(Chief Controller of Explosives),Nagpur. For all flame proof equipments manufactured locally (indigenously, the testing shall be carried out by any of the approved test house like CMRI / ERTL etc. The instruments shall in addition bear the valid approval from PESO(Petroleum Explosives safety organizer) / CCE(Chief Controller of Explosives), Nagpur. For all intrinsically safe equipment manufactured locally (indigenously, the testing shall be carried out by any of the approved test house like CMRI / ERTL etc. The equipment shall in addition bear the valid approval from PESO (Petroleum Explosives safety organizer) / CCE(Chief Controller of Explosives),Nagpur.	
2.9	Transmitters	
2.10	Monitoring and Control loops	Smart type with HART protocol
2.11	Interlock and shutdown system (PLC) loops	Smart type with HART protocol
2.11.1	Integral LCD type outputmeter	Required (Display output in user configurable engineering units) with each transmitter.
2.11.2	Temperature transmitter	Field mounted Smart type with HART protocol required for all temperature elements except for bearing temperature elements.

S. No.	Requirement	Description
2.11.3	Level transmitters	Level transmitters shall be Radar type.
2.12	Smart transmitters offered by Bidder shall be suitable for calibration with Universal type Hand held Configurator (1 No to be supplied by bidder). Bidder shall supply suitable configurator (HHC-1 no). (Intrinsically safe with battery charger) of each type for configuration of the instrument	
2.13	Transmitter accuracy (PT, PDT, FT, DP LT)	As given below
2.13.1	For ranges of ≥ 760 mm WC	$\pm 0.075\%$ within a turndown of 1:10 of the offered span
2.13.2	For ranges < 760 mm WC	$\pm 0.15\%$ within a turndown of 1:10 of the offered span
2.13.3	Dia. Seal type with ranges ≥ 500 mm WC	$\pm 0.25\%$ within a turndown of 1:10 of the offered span
2.13.4	Dia. Seal type with ranges < 500 mm WC	$\pm 0.5\%$ within a turndown of 1:10 of the offered span
2.14	Temp. Transmitter accuracy (with cold junction compensation with thermocouple element)	As given below
2.14.1	For temperature ranges above 0 to 150 °C and up to 0 °C to 350 °C	$\pm 0.25\%$ of URL
2.16.2	For temperature greater than between 0 °C to 50 °C and up to 0 °C to 150 °C	$\pm 0.5\%$ of URL
2.14.3	For temperature < 50 °C	$\pm 1.25\%$ of URL
2.15	Temp. Transmitter accuracy (with RTD element)	As given below
2.15.1	For temperature range > 350 °C	$\pm 0.075\%$ of full scale
2.15.2	For temperature range between 150 °C to 350 °C	$\pm 0.15\%$ of full scale
2.15.3	For temperature range < 150 °C	$\pm 0.2\%$ of full scale
2.16	Control valve & SMART positioner.	
2.16.1	Anti-Surge Control valve	Required.as per P&ID
2.16.2	SMART positioner	
a)	Type	Smart type with HART protocol (latest version). (Note-3)
	Note-3: Positioner shall be universal in nature to facilitate use with any type of pneumatic actuator like single acting and double acting for both sliding stem and rotary shaft valves. Positioner shall be supplied by Bidder from one of the following makes i.e. M/s Dresser,M/s Fisher, M/s Metso,M/s Samson and M/s Flowserve	
b)	Positioner enclosure	Metallic
2.17	Control valve limit switches	Proximity type, intrinsically safe
2.18	Pressure gauges	
a)	Case material	SS304

S. No.	Requirement	Description
b)	Safety type, solid front case for pressure gauge	Required for toxic service or with ranges 0 to 100 kg/cm ² g and above
2.19	Temperature gauges	
a)	Type	Generally Bimetallic type
b)	Case material	SS304
2.20	Thermocouple	
a)	Type	Generally K type
b)	Grounded/ ungrounded	Grounded type
2.21	RTD (wherever applicable)	PT-100, 3 wire, calibration as per IEC 60751
2.22	Thermowell and thermowell flange material	Minimum 316 SS or better for thermowells and thermowell flanges as per Piping Material Spec.
2.23	Air Filter Regulator filter size	5 micron
2.24	Solenoid valve insulation class	Class F
2.25	Terminal blocks	Internal terminal block for all instruments, anti-vibration type, suitable for terminating a minimum of 1.5 mm ² size cable conductors. Flying leads are not acceptable.
2.26	Terminals	Screw less clamp type
2.27	Barriers (wherever applicable)	Required
2.28	SS Tag plate	Required for all instruments, gauge boards, and local panel.
	Threaded end connections for instruments shall be to NPT as per ANSI B 1.20.1. Flanged end connections shall be as per ANSI B 16.5. All flanges and flanged valves shall have smooth surface finish (125 – 250 AARH) as per ASME B46.1.	
3.0	POWER SUPPLY REQUIREMENT (Note-4)	
3.1	Control system	110 V AC 50 Hz UPS
3.2	Interlock & shutdown system	110 V AC 50 Hz UPS
3.3	Interrogation voltage for contact input	24 V DC
3.4	Solenoid valve	24 V DC
3.5	Intrinsically safe transmitters (loop powered)	24 V DC
3.6	Proximity type limit switches	24 V DC
3.7	Panel lighting	230 V AC 50 Hz (Non-UPS)
	Note-4: Purchaser will provide one power feeder of 110VAC UPS to UCP in Control Room. Further distribution shall be by Bidder. Any other power required for Bidder supplied hardware shall be derived out of 110VAC, UPS and the same shall also be in Bidder's scope. Bidder shall indicate estimated power consumption for 110 V AC (UPS) & 230 V AC Non UPS along with bid.	
4.0	INSTRUMENT AIR REQUIREMENT (note-5)	

