

Technical specifications of Remote Controlled Mobile Radiation Monitoring System

1. SCOPE OF WORK

The scope of the work covers detailed design based on the conceptual design provided by BARC, preparation of component level/sub-assembly level/assembly level drawings and their development, component selection of electrical/electronic modules and procurement, PCB design, fabrication and mounting of the components of electrical/electronic modules, routing diagrams for various electrical/electronic modules, selection/procurement of raw materials including bought out components, manufacturing, assembly, associated software development, testing and safe delivery of Remote Controlled Mobile Radiation Monitoring System (RCMRMS) (04 Nos.) meeting the conceptual design provided by BARC.

The detailed scope of the work is as follows:

- A. Design of RCMRMS based on preliminary design furnished by BARC.
- B. Preparation of General Arrangement (GA) layouts, component level, sub-assembly level & assembly level drawings and obtaining approval from BARC.
- C. Component selection of electrical/electronic modules, procurement of components and preparation of routing diagrams for various electrical/electronic modules.
- D. PCB design, fabrication and mounting of the components of various electrical/electronic modules.
- E. Identification of raw materials including bought out components to be used in various sub-assemblies & assemblies of the equipment.
- F. Software development for mobile platform operation, data capturing, transmission
- G. Procurement/design of suitable Remote Terminal Unit (RTU) and related software development including GUI for Remote Terminal Unit (RTU).
- H. The job should be executed in the following phases:
 - i. Phase 1: Preliminary design review: The vendor should submit preliminary designs, including general drawings, for the user's approval.

- ii. Phase 2: Detailed design review: The vendor should submit detailed designs with 3D models and detailed drawings for the user's approval.
 - iii. Phase 3: Manufacturing of one(1) unit of RCMRMS
 - iv. Phase 4: Associated software development, integration and testing at the vendor's site.
 - v. Phase 5: Demonstration and mockup trials at BARC premises.
 - vi. Phase 6: Minor changes shall be incorporated in the design as required at the time of execution of work.
 - vii. Phase 7: Manufacturing of three (3) units of updated RCMRMS.
 - viii. Phase 8: Integration with software suite and testing at the vendor's site.
 - ix. Phase 9: Demonstration at BARC premises.
- I. Supply of GA layouts, as-built assembly, sub-assembly & component level drawings including routing diagrams, BOM, design and gerber files of the fabricated electronic modules in soft copy along with two sets of hard copies of above drawings, Source codes of embedded softwares along with GUI software, operation/maintenance manuals, and part catalogs.

2. GENERAL DESIGN FEATURES

1. Mechanical System
 - i. The design and construction shall be such that the motions are smooth (low friction), jerk-free and low effort type.
 - ii. Design and drawings shall be reviewed by BARC for all components.
 - iii. The gears to be used for various drives shall have minimum backlash.
 - iv. Roller chain/Gears to be used for various drives shall have a long life (at least 5 years) by selecting proper material of construction & surface treatment.
 - v. Standardization of fasteners shall be adopted in the design.
 - vi. The fit between mating parts shall be ensured for the smooth functioning of the equipment.
 - vii. Components/parts shall be machined within the tolerances as per the approved fabrication drawings. The use of shims, washers, etc. for achieving a fit must be avoided.
2. Electrical/Electronic & Control System

- i. As each motion of the equipment is operated independently, related interlocks/logics shall be designed appropriately for easy approach & rectification.
- ii. Rugged duty micro switches shall be employed for independent (& simultaneous) limit sensing of motions, wherever necessary.
- iii. The onboard electronics should have suitable arrangements for heat dissipation.
- iv. All power & control cables shall be suitably selected to meet our requirements.
- v. All major components used must be procured from reputed manufacturers only after obtaining approval from BARC.
- vi. For any non-standard electrical/electronic items, two sets of spares must be provided.

3. FUNCTIONAL SPECIFICATIONS:

Fig. 1 shows the context diagram of the Remote Controlled Mobile Radiation Monitoring System. It consists of two units:

- a) **Mobile Robot:** It shall be a battery operated, wireless remote controlled vehicle. It shall have a camera module and a robotics arm unit (refer section 4.1.1)
- b) **Remote Terminal Unit (RTU):** RTU shall be a compact handheld unit to remotely control the motion of the Mobile robot as well as the robotic arm unit of the mobile robot along with the rotation angles of the camera module. Also, the GUI of RTU shall display the live video stream of the camera and the radiation data from the GM tube and scintillator based Radiation Monitoring Systems, collectively known as Radiation Detection Module.

