

PART 2: EMPLOYER'S REQUIREMENTS

CHAPTER 6: MAINTENANCE & TRAINING

Table of Contents

1. INTRODUCTION.....	3
2. GENERAL PRINCIPLES OF AN EFFICIENT MAINTENANCE SYSTEM	3
2.1 MAINTENANCE MANAGEMENT	3
3. IMPLEMENTATION OF MAINTENANCE.....	4
3.1 The Levels of Preventive Maintenance.....	4
3.2 Determining Requirements in terms of Facilities and Tools.....	4
4. SUPERVISION AND PLANNING OF MAINTENANCE	5
4.1 General	5
4.2 Employer's Maintenance Strategy	5
4.2.1 Maintenance Strategy.....	5
4.3 Different Levels of Planned Maintenance.....	5
4.4 Supervisory Staff	5
4.5 Maintenance during DLP	5
4.5.1 Maintenance Management System (MMS) and Maintenance Arrangement.....	5
4.5.2 Competency of Personnel.....	6
4.5.3 Maintenance requirements	6
4.6 SOFTWARE SUPPORT	7
4.6.1 General	7
4.6.2 Security Obligations.....	8
4.6.3 Other obligations	8
5. OPERATION AND MAINTENANCE DOCUMENTATION	9
5.1 General	9
5.2 Operation & Maintenance Manuals	10
5.3 Quantity of Manuals	11
6. TRAINING	11
6.1 General Requirements	11
6.2 Training Plan.....	12
6.2.1 Employer's Staff Training.....	12
6.2.2 Maintenance Staff Training	12
6.3 System Equipment Training.....	12

1. INTRODUCTION

This Chapter describes the maintenance philosophy and training of maintenance staff for power supply, control & monitoring installations taking into account international standards and Railway practices.

The Contractor shall provide comprehensive training and documentation to the employer's staff in accordance with the requirement of this chapter and the chapter of General Specifications.

This training shall enable all the installations, to be operated and maintained in the most efficient and safe manner, so as to achieve the maximum reliability and economy required by such Mass Rapid Transit System.

2. GENERAL PRINCIPLES OF AN EFFICIENT MAINTENANCE SYSTEM

The maintenance philosophy and management described below should be seen within the framework of the state of the art and the general prevailing reference standards with regard to the maintenance of durable goods (in particular, standards X60-000, X60-010 and X 60020).

2.1 MAINTENANCE MANAGEMENT

The management of the maintenance process entails defining various levels of responsibility and enabling them to implement the strategic orientations defined by the directing authority:

- a) by defining their respective missions,
- b) by setting objectives for each person,
- c) by translating these objectives into action plans,
- d) by implementing the means required to carry out action plans,
- e) by diagnosing the causes of any deviation from the set objectives,
- f) by taking corrective measures concerning the action plans or the objectives.

This management process requires a global approach and helps to improve the performance of the maintenance work of different components with quality, on time and at low cost.

It must be implemented at three levels:

- at the level of human resources and management in the context of the scheduling of work, the allocation of human resources and the training of personnel,
- at the skills level to ensure quality, safety and suitable working conditions,
- at an economic and financial level to ensure responsible management of production, spare parts, purchasing and miscellaneous costs.

The quality of this management depends on the capability of those entrusted with operation and maintenance responsibilities:

- to exploit the results of management within their field of responsibility,
- to react in the event of any deviation from the action plans defined with a view to achieving the set objectives.

Within the context of this approach, the management control function ensures timely advice to be given to those with operational and maintenance responsibility:

- by placing at their disposal, the tools and information required for piloting and diagnosis,
- by participating in carrying out this diagnosis,
- by participating in the task of defining the objectives to be achieved.

In conclusion, the process of maintenance management must incorporate two major components: the management of human resources and the study of the most suitable means of achieving the set objectives.

