C) TECHNICAL REQUIREMENT'S (ERT)

10) LINEAR HEAT DETECTION SYSTEM (For TUNNEL Section)

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10 LINEAR HEAT DETECTION SYSTEM (LHDS)

10.1 GENERAL

Linear Heat Detection System shall be provided throughout the tunnel of MMSP line, in accordance with the requirements of NFPA 130, NFPA72 and local codes.

This document describes the functional specifications, the technical constraints and the area to be covered by the LHDS system and the performances to be achieved.

General requirements regarding design, manufacturing, installation, testing and commissioning are also defined in the document.

This specification shall be considered as the minimum requirement by the bidders who shall demonstrate their compliance with those requirements.

10.2 DEFINITIONS AND ABBREVIATIONS

10.2.1 Definition

Definition	Description
LHDS	Linear Heat Detection System
BOCC	Backup Operational Control Centre
OCC	Operational Control Centre
SCR	Station Control Room
Console	Input-output device to operate the computer including but not limited to a keyboard, display and mouse.
Depot	All the areas including Depot access line, stabling tracks, shunting tracks, workshop, test track, car washing track, wheel re-profiling track, light repair shop and maintenance shop.
Earthing	Same as 'grounding'. The connection of equipment introduces non-current carrying through metal parts to the earth, to provide safety to personnel, the public and equipment.
Main Line	The Metro Manila Subway line Between Qurino Highway station to Bicutan station and from Lawton East Station to NAIA T3 station
MTBF	Mean Time Between failures, the time from when the system breaks down to when it recovers from trouble. This is a standard indicating the reliability of system and is shown with the average time.
PLC (Programmable Logic Controller)	PLC is a programmable controller, which utilizes ladder diagram programming and advanced instructions for use in Automation environment.
Power Receiving Post	It is not directly able to receive electricity to Depot substation from

Definition	Description
(PRP)	Meralco grid, so it will be installed Power Receiving Post so that there is no obstacle in receiving electricity.
RAMS	Reliability, Availability, Maintainability and Safety
RTU (Remote Terminal Unit)	Interface unit between control panel and SCADA.
The Employer	The person named as employer in the Contract Data and the legal successors in title to this person.
The Engineer	The general consultant who is engaged by the Employer as the consult to review and approve the system design, construction, testing and commissioning of the entire railway assets into revenue service.

10.2.2 Abbreviation

Abbreviation	Description
BOCC	Backup Operation Control Centre
BMS	Building Management System
CISPR	Comité International Spécial des Perturbations Radioélectriques
EIA	Electronic Industries Alliance
EMC	Electro-Magnetic Compatibility
EMI	Electro Magnetic Interference
ERG	Employer's Requirements General Specification
ERT	Employer's Requirements Technical Specification
IEC	International Electrical Codes
IEEE	The Institute of Electrical and Electronics Engineers, Inc.
IP	Internet Protocol
IP-PBX	IP-Private Branch Exchange
ISO	International Organization for Standardization
ITU-T	International Telecommunication Union-Telecommunication Standardization Sector
ITU-R	International Telecommunication Union-Radiocommunication Standardization Sector
JICA	Japan International Cooperation Agency
LHDS	Linear Heat Detection system
MTBF	Mean Time Between Failures
MTTR	Mean Time to Restore
NFPA	National Fire Protection Association
NTC	Philippine National Telecommunication Commission
NTP	Network Time Protocol
OCC	Operation Control Center
ODF	Optical Distribution Frame
OFC	Optical Fiber Cable
OTDR	Optical Time Domain Reflectometer
OJT	On the Job Training

Source: JICA Study Team

10.3 REFERENCE STANDARDS

10.3.1 Standards

The LHDS shall be designed, manufactured, installed and tested in compliance with the following relevant standards, codes and local regulations.

