

**CHAPTER 6**

**Maintenance & Training**

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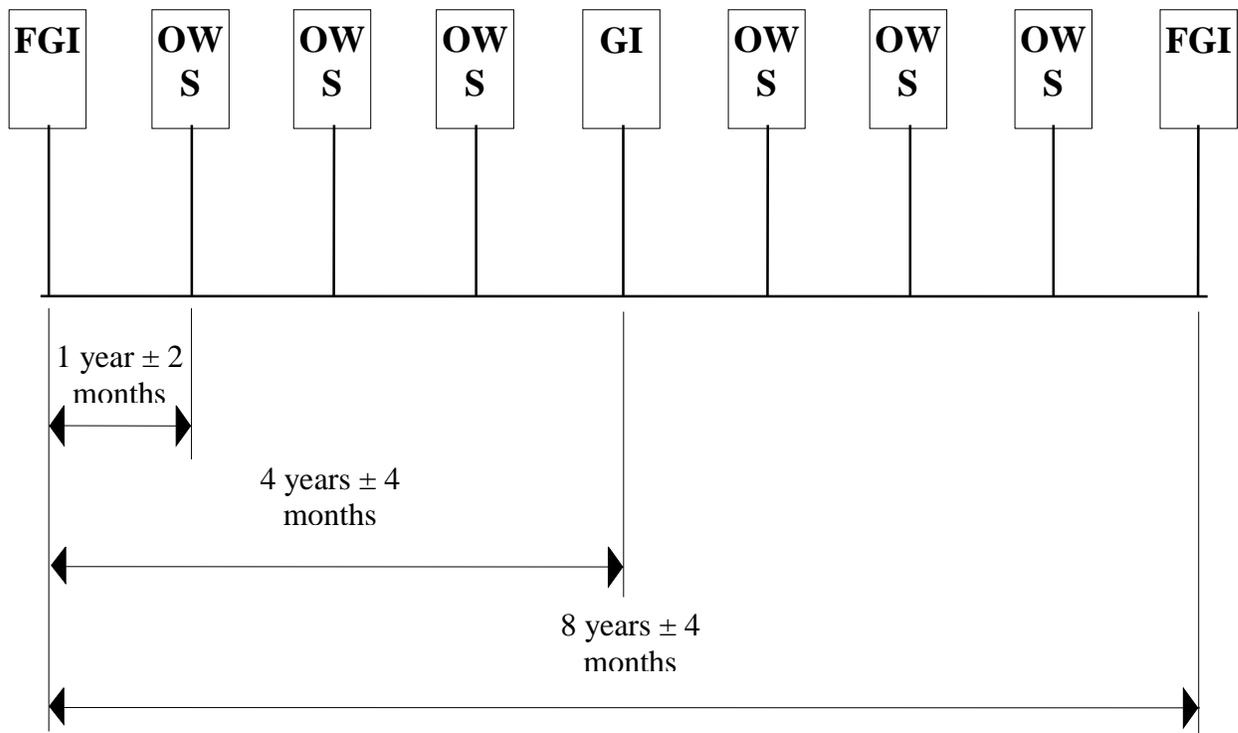
**1. INTRODUCTION**

This Chapter describes 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.

**1.1 Preventive maintenance periodic inspections cycle**



**2. OPERATION AND MAINTENANCE DOCUMENTATION**

**2.1 General**

The Contractor shall provide Operation and Maintenance manuals, for use by supervisory, operating and technical staff of Employer.

Requirements of submission have been furnished in the relevant Chapter of GS.

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 pocket books 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 effected.

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.

## **2.2 Operation Manuals**

The Contractor shall provide operation manuals 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 Sub-systems shall be provided. **The Operation Manuals shall focus on operation aspects under normal and emergency conditions.**

## **2.3 Maintenance Manuals**

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:

manufacturers' documentation supplied as standard with the equipment;

- hardware configuration with details of expansion capabilities and options;
- programme loading instructions, including runtime environment configuration;
- 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;
- flow charts, data flow diagrams and state diagrams as appropriate;
- description of software modules including purpose, linkage with other modules, error routines and any special considerations;
- memory maps for both internal and peripheral memory showing description of all programmes, data files, overlay areas, memory available for expansion and the like;

- loading and operating instructions for diagnostic programmes and specifically developed debugging tools; and
- 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 maintenance 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:

Part number

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

## **2.4 Quantity of Manuals**

The Contractor shall supply Original plus five hard copies of Operating Manuals; Maintenance Manuals and Subsystems / Systems spare parts catalogue.

These Manuals and Catalogue shall also be submitted in electronic format (CD).

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.