3. IMPLEMENTATION OF MAINTENANCE

3.1 The Levels of Preventive Maintenance

The RSS & EHV Cabling System installed shall be such that it requires little or no maintenance at all. However, the Contractor shall prepare a 4-level preventive maintenance plan, which shall be made available to the Employer to organize for the maintenance. The maintenance plan is based on four levels of preventive maintenance which differ according to the nature and scope of the interventions carried out there:

- **level 1:** systematic in-service examinations, which provide a means of detecting (without any specific tools and by personnel who are not necessarily skilled) any anomalies which may have occurred in service according to a random or fortuitous process, and which may affect traffic and safety,
- **level 2:** systematic periodic inspections, which allow skilled personnel to ensure that, taking account of the service to be provided until the next scheduled intervention of similar importance, the equipment or the element inspected offers predetermined guarantees of reliability.
- **level 3:** the replacement of elements which are triggered within the framework of systematic preventive maintenance (when the element reaches the end of the programmed potential) or conditional maintenance (when it is noted in the course of an inspection that the normal operation threshold criteria have been reached), but also within the framework of corrective maintenance,
- **level 4:** interventions on dismantled elements and structural equipment (such as body) carried out to restore the elements concerned to the same level of operation as an identical new one. These interventions (or overhaul operations) usually involve resources related to a reconstruction of the element in question.

The frequency of the maintenance operations defined in the cycle can be expressed either in time (e.g.: every 6 months) or in units of actual utilization (e.g., months of operation, electrical power or current flowing through an equipment, mechanical wearing). The choice depends essentially on the foreseeable or observed disparity in service of elements belonging to the same family within the relevant cycle.

3.2 Determining Requirements in terms of Facilities and Tools

The Contractor shall prepare and make available to the Employer, details of requirements of Tools and facilities required for maintenance of the RSS & EHV Cabling System. In this context, the following aspects shall be kept in mind.

The achievement of the objectives assigned to the maintenance division with regard to quality, safety and regularity for the lowest possible overall cost requires the implementation of a number of resources which must be perfectly tailored to the requirements.

The facilities and tools are part and parcel of the resources placed at the disposal of the maintenance division to achieve the set objectives.

Owing to the cost of these facilities, the number of maintenance centers to be equipped and the necessity of keeping the maintenance actions consistent and uniform, the main choices of facilities and tools are integral part of the System maintenance policy and program.

When determining these requirements, in-depth knowledge in the dedicated maintenance plan is needed while taking due account of the experience acquired in similar fixed installation which has been in service for several years.

4. SUPERVISION AND PLANNING OF MAINTENANCE

4.1 General

The scope and requirements of supervision and planning of maintenance are stipulated in DLP and spare policy of BI-RIDE mentioned in Preamble of BOQ. The following outlines the Employer's maintenance strategy, different levels of maintenance, the Maintenance Management System and the arrangement for maintenance.

4.2 Employer's Maintenance Strategy

4.2.1 Maintenance Strategy

The Contractor shall ensure that the design of the software and hardware of the system designed, installed and commissioned is supportable throughout the service life of the System to address, as a minimum, the following:

- a) design errors in the System
- b) operational changes
- c) environment changes; and
- d) changes in infrastructure.

According to the maintenance strategy, all equipment and infrastructure supplied for the 'Project' must be such as to ensure for minimum or no maintenance. Maintenance activities required must be capable of being performed with little or no impact on the train service. In addition, the maintenance work systems shall ensure safety of personnel and equipment.

During the Defects Liability Period (DLP) maintenance of all Works will be stipulated as per DLP and spare policy of BI-RIDE mentioned in Preamble of BOQ

The Contractor, upon noticing any defects, deficiency in quality and quantity of spares and materials shall without delay, arrange for alternative source of supply and submit his proposal to the Employer's Representative for review.

4.3 Different Levels of Planned Maintenance

Routine preventative maintenance will be carried out at regular intervals based on condition, reliability, usage, and service history and equipment manufacturers' recommendations. The Operating and Maintenance Manual shall describe the different levels of planned maintenance.

