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# 1.0 TESTING, ADJUSTING, BALANCING AND COMMISSIONING REQUIREMENTS

## 1.1 GENERAL

This section specifies the requirements for all testing, adjusting, balancing and commissioning (TABC) of mechanical works to be carried out under the contract. The objectives of TABC are;

i. To verify the delivered materials are as per approved specification and good physical condition.

ii. To verify the installation works are carried out in accordance to specification and good engineering practises.

iii. To verify the performance in terms of functionality, safety, maintainability and operational ability of the installed equipment/systems meet the specified design intention through a series of tests and adjustments.

iv. To ensure all test results are systematically recorded and verified prior to system commissioning.

TABC works are divided into four stages as the following;

i. Pre Delivery stage.

ii. Delivery stage.

iii. Installation stage.

iv. Functional Performance Test stage.

Contractor shall submit Inspection and Testing Plan (ITP) of TABC works to be carried out in accordance to this specification to Superintending Officer (S.O) for review and approval.

## 1.2 INSPECTION AND TESTING PLAN (ITP)

ITP shall consist of;

i. List of All TABC Requirement

All TABC works with specific scope and boundaries shall be clearly stated at every stage of TABC works and comply with the regulation of Jabatan Bomba dan Penyelamat Malaysia and document contract. Sample of Inspection and Testing Plan as per Table1.

ii. TABC Work Schedules

TABC work schedules shall be integrated into main project schedules.

iii. Method Statements

TABC method statements shall consists of TABC procedures, responsibility, necessary tools, measuring equipment and accuracy, consumables and acceptance criteria. Type of test required is listed in Schedule of Inspection and Testing.

Method statements and acceptance criteria for all equipment installation stage inspection and functional performance testing shall be endorsed by manufacturer or manufacturer's valid representative.

Acceptance criteria shall be stated as per Schedule of Design Requirements, technical specification or any applicable standards.

ITP shall be updated for any changes and resubmitted to S.O/S.O's representative for approval.

Prior to the commencement of the TABC works as per approved ITP, contractor shall issue Request for Inspection and Testing (RFIT) to the S.O. During the TABC, contractor shall have his supervising foreman and mechanics available to aid in testing and to perform any adjustments as directed. The TABC works shall be carried out under the direction of experienced personnel and witnessed by S.O or S.O's representatives. No subsequent installation works shall proceed without S.O approval of the test result.

Depending on the specific demands of individual installation, S.O's Representative may require additional or substitute testing works in regard to any elements in the installation other than those indicated in this specification.

***Table 1 : Sample of Inspection and Testing Plan***

| Stage | Inspection and Test Name | Scope and Boundaries | Responsibility | Method Statement | Test Form No | Expected Date |
|---|---|---|---|---|---|---|
| Pre Delivery Stage | Pump Performance Test | Sprinkler Pump | Manufacturer | MS-ITP-01 | TF-01 | 17-Jan |
| | Switchboard Test | Switchboard | Manufacturer | MS-ITP-02 | TF-02 | 17-Jan |
| Delivery Stage | Visual Inspection | Sprinkler Duty, Standby & Jockey Pump | Contractor | MS-ITP-03 | TF-03 | 17-Mar |
| | Measurement (size & capacity) | | Contractor | MS-ITP-04 | TF-04 | 17-Mar |
| | Documentation (DO, QA etc.) | | Contractor | MS-ITP-05 | TF-05 | 17-Mar |
| Installation Stage | Flushing Test | Sprinkler Pipe | Contractor | MS-ITP-06 | TF-06 | 17-May |
| | Leak Test | Pipe and fittings | Contractor | MS-ITP-07 | TF-07 | 17-Jun |
| | Cable continuity and insulation Test | Power cable from incoming supply to Switchboard and from Switchboard to motor | Contractor | MS-ITP-08 | TF-08 | 17-July |
| | Water Tank Inspection | Leveling (pump & tank), painting, leaking, ladder, electrode sensor, incoming pipe, outgoing pipe, scour pipe, balancing pipe, valves & Fittings | Contractor | MS-ITP-09 | TF-09 | 17-July |
| | Orientation of Equipment Inspection | Sprinkler Duty, Standby/diesel engine & Jockey Pump | Contractor | MS-ITP-10 | TF-10 | 17-Aug |
| Functional Performance Stage | Sprinkler Pump Start-up Test | Pumps, Switchboard, all switches and sensors, valves & fittings | Contractor | MS-ITP-11 | TF-11 | 18-Sept. |
| | Sprinkler Pump Functional Performance Test | | | MS-ITP-12 | TF-12 | 18-Sept |

### 1.2.1 Pre Delivery Stage

Pre-delivery inspection and performance test shall be conducted if stated in the Schedule of Inspection and Testing requirements. These tests may be witnessed by the government's representative if deemed necessary by the S.O. All travelling, food and accommodation cost of government representatives related to witnessed performance test shall be borne separately by the government.

A factory test is understood to mean testing at a dedicated test facility, often at manufacturer's plant or at an independent and accredited test facility and to be agreed by the S.O.

Performance test method statement, test standard and acceptance criteria shall be submitted to S.O for approval prior to such testing. The manufacturer shall conduct the test, passes judgement of acceptance and produces a signed test report. All test report shall be submitted to S.O for approval. Manufacturer shall be responsible for any reworks and adjustment of the equipment if the test results fail to adhere to the agreed acceptance criteria.

#### 1.2.1.1 Pump Factory Performance Test

Performance rating tests for the sprinkler pumps shall be performed by the manufacturer to verify equipment performance against design specifications and compliance with the specification.

Performance rating test of duty and standby pumps shall comprise of Malaysia Standard heavy duty end suction pump MS2616:2015 Fixed Fire Fighting System-Fire pumps, as per schedule of design requirements.

#### 1.2.1.2 Switchboard Inspection and Test

Routine tests on the Switchboard (category 1: I ≤ 600A by Suruhanjaya Tenaga) shall be carried out before delivery to site. Routine tests shall include inspection and checking of wiring, electrical continuity of the protective circuits, connections and effectiveness of mechanical actuating elements and interlock. Test Results or Certificate duly certified by Competent Person as in Electricity Regulations 1994 shall be issued for every switchboard supplied and installed.

### 1.2.2 Delivery Stage

All incoming material and equipment to site shall