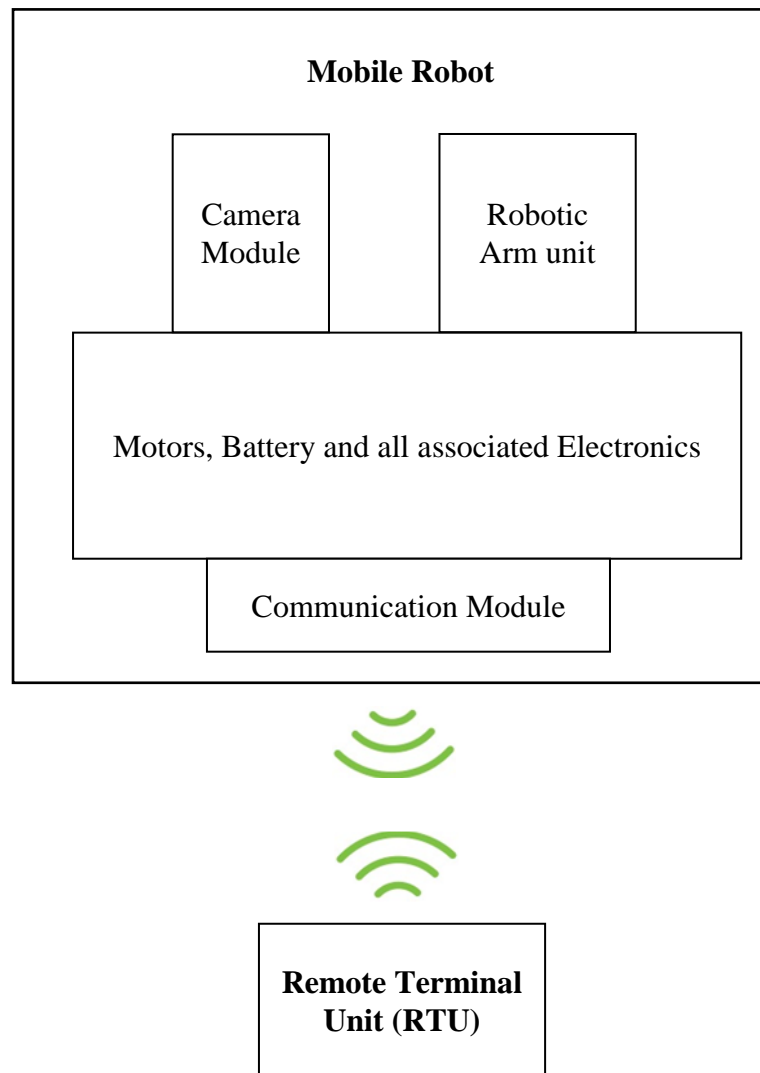


Figure 1: Context Diagram of Remote Controlled Mobile Radiation Monitoring System

There shall be a provision to archive the Radiation Detector Module (RDM) data in mobile robot & RTU both. It shall be possible to transfer the surveillance data to PC for offline analysis with either wired or wireless communication from mobile robot and RTU .