S. No.	Requirement	Description
	Minimum Pressure	4.5Kg/cm ² g
	Normal Pressure	6 Kg/ cm ² g
	Design Pressure	9.5 Kg/ cm ² g
	Note-5: Purchaser will provide one instrument air connection at battery limit. Further instrument air distribution shall be by Bidder. Instrument air connection size shall be finalized during detail engineering after the analysis of exact consumption of instrument air.	
5.0	CABLES & CABLE GLANDS	
5.1	Type (single pair as well as multipair)	1.5 mm ² twisted in pair individually and overall shielded with aluminium Mylar tape with drain wire and armoured. Multipair cable shall be 6P(1.5mm ²) or 12P(1.5mm ²) type
5.2	Flame retardant+Low Smoke	Required, as per IEC 60332 Cat. A.
5.3	Cable glands	Nickel-plated brass, double compression type suitable for armoured cables. Cable glands shall be Exd/Flameproof type.
5.4	Slipper type PVC sleeves (cable shrouds)	Required (over cable glands for all cable entries in junction boxes).
6.0	JUNCTION BOXES	
6.1	Separate JB's for different type of signals	Yes Separate JB's for signals for Intrinsically safe & flameproof instruments, 4~20 mA signals, Contacts, Thermocouples, RTDs, Solenoid valves, Vibration & temperature monitoring signals for machine monitoring system
6.2	Type of JB's	Weather proof for IS instruments and flame proof for Ex-proof instruments
7.0	INSTALLATION REQUIREMENT	
7.1	Instrument impulse lines	Piping for - all hydrocarbon service , - high pressure service ($\geq 600\#$) (note-6) Tubing for - Utilities.
7.2	Piping material used in installation hook up	As per Piping Material specifications.
7.3	Tubing used in impulse line	Minimum SS 316L tube, 1/2" OD size
7.4	Instrument valve manifold	Integral type
7.5	Impulse line isolation valve (after first isolation valve)	Globe type
7.6	Impulse line vent & drain valves	Globe type
7.7	Instrument air isolation valve for each instrument	Ball valve of SS 316
7.8	Instrument connection sizes	As per 7-52-0001 and 7-52-0002 attached with Job Specification.

S. No.	Requirement	Description
	Note-6: Remote type Installation Standards shall be followed. EIL installation standards are attached for reference. All the transmitters should have horizontal impulse entry only for easy interchangeability without impulse modification in future.	
7.9	Instrument air signal, air supply, steam tracing (where applicable) tubing	6 mm OD SS316 tube for instrument air supply tubing and 6 mm OD Copper tube for steam tracing.
7.10	Cable routing	Galvanized mild steel perforated trays of 2.5 mm thickness shall be used for branch cables / single pair cables from instrument to junction boxes. Ladder trays/duct shall be MS hot dip galvanized.
7.11	Spare space in cable trays	Cable trays shall have at least 50% spare space
7.12	Cable entry in junction box	From side or bottom
7.13	Ferruling inside JB's	Heat shrinkable printed sleeve type
7.14	Accessibility of instruments	Any instrument not accessible from grade/ platform shall be provided with accessing platform.
8.0	MISCELLANEOUS	
8.1	Proven track record	The instruments and systems as being offered / supplied should have been operating satisfactorily under similar process conditions for at least 4000 hrs. PTR for the offered control system shall be furnished as per the attached PTR format along with bid.
8.2	Vendor list	All Instrument items shall be from EIL approved vendors indicated in the attached vendor list. For items not from approved vendor list, Bidder shall furnish proposed sub-vendor list for purchaser's approval along with PTR of such sub-vendor.
8.3	Specialty services	For PLC based control system, Vibration & temperature monitoring system, master/performance/load sharing controller and Anti-surge control system bidder shall hire the single point specialist services from the respective sub-suppliers of all the above mentioned systems for design, detail engineering, supply of all component needed, installation & commissioning as detailed below: a) During engineering stage: To approve all applications related issues and configurations,

