

## Annexure 1

### **TECHNICAL SPECIFICATION OF WHOLE BODY CONTAMINATION MONITOR**

#### **1. Scope of Supply**

Scope of supply includes design, fabrication, supply, installation and commissioning of Whole body contamination monitor as per specification.

#### **1.1. Supply**

a) Supply of instruments and accessories as per Technical Specifications of this tender.

#### **2. Detailed Specification of Instruments**

#### **2.1. Whole Body Contamination Monitor**

The Beta-Gamma whole body contamination monitor will be installed at designated location and will be used for monitoring of contamination on all part of body including Head, Feet and Palm of the personnel. The system shall comprise a set of detectors fixed in a portal frame and a signal processing & display unit. The portal frame shall be fabricated for side entry and to monitor the human body from front and back. The system shall provide local display of counting data of all the channels on a LCD screen and gives alarm display when contamination exceeds the preset alarm level. In case of contamination, system shall also provide a contact output for external use and take photo of the person contaminated. The detailed specifications of the system are given below.

#### **2.1.1. Detector Assemblies**

- 2.1.1.1. Radiation Detected : Beta - Gamma
- 2.1.1.2. Minimum Activity : 1.5 Bq/cm<sup>2</sup> beta radiation from Sr-90 in presence of 0.2 mR/hr gamma background with 99% confidence level with 5 sec counting time for each channel.
- 2.1.1.3. Applicable Standard : IEC 61098:2003 "Radiation protection instrumentation - Installed personnel surface contamination monitoring assemblies". In case of any deviation of this technical specification from the standard, this specification will prevail over the requirement of the standard.
- 2.1.1.4. Minimum No. of Channels : The system will have minimum 13 channels (CH1 – CH13) as shown in fig.1 (Head, Face front, Face back, Chest, Back, Waist Front, Waist Back, Palm Left, Palm Right, Leg Front, Leg Back, Foot left and Foot Right)
- 2.1.1.5. Detector type : Plastic scintillation detector suitable for high beta efficiency and average gamma efficiency.

- It should have three layer of light proof foil. The detector should give uniform response throughout its area. This will be verified by taking beta source response in contact of detector at different locations of the detector.
- 2.1.1.6. Photomultiplier Tube (PMT) : One PMT with each plastic scintillation detector. It must be compatible to detector to achieve the detection limit.
- 2.1.1.7. No. of detectors : Each channel will have minimum one detector. However, the size of each detector must not be less than 300 mm \* 300mm except foot detector. Each foot channel will have only one detector. The active area of each foot detector must not be less than 520 cm<sup>2</sup>.
- 2.1.1.8. No. of counters : Each channel should have at least one counter.
- 2.1.1.9. Detector Assembly : Detectors of each channel shall be fitted in plug in type detector assemblies for ease of maintenance. The detector should be fitted with proper support to avoid chance of loose connection.
- 2.1.1.10. Lead shielding : As required to achieve the minimum detectable limit specified above. They shall be fabricated and fitted in the instrument so that they can be detached easily for maintenance. Detector / circuitry should be removable from assembly without removing lead shielding for maintenance.
- 2.1.1.11. Protection Grill : Detector assemblies shall be protected by a thin SS grill. It should be mounted for easy dismantling.
- 2.1.1.12. Detector Housing : Detectors shall be housed in a portal frame fabricated with M.S angles and sheets. Necessary lead shielding and S.S. grills shall be provided for the detectors.

### 2.1.2. Foot Detector

- SS grill plate shall be provided to protect the detectors from any physical damage.
- Suitable optical sensor shall be provided to ensure presence of foot. This will be used for auto start of system counting.
- Number of sensors for each foot shall be such that the proper positioning of the foot shall be ensured during monitoring.
- Operation of these sensors shall control the signal processing.
- Minimum active area for foot detector will be 520 cm<sup>2</sup>.

### 2.1.3. Head Detector

- The adjustment shall be possible between 1450 mm and 1900 mm from foot level.
- Head detector assembly position shall be adjustable within  $\pm 5\%$  manually.