- DOTr Order, Philippines;
- Public Telecommunication Policy Act (NTC);
- ANSI：American National Standards Institute;
- CISPR：Comité International Spécial des Perturbations Radioélectriques;
- DIX：Dec, Intel, Xerox;
- EIA：Electronic Industries Alliance;
- IEC：International Electrical Commission;
- IEEE：Institute of Electrical and Electronics Engineers;
- IETF： Internet Engineering Task Force;
- ISO：International Organization for Standardization;
- ITU-T：International Telecommunication Union Telecommunication Standardization Sector;
- ITU-R：International Telecommunication Union Radio Communication Sector;
- RFC：Request for Comments;
- JIS：Technical Regulatory Standards on Industrial Standards;

Table 10.3.1 LHDS Standards and Details

Standard	Series	Details
IEC	60331	Tests for electric cables under fire conditions
	60332	Test on electric and optical fiber cables under fire conditions
	60754	Test on gases evolved during combustion of materials from cables
	1034	Measurement of smoke density of cables burning under defined conditions
	62236	EMC Directive
	62305	Protection against lightning
	60721	Classification of environmental conditions
	60870-5	Tele control Equipment's and systems
	60529	Degree of protection- IP Code
NFPA	130	The standard set out by the National Fire Protection Association (NFPA) of America that sets fire protection requirements for the entire railway system
	72	National Fire Alarm and Signaling Code

Source: JICA Study Team

10.4 SYSTEM OVERVIEW

10.4.1 General

The LHDS inside tunnel area shall monitor environments along of the tunnel i.e. heat, temperature etc. The tunnel temperature shall be measured by the linear heat detector and will be transmitted to the TVS / Fire Alarm System at each station.

10.4.2 Scope of Work

The scope of works within the Contractor shall include, but not be limited to:

a) Design, Supply, manufacture, shipping and delivery to site.
b) Installation, training, testing, commissioning and support to line operation for the MMSP Line.
c) Ancillary scope of work shall include:
    - Local cabling including terminations within buildings and external cabling along the trackside and tunnels;
    - Alarm and Event Printers;
    - Report Printers;
    - Equipment's cabinets, racks and cubicles;
    - Secondary cable containment;
    - All test equipment and special tools and equipment's necessary for testing and commissioning; and
    - All support documents as specified in the contract.

d) Other Scope of work

The other scope of works shall include, but not be limited to:

- Partial commencement of train and station operation;
- Operation plan on the NSRP-South line;
- Installation requirements;
- Interface requirements;
- Requirements for test;
- Requirements for measurement and measuring instruments;
- Requirements for Spare parts and consumables;
- Training requirements; and
- Maintenance requirements.

10.5 PERFORMANCE REQUIREMENTS

10.5.1 General

The Contractor shall carry out System Assurance (SA) activities in accordance with the contract.

If any changes of requirements or design are to be implemented, the Contractor shall conduct relevant System Assurance Activities to ensure the achievement of the RAMS targets specified in the Contract.

10.5.2 Reliability, Availability and Maintainability (RAM)

The Contractor shall ensure the system and equipment design to be complied with the RAM targets at the design stage through RAM analysis. The achievement of the RAM targets shall be demonstrated by RAM demonstration test.

The contractor must ensure that the design of the system and equipment is complied with RAM objectives during the design phase by using RAM analysis. Achieving RAM goals must be demonstrated by a test.

The contractor shall conduct a reliability analysis during the design phase to verify that LHDS and equipment design meet reliability targets. The analysis takes into account the environmental conditions that equipment may encounter with revenue operations.
The contractor can offer other goals as needed to match their solutions.

a) Availability Requirement

LHDS is designed to work 24 hours a day, every day of the year. LHDS control and monitoring features shall be designed to meet the availability of 99.99%.

Availability shall be calculated based on the MTBF and MTTR achieved, i.e.
Availability= MTBF / (MTBF+MTTR).

The calculated figures are the inherent Availability, which excludes the time to mobilize the operation and maintenance staff to fault location.

To ensure Availability of the LHDS, the service life shall not be less than 20 years.

b) Maintainability Requirement

The LHDS shall have a mean time to restore (MTTR) of 30 minutes. This shall not include the travelling time.

The Contractor shall provide records of simulation to ensure the MTTR is met prior to the

systems installation. Service records shall also be maintained to verify that. The service life of the LHDS shall not be less than 20 years.

c) Demonstration

The Contractor shall conduct the demonstration tests in accordance with the requirements in contract to ensure the achievement of the RAM targets.

All reliability and calculations shall be conducted during the design phase and updated with failure reporting, analysis and corrective action system (FRACAS) records during the factory test / inspection phase and test and commissioning phase.

