Functional requirements specifications for Generative AI-based Kavach Design Documents Generator

1. Scope

The proposed AI-based design system aims to automate and accelerate the process of designing tag placement, tag data table of control, track profile table for KAVACH systems (the Indian Railway Automatic Train Protection system). The system shall utilize artificial intelligence and machine learning techniques to generate optimal tag layouts, tables, elevation profiles, and tag information based on input data from railways.

2. Objective

a) Generative AI shall be used to develop the following covers design documents in dwg and PDF formats:
   i. RFID tag layout
   ii. RFID Tag data format
   iii. Kavach table of control
   iv. Kavach track profile table
   v. Radio network design
b) The total scope of the work consists of the development of documents for about 10000 installations in the next 5 years.

3. Design Inputs

a) The rule book for RFID Tag-TIN Layout Guidelines can be found in Annexure-H (copy enclosed)
b) The rule book for KAVACH Control Table Guidelines can be found in Annexure-I (copy enclosed)
c) The rule book for Radio network design (copy enclosed).
d) The sample gradient plan (index plan) is enclosed with this document
e) The sample signal interlocking plans and signalling table of control are enclosed.
f) The bidders will receive PDF copies of signal interlocking plans, signalling table of control, gradient data index plans and survey reports for track side requirements and radio requirements.
g) Each station shall at least have -70dbm signal strength. Otherwise, new station shall be generated.
h) Each station ID shall be unique five-digit number. Rule of station ID naming will be shared by RDSO.
i) Based on these documents, the prospective bidder shall develop the documents described in point number one above using generative AI.
j) The documents will be submitted to the associated Kavach manufacturers and they have to check and certify as fit for use to the concerned Railways.

4. Functional Requirements

4.1 Input Processing

a) Accept and process input data in various formats, including:

- PDF/ DWG (AutoCAD) files of railway track layouts (signal interlocking plans) and Signal control tables.
- Survey data with distances of various key structures such as signal posts, station building, traction poles, turnouts, and radio coverage.
- Gradient data (index plan)

4.2 AI-Based Design Generation

a) Utilize a combination of AI, Gen-AI, Machine Learning and rule-based systems to generate the documents specified in the objective for each station.

b) Provide a user-friendly interface for:

- Uploading input data
- Initiating the design process
- Reviewing and validating generated designs
- Exporting final designs and reports

4.3 Mobile Application

a) Develop a mobile application for on-site data collection and design review

4.4 GIS Functionality

a) Integrate GIS capabilities to:

- Visualize and analyze spatial data of railway tracks, signals, and tags
- Represent the railway network structure
- Provide interactive maps for design review and modification
- Support geospatial analysis for optimizing tag placement
- Enable layering of different data types (e.g., tracks, signals, elevation)
- Facilitate integration of survey data and DWG files into a cohesive spatial view
- Support mobile application with location-based services for on-site work

4.5 User Management and Access Control

- Implement role-based access control for different user types (e.g., designers, validators, administrators).
- Ensure proper data access and editing permissions based on user roles.

4.6 Validation and Approval Workflow

- Implement a workflow for design validation and approval.
- Allow for comments and feedback on generated designs.
- Support iterative design improvements based on validator input.

4.7 Integration Capabilities

- Provide APIs for potential integration with existing railway management systems.

4.8 Others

- The prospective bidder shall provide the specific requirements for samples of each type of these documents.
- The prospective bidder shall specify the cloud requirements for hosting the above services.
- The support for maintenance and future upgrades shall be given for the next five years.
- The software developed shall be secured in escrow account for future continuity.

5. Evaluation Criteria

5.1 Experience in the field of Artificial Intelligence

- For Railways – Main line or Metro
- For Radio Network Design
- For Disaster management systems
- For Health care
- Any safety critical systems or mission critical systems such as nuclear energy, space, air transport, defense, or other government organizations.

6. Key Performance Indices

6.1 Accuracy of Design

- Evaluate the accuracy of generated designs compared to manually created designs.
- Assess compliance with railway standards and regulations.

6.2 Usability and User Experience

- Evaluate the intuitiveness and ease of use of the user interface.
- Assess the effectiveness of the mobile application for on-site use.

6.3 Scalability and Performance

- Test the system's ability to handle increasing numbers of users and data volumes.
- Evaluate processing times for various input sizes and complexities.

6.4 Innovation and AI Capabilities

- Assess the sophistication and effectiveness of the AI and machine learning models employed
- Evaluate the system's ability to learn and improve over time

6.5 Integration and Extensibility

- Evaluate the ease of integration with existing systems
- Assess the potential for future expansions and enhancements