**2.1.4. Detector arrangement:** Detector arrangement should be as follows:

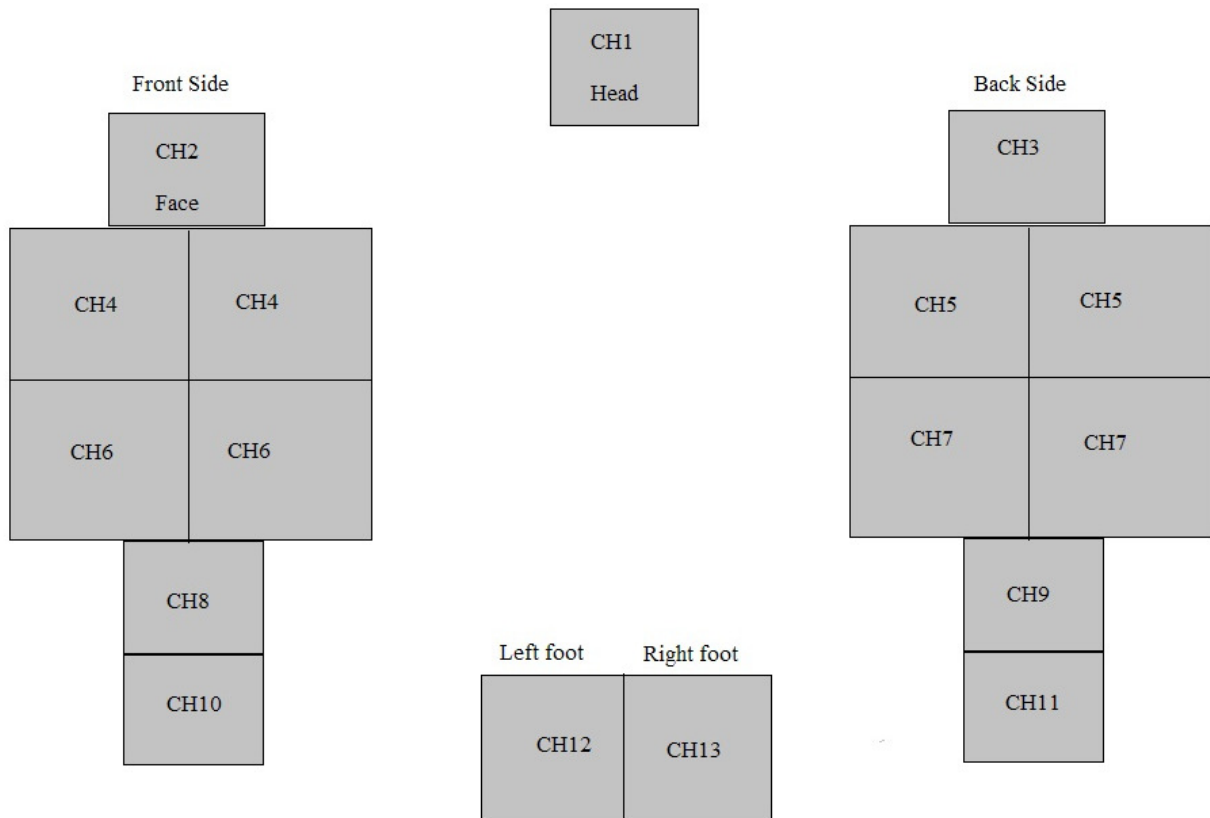


Fig 1: Arrangement of detectors assembly

### 2.1.5. Electronic unit

The electronic unit shall consist of the low voltage and high voltage power supply, signal processing and counting unit and PC based data acquisition for remote display.

#### 2.1.5.1. Low voltage and high voltage power supply:

The monitor shall have a High voltage power supply unit for the detectors and a low voltage power supply unit which supplies the DC power supplies required for the Electronic unit. It shall have a very good line voltage and load regulation for all the supplies. It shall be fitted with Mains line filters to avoid line interferences.

The High voltage output shall be adjustable either by handheld configurator or host PC or by adjustable pre-set. EHT should be displayed on the display on demand. The EHT shall adjustable from 300 V to 1200 V DC.

### **2.1.5.2. Signal processing and counting unit**

It shall comprise the hardware and software to carry out the following functions:

- Signal conditioning including the pre-amplification, pulse shaping, pulse height discrimination etc.
- Signal processing, display of counts & messages and Alarm indication.
- Data communication to Remote Host PC through Ethernet port.
- Data storage of last 100 alarms & 100 data and Image
- Background subtraction facility - ON/OFF
- Over range response
- Acquisition of background data periodically in case of background subtractions ON.
- Background low and background high level.

The detailed technical specifications of the counter and timer shall be as follows.