FRACAS shall be in accordance with EN50126, the contractor shall implement a Failure Reporting, Analysis and Corrective Action System (FRACAS), to monitor and manage all failures encountered during factory tests/inspections, site test & commission and Defect Liability Period;

The FRACAS shall be used to establish the root cause of failures that occur, determine the appropriate corrective actions and to track progress and effectiveness in elimination of systematic failures;

The Contractor shall submit the FRACAS procedure (including all subsequent revisions) for approval; and

A Failure Review Board (FRB) shall be established by the Contractor to review and manage all results and any FRACAS reports produced during testing.

10.5.3 System Safety Requirements

Please refer Section 12 of Volume II, part 2, Section VI, b) General Requirements (ERG) for system safety requirement.

The Contractor shall apply a structured and systematic approach as detailed in Standard EN 50128 for System Safety. Potentially unsafe conditions are to be identified and controlled in order that all hazards are properly mitigated to the negligible level.

10.5.4 Performance Criteria for LHDS

System Response

The time takes to update digital status or messages in the real-time event window of LHDS workstations shall not exceed 1 seconds. This shall be measured from the moment receive the signal at the interface point to the point that is displayed/updated on LHDS / BMS system.

10.5.5 Configuration of Maintenance

The contractor shall prepare and submit configuration of maintenance for the LHDS.

The configuration of maintenance shall be classified as to Corrective Maintenance (CM) and Preventive Maintenance (PM).

To implement maintenance of the system, the parts or items for CM and PM need to be clarified through a Maintenance Management plan.

10.6 DESIGN CRITERIA

10.6.1 Environmental Condition

(1) Temperature

- Tunnel Temperature : 0 to 60 Degree Celsius.

(2) Relative humidity

- Indoor : 90% or lower
- Outdoor : 100% or lower

(3) Lightning Area

- Sever Lightning Area

(4) Salt Damage District

- Around 10km from coastline

(5) Flood and Earthquake

- Action Required

10.6.2 Design Condition

10.6.2.1 Common Items

(1) Compliance with standards

The LHDS system shall comply with international standards, Japanese Standards and Philippine standards.

(2) Operating Parameters of LHDS System

Redundancy of the LHDS system inside Tunnel shall be achieved by providing duplicated

transmission path, duplicated or stacking of equipment etc.

The equipment of the LHDS shall be a hot standby system.

(3) EMC (Electro Magnetic Compatibility)

The equipment of the LHDS shall satisfy with the following conditions for Electro Magnetic Interference (EMI).

- EMC shall comply with international standard IEC 62236 in railway field.
- The EMI emitted by the equipment of the LHDS shall not affect other equipment
- The equipment of the LHDS shall operate satisfactorily even if it receives EMI generated by other equipment.

(4) Equipment management

The contractor shall ensure the safety and reliability and durability of the operation under the given environment by adopting appropriate protection method and appropriate equipment.

The contractor shall ensure the reliability of the system in all processes including design, production, in-factory testing, installation, field test etc.

The LHDS shall be a maintenance free system and the monitoring system shall be able to notify maintenance staff of equipment failure.

(5) Service Life

The LHDS shall be designed for continuous operation over 20 years.

(6) Surge current

To protect the LHDS equipment from the surge current, the copper cable shall be provided with a protection device to absorb the surge current, etc.

(7) Grounding (Earth)

Equipotential grounding method shall be applied to entire LHDS.

In cooperation with the power supply and the signal side, the contractor shall measure resistance value of equipotential grounding.

The LHDS equipment shall be connected to a grounding device.

10.6.3 Equipment Supply and Installation

The LHDS system shall installed inside the tunnel area, also shall be housed with BMS standard server

rack or separate rack subject to design approval from the Engineer.

10.7 SYSTEM TECHNICAL REQUIREMENTS

10.7.1 General Requirement's

The Contractor shall design LHDS to be more effective for operations and safety of people in the MMSP line inside tunnel area.

Fibre optic linear temperature sensing system shall provide a low maintenance means of monitoring, detecting and reporting the presence of a fire condition as well as increase in tunnel temperature beyond the set limit at any and all points along a multiple km length of standard telecommunications grade dual fibre optic cables to be laid in the tunnels. The above system operation shall not be affected by adverse environments such as dirty, dusty, damp, corrosive etc. or by electrically
noisy (RFI, EMC) conditions.