4. TECHNICAL SPECIFICATIONS

4.1.1 MOBILE-ROBOT SPECIFICATIONS

Operating Power supply	:	An onboard battery along with a power on-off switch.
Operating speed	:	Up to 0.5 m/s (Maximum). Speed should be user-controllable from RTU and bidirectional. Velocity, acceleration and position control shall be in closed loop. Velocity control shall be in the steps of at least 5mm per second.
Traction	:	4 wheel skid steer drive with steerable wheels for zero turning radius and suitable mechanical couplings between a motor and wheel. The Motors shall be geared motors with a suitable position encoder.
Radiation Detector Module (RDM)	:	<p>The Radiation Detector Module shall contain two types of Radiation Detector Assembly (RDA) and their associated pulse processing electronics (PPE). The two types of RDA are as follows:-</p> <p>1) GM-tube based RDA: It shall consist of two GM tubes (low range and high range) detector module and associated processing electronics. The weight of GM tubes is approx. one hundred grams and tentative part number is ZP1313.</p> <p>2) Scintillator based RDA: It shall consist of a NaI(Tl) scintillator detector module typically cylindrical in shape and associated processing electronics. The weight of detector is approx. 2.5 kg, diameter 8 cm and height 25 cm.</p> <p>Exact model no. of the detectors will be provided by BARC.</p>
Data Logging	:	The onboard storage shall be able to log the time-tagged Radiation Data of more than 100 hours of operation. A provision of transferring this data to PC shall also be available.
Robotic Arm unit	:	<p>Robotic arm unit shall be mounted on the Mobile Robot and shall consist of two arms:</p> <p>Arm1: It shall be a telescopic arm coupled on Robot base with length varying from 80cm to 150cm. It shall also have at least 90° pitch and 360° continuous yaw rotation from robot base.</p> <p>Arm2: It shall be a telescopic arm attached at the upper end of the Arm1 with length varying from 80cm to 150cm. It shall also have at least 90° pitch rotation from the Arm1 upper end.</p> <p>Arm2 shall carry GM-tubes based RDA and Scintillator Based RDA both. Scintillator based RDA shall be fixed on Arm2 at 50cm</p>

	<p>distance from Arm1 upper end. GM-tube based RDA shall be mounted as end effector on Arm2 with 180° pitch and yaw rotation from the Arm2 end.</p> <p>Note: 1. Robot shall have warning for tip over and shall be able to counter it. Robotic arm unit shall be detachable from Robot base.</p> <p>2. The speed of the linear joints in telescopic arm shall be more than 5 mm per second and angular speed of all rotations shall be more than 1.2 degree per second.</p>
Camera Module	<p>The camera module (CM) shall be mounted on the mobile robot. CM shall be rotatable so that camera can capture a full 360° horizontal view and atleast 90° vertical view. The module shall have suitable LEDs for camera operations in low light conditions. Camera resolution shall be atleast 5MP.</p>
Electronic Modules	<p>To execute the project typically following electronic modules shall be designed, developed, tested/procured: Central Controller, DC-DC Converters, Motor Drivers, Motor Controller, GM tube pulse processing circuit, Multi Channel Analyzer (at least 512 channels) for Scintillator detector with resolution less than 7.5 % for 662 keV with NaI(Tl) detector, Wireless Data Transceivers, Obstacle Detection Electronics and auxiliary electronic circuit. The power supplies for all the modules shall be derived from LiPo battery of mobile robot. Supplier shall provide the schematic, layout and Gerber file as deliverables amongst other deliverables. Suitable arrangements for heat dissipation shall be provided.</p>
Communication Antenna	<p>Communication Antenna shall be mounted on a 3 fold vertical rod such that the antenna height can be manually adjusted upto 3 meters.</p>
Power management features	<p>The onboard battery shall have over-charge protection, Over-discharge protection, over current protection (Charging/Discharging). Onboard Low battery alarm. The central controller on mobile-robot shall have the capability to switch on/off any electronic module manually.</p>
Endurance	<p>Atleast 4 hours of continuous operation on a single charge of the battery.</p>
Cyclic life of Battery	<p>≥250 cycles at 80% DoD</p>
Charging time of Battery	<p>Not more than 4 hours for 80% DoD. A suitable balance battery charger shall be supplied along with the system.</p>
Material of	<p>All structural parts shall be of SS304 or Carbon fiber only.</p>

construction	Aluminium is acceptable only for Gearbox. For the wheel's tyre , PU rubber can be used.
Working area	: Without Robotic Arm Unit: Concrete Floor with obstacles of height and length no more than 3 cm and maximum slope less than 15 degrees. : With Robotic Arm Unit: Concrete Floor with obstacles of height and length no more than 2 cm and maximum slope less than 5 degrees (While the arm is folded).
Obstacle Detection	: Using a suitable number of non-contact type proximity sensors with the coverage in all four directions around chassis. : Distance sensing range > 1000mm The alarm distance shall be remotely settable.
Operating conditions	: -10°C to 50°C
Dimensions	: Not more than 500mm×500mm×1150mm (L×W×H)
Weight	: Not more than 60kg.