4.4 Supervisory Staff

The Contractor shall provide supervisory maintenance staff who are expert in all the different levels of fault finding, maintenance and repair of the various relevant systems supplied under the Contract:

- a) Cabling system
- b) Receiving substation
- c) Traction substation including associated switchgear.
- d) Auxiliary main substation

Stipulations of clauses 12.3.2, 12.3.3 and 12.3.4 of the GS and DLP and spare policy of BI-RIDE shall apply here.

4.5 Maintenance during DLP

4.5.1 Maintenance Management System (MMS) and Maintenance Arrangement

During non-operation time, sections of line will be closed for maintenance work. The minimum time for possession periods is 3 hours. Ideally, this time shall be the free time available for work. It excludes time required for trains to return to their stabling point and time required to take and

give up possession. This time is, however, not available for maintenance in depot.

4.5.2 Competency of Personnel

During Defects Liability Period (DLP) the Contractor shall provide Maintenance and Supervision, for which purpose the Contractor shall provide necessary experienced engineers, whose role is described in DLP and spare Policy mentioned in Preamble of BOQ and that the warranty/guarantee obligations of the Contractor remain undiluted. During the DLP the Contractor shall carry out maintenance with sufficient trained and competent personnel.

Such persons shall have their generic competence established and must demonstrate their specific competence and knowledge in the particular systems, environment and procedures.

The Contractor shall provide evidence of specific competence and knowledge, which shall include:

- a) assessment and certified training in particular software applications and operations;
- b) recording of competence and work in the license holders logbook; and
- c) receiving or in receipt of sufficient and current exposure to the area of work that the holder is licensed for.

Routine spot checks on licensing may be carried out from time to time by the Employer's Representative qualified personnel on the proficiency of the Contractor staff. In the event of a failure, the Contractor shall undertake the management and investigation necessary to identify and rectify the cause.

Should the Employer, during the DLP require further investigations at other Sites throughout the system, the Employer will formally request the Contractor to undertake such investigations.

4.5.3 Maintenance requirements

Contractor shall be required to attend promptly all the defects appeared in the system during the defect liability period. The contractor should note DLP and spare Policy of BI-RIDE. Details of Major equipment are mentioned in DLP and spare Policy of BI-RIDE

Testing and Re-commissioning of System and Equipment

In the event of a failure requiring modifications to the System, the Contractor shall undertake any testing and re-commissioning required. Any such modification shall be submitted for Employer's Representative review.

Temporary Alterations to Restore Service

The Contractor shall undertake any temporary modifications necessary to maintain service. Any such modification shall be submitted for Employer's Representative review.

Discrepancies between Installation and Design Records

Should the Contractor discover inconsistencies between the maintenance drawings and documentation and the installed equipment, the Contractor shall correct all such errors within two weeks.

Communications

The Contractor shall ensure that adequate communication facilities are provided to its staff during the DLP.

Location of Staff

The Contractor shall be responsible for locating staff such that the Contractor meets its obligations.

Storage of Equipment and Materials during the Maintenance Period

The Contractor shall ensure that no equipment is to be stored along the trackside/road/public area.

The Employer will provide defined storage locations for the support all the different levels of Maintenance. The Contractor shall satisfy itself and the Employer's Representative that the storage locations for equipment and materials will meet the performance requirements of this PS.

Maintenance Regimes

The Contractor shall provide documented maintenance regimes to be followed by the Employer upon substantial completion of various components of the work until the end of the DLP. The Contractor shall produce a maintenance regime as a part of the O&M Manual for the equipment that shall comprise two constituent parts, corrective and routine/preventative maintenance. Routine/preventative maintenance shall be non-intrusive to the day-to-day operation of the train service and be capable of being pre-planned in advance of the work.

Corrective maintenance shall be available 24 hours per day, able to respond to all foreseeable circumstances. The maintenance regime shall cover all parts and equipment of the system designed, installed and commissioned by the Contractor. The Contractor shall take into account the requirements of the operations and maintenance when determining and proposing its maintenance regime.

Scope and Hours of Coverage

The regime and structure of corrective maintenance shall be robust in design. The Contractor shall provide full 24 hour On-Call coverage and shall be such that initial response and rectification of failure are in accordance with the following:

- a) assistance to first level and corrective maintenance within 30 minutes, upon request of first line maintainer
- b) 24 hours from notification to collection for third level maintenance; and
- c) replacement or repair of component from factory within 2 weeks including transportation time. Any extension to this time shall be agreed with the Employers and a replacement provided.