10.7.2 System Integration Requirements

The Contractor shall be responsible to coordinate with respective systems to carry out the design, development, testing and validation for the interface and integration including, but not limited to the following systems.

a) BMS
b) Tunnel Ventilation System (TVS).
c) Fire Alarm System.
d) Other if any

10.7.3 Functional Requirements

The function of the system is to detect a developing fire /heat at the earliest possible stage, provide information with regard to its location, and activate fire alarms and associated systems as appropriate to facilitate rescue and to minimize losses. A facility heat detection subsystem shall be provided to detect the presence and provide warning of excessive heat or rapid temperature increase.

Tunnel LHDS shall be activated as soon as the ambient temperature exceeds a preset temperature limit. Each detector shall have 2 levels of triggers, one to warm a potential risk of fire and one to warn in case of high temperature. They can be used to detect the rapid build-up of excessive temperatures. The LHDS shall provide zoning information regarding the location of source of heat. Tunnel LHDS shall also provide the average temperature of the zone covered for the Tunnel Ventilation System.

Monitoring capabilities shall be programmed for the following conditions as minimum.

a) Fixed Temperature Alarm
b) High Average Temperature Alarm
c) Rate of rise Alarm
d) Other if any

10.7.3.1 Overview of LHDS Functions

The Principal functions of LHDS System are the following:

The alarms shall be transmitted to a specific LHDS panel as defined above.
The LHDS shall be able to detect and to provide warning about excessive heat or rapid temperature increase.

The Distributed Temperature Sensing (DTS) unit which is used in conjunction with the specified metallic or non-metallic fibre cable shall utilize Optical Time Domain Reflectometry (OTDR) technology as the basis for its operation. With connections between the DTS unit and fibre being single or double ended, the latter shall allow continued detection with a break in the fiber. Communication options shall be available for integration with a customer central control system located in station, OCC / BCC in through TVS BMS system. The scope shall include all necessary interfaces and interfacing equipment required to be provided with TVS BMS system being installed by civil Contractor and shall include Relays, TCP/IP, Modbus, other if any

The DTS system shall allow configuration of different alarm temperatures along sections ("zones") of a single fibre optic linear temperature sensor cable installation. It shall have an inbuilt compensating facility for differences in ambient temperatures that may be present within a risk area without loss of sensitivity and shall be effective when installed at the exact point of risk as when used for more area protection risks. Monitoring at the exact location of a potential overheat / fire condition shall remove any requirement for favorable airflows to carry the heated air up to a roof or ceiling height. Care must always be taken during system design stage with installation location recommendations and should always consider the potential obstruction that any incorrectly located fiber optic sensor cable could present to site engineers who may have to regularly access the area/s protected by the linear detection system for routine maintenance, repair or replacement of plant /process machinery.

In the tunnel for Protection of more "open" area risks, the DTS shall provide superior response to point type devices as it monitors for temperature changes at ANY and ALL points along its length. Mechanical flexibility shall be allowed for vertical runs of the sensor cable to be integrated within

higher level horizontal runs – bringing the "continuous detector" closer to the origin of the temperature rise. Care should be taken to ensure sensor cable fixing locations do not expose the system to excessive levels of vibration and that any bend that may be introduced by an installation contractor in the cable is within manufacturer's recommendations tolerances.

The Design criteria for DTS systems shall be as follows:

a) Dual fibre connection
b) Single or Double ended fibre connections
c) Multiple Alarm levels / "zone"
d) Broad operating temperature range
e) Inherently safe in operation
f) Low power consumption
g) Operating Lifetime < twenty (20) years
h) ISO9001 Manufacturing Certification
i) Conforms with appropriate International Standards
j) Other if any.

10.7.4 Specific Functionalities for Station LHDS system

a) Supervision of tunnel equipment will be monitor by
- BMS
- Other if any, shall be included during design;

b) Monitoring of Alarm

The LHDS/BMS fire alarm panel at each station shall monitor the alarm initiated by the LHDS detection and protection system.

c) Equipment Status and alarm Summary

Each Station shall obtain the individual equipment status and generate summary status and summary Alarm for individual group of equipment of each station for conveying to and display at BMS Workstations.

10.7.5 Hardware Requirements

The tunnel heat detection system shall consist of cables, DTS / Local LHDS control Panel at stations, automatic detection sensors and manually /automatic activated devices, mimic panels, audible/visual alarms, etc. subject to design approved by The Engineer.

LHDS cables shall be fire resistant and LSOH. In addition, they will comply with the requirements of the

reference fire protection codes.