4.1.2 REMOTE TERMINAL UNIT (RTU) SPECIFICATIONS

Operating Power supply	: An onboard battery along with a power on-off switch.
Form Factor	: RTU shall be a single handheld device with at least 7" display.
Connection with Mobile-Robot	: RTU shall be able to communicate with Mobile-Robot wirelessly.
Communication Range	: 1 km Line of Sight between Mobile-Robot and RTU with AES secured link. License Free Band in India.
Controls	: RTU shall have a GUI using which the Mobile-Robot's movement, robotic arm's motion, and camera rotation angles are controlled. The live video stream of the camera and the radiation data shall also be displayed on the same GUI.
Power management features	: The LiPo battery shall have over-charge protection, Over-discharge protection, over current protection (Charging/Discharging). : The RTU shall have battery status indicator for RTU battery as well as Mobile Robot battery along with the lowbattery alarm for both batteries.

Data Logging	:	The onboard storage shall be able to log the received Radiation Data of more than 100 hours of operation. A provision of transferring this data to PC shall also be made.
Weight	:	Not more than 2 kg.
Endurance	:	Atleast 6 hours of continuous operation on a single charge of the battery.
Cyclic life of Battery	:	≥ 250 cycles at 80% DoD
Charging time of Battery	:	Not more than 4 hours for 80% DoD. A suitable balance battery charger shall be supplied along with the system.

5. ACCEPTANCE CRITERIA

- a) The items under the scope of supply shall be subject to surveillance/inspection by the indenter or his authorized representative, during the progress of the work and/or before final delivery.
- b) The vendor shall develop an Integration and test procedure in consultation with BARC. A detailed test report shall be submitted and approved by BARC. The system shall be accepted as per this mutually agreed test procedure.
- c) Lack of any of the desirable feature/requirement shall be considered as rejection criteria.

6. CONFIDENTIALITY CLAUSE

- a) *BARC is the sole proprietor of all drawings and documents of the equipment*
- b) *IPR of BARC should be protected*
- c) *No party shall disclose any information to any third party concerning the matters under this Contract generally. In particular, any information identified as "Proprietary" in nature by disclosing party shall be kept strictly confidential by the receiving party and shall not be disclosed to any third party without the prior written consent of the original disclosing party. This clause shall apply to sub-contractors, consultants, advisors or the employees engaged by a party with equal force.*
- d) *"Restricted information" categories under section 18 of the Atomic Energy Act, 1962 and "Official secrets" under section 5 of the Official Secrets Act, 1923: Any contravention of the above-mentioned provisions by any contractor / sub-contractor, consultant, advisor or the employees of the contractor will invite penal consequences under the aforesaid legislation.*
- e) *Prohibition against the use of BARC's name without permission for publicity purpose. The contractor or sub-contractors, consultants, advisors or the employees engaged by a party shall not use BARC's name for publicity purpose through any public media like: press, radio, TV or Internet without any prior approval of BARC (wide circular ref.: 2/Misc-9/Lgl/2001/92 date 30/04/2001)*

7. DOCUMENTATION

The vendor shall prepare the following document during the various stages of development:

1. System design document
2. Hardware design document
3. Software design document
4. Integration and test Procedure

These documents shall be approved by BARC and shall be supplied by the vendor along with other deliverables.

8. DELIVERABLES

1. Four units of Remote Controlled Mobile Radiation Monitoring System (RCMRMS) (1 unit +3 units as described in section "scope of work")
2. The vendor shall supply the following in soft copy along with two sets of hard copies:
 - a. GA layouts, as-built assembly, sub-assembly & component level drawings including routing diagrams,
 - b. Bill of material of off the shelf components (i.e Motor, GearBox etc.)
 - c. BOM, design and gerber files of the fabricated electronic modules
 - d. Source codes of embedded softwares along with GUI software (For Mobile unit and RTU both)
 - e. System design document
 - f. Hardware design document
 - g. Software design document
 - h. Integration and test Procedure
 - i. Operation/maintenance manuals
 - j. Part catalogs