S. No.	Requirement	Description
		networking, cabling & electrical design etc. b) During order execution stage: To participate in the machinery FAT/SAT and to oversee timely supplies of various components of the system envisaged. c) During installation & commissioning: To supervise & verify the installation and calibration on site of field instruments & system components being supplied and documentation of the complete installation. Testing & commissioning shall be done under supervision of respective manufacturer's specialists. Bidder to make specialists' services available during testing & commissioning. d) To optimise the overall system w.r.t. appropriate integration and interface with Purchaser's other system.
8.4	Painting requirements	Painting of installation material, instrument supports and structural supports shall be as per painting specification attached elsewhere in MR.
8.5	Logistic support	Logistic support certificate as per Annexure – I from the all major instrument supplier shall be provided by Bidder along with the offer.
8.6	Loop Checking	Bidder is responsible for loop checking in coordination with purchaser's contractor at site. Site activities for loop checking like laying, dressing, identification & tagging, ferruling, termination of cables, calibration for all the instruments shall be carried out by purchaser's contractor. However bidder shall supervise & provide all necessary assistance to the purchaser's field contractor for these site activities. However checking of interconnection between instruments / equipments inside control room and performing loop checking with the co-ordination of field contractor shall be in the scope of bidder. Before proceeding for loop checking the calibration results of individual instruments shall be recorded in the format, which shall be approved by EIL/Purchaser for correctness of

S. No.	Requirement	Description
		installation/measurements and calibration results
8.7	Training requirements for PLC system	Required At Vendor works: 7 days for 2 person At Site works: 7 days, Two batches of 6 person
9.0	SPARES (Note-7)	
9.1	Mandatory Spares	Bidder shall provide Mandatory spares as per Mandatory spares list Doc no. B240-910-16-51-SS-5010 attached. Prices for mandatory spares shall be included in the base price.
9.2	Commissioning spares	Instrument commissioning spares shall be supplied as required for successful commissioning of the compressor. The same shall be included in Bidders offer. Vendor shall procure these spares as per recommendation of sub vendors/Suppliers and these shall be available at the time of commissioning. These shall include all instrumentation and control items including for sub-package items. Bidder shall note that in case any additional spare is consumed during erection and commissioning over and above the quoted erection and commissioning spares, the same shall be supplied by bidder without any time and cost implications. Also, if any spares are consumed during commissioning from mandatory spares, the same shall be replenished by bidder without any cost implication.
9.3	Installed spares	Bidder shall provide installed spares duly wired with barriers etc. (as applicable) as per details given below: I. For each Vibration Monitoring System: (i) I/O Level:- 20% (ii) Marshalling:- 20% II. For Panel Status lamps, switches, push buttons :- 20%
	Bidder shall ensure 20% additional spare space for marshalling and I/O modules for future in Vibration monitoring cabinet.	
9.4	2 years operation spares	Bidder shall furnish separate list of recommended spares for instruments / system for 2 years operation along with unit price.
9.5	Engineering Spares	Bidder to consider 30% Total I/O's as engineering spares. These are to be

S. No.	Requirement	Description
		considered in addition to all other spares
	Note-7: Requirements of spares indicated in any other Standard specification shall not be considered.	
10.0	INSPECTION & TESTING	
10.1	Factory testing & inspection of all instrument items by Vendor's authorized representatives, EIL/Owner, unless specified otherwise	Yes

11 Other Notes:

11.1. Design Philosophy and other requirements:

- 11.1.1 The operation, monitoring & control of the Gas turbine compressor is envisaged via higher level operator interface (HMI) for control and monitoring of entire Gas turbine & compressor unit package through Programmable Logic Controller (PLC). Sequential start up / shutdown operation shall be implemented through sequential logic in Integrated Gas turbine and compressor control system based on PLC. Instruments and control shall be of fail-safe design.
- 11.1.2 Loops for Interlock / shutdown and alarm, indication / control shall be completely independent of each other including the field sensor / transmitter. There shall be no sharing of the loop components on the same line for a closed loop for control / indication / alarm and a loop for interlock or shutdown.
- 11.1.3 Loss of air-conditioning in the control room shall not result in malfunction or erratic behavior of instruments or shutdown of the system. The system shall be designed to operate for a minimum period of 2 hours without air conditioning.
- 11.1.4 All required push buttons and selector switches etc. for operation of various equipments shall be through soft keys in the consoles except for some critical operation like ESD etc., which shall be mounted on GTC Unit Control Panel in control room by the bidder.
- 11.1.5 Suitable bypass for interlock with annunciation / indication shall be provided for start up of Gas Turbine and Compressor in respective system.
- 11.1.6 All hardwired lamps for alarms; indication etc. shall have lamp test facility. Lamps used shall be of LED type. Screw less terminal blocks (cage clamp technology) are to be used in all panels, marshalling cabinets/ auxiliary panels etc
- 11.2 Operation, monitoring & controls and Interlock / Shutdown System
 - 11.2.1 All operation, monitoring & controls and interlock & shutdown logic functions for the gas turbine & compressor package including its auxiliaries like lube oil, dry gas seal (as per API 682) & fire and gas detection etc. shall be executed by the bidder individually in the PLC based Integrated Turbine and compressor Control System for entire GTC train. Bidder shall supply PLC based Integrated Turbine and compressor Control System.
 - 11.2.2 PLC based control system with its individual MMI & printers and serial data interfaces shall be provided in accordance with the data sheet B240-910-YE-DS-5010 and the configuration diagram B240-910-16-51-0001 enclosed with this requisition. However bidder shall note that the configuration indicated in the enclosed drawing is indicative only. Bidder shall provide all