- |                              |   |   |
|------------------------------|---|---|
| 2.1.5.2.1. Counting Range    | : | 0 to 9999 COUNTS  |
| 2.1.5.2.2. Monitoring Timing | : | 0 to 99 seconds configurable  |
| 2.1.5.2.3. Alarm Range       | : | 0 to 9999 COUNTS  |
| 2.1.5.2.4. Alarms            | : | Independent alarm level for each channel should be user configurable in step of 1 count |

### **2.1.6. Human Machine interface**

#### **2.1.6.1. Indications & controls**

- |                              |   |   |
|------------------------------|---|---|
| 2.1.6.1.1. Mains switch      | : | The mains switch shall be provided at the back side of the monitor.   |
| 2.1.6.1.2. Mains indication  | : | Red LED to indicate mains power ON.   |
| 2.1.6.1.3. EHT switch        | : | The EHT ON/OFF switch shall be provided at the back side of the monitor.  |
| 2.1.6.1.4. EHT indication    | : | Red LED to indicate EHT ON  |
| 2.1.6.1.5. Occupancy Sensor  | : | The monitor shall be provided with optical sensor to detect the presence of person on the platform of whole body contamination monitor.   |
| 2.1.6.1.6. Test switch       | : | A push button shall be provided to check the background.  |
| 2.1.6.1.7. Image Acquisition | : | Two fixed focus dome cameras with minimum 1 MP resolution and manual pan tilt will be installed and configured for automatic rear and front image acquisition of contaminated person. |
| 2.1.6.1.8. Alarm indication  | : | Indication for individual channel to be provided.   |
| 2.1.6.1.9. Display           | : | The display should be graphical display and it should have facility to display the accumulated counts, Alarm set point of each channel. It will                                       |

	show set parameters on demand.
2.1.6.1.10 Visual display	: LCD color graphical display.
2.1.6.1.11 Visual alarm	: Red LED / cluster for indicators for each channel.
2.1.6.1.12 Audio Alarm	: Loud audio tone with two different frequencies.
2.1.6.1.13 Incomplete operation	: Yellow LED Indicator will be ON when the counting is interrupted before the set time.
2.1.6.1.14 Clear Indication	: Green LED indicator will be ON when all the channels are clear.

Given below is a partial list of the functions to be carried by the Visual display.

- Display normal status messages.
- Visual display of monitoring in progress.
- Display of individual channel readings with graphical layout of human body.
- Alarm annunciation with graphical layout of human body
- Background checking and display
- User friendly Instructions for in English & Hindi
- Programming of the instrument.
- Display of Alarm Setting and background level.

### **2.1.7. System Configuration**

Before the system starts operating, various parameters like counting time, Alarm limit etc. shall be checked by software. The system shall not operate unless all the system parameters are entered and they are within the limits.

Configuration parameter entry shall be one of the options available on the menu displayed normally at the bottom of row of the colour monitor. Access to this mode shall be through password only.

Facility shall be provided in the system for entry/modification of following parameters.

2.1.7.1.	Signal counting time	: 1 - 99 secs in steps of 1 sec
2.1.7.2.	Background counting time	: 1 – 99 secs in steps of 1 sec
2.1.7.3.	Alarm high limits	: 0 - 9999 CPS/CPM
2.1.7.4.	Background low limit	: 0 - 9999 CPS/CPM
2.1.7.5.	Background high limit	: 0 - 9999 CPS/CPM

During parameter entry if any of the above are not within the limits defined above, the system shall not accept the data. Proper warning message shall be displayed under such condition.

### **2.1.8. Instrument Fault indication**

- EHT failure: Visual alarm with flashing red LED indication & "EHT fail" message on display

- Detector failure: Visual alarm with flashing red LED & "Detector Fail" message on display.
- Fault indications should be cleared automatically if normal status is resumed.

### 2.1.9. Functions

- Commencement of Monitoring** : Monitoring commences once the monitor detects the occupancy on platform.
- Termination of counting** : Counting shall terminate on elapse counting time or eviction of platform whichever is earlier.
- Incomplete operation Alarm** : To generate incomplete Audio/visual Alarm in the event of platform being vacated before the elapse of counting time.
- Contamination Alarm** : Distinct Audio Visual alarm per channel in the event of counts detected equals/exceeds the alarm level.
- High background Alarm** : Distinct Audio visual alarm in the event of counts detected equals/exceeds the preset high alarm setting during the background monitoring.
- Data Storage** : The computer shall store all the contamination data including corresponding image of persons with date & time.
- Background Counting** : After switching ON if all the system parameters set are within the range and if there are no other failures, the system shall count background (BG) for background set time. Then background counts per system (CPS) are computed for individual detector assemblies and if the background CPS is within the limit set, the system shall indicate 'READY'. If background is not within the limit the system shall display message 'BACKGROUND HIGH' in flashing mode. The system shall continue to update the background in every BG Set time if the system is idle (i.e. not used). Whenever the average BG is higher than the set value, the 'READY' display shall go 'OFF' and "High Background" shall be displayed on the LCD monitor. During background counting cycle, if any of the detectors show low alarm then READY shall go OFF and system operation shall be inhibited
- Signal counting** : When a person stands on the monitor properly, the system shall start signal counting. During signal counting, the message SIGNAL COUNTING ON in flashing mode shall be displayed with down counting in seconds and the whole body figure shall be displayed on the LCD Monitor. After signal counting period, the system shall compute the count rate (CPS) for individual detector and shall subtract the BG (if configured). This value shall be compared with set alarm limit for individual detector assembly and alarm message shall be provided.