As a minimum fire rated cables shall comply with IEC331 for 3 hours operation at 750°C and for 3 hours operation at 950°C under defined conditions. Cables shall also comply with IEC332 for flame propagation properties, IEC754 for acid gas emission and IEC1034 for smoke emission.

10.8 LHDS OPERATIONAL SCENARIOS

The LHDS system shall be operational 365 days a year, seven days a week, 24 hours a day.

The MMSP operation hours are subject to O & M Management Plan approval from the Employer.

10.8.1 Normal Mode of operation

All LHDS equipment shall work properly in all location of Tunnel

The LHDS operation shall not impact any other system during operation hours of MMSP.

10.8.2 Degraded Mode of operation

The LHDS system shall be design in a way that a single point failure shall not affect the services and operations.

LHDS shall have internal & external equipment redundancy.

All interface connection to BMS/Fire Alarm System shall have redundant circuit connections.

In the LHDS Detailed Design document, the contractor shall provide a summary of the impact of failure of each item of equipment on the LHDS users' services. Failure scenario shall be described based on each equipment and sub-component failure. The services of LHDS shall be maintained even in degraded mode.

The Design Document shall clearly describe the scenario of Local and centralized control.
In degraded mode the LHDS equipment units shall be fully functional and manage all services of local station area.

10.9 SYSTEM INTERFACE REQUIREMENTS

10.9.1 General

The LHDS System shall interface with Fire Alarm System/TVS/BMS that to be provided by Civil Contractors of MMSP Line.

10.9.2 Interface Control Management

The Contractor is responsibility to develop the design of the interface to meet all functional and technical requirements.

The Contractor shall keep informed all parties in respect of identifying all the interface required by the LHDS and other relevant systems.

All equipment supplied under the LHDS shall be compatible with each other and also with other system hardware and software requirements.

Protocols for any interface communication shall be agreed and tested with common agreement of mutual parties with respect to system interface.
The LHDS system shall be open to accept interface requirements with any future extension if required as confirmed by The Employer with the approval of The Engineer.

10.9.2.1 Functional Interface Requirement with the BMS system.

LHDS shall provide health status and alarm to BMS/Fire Alarm System at each station for control and monitoring purpose.

The interface between LHDS and BMS/Fire Alarm System shall include the following functions.

- Monitoring of operational status of LHDS and control of them for all underground tunnel area.
- Monitoring of LHDS system at BMS inside underground station for function on normal and emergency condition.
- Major Equipment status and alarm of LHDS shall be transmitting to BMS.

The CP106 and Civil Contractors shall be responsible for all interfaces mentioned above.

The interface requirements of the LHDS are shown in the Table below.

Table 10.9.1 Interface requirements of LHDS system with other Systems

Sub system	Functional Description / Objective	Limit of Interface	Interface Facilitator
BMS/Fire Alarm System	The LHDS control panel will gather data pass the gathered data into the –BMS systems. .	Both Contractor, CP106 and Civil Contractors shall determine demarcation point of interface. The CP106 Contractor shall define the content of the data that to be sent to BMS/Fire Alarm System.	The Civil Contractors and CP106 Contractor shall responsible for the interface and integration between LHDS and BMS/Fire Alarm System including TVS.

10.10 PARTIAL COMMENCEMENT OF TRAIN OPERATION

10.10.1 Overview

The Metro Manila Subway plans commencement of train operation at 15 stations from Quirino Highway station to Bicutan station (Including though operation plan to enter on NSRP-South line.) and Depot. Also, there is a plan to extend 3 stations from Lowton East station to T3 station.

However, 3 stations from Quirino Highway station to North Ave. station and Depot will be precedes and will perform partial operation prior to total system operation.

10.10.2 Response to Partial and Full Commencement of train operation

Because the Metro Manila Subway is conducted in two stages of partial commencement of train operation and commencement of full train operation, the LHDS system also needs to deal with it. Further, the connection test of the LHDS will be performed at the time of the partial commencement of train operation and at the Commencement of full train operation.

10.11 INSTALLATION REQUIREMENTS

10.11.1 Approval of the delivery equipment

The contractor shall prepare and submit the documents of equipment to be delivered for approval by the Engineer.

Approval documents of equipment etc. shall be submitted at the direction of the Engineer.