the required hardware's and software's to meet the functional requirement as specified here and elsewhere in this document and shall also furnish the offered system configuration.

11.2.3 Bidder shall provide the interlock and shut down scheme for complete package to EIL / purchaser for approval, in the form of:

- a) Write up.
- b) Logic / Ladder diagram as per ISA S 5.2
- c) Sequence of operation diagram of start-up / shutdown / normal operation.

11.2.4 All compressor and turbine related pre alarms shut down alarms and system alarms shall be displayed on HMI. There should be FIRST OUT string configured to display the very first alarm in case of trips along with PLC bit address or cross reference.

11.3 Gas Turbine Control System

11.3.1 Bidder shall provide fault tolerant, PLC based Integrated Gas Turbine and compressor Control System with fail-safe design and adequate redundancies, as per bidder standard, for continuous uninterrupted and safe operation of the machine.

11.3.2 Integrated Gas Turbine and compressor Control System shall be provided with colour graphic operator consoles (TFT type), one panel mounted and the other table mounted, in accordance with the configuration diagram B240-910-16-51-0001 & B240-910-16-51-0002 enclosed with this requisition for complete centralized man machine interface, monitoring and control. System shall be provided with displays complete with required hierarchies and alarm management for easy operation and control of the system. Display shall also include graphic mimics of train process P&ID's.

11.4 Axial & Radial Vibration, Bearing & Winding Temperature Monitoring System

11.4.1 Compressor shall be provided with individual monitoring system located in control room, which shall include monitoring for compressor as well as turbines.

11.4.2 The monitoring system shall be mounted on standalone racks supplied by bidder.

11.4.3 For data transfer to Machine monitoring system(MMS) shall be provided with individual communication processors (TDI) mounted in Unit Control Panel (UCP) which shall collect static as well as dynamic machinery data under steady state as well as start-up & shut-down conditions and shall be provided with serial link.

11.4.4 Serial communication link from Vibration and temperature monitoring system shall be provided by bidder for communication to GTC PLC through suitable protocol.

11.4.5 Special cables from probes to proximities / transducers to the monitoring system in control room and other serial link cables shall be in bidder's scope of supply.

11.4.6 Bearing & winding temperatures shall be measured at the points as specified elsewhere in this requisition. Sensor shall be RTD element, platinum, 100 ohms at 0°C, of three-wire type. Calibration shall be as per DIN 43760 standard.

11.4.7 Key Phasor

11.4.7.1 Bidder shall provide key phasor system or performing analysis of vibration signals to determine machine malfunctions. It shall consist of proximity probe, transducer, extension cable etc. and other accessories to make the system complete. Bidder shall provide necessary reference on the shaft to determine once-per-turn occurrence.

11.5 Gas and Fire Detection System

11.5.1 Bidder shall provide separate Fire and Gas Detection System (including sensors & transmitters) for each Gas Turbine enclosure (LEL, Heat and Flame detectors). It shall be connected to compressor PLC provided by the bidder and located in control room.

11.5.2 Gas Detection

11.5.2.1 Bidder shall design and provide hazardous gas detection system (including sensors & transmitters) for alarm and shutdown for inside enclosures, combustion air intake plenum chamber, ventilation intake and exhaust of gas turbines so as to protect personnel and equipment from hazardous gas infiltration as per relevant NFPA standards and API recommended practices. Gas detection system shall meet all mandatory requirements specified by gas turbine manufacturer. The gas detector shall be Smart, IR type with 4-20 mA output. The detections shall have two levels of alarm and trip setting adjustable over the entire range (20%, 50% LEL typical) with reference to concentration of gases before the hazard level (100% LEL) is reached. All gas detectors transmitters and the cables located inside the turbine enclosure shall be suitable for a temperature of 200°C.

11.5.2.2 20% LEL, 50% LEL and malfunction alarms are to be generated in UCP PLC for annunciations and also audible alarm in local shall be provided. Coincident detection of 50% LEL in turbine enclosures shall close the main fuel valve, shutdown the compressor system, shutdown the ventilation system. However, in case of equipment surface temperature (inside enclosure is above 200°C) ventilation shall continue until temperature drops down to below 200°C. Single detection of 50% LEL shall provide only alarm.

11.5.2.3 In all locations where gas detection is required, at least two detectors along with transmitters shall be provided. Bidder shall decide location of gas detectors during detailed engineering.

11.5.2.4 The audible alarm and gas detection system (sensors/transmitters) shall be suitable for the area classification. Sealed conduits shall be provided for safe function in the event of hazard within the enclosure.

11.5.2.5 Detection system shall consist of gas detector / transmitter with 4-20 mA output connected to PLC in control room where further control scheme for the Gas Detection System shall be implemented to achieve the above specified functions.

11.5.3 Fire Detection

11.5.3.1 Bidder shall design and supply inside the GTC enclosures, a Fire Detection system as per the NFPA Standards and API Recommended practices.

11.5.3.2 Manifestation of fire shall be sensed by the following methods:

1. Ultraviolet (UV) Light Detectors arranged for coincident actuation
2. Thermal detectors for fixed temperature detection & rate of rise in temperature.

11.5.3.3 The self-checking type UV Light Detectors shall detect flash fires. They shall not be sensitive to direct or reflected sunlight or normal artificial lighting. They shall be provided with automatic optical integrity. Thermal detectors shall be provided to detect fixed temperature.

- 11.5.3.4 The detectors along with transmitters shall be provided by bidder inside the turbine enclosure at appropriate locations. A Minimum of two UV detectors shall be provided in each location to facilitate co-incident activation.
- 11.5.3.5 Activation of coincident UV Light Detectors or coincident Thermal detectors (in the gas turbine enclosure) and / or single thermal detector shall sound a local alarm, as well as remote alarm located in Control Room; close the main fuel valve and cause emergency shutdown of the equipment. Any single UV detection or thermal detection shall sound local and remote alarm.
- 11.5.3.6 All the detectors and its transmitters shall be listed or approved by Factory Mutual or Underwriter's Laboratory Inc. for hazardous locations.
- 11.5.3.7 All the detection devices shall be wired in sealed conduit and NEMA7 / "EExd" enclosures, in order to function safely should hazard exist inside the enclosure. The total fire detection system shall be suitable for Zone-1 area. All the UV detectors/transmitters and cables located inside the turbine enclosure shall be suitable for a temperature of 200°C.
- 11.5.3.8 Thermal Detectors shall have stainless steel body construction and shall be Flame proof, rate compensated, fixed temperature type with 4-20 mA transmitters, which shall be connected to respective PLC.
- 11.5.3.9 Fire Suppression System shall be designed so that it can be activated automatically by receiving a signal from the PLC's after being activated by coincident signals received from fire detectors located inside the enclosures. It shall also possible to manually activate the fire suppression system in the event of a signal from any of the devices either from control room or from local gauge board.
- 11.5.3.10 A suitable time delay (approximately 30 seconds, adjustable), with audible and visible flashing red light alarm, shall be provided before the release of fire extinguisher to facilitate escape of the personnel. Fire Extinguisher Release alarm shall also be annunciated in control room.
Facility is to be provided to lock fire suppression system during maintenance period for both initial and reserve cylinders to avoid accidental release of fire suppression system.
- 11.6 Compressor / Capacity Control System: Master / Performance /Load sharing Controller & Anti-surge Controller:
- 11.6.1 The system in general shall be provided in accordance with the Instrument Job Standard Specification for Package Units" (6-52-0052 & Capacity control system configuration as per schematic B240-910-16-51-SK-0002 enclosed with this requisition and as per the indicative scheme as indicated in the enclosed P&ID's. However bidder shall note that the configuration indicated in the enclosed drawing is indicative only. Bidder shall provide all the required hardware's and software's to meet the functional requirement as specified here and elsewhere in this document and to achieve a fully automatic mode of operation.
- 11.6.2 The anti-surge controller (**as per API 670**), emergency surge detectors shall be a separate dedicated controller for each stage of the compressor. The bidder shall supply this installed on individual compressor control panel located in control room.The bidder shall supply this installed on unit control panel located in control room.
- 11.6.3 Load Sharing / Performance Master Pressure Control
- 11.6.3.1 Bidder shall supply Load Sharing / Performance Master Pressure Control System of Gas compressor Units. The same shall be a separate dedicated standalone Controller System suitably interfaced with the UCP PLC for the Logic and Sequence control.

- 11.6.3.2 The Bidder shall supply a fully integrated performance control system that provides dedicated high-speed control of the closely coupled process control loop(s). Integrated limiting loops shall be provided with the supplied performance control system in order to maintain the compressor and driver within the OEM and process defined safe limits. Provisions shall be included to move smoothly from speed or throttling control to process control based on modulation of the antisurge valve(s) at periods of reduced process demand and during fast moving or large process disturbances. Bidder's control system should include automatic tracking and mode switching between speed (fuel) control and the associated process and antisurge control loops. Speed and/or power limiting algorithms shall be designed for smooth transition in and out of process control loop tracking. A dedicated master performance control system shall be used for the primary process variable and limiting loops. This master controller shall work with the dedicated antisurge system associated with each compressor.
- 11.6.3.3 The System shall provide control of both discharge / suction pressures and flow in the Compressor by automatically varying Turbine's rotational speed which shall be consistent with the primary goal of preventing surge and provide regulation of the overall system capacity to accurately meet the discharge flow rate requirements.
- 11.6.3.4 The System shall calculate compressor operating point deviations in a manner that is invariant to changes in inlet conditions, including changes in inlet pressure, inlet temperature, gas composition (molecular weight and specific heat ratio), compressor polytrophic efficiency and rotational speed.
- 11.6.3.5 In response to bringing one compressor on-line or taking one off-line, the System shall re-establish steady-state operation with all units equally (within 1%) in no more than 30 minutes.
- 11.6.3.6 The System shall maximize energy efficiency within the compressor network by distributing the total load so as to maintain each compressor the same distance from surge, thus avoiding unnecessary recycle.
- 11.6.3.7 In the event of series load sharing, the compressors are to operate equidistant to surge when they are not recycling and with equalized recycle flow when they are. When the compressors are not recycling their mass flow rates must be the same.
- 11.6.3.8 The System shall provide automatic limitation of network throughput as required to avoid a variety of Turbine, Compressor, and process limits, such as maximum process pressures, rotational speeds, and turbine exhaust-gas temperatures.
- 11.6.3.9 Master/Overall Performance Control function of the System shall regulate the overall load distribution by influencing the outputs of the Antisurge and the individual secondary Performance Controllers.
- 11.6.3.10 The System of individual or the Secondary Performance Control function of the individual compressors shall regulate the throughput of its own compressor by manipulating its speed. It shall calculate its output in relation to the changes in the Master Performance Control function output and the compressor's distance from surge line (obtained by monitoring Anti surge Control function) for protecting the Compressors from surge, avoiding unnecessary recycling and providing the optimum performance.
- 11.6.3.11 The System's overall or the Master Performance Control / Load Sharing function shall regulate the Compressor train's discharge flow by indirectly manipulating the control elements of the Antisurge and Secondary Performance Control functions. When the Compressor is operating far from its surge limit, deviations shall be countered primarily by the Secondary Performance control functions with little or no change in the recycle rate.

When the Compressor is operating near its surge limit the deviations shall be countered primarily by changing the recycle rate with little or no change in the Compressor throttling valves.

- 11.6.3.12 The System's Master Performance Control/Load sharing function shall calculate its output to provide the optimum response for ensuring the specified performance of the Compressor Control system. It shall provide limiting control of the Compressor train suction and discharge pressures using necessary control logic with user-configurable coefficients. When one of these variables is outside its user-selectable limit, the system response shall be such to restore the normal/optimum functioning of the system.
- 11.6.3.13 The System's Secondary Performance Control function shall provide limiting control of each Compressor's suction and discharge pressure using necessary control logic with user-configurable coefficients. When one of these variables is outside its user-selectable limit, the system response shall be such to restore the normal/optimum functioning of the system.
- 11.6.3.14 Each of the System's Secondary Performance Control function shall exchange information with all other Anti surge and Performance Control functions in order to implement optimum control responses for regulating the Compressor to increase the precision of the process control by reducing adverse loop interactions. This response shall also be added to the combined PID and Variable-Gain responses.
- 11.6.3.15 The System's Secondary Performance Control function shall incorporate features to automatically detect compressor start-up and shut-down based on the value of analog input and to ramp their output signals up and down in response to such changes.
- 11.6.3.16 In the event that a Secondary Performance Control function of the System fails to receive the requisite load-sharing information from the master control function, it shall revert to controlling one of its own input signals using a system specific control response that is fully configurable by the user.
- 11.6.3.17 The purpose of these controls is to maximize energy efficiency within the subject compressor network by distributing the total load so as to maintain each compressor at the same relative distance from surge, thus avoiding unnecessary recycle at times of reduced throughput.
- 11.6.4 Anti-surge Controllers (ASC)
- 11.6.4.1 Anti surge controller to be supplied of microprocessor based anti-surge controllers for new compressor package. Recycle valves are also to be supplied. Bidder shall provide surge control system supplier's confirmation on adequacy and suitability of the selected recycle valves for their system.
- 11.6.4.2 These shall be mounted and wired suitably by package supplier on the main compressor Unit Control Panel located in the control room.
- 11.6.4.3 These controllers shall have necessary digital displays and keyboard for monitoring operation, in addition to monitoring & operation through HMI, and data entry and provision of inter-connection to PLC.
- 11.6.4.4 These controllers shall have necessary digital displays and keyboard for monitoring operation, in addition to monitoring & operation through HMI, and data entry and provision of inter-connection to PLC.

- 11.6.4.5 The controller shall be such that it shall allow compressor to operate as close as possible to the actual surge line @ 2% away from actual surge line safely.
- 11.6.4.6 The controller shall provide stable operation. It shall also be very sensitive to achieve correct/accurate opening of the antisurge (bypass) valve without hunting. Even with upset conditions, it shall not allow surging. This shall be achieved by fast response transmitters and by pass valve as well as by special algorithms in software, to be used only for recycle valves.
- 11.6.4.7 Auto/manual station, inputs for bias and other settings as required for adjusting the surge control/safety line shall be provided.
- 11.6.4.8 A trip control algorithm as an overshoot limit control shall be provided. This feature will quickly open the recycle valve to a preset position, upon an external trip signal from the compressor shutdown system (or from other status signals indicative of a sudden reduction in flow rate).
- 11.6.4.9 Manual operation of recycle valve shall have override by anti-surge controller. Controller shall be capable of checking the input signal failure and taking action for safe operation with necessary indication on the panel.
- 11.6.4.10 Antisurge Control Requirements
- 11.6.4.10.1 Antisurge control loops shall continually calculate the distance between the operating point and surge limit line in a manner that is invariant to changes in inlet conditions, including changes in inlet pressure, inlet temperature, gas composition, molecular weight and specific heat ratio.
- 11.6.4.10.2 Multiple field proven antisurge algorithms shall be available in the supplied antisurge control system. These algorithms shall be accessible via user configuration for each antisurge control loop, such that any unexpected field modifications can be easily accommodated.
- 11.6.4.10.3 The antisurge system shall include a dedicated surge control algorithm for each compressor section. Dedicated antisurge control valves will also be used for each section unless otherwise indicated by the user approved piping and instrumentation diagram.
- 11.6.4.10.4 The antisurge system shall work in harmony with the closely coupled process control loops in order to provide for a smooth transition from speed or throttling control to performance control using the antisurge valve at lower process load levels.
- 11.6.4.10.5 The antisurge system shall be capable of recognizing transmitter failures and automatically switching to a fallback strategy allowing continuation of automatic control. Alarms should be provided to signal operator to any system fault.
- 11.6.4.10.6 The antisurge control algorithm shall incorporate a surge detector and surge cycle counter. Surge detection shall be based on comparing the rate of change of the flow and/or discharge pressure to user configurable limits. Provisions must also be made for recording and displaying the maximum observed rate of change for each of those variables, as an aid to configuring the detection system based on the results of a surge test on the given machine.
- 11.6.4.10.7 Should extraordinary conditions push any compressor section into surge, the system shall be designed to automatically break the surge cycle before the second cycle can occur. In addition, the system shall provide for automated recovery from surge without operator

intervention. Also, upon surge detection, the surge control line shall be automatically readjusted for more antisurge control margin until an investigation of the circumstances of the event can take place.

11.6.4.10.8 The antisurge control algorithm shall incorporate standardized operating modes for forcing the antisurge valve fully open (normally when the compressor is shut down) and fully closed during purging operations. These states shall be selected on the basis of discrete inputs and/or the compressor's rotational speed, flow rate, or discharge pressure.

11.6.4.10.9 The System shall manipulate the Recycle Control Valve /Valves so as to maintain an adequate but not excessive margin of safety between its compressor section's operating point and surge limit, as described below. The Control System's response shall be such to quickly increase the recycle flow rate in the event of large and/or fast disturbances.

11.6.4.10.10 The System shall provide reliable anti-surge control and protection of each compressor stage in any operating mode, including start-up, purge, idling, and shutdown of the machine.

11.6.4.10.11 The System shall protect each stage of compressor from surge-induced compressor damage and process upsets with minimum recycle and minimize adverse interactions between the various control functions.

11.6.4.10.12 In the steady state, the deviation of the discharge pressure from its set point shall not exceed preferably ½%.

11.6.4.10.13 In response to full closure of network suction or discharge block valve, the System must not allow any compressor to surge. In response to the simultaneous closure of both valves, the system should not allow any compressor to surge more than once.

11.6.4.10.14 The set point of the anti surge control functional response shall be a user-configurable function for volumetric flow, thus compensating for changes in the rotational speed or guide vane geometry and shall be increased each time a surge cycle is detected. The above-referred set point shall also be increased when the rate at which the compressor operating point is moving toward its surge limit increases. Once an adequate margin of safety has been restored, this additional margin-of-safety shall be decayed at a user-adjustable rate.

11.6.4.10.15 The System shall also implement necessary responses to the changes in the master/ Performance Load Sharing Control functions' output when the compressor is operating near its surge limit.

11.6.4.9 Emergency surge detector

11.6.4.9.1 This detector shall be provided as back up to the anti-surge controller. In the event of failure of anti-surge controller/system, the emergency surge detector shall prevent machine damage due to surge by opening the recycle valve very fast on sensing the second surge cycle. Alarm shall be provided on first surge cycle.

11.6.4.10 Bidder shall be fully responsible for proper sizing, selection and supply of anti-surge control valve as per the recommendations of the anti-surge controller manufacturer. **The anti-surge controller manufacturer shall vet sizing calculations of anti-surge control valve** & it shall be submitted to EIL for information before procurement of the valve.

11.6.4.11 A maintenance notebook computer with the latest version of CCC's Engineering Utilities shall be supplied.

11.7 PLC system

- 11.7.1 UCP PLC system for GTC train and operator consoles shall be as per PLC data sheet document no B240-910-YE-DS-5010 attached with this requisition.
- 11.7.2 This specification of PLC shall be read in conjunction with standard specification for PLC no 6-52-0040 enclosed with this MR.
- 11.7.3 The changeover of Dual Processor in PLC shall be bump less and the system shall be fail-safe. Redundancy shall be provided for complete Processor sub-system including CPU, Memory, communication and Power supply. And I/O's shall be non redundant.
- 11.7.4 In PLC redundant communication sub system, on failure of active device, the redundant device shall take over automatically without interrupting the system operation.
- 11.7.5 PLC operation shall be completely unaffected by a momentary power loss of the order of 20 milliseconds.
- 11.7.6 Field mounted type, vendor's standard design, remote I/O's for GTC PLC can also be accepted provided the same are field proven in similar application and certified for hazardous area application.
- 11.7.7 The PLC shall include GTC/station control as per P&ID attached with the MR.

11.8 OPERATOR CONSOLE

- 11.8.1 The PLC console (control room mounted) shall be used as operating cum engineering console. The UCP Panel mounted HMI shall be used as operator console only. The Engineering workstation shall be used for PLC Programming, MMI development, Program storage, and fault diagnostics in addition to the monitoring and Plant operation. The MMI software shall be from the original manufacturer of PLC and should not be third party software.
- 11.8.2 Operator console shall have data equalization and clock synchronization among each other. If alarm is acknowledged on one console then same shall be acknowledged automatically in other console.
- 11.8.3 Operator console shall be server grade industrial PC and hardware configuration shall be minimum with 21" color TFT LCD monitors with keyboard and optical mouse.
- 11.8.4 All alarm log printers shall be Laser type as per PLC data sheets. And one no. laser jet colour printer A3 size, shall be supplied.

11.9 Special Requirements

- 11.9.1 Interface from bidder supplied Control System PLC with Purchaser's Existing Plant Control Station/ /SCADA (RTU).
- 11.9.2 Bidder shall provide serial communication link along with interconnecting cables for all data transfer from bidder supplied package PLC to SCADA/DCS/PLC.
- 11.9.3 Bidder shall provide all necessary hardware, software etc. in bidder supplied systems and other details required for interfacing of their package PLC and from PLC to purchaser's PLC / SCADA (RTU). In addition to this, the communication software shall be supplied in electronic media (CD/DVD) for testing the communication link.

- 11.9.4 Bidder shall be fully responsible for proper integration of their supplied system to purchaser's PLC/SCADA (RTU)/DCS and bidder supplied at site and bidder shall provide all necessary assistance to purchaser for establishing all the serial links with station PLC/SCADA (RTU) fully functional & operational.
- 11.10 Sequential Start-up and Shutdown Logic
- 11.10.1 The microprocessor based Gas Turbine Control system and Programmable Logic Controller (PLC) shall include an automatic sequential start-up and shutdown logic designed to provide reliable programmed starting, acceleration and full load operation of the unit and safe shutdown of the entire turbine compressor system. Separate interlock and logic system shall be provided for each train. Sequential logic shall reside in non-volatile memory.
- 11.10.2 Bidder shall ensure that unit will be shutdown safely in case of failure of microprocessor based Turbine control system and PLC. Bidder shall provide required back up through hardwired fast path relays for safe shutdown of the unit in case of such processor failure. In addition, safe shutdown should also, at least, cover the following:
- a) Engine over temperature
 - b) Over speed of GT / PT
 - c) Fire & Gas Detection coincident logic.
 - d) ESD etc.
- 11.10.3 Sequence and interlock requirement of complete Gas Turbine Compressor Train shall be implemented in dedicated Turbine Compressor Control System and GTC Train PLC. This shall include the following as a minimum:
- a) All shutdown / interlocking, sequential start-up and other auxiliary equipments shall be located within the compressor unit control panel / PLC.
 - b) Start-up and shutdown of the entire compressor train (i.e. unit train valves, process gas after coolers, Knock out drums process interlocks etc.) shall be executed by these microprocessor based Turbine Compressor Unit control system and train PLC to centralize the train operation into single stream.
 - c) To avoid accidental operation, all important push button, switches etc. shall have one common flushed Master Control Button. Action shall take place when both the buttons are pressed together.
 - d) Operation mode selector switches, as required on compressor unit control panel / PLC console for mode of operation shall be provided.
 - e) Fuel gas Cut-Off valve leakage check through suitable logic and pressure sensor's between the fuel shut off valves shall be provided.

12.0 LIST OF ATTACHMENTS:

As per document No B240-910-16-51-LA-5010 attached elsewhere in this requisition.