### 2.1.10. Visual Indication scheme of alarms:

Operation	Display legend	Visual indication
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		<b>Color</b>	<b>Status</b>
Monitoring in progress	Counting ON	Green	Flash
Monitoring complete	Clear	Green	Steady
Monitoring Incomplete	Incomplete operation	Red	Steady
High / Low Background detected	Background High / Low	Red	Flash
Contamination detected	Contamination Detected <b>(Body part contaminated shall be displayed in Red)</b>	Red	Flash

#### 2.1.11. Audio Alarm :

On contamination/incomplete operation, an audio alarm should be initiated. The duration of alarm, tone and volume should be user settable.

#### 2.1.12. Computer Interface: -

The whole body contamination monitor shall be provided with an Ethernet 10/100 Mbps port (RJ-45) and CAT 6 cable with minimum 100 meter length for interfacing with a remote IBM PC-compatible computer. The features to be supported by Ethernet port are given below.

- The PC and the instrument shall operate in a host-slave configuration and the software protocol shall be Modbus/TCP.
- The PC as the host shall give commands and send queries. The monitor shall carry out the various functions as per the required information in response to the queries.
- The firmware of the instrument shall be able to send the instrument data like alarm settings, alarm status, current reading, diagnostic status of EHT / detectors etc. to the Host PC continuously.
- The firmware shall also send the history data for at least the last 24 hours on demand.
- The firmware shall be able to receive commands from Host PC and carry out the setting of different parameters like alarm settings, EHT setting, Instrument address etc.
- The configuration settings shall be password protected and the password shall be user defined.
- Detailed list of the command and response for the Host-slave communication shall be provided in manual.

The data acquisition and display software will preinstalled in personal computer (PC) with Keyboard & Mouse and LCD Colour monitor shall be provided in system for data acquisition, setting parameters, providing displays visible alarm etc. Remote audio alarm is generated using internal speaker in data acquisition computer.

The PC shall be of latest version available in the market and shall have provision for up gradation. The hardware specification given below is only for reference and is the bare minimum requirements.

2.1.12.1.	Processor	:	Intel Core I-5
2.1.12.2.	Motherboard	:	Compatible with above processor.
2.1.12.3.	Hard Disk	:	500 Gb or higher (high speed SATA)
2.1.12.4.	Main memory	:	8 GB RAM
2.1.12.5.	LED Monitor	:	15 inch or higher
2.1.12.6.	DVR	:	Internal Plug in Module for DVR card
2.1.12.7.	DVD	:	DVD R/W
2.1.12.8.	Operating system	:	Preloaded genuine windows 10 professional-64 bit and all necessary softwares
2.1.12.9.	PC will be preassembled with mouse, keyboard and front 6 USB		

### 2.1.13. Self Diagnostics:

The monitor shall have extensive built-in diagnostics to alert in case of failure and. to assist in trouble shooting. The diagnostics shall include functions to monitor,

- Detector Fault
- Low voltage power supplies,
- High Voltage Detector supply,
- System functions

The diagnostics shall run and 'Power On' Self-Test. It shall also be possible to invoke any diagnostic function on demand.

Test points shall be provided for checking the EHT voltage and for connecting external input pulse signals.

There shall be a provision to bypass any individual detector / channel.

The firmware should not halt monitoring / data acquisition function any time. The firmware shall be designed for high reliability and availability.

### 2.1.14. Construction:

All the detector assemblies, Electronic unit and PC with colour monitor shall be mounted on a suitable portal frame with due consideration for sensitivity of operation, maintenance etc.

