STACK GAS MONITORING SYSTEM
TYPE:SM809

Technical Data

FEATURES :

- Measures gross α, gross β, & Kr^{85} individually using 3 individual detector systems.
- Uses Zns (Ag) coupled to PMT for gross α & End window GM detector for gross β detection.
- Uses thin SS walled GM detector for detection of Kr^{85} / Ar- 41
- 3 Independent counter channels to measure countrate in the range of 0-10^6 CPM and provide 4-20mA O/P and relay contacts on alarm condition.
- Test mode to check count rate channel performance.
- Communication with MODBUS-TCP compliance.
- Ethernet port with MODBUS-TCP compliance.

Stack Monitoring is an essential requirement in Radiochemical and reprocessing plants apart from its need in reactors and atomic power stations.

Stack Gas Monitoring system offered by Nucleonix is a complete system designed for monitoring

kr^{85}, gross β and gross α. The system essentially has 3 detector assemblies with suction pump and a state of art electronic unit. Except α, rest of the detector systems will have adequate lead shielding to minimize the background.

Conceptual system block diagram is shown in the figure. The pump used will have suction capability of 200-300lpm. System will have three analog / digital rotameters to indicate flow rate upto 200lpm, one for α and other for kr^{85} & β channels.

kr^{85} is detected by allowing the air to pass through a large volume chamber containing a long thin SS walled GM detector.
Gross β can be detected by end window GM detector / thin plastic scintillator coupled to PMT. Either of them can be offered.

Gross α is detected by ZnS(Ag) Scintillator coupled to PMT. Electronic unit comprises of 3 independent counting channels corresponding to each of the detector outputs, 3 independent high voltage modules, power supplies, display electronics etc.

SPECIFICATIONS

The Stack Monitoring System (Alpha, Beta and Kr 85) shall be capable of monitoring airborne releases of alpha& beta emitting radio nuclides and Kr 85 activity in the gaseous effluents being released through Stack. The instrument shall comprise three sets of air sampler cum detector assembly and an electronic unit. The detectors shall be ZnS (Ag) Scintillation detector, Halogen quenched end window GM detector and thin wall GM detector. The electronic unit shall comprise three channels of low voltage supplies, High voltage supply, Pre-amplifier & Amplifier, Count rate meter and Alarm generation module. The electronic unit and the detector assemblies shall be mounted on a single floor mounted trolley.

The gas effluents being released through the stack is to be sampled from exhaust duct and returned to the duct after passing through the air samplers. Sampling pipes with holes shall be fitted inside the duct through the cross section. Two nos. of ¼ "SS Pipes shall be welded to the duct at these sampling points. The pipes shall be laid upto the location of the stack monitoring systems. Each pipe shall be provided with two taps along with isolating valves and they shall be connected to the air sampler of running and standby instruments. Typical drawing of sampling line and piping will be provided to the successful bidder. Final fabrication drawings shall be got approved from the user department.

AIR-SAMPLER CUM DETECTOR ASSEMBLY (ALPHA):
The air sampler cum detector assembly for alpha shall consist of a filter holder 60mm dia., a suction chamber with two nozzles (air inlet and outlet) of size ¾ serrated and detector housing. . Typical drawing will be provided to the successful bidder.

Air sampler shall be fabricated with stainless steel SS 304L. Minimum 4 numbers of threads shall be provided for free and smooth fixing and removal of each part of the sampler assembly. Air sampler shall be designed and fabricated to achieve the particle collection efficiency better than 99% for air particles down to 0.3 micron size on glass filter paper. It shall be designed considering the iso-kinetic properties of particles for uniform dust collection over entire filter paper area. The air sampler shall be tested for zero leakage at 2 Kg/sq.cm.

The Detector assembly for Alpha monitoring shall have the following specifications:

- Detector and size : ZnS(Ag) phosphor, 50mm dia coupled to a matched photo-multiplier with pre-amplifier.
- Window Thickness : 1.5 mg/cm^2 light-sensitive pin-hole free aluminized mylar with protection against puncture.
- Detector Efficiency : Not less than 25% for plutonium alpha particles over the entire window area.

AIR-SAMPLER CUM DETECTOR ASSEMBLY (BETA):
The air sampler cum detector assembly for beta shall consist of a filter holder 60mm dia., a suction chamber with two nozzles (air inlet and outlet) of size ¾ serrated and detector housing. Typical drawing will be provided to the successful bidder.