The documents for approval shall include the following contents:

- Function and performance

- External dimensions and weight
- Input voltage
- Type
- Environmental limitation condition (temperature, humidity, etc.)
- Other documents that are require by the Engineer.

10.11.2 Approval of construction plan

Design work shall be carried out based on the field survey results of the contractor. The contractor shall make the design construction plan before starting the design construction and shall submit to the Engineer for approval. The document of construction plan shall be submitted to Engineer before starting the construction. The submission date shall be proposed by the contractor and approval by the Engineer.

The construction plan shall include the following aspects:

- Construction structure;
- Construction method;
- Quality plan of the construction;
- Progress schedule of the construction;
- Safety measures; and
- Other documents that the Engineer requires.

10.11.3 Approval of construction working drawing

The contractor shall complete the construction working drawing before starting the construction and shall submit to the Engineer for approval. The construction working drawing shall be submitted to the Engineer before the construction starts. The submission date shall be agreed by the Engineer.

10.11.4 Record of construction

The contractor shall record the activities of construction.

The contractor shall organize and records the results of discussion.

Tests regarding the construction that to be conducted by the contractor shall be recorded promptly.

Other necessary matters shall be recorded.

10.11.5 Construction site management

10.11.5.1 Construction management

The contractor shall establish the construction management system and manage the quality, construction process, safety measures etc. in order to complete the construction in accordance with the design.

The contractor shall submit the design and construction standard which defined by the contractor to the Engineer for approval. The contractor shall carry out the work in accordance with the design and

construction standard defined by the contractor.

10.11.5.2 Quality control of construction

The contractor shall perform the necessary management such as instruction, checking and tests if necessary, based on the quality plan of the construction plan.

10.11.5.3 Securing safety during construction work

The contractor shall manage the construction site by taking care of the safety and ensure the accident prevention measures are put in place.

Workplace safety shall comply with the laws and regulations established by the Department of Labor and Employment (DOLE) of the Philippines. In addition, the contractor shall comply with its own safety standards as well as JICA Health and Safety Standards.

The contractor shall submit the safety management plan established by the contractor to the Engineer for approval.

10.11.5.4 Report of accident

When accidents occur during the construction works, the contractor shall immediately report to the Employer or Engineer.

10.11.5.5 Equipment protection

The contractor shall appropriately protect the equipment in order to avoid damages to the equipment or constructed parts.

10.11.6 Completion of the construction

The contractor shall submit the construction completion documents to the Engineer when the construction is completed. The submission date is decided by the contractor and approval by the Engineer.

The Construction completion documents shall include the following contents.

- The drawings for facilities at the time of the construction completion and the present conditions of the structure.
- Completed drawing of main construction material
- Test results document
- Instruction and maintenance manuals.
- Other documents that Engineer require.

10.12 REQUIREMENT FOR TESTING

10.12.1 Test plan and procedure

The contractor shall prepare and submit a test management plan and test procedure for the Engineer's approval. Test plan and test procedure shall be submitted to the Engineer prior to the tests.

The contractor shall prepare the test and request the Engineer for a witness.

For the testing that is not witnessed by the Engineer or Employer, the contractor shall submit a copy of the test results to the Engineer.

The Contractor shall coordinate with other contractors for factory acceptance tests, operational test, and system integration test in order to secure the correct interface for data collection. Integration test with multiple contractors shall verify the interface and demonstrate that it meets the interface requirements.

The test shall be conducted based on the demand of the contract under the instruction of the contractor.

The contractor shall provide all the necessary test equipment, special tools, simulator, test software, etc.

10.12.2 Submission of the test results

The contractor shall record all the contents and results of the test.

The contents and the results of test shall be submitted to the Engineer for the approval.

The result of the test shall be submitted by the day specified by the Engineer after completion of the test.

10.12.3 Test stage

The tests shall be divided into the following aspects.

- Factory Acceptance test;
- Installation test;
- Operational test;
- Integration test;
- Commissioning (Trial Run) Test.

10.12.3.1 Factory Acceptance Tests

Factory Acceptance Tests (FATs) shall be conducted at the place of manufacture of the system and comprehensively represent the system in terms of architecture and load, to demonstrate the performance of the system against the Employer's Requirements Technical Specification and the approved final design. The factory test shall include at least the following items.

- Visual inspection;
- Inspection of dimensions and shape;

- Function test;
- Operational test;
- Software Confirmation Tests;
- Dustproof and waterproof test.