### 3. TRAINING

#### 3.1 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 TS and in the GS. A central training school has been planned for this purpose.

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 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 the relevant Chapter of the GS. **The training manuals shall be submitted in original plus five hard copies and in electronic format (DVD).**

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.

#### 3.2 Mock-Up for Training

The Contractor shall install mock-up equipment for system and any such facility(s) considered necessary for the training of Employer's staff in the training school.

The training mock-up shall include but not limited to the following: -

Clear Cut Section drawings / photographs of various power supply equipments such as Circuit Breakers, Interrupters, Current Transformers, Potential Transformers, Lightning Arresters and Isolators.

- Cut Section drawings / photographs of HV & MV cables
- Cut Section drawings / photographs of Gas Insulated Switchgear
- Clear photographs of transformers, their windings, bushings etc.
- Samples of various clamps and fittings used

- Samples of various conductors used
- Clear drawings and photographs of Control panel, protection schemes, earthing and bonding arrangement;

The Contractor shall submit full details of the training span and other mock up equipment, photographs etc. including proposed training activities and objectives, for the Employer's review in accordance with clause 3.1 of this Specification.

### **3.3 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:

- Details of the Contractor's ability to carry out the necessary training.
- Details of the proposed approach to structuring and providing the courses required.
- Course details including duration, maximum number of trainees, ratio of trainees to trainers, facilities required or available and prerequisites for attending the course.
- 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.

#### **3.3.1 Training of Employer's Training Instructors (ETI)**

The objective of the training is to enable the Employer's Training Instructors to be competent to deliver future training courses for other employees of the Employer.

The Contractor shall provide training to the Employer's Training Instructors on the various Systems. Aspects covered shall include, but not be limited to, the following:

- Configuration of the entire System, including interface with the supply system at the feeding points;
- Feature and functional principles of the entire System;
- System design aspects including but not limited to design standards, design criteria and parameters, short-circuit and other calculations, insulation and protection co-ordination;
- Details of major equipment and material including but not limited to 25kV circuit breakers, interrupters, isolators, voltage and current transformers, Conductors, fittings, assemblies and protection relays, and cables of different types and their joints used in the System;
- Details of 33 kV Switchgear and protection;
- System operation and maintenance management and procedures;
- Earthing and bonding arrangement, covering safety aspects of touch and step potential, safety to personnel, passengers and outsiders.
- SCADA Integration.

### 3.3.2 Operations Staff Training

The objective of the training is to enable the Employer's operations staff to be familiar with the 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. After classroom training which includes mock ups of equipment, the staff shall be trained in actual operation.

### 3.3.3 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.

## 3.4 Computer Based Training (CBT)

The Contractor shall submit, for the Employer's Representative's review, the following CBT information documents:

- Operation of the Auxiliary power Systems;
- Maintenance of Auxiliary power Systems;
- Operation Bay Controllers;
- Operation of Substation Automation System;

The CBT Information Document on Operation of individual System shall contain, but not be limited to, the following:

- General introduction of the System, its functionality and objectives (including the RAMS requirement);
- Single line diagrams;
- Description of the System operation principles, for both normal and emergency operation conditions;
- An overview on the System configuration, including interface with other agencies;
- General description of the functions of each key equipment and components of the System with photographs showing the appearance of each of them;
- Where they are located throughout the System;

- List of potential hazards that may arise in operating the System; and
- Any specific points to note in operating the System to ensure safety to personnel (the Employer's staff and members of the public) and equipment.
- Electric shock treatment.

The CBT Information Document on Maintenance of individual System shall contain, but not be limited to, the following:

- General description of the functions of key components of the System, with photographs showing the appearance of each of them;
- A general description of the proposed maintenance strategy of the System and major components;
- The maintenance plan and procedures proposed for the System and major components in accordance with the MMS;
- A general description of the 1st, 2nd 3rd and 4th maintenance activities (as described above) required for the System and major components;
- An introduction to the special tools and equipment required for maintaining the System and major components;
- A description of the symptoms of the common faults found on the System;
- Simulation of faults on the entire System, and how to promptly restore the system; and
- Other points to be noted in effectively maintaining the System.

### 3.5 Training Requirements

Man week of contractors training instructors for training employers Maintenance personal in INDIA

GIS and other switchgear	2
Cables & Transformers	2
Electrical safety & Earthing	2
SCADA Integration	1

Man week of contractors training instructors for training employers operating personal in INDIA

GIS and other switchgear	2
SCADA Integration	1

Man weeks of employers personnel's for Off-Shore training at Contractors works

GIS and other switchgear	Maintenance/Operation	2
	ETI	1
Transformer	Maintenance/Operation	2
	ETI	1