2.1.14.1.	Frame material	:	M.S.
2.1.14.2.	Grills	:	S.S. grills
2.1.14.3.	Dimensions of frame must be less than	:	
	• Width	:	600 mm.
	• Depth	:	1300 mm.
	• Height	:	2000 mm.
2.1.14.4.	Lead Shielding	:	As required to meet the minimum detectable activity level.
2.1.14.5.	Frame and electronic unit shall be fabricated to prevent rodent entry.		



2.1.14.6. It shall be provided with required ventilation / cooling

2.1.14.7. It shall be provided with dust filters.

### **2.1.15. Operating Environment**

2.1.15.1. Input Power : 240 Volts AC  $\pm$  10%

2.1.15.2. Operating temperature : Up to 50° C

2.1.15.3. Relative humidity : Up to 95%

2.1.15.4. Mode of operation : Continuous round the clock

### **3. Testing & Inspection**

- a) Pre-dispatch inspection & testing shall be carried out by the purchaser at the vendor's place.
- b) Instrument shall be designed as per the relevant IS/IEC/ANSI standard for nuclear instruments.
- c) The radiation source response shall be checked with the standard source certified by approving agency.

#### **3.1. Tests to be carried out during Pre-dispatch inspection**

Pre-dispatch inspection shall include various tests like Physical, Electrical, Functional, detection efficiency and communication tests. Some of the typical tests are listed below. However, some more tests may be desired based on the type of instrument and design will be included during the inspection.

##### **3.1.1. Physical test**

- a) Verification of BOM
- b) Enclosure construction
- c) PCB fabrication
- d) Detector Housing
- e) Laying of cable
- f) Easy removability of component / detector for maintenance
- g) Workmanship

##### **3.1.2. Electrical Test**

- a) Internal layout and wiring
- b) Load & line regulation test for DC voltages (on sample)
- c) Load & line regulation test for EHT (on sample)

##### **3.1.3. Functional Test**

- a) Power ON test
- b) Display & LED indication test
- c) Detection efficiency
- d) Response with electronic pulse
- e) Alarm test
- f) Communication test for 100 meters cable.
- g) Detector performance
- h) Diagnostic tests
- i) Minimum detectable activity

4. **Information should be provided along with quotation**
  - a) Detailed Technical Specifications, Material of construction, Make and Model of offered items.
  - b) Compliance/Deviation statement for tender specifications.
  - c) Detailed drawings wherever applicable.
  - d) Applicable Standards.
  - e) Previous supply details to DAE/PSU/Govt. Organizations.
  - f) Radiation Sources and Calibration facility available with the vendor in-house.
  - g) Details of the company's profile, in-house manufacturing and testing facilities.
  
5. **Installation:** The system shall be installed at the designated position provided at the site and tested along with the site engineers by the supplier. Test reports for the test performed at site shall be prepared by the supplier and submitted to site engineers on completion of the installation and testing of the instruments. QAP for the test shall be prepared by the supplier within 30 days from the date of receipt of purchase order and the same shall be approved by the purchaser within 15 working days after receipt of the QAP.
  
6. **Documentation:** Two sets of hard copies along with a set of soft copy shall be submitted approvals. Two sets of "As Built" documents and soft copies shall be provided after execution.
  - a) QA / Test reports for all items.
  - b) Calibration reports.
  - c) Circuit diagrams and descriptions with maintenance hints
  - d) Operation Manuals, Service Manuals.
  - e) Test reports.
  
7. **Warranty:** Warranty shall be provided for all supply items. It shall be for 12 months from the date of final acceptance of items at site. Warranty certificate shall be provided for all supply items.
  
8. **Qualification Criteria of Bidder:**
  - a) The bidders shall have adequate experience for manufacture / supply of Whole body contamination monitor. Copies of purchase order/work orders of same type of whole body contamination monitor supplied in past 5 years in support of confirmation of technical specification shall be submitted.
  - b) The bidder shall have organizational structure with respect to design, drafting, engineering planning, and procurement manufacturing/production and quality assurance. An organization chart shall be submitted.
  - c) The facility for calibration with radiation sources shall be in-house or can be outsourced. The bidder shall clearly specify it in the bid. Such facility shall be certified by the authorized agency and such certificate shall be provided with the bid.

**9. Notes for Bidder**

- a) The bidder shall list all non-conformities to specification separately.
  - b) Offered models shall be standard, proven & designed as per applicable standard.  
Bidder shall furnish relevant certificates for various qualifications.
- 10. End use certificate:** BARC will not provide any "End Use Certificate".
- 11. Delivery Period:** Six months from placement of Purchase Order.