Air sampler shall be fabricated with stainless steel SS 304L. Minimum 4 numbers of threads shall be provided for free and smooth fixing and removal of each part of the sampler assembly. Air sampler shall be designed and fabricated to achieve the particle collection efficiency better than 99% for air particles down to 0.3 micron size on glass filter paper. It shall be designed considering the iso-kinetic properties of particles for uniform dust collection over entire filter paper area.

- Silencer : The pump should be

The air sampler shall be tested for zero leakage at 2 Kg/sq.cm. The assembly is to be shielded by 50mm of lead in a manner that provides easy access for loading and unloading of the filter paper and removal of detector. The opening portion of the lead assembly shall be provided with heavy duty hinges, soft pads and locking arrangement. The lead assembly shall be designed with proper care to avoid any injury to the technicians while opening and closing the assembly.

The manufacturer shall test and provide certificate for collection efficiency of particulate activity for the Air sampler assemblies.

The Detector assembly for Beta monitoring shall have the following specifications:

- Halogen-quenched end-window G.M. Counter
- Type : LND - 72314 or equivalent
- Window : 1.5 - 2.0 mg/cm^2, mica
- Wall thickness : 1.5 mm
- Effective length : 36.25 mm.
- Effective dia : 28.12 mm
- Material : 446 SS
- Max. tube dia. : 33.0 mm.
- Max. overall length : 52.50 mm
- Operating voltage range: 450-750 V.
- Operating voltage : 500 V
- Max. plateau slope : 5% per 100V
- Max. background : 15 cpm with 5 cm of lead sheilding.
- Beta efficiency response : Upto 4 Mev
- Gamma energy : 0.3 MeV to 1.5 MeV

Air-sampler cum detector assembly (krypton):
The air sampler cum detector assembly shall consist of a detector chamber with two nozzles (air inlet and outlet) of size ¼" serrated. Krypton (Kr 85) is detected by passing the air with gaseous effluents through the large volume detector chamber containing 2 numbers of long thin SS walled GM detector.
The detector chamber shall be fabricated with stainless steel SS 304L. The detector shall be mounted in the chamber. The chamber shall be provided with proper gaskets for arresting leaks.

Pre-amplifier and Amplifier: Three

The assembly is to be shielded by 20mm of lead in a manner that provides easy access for removal of detector. The opening portion of the lead assembly shall be provided with heavy duty hinges, soft pads and locking arrangement. The lead assembly shall be designed with proper care to avoid any injury to the technicians while opening and closing the assembly.

The Detector assembly for Krypton monitoring shall have the following specifications:-

- Halogen-quenched thin walled GM detector (suitable for beta detection)
- Type : LND 719 or equivalent
- No of detectors : 2
- Operating voltage range : 750-950 V.
- Operating voltage : 900 V
- Max. plateau slope : 5% per 100V
- Sensitivity : 90 cps/mR/Hr.

Suction / vacuum system : This Suction / Vacuum system shall provide the required suction for drawing air through the filter paper in the air sampler assembly. The system shall comprise a Dry type, noise-free, continuous duty, pump-motor set.

Vacuum pump-motor set :

- Free air displacement : 150 liters/min (Min.)
- Ultimate vacuum : 550 mm Abs (22" Hg)
- Pressure : 1.4 Kgs/cm^2 (20 lbs)
- Duty : Continuous.
- Electric Motor : ½ HP, 1440 RPM with gear box, 220/230V AC, capacitor start, single phase TEFC B-56 frame, Class "B" insulation, continuous rating Crompton or equivalent.
- Vanes : Made of self lubricant special H17 grade graphite.
- Bearings : Sealed ball bearings.
- Mountings : Pump and motor mounting shall be on a common base plate.
- Drive : "V" belt and pulley driven (belt covered by belt guard)
- Air inlet/outlet : ¼" serrated nozzles.
- Vibration : suitable anti-vibration pad.

Recorder output : 4 to 20 mA, with

provided with a silencer to give a noise free operation.
- Pump failure alarm : Pump failure alarm indication shall be provided on the instrument and the same shall be wired on the remote console.
- Make : The pump shall be of M/s Tawde make or equivalent.