10.12.3.2 Installation test

Installation tests shall be conducted after the installation is completed to verify the completeness and accuracy of the installed equipment and the correctness with respect to the approved design of all elements of the installation. The installation tests shall include at least the following items:

- Cleaning;
- Performance;
- Rate value of equipment;
- Position and level;
- Termination and marking;
- Protection of cables;
- Cable bending radius;
- Terminal condition;
- Separation distance;
- Consistency with drawing;
- Connection with installation equipment;
- Power breaker.

10.12.3.3 Operational test

Operational test shall comprise testing of the complete system excluding interfacing systems, i.e. with interfacing systems simulated to demonstrate end to end performance. The operational test shall include at least the following items.

- Function confirmation;
- Performance confirmation;
- Alarm confirmation;
- Software confirmation;
- Communication check between devices;
- Visual confirmation of equipment performance;
- Interface confirmation;
- Demonstration in operation.

10.12.4 Expenses of test

The contractor shall bear all the expenses related to the tests including tests by members of expertise and government offices.

When testing is conducted in a country other than the Philippine country, the contractor shall determine the test site for approval of the Engineer.

The contractor shall be responsible for traveling schedule, travel costs, accommodation costs, meal and etc.

The Contractor shall be bear all expenses and responsible for shipping and arrangements of equipment's at vendor factory for integrating testing with all interfaces.

10.13 CONTRACTORS RESPONSIBILITIES FOR ON-SITE TESTING

The Contractor shall implement all tests in accordance with the Test Management Plan.

The Contractor shall be responsible for all instruments, gauges, test equipment, tools, accessories, personnel, services and necessary facilities required for the execution of all tests and inspection. Wherever necessary, the Contractor shall provide two or more sets of testing equipment, tools, and others to expedite testing.

Test equipment, tools, and others necessary for subsequent preventive and corrective maintenance are to be provided. The use of these test equipment, tools and others shall be subject to approval by the Engineer.

The Contractor's responsibility for surveillance and security of the system shall remain in force for each part of the system until such a time that the Engineer issues the appropriate taking over certificate and the Employer takes over the system.

10.14 REQUIREMENTS FOR MEASUREMENT AND MEASURING INSTRUMENTS

The contractor shall provide the measuring instruments necessary for the maintenance of the LHDS. The contractor shall provide the certificates and Operation manual of the measuring instruments.

10.15 REQUIREMENTS FOR SPARE PARTS AND CONSUMABLES

10.16 TRAINING REQUIREMENTS

The contractor shall perform necessary training for maintenance staff to maintain the LHDS.

The Training shall include the following.

- Daily inspection and recording;
- Operation and control;
- Calibration measuring instrument;
- Monitoring of LHDS system;
- Troubleshooting;
- OJT.
- Other if any

The training shall be completed before the MMSP line operational commencement. The contractor shall prepare teaching materials necessary for training. The Contents of the training shall be submitted to the Engineer and receive approval. The contents of training shall be submitted to the Engineer before a training start. The contractor shall bear the cost of training.

10.17 SUPPORT DURING DEFECTS NOTIFICATION PERIOD

10.17.1 Packing

All equipment must be packed in order to avoid damage such as deformation or rust caused by vibration and moisture during transportation.

The electronic circuit board and the removable equipment to which the rack shelf and the plug are connected must be packed and shipped, respectively.

The contents and usage of the packaged equipment shall be indicated on the outside of the package.

10.17.2 Storage

The equipment before installation shall be stored at the site or the place appropriate for storage. The equipment shall be stored the place without fear of damage and theft when keeping it in places other than the site.

10.17.3 Shipping

Delivery schedule shall take into consideration carrying-in of equipment directly to the site.

10.18 MAJOR MATERIAL INSTALLATION

The major materials for the LHDS system shall be installed as following from Table 10.28.1

Table 10.18.1 Major material installation at Tunnel and station Area

Building Name etc.		LHDS Cable	Equipment/RTU/PLC /control Panel/DTS/etc.	Monitoring & control
1	OCC / Administrative		◎	O/◎
2	BOCC		◎	O/◎
3	All Tunnel Section	◎		–
4	All Stations		◎	O/◎

【Note】 ◎: Major material installation, **O** : Monitoring & control

Source: JICA Study Team

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