All elements of First Line preventative maintenance shall be carried out and completed during non-traffic hours without interrupting train services.

Failure Investigations

The Contractor shall conduct failure investigations. The OCC Controller will determine priorities in the event of a conflict between the Contractor and other Contractors during failure investigation.

Disputes between the Contractor and other Contractors will be resolved by the Employer's Representative. The Contractor shall make available to the Employer all test and failure data as required.

4.6 SOFTWARE SUPPORT**4.6.1 General**

The Contractor shall submit to the Employer's Representative for review, the software support plan at least 90 days before commencement of software installation. All changes, bug fixes, updates, modifications, amendments, new versions shall not result in any nonconformance with this Specification.

The Contractor shall submit all new versions to the Employer's Representative for review at least

2 weeks prior to their installation. The new versions of software shall not degrade the operation of the System.

4.6.2 Security Obligations

Within 14 days of the installation of any software into the Permanent Works by the Contractor, the Contractor shall submit to the Employer's Representative for retention by the Employer two back-up copies of the software.

Any software item delivered by the Contractor to the Employer's Representative pursuant to the above Paragraph shall not be translated or modified by the Employer without the prior consent of the Contractor unless:

- a) the owner of the software becomes insolvent or has a receiving order made against it or makes an arrangement or assignment or composition with or in favour of its creditors (including the appointment of a committee of inspection) or goes into liquidation or commences to be wound up or has a receiver, liquidator, trustee or similar officer appointed over all or any part of its undertaking or assets or if distress, execution or attachment is levied on, or if an encumbrance takes possession of, any of its assets or any proceeding or step is taken which has an effect comparable to the foregoing in any relevant jurisdiction; or
- b) the owner of the software ceases to trade; or
- c) the owner of the software assigns copyright in the software and the Contractor fails within 60 days of such assignment to procure in favour of the Employer, a licence from the new owner in the same terms as that required by the Contract; or
- d) the Contractor is in breach of any of his obligations under the Contract.

4.6.3 Other obligations

The Contractor shall inform the Employer's Representative immediately when a fault is discovered within delivered software or documentation. On receipt of a request from the Employer's Representative for identification or further diagnosis of a failure or fault, the Contractor shall provide appropriate resources. The Contractor shall provide written details as to the nature of the proposed correction to the Employer's Representative.

Training

The Contractor shall provide training for Employer's staff to enable the Employer to make proper use of any new versions.

Fixes or Patches

The Contractor shall notify the Employer promptly of any fixes or patches that are available to correct or patch faults. The Contractor shall detail any effect such fixes or patches are expected to have, upon the System.

New Versions

The Contractor shall ensure that all new versions are fully tested and validated on the simulation and development system prior to installation. The Contractor shall ensure that all new versions are fully tested and commissioned once installed on the Site. The Contractor shall deliver to the Employer any new version, together with the updated Operation and Maintenance Manuals. The Employer shall not be obliged to use any new version and that shall not relieve the Contractor of any of its obligations. Any effect upon the performance or operation of System that may be caused by a new version shall be brought to the Employer's attention.

Debugging and Trace Software

The Contractor shall provide debugging or trace logging software. The Contractor shall not install

debugging or trace logging software that affects the performance or functionality of the System.

Routine and Corrective Maintenance Procedures

Routine and corrective maintenance procedures shall be supplied for all equipment. The format shall be as follows:

- a) Uniform format and layout irrespective of equipment supplier
- b) Colour coding for each activity
- c) Cross referenced to the Operation and Maintenance Manuals; and
- d) Document control information.

Operation Activities

All operational activities shall comply with the Employer's safety rules, and requirements of the Operation and Maintenance Manuals. The Contractor shall recommend in detail the frequencies for preventive and corrective maintenance, and what items of work are to be carried, including but not limited to the following:

- a) Step-by-Step procedure to carry out the task
- b) Diagrams and flow charts for illustration, if applicable
- c) Precautions for the maintenance personnel to follow; and
- d) Estimated duration and manpower required.