Flow measurement and regulation:
- The instrument shall have two sets Air rotameter 50- 200 lpm. with ¾ serrated SS nozzles for connection to 12 mm ID PVC / Copper tubing.
- Rotameters should be mounted on a tamper-proof manner in the air sampling line.
- One rotameter shall be connected to the air sampler for Alpha and the other to the air sampler for beta.
- The outlet of air sampler for alpha activity shall be connected to the air sampler for Krypton and then back to the stack
- Needle valve shall be provided to isolate and for setting / adjusting the flow rate.
- Provision shall be given to discharge the hot air from the vacuum pump

Electronic unit : The electronic Unit shall comprise of three channels of Low voltage power supplies, EHT supply, pre-amplifier, amplifier, count-rate meter based on Intel Microprocessor/microcontroller and audio visual alarm system shall be provided for the two detectors.

Low Voltage power supply : Independent low voltage power supplies shall supply the DC power supplies required for the operation of each channel of electronic module. They shall have a very good line voltage and load regulation. The modules shall be fitted with Mains line filters to avoid line interferences.

EHT Supply : Three independent EHT channels shall be provided for the working of the Beta, Krypton & Alpha channel detectors. The output voltage of each channel shall be continuously variable from +300V to +1500V independently. Output should be adjustable by screwdriver and EHT shall be shown on the display by the use of the keypad.

independent Pre-amplifier & amplifier channels compatible with the two GM detectors & ZnS Scintillation detector shall be provided. It shall provide the amplification and shaping for the pulse signals from the detectors. The output of the amplifier will be given to the Count rate meter for further data processing and display.

Count-rate meter : Three independent Count rate meters shall be provided for processing the data from the three detectors and display the same. Each count-rate meter shall have the following specification

- Unit : CPM / CPS / Bq
- Ranges : For Alpha and Beta channels
  0 - 50000 CPM OR
  0 – 2000 CPS OR
  0 - 50000 Bq, with provision for unit selection and range adjustment.
  For Krypton Channel :
  0-500000 CPM OR
  0 – 20000 CPS OR
  0 – 250000 Bq with provision for unit selection and range adjustment.
- Time Constant : Between 60 to 1 sec automatically varying inversely with count-rate through out the range.
- Display : Auto Ranging direct reading, 6 digit 7 segment LED display & 16x2 LCD display. 6x7 LED display is interfaced using multiplexed display driver and is used for display of count-rate and hardware status indication & 16x2 LCD for visualization of preset alarm and other parameters
- Display updating : First reading on Power ON within 12 secs.
  Normal (Slow) : 60 sec to 12 sec automatically varying inversely with the radiation level.
  Abrupt detection : Update the current reading within 1 sec and return to normal mode.

Overload : Senses overload above 200% of fullscale indicates on display “OL”

Over-range : Senses if the radiation field being measured has exceeded the measurement range of the instrument and upto 200% of the instrument and displays “OFl”.

600 ohm load.

Recorder output stability
a) Non-linearity :Max = 0.025% of Span
b) Offset current (Io=4mA) : Max = 0.0005% of Span / °C
c) Span Error (Io=20mA) : Max = 0.005% of Span / °C

- Accuracy : +/ - 5% Full scale.
- Calibration Accuracy : +/- 5% through out the range.
- Testing Facilities : Provision to inject a suitable pulse generator signal for routine testing of Count rate meter shall be provided on the rear panel.
  Additionally a test pulse mode through software for checking count-rate meter shall be provided
- Instrument “ON” Indication: Large Area Green LED Lamp. This will indicate the Normal condition also.

Audio visual alarm system:
- Alarm range : 1 to full scale reading
- Alarm setting : The alarm level setting shall be carried out through
  Ethernet port with handheld configurator / PC with password protection.
- Alarm Indication :

a) Red (LED) flashing large area window display
b) Loud audio tone (dual frequency tones)

- Alarm annunciation scheme:As tabulated below;

Parameter Status	Visual indication (Red LED)	Audio
Normal	OFF	OFF
Abnormal (Active)	Flashing	ON
On ACK After being abnormal	Steady Red	OFF
Reset after returning to Normal	OFF	OFF

- Instrument Controls :

Computer Interface: Each channel

All the alarms generated during

a) Acknowledgement switch for muting audio.
b) Reset switch for resetting the Alarm indication and alarm relay.
c) Power ON/OFF switch with Power ON indication.
d) EHT ON/OFF control is provided on the front panel of the instrument

- **Instrument Fault indication:**

a) EHT failure: Visual alarm with flashing red LED indication & "Eht" message on display
b) Detector failure: Visual alarm with flashing red LED & "d-FL" message on display.
c) Microprocessor / microcontroller failure: Visual alarm with flashing green lamp.
d) Fault indications shall be cleared automatically if normal status is resumed.

Housing :
All the modules of the Electronic unit shall be housed in rack mounted type cabinet. The modules shall be plug in type and all the controls and display on the front panel. The enclosure shall comply with IP-21.

Remote /External Console:

The instrument shall be provided with three remote console connectors for the three channels.

- 4 - 20 mA linear proportional to full scale display output. Current output shall be able to drive load of 600 ohms. Output circuitry shall be able to drive 200 mtrs.of twisted pair of wires.
- Two sets of potential free contacts of Alarm relay (Change over). Contact rating 3 Amp at 250 VAC. The relay shall be energized on normal condition and de-energised under alarm condition.
- Remote alarm acknowledgement and reset signals for the field instruments.
- Indication of instrument fault condition (detector, EHT & microprocessor failure), over range & overload conditions by up-scale 4-20 mA. (22.5 mA).
- Pump failure alarm contact.
- All these signals shall be terminated on a 17 pin socket (Allied Connectors). The corresponding mating plug with 5 mtr cable shall be supplied with the monitor. Wiring scheme shall be got approved from the user.
- DB9 connector for RS485 port.

of the instrument will have a RS-485 Serial Communication port for interfacing with a IBM PC-compatible computer. The PC and the monitor operate in a host-slave configuration in a multi-drop network through this interface. The PC as the host will give commands and send queries. The monitor will carry out the various functions as per the required information in response to the queries.
The firmware of the monitor is able to send the instrument data like Instrument ID, Instrument type, Input range, Display range, alarm settings, alarm status, current reading, diagnostic status of EHT/ GM tube etc. to the Host PC on demand. The firmware is able to receive commands from Host PC and carry out the setting of different parameters like Instrument ID, Instrument type, Input range, Display range, alarm settings, Ack, Reset, EHT setting etc. The configuration settings are password protected and the password is user defined. Detailed list of the command and response for the Host-slave communication will be provided by the user.

The detailed specifications for the interface are as follows:-

Type : RS-485 Multidrop Serial Communication Port, Half Duplex Bi-directional communication.
Character Format : ASCII
Protocol : Modbus/RTU
Bit Rate : User configurable to 9600 or 19200 bits per sec.
Address : User configurable from 0 to 255.
Connector: 9-pin D-type connectors (2 connectors connected in parallel for daisy chaining a number of instruments).The mating connectors with cover is supplied.

Self Diagnostics : The monitor shall have built-in self diagnostics. On being powered it shall perform tests to ensure that all components and sub systems are functioning properly. It shall check for the Power supply, High Voltage Supply, Detector, Counting and measuring circuits, Alarm Systems and Display Systems.
diagnostics shall be Auto Reset type.
The firmware shall not halt monitoring / data acquisition function any time. The firmware shall be designed for high reliability and availability.
Test points shall be provided for checking the EHT voltage and for connecting external input pulse signals.

Input Power : 230VAC +/-10%, 50Hz, single phase supply. Shall be provided with spike suppressor and line filter. Power ON/OFF indication shall be provided with an indicator LED.

Environment : The instrument shall be able to withstand temperature upto 50 deg C and relative humidity upto 90% in radiation areas.
The instrument enclosure and detector assembly shall comply with IP-21. Electronic units shall withstand cumulative radiation dose of 10000 Rad. (30 years of operation).

Instrument trolley:

- All the hardware like Vacuum pump, Air sampler - detector assembly, lead shielding, rotameters, Electronic unit etc may be fitted in an Instrument trolley made of M.S.
- The trolley shall be provided with castor wheels with locks / breaks.
- The trolley shall be powder coated with Siemens Grey colour.
- Front and Rear sides shall have doors with magnetic lock.
- The doors shall be provided with holes to facilitate air suction from surroundings.
- The vacuum pump shall be fitted at the bottom with guards & shock absorbers.
- Pump discharge (hot air) shall go out of cabinet.
- Two Mains supply boards with required sockets, indicators and switches / MCBs shall be provided inside the trolley.
- One power board shall be used for Vacuum pump and the other shall be used for electronic unit.
- Internal PVC tubing shall be done between Suction head, rotameter, pump etc.