5. OPERATION AND MAINTENANCE DOCUMENTATION

5.1 General

The Contractor shall provide interactive Operation and Maintenance manuals in soft copies as well as in hard copies which should be updated, based on the review by BI-RIDE up to the end of DLP, for use by supervisory, operating and technical staff of Employer.

Requirements of submission have been furnished in Chapter 11 of GS and DLP and spare Policy of BI-RIDE. Each and every manual shall be divided into indexed sections explaining the subject matter in logical steps.

Most manuals shall consist of A4-size printed sheets bound in stiff-cover wear-resistant binders clearly and uniformly marked with the subject matter and reference number. Where alternative sizes are proposed, (e.g. A5/A6 pocketbooks of schematic wiring diagrams) these shall be submitted for review of Employer' Representative. The binding shall allow for all subsequent changes and additions to be readily affected.

Information shall be provided in pictorial form wherever possible and shall include step-by-step instructions and views of the particular equipment including exploded views. Programmable equipment shall be supplied with sufficient flow charts and fully documented programmes to enable faults to be quickly identified and system modification to be undertaken at any time.

The Contractor shall provide clarifications and amendments to the Operation and Maintenance manuals as necessary during the Defects Liability Period. Updates shall be provided for the originals and all copies. The Operation & Maintenance Manuals should be issued by the concerned OEM or, if by the contractor, it should be duly ratified by the OEM.

5.2 Operation & Maintenance Manuals

Operation Details covered under Manual:-

The Contractor shall provide details explaining the purpose and operation of the complete system together with its component subsidiary systems and individual item of equipment. The characteristics, ratings and any necessary operating limits of the Equipment and Subsystems shall be provided. The Manual shall focus on operation aspects under normal and emergency

conditions.

Maintenance Details covered under Manual: -

The Contractor particulars of operating parameters, tools for dismantling and testing, methods of assembly and disassembly, tolerances, repair techniques and all other information necessary to set up a repair and servicing programme.

The Contractor shall provide documentation for all hardware and software for computer systems and other associated electronic equipment to meet the following requirements.

Such documents shall include but not be limited to:

- a) manufacturers' documentation supplied as standard with the equipment
- b) hardware configuration with details of expansion capabilities and options
- c) programme loading instructions, including runtime environment configuration
- d) programme listing including comprehensive 'comment statements' in hard copy and soft format for source code, compilers and development tools necessary to modify and recompile software
- e) flow charts, data flow diagrams and state diagrams as appropriate
- f) description of software modules including purpose, linkage with other modules, error routines and any special considerations
- g) memory maps for both internal and peripheral memory showing description of all programmes, data files, overlay areas, memory available for expansion and the like
- h) loading and operating instructions for diagnostic programmes and specifically developed debugging tools; and
- i) programming manuals relevant to operating systems, languages, development tools, etc.

The manual shall also include inspection/overhaul procedure and periodicity of various inspection/overhaul schedules in detail including the tools, special tools/plants, and facilities required. The manual shall be subject to review by the Employer's Representative.

The manual shall also include an illustrated parts catalogue of all plant supplied and shall contain sufficient information to identify and requisition the appropriate part by maintenance staff.

The catalogue shall comprise 3 sub-sections.

The first shall be an alphanumeric parts list, which shall include the following information:

- a) Part number
- b) Description
- c) Name of manufacturer
- d) Quantity and Unit
- e) Part number of next higher assembly (usually a line replaceable unit).
- f) Cross-reference to figure number.
- g) Category: e.g. consumable, line replaceable unit, repairable.
- h) Life-expected life, Mean time between failure or mean distance between failure where available.
- i) General or specific purpose

The second is a series of illustrations to indicate the location of each replaceable item which shall be clear and progressive with exploded views to enable parts to be identified easily by cross-reference with the alpha-numeric list.

And the third an indicative price list which shall list in alpha-numeric sequence the part number with the price, lead time and vendor.

5.3 Quantity of Manuals

The Contractor shall supply original plus five hard copies of Operating & Maintenance Manuals for each RSS. These Manuals shall also be submitted in electronic format (CD). The drawing files shall be in AUTOCAD format (dwg.) and in pdf format of latest version duly readable in the latest window-based operating system.

The format of the electronic copies shall be proven in at least two other applications and shall allow for links between parts catalogue and maintenance instructions. The Documents Management System and Language used shall be subject to Employer's Representative's review.

6. TRAINING

6.1 General Requirements

The Contractor keeping the above aspect in view shall provide comprehensive training to the Employer's staff in accordance with the requirements contained in this PS and in the GS (Chapter 10).

The training shall be carried out at such locations where the greatest benefit for trainees may be gained. This may be in India, abroad, at place of manufacture, assembly or testing, or at such other locations as may be necessary. All places of training shall be subject to review by Employer's Representative.

The training courses and/or sessions shall include system performance requirements and all major equipment and works designed, by the Contractor.

The calculation of cable capacity, short circuit capacity, overload capacity and duty cycle shall form part of training. This will include details regarding Bonding, Earthing, Sheath Voltage Calculations, Effects of various types of Bonding, Termination and Joints.

The specific objectives of each course, training facilities to be used, the qualification and experience of the training instructors and the assessment criteria shall be developed by the Contractor and submitted to the Employer's Representative for review at least three months before any course is conducted.

Manuals to be used for training, including the manuals to the instructors and trainees, shall be delivered to the Employer's Representative at least six months before the issue of the Substantial Completion Certificate for the Works, as required under Chapter 10 of the GS. The training manuals shall be submitted in original plus five hard copies and in electronic format (CD).

The Contractor shall provide full-time on-Site management and co-ordination of the entire training programme to ensure the continuity of classes, and proper distribution of training materials, and be responsible for interfacing with the instructors.

The training courses shall be delivered to all relevant Employer's staff, including instructors, operation and maintenance engineering staff. The proposed training requirements are given at the end of this chapter Training Plan

The Contractor shall submit a Training Plan in accordance with the requirements of the General Specification. In addition, the Training Plan shall include the following:

- a) Details of the Contractor's ability to carry out the necessary training.
- b) Details of the proposed approach to structuring and providing the courses required.
- c) Course details including duration, maximum number of trainees, ratio of trainees to trainers, facilities required or available and prerequisites for attending the course.
- d) Recommendations for additional training or alternative means by which the Employer's training objectives may be met.

The Training Plan shall be submitted for review by the Employer's Representative and will be implemented in a timeframe such that complete and comprehensive training has been received by

the designated Employer's staff prior to the System Acceptance test.

6.1.1 Employer's Staff Training

The objective of the training is to enable the Employer's staff to be familiar with all equipment in the RSS Systems, with focus on the operational aspects under normal and emergency conditions.

The training shall also enable the trainee to acquire full capability for identification, trouble shooting and rectification of faults in the specified duration for all the equipments installed at RSS. After classroom training, the staff shall be trained in actual operation (at RSS).

6.1.2 Maintenance Staff Training

The objective of the training is to enable the Employer's maintenance staff and Engineering staff to be familiar with the Systems focus on the maintenance aspects of the System including but not limited to the following: -

- Full understanding of all the equipment, sub-systems and system, their function, maintenance and overall requirements.
- Procedures to be followed for unscheduled maintenance and repair.
- Identification of failed components and sub-systems in electronic equipment by use of special test kit as necessary.
- Modification in the software to extend or modify the control, monitoring, and protection functions.

6.2 System Equipment Training-

Training for the following Equipments shall be conducted: -

S. No.	Equipment
1	220 kV GIS
2	CRP & SAS
3	33 kV AIS
4	25 kV GIS

Training for the above mentioned Equipments shall be conducted as per the following schedule

S. No.	Equipment	No. of Days
1	On-Shore (in India)	16
2	Off-Shore (outside India)	12

Other system trainings shall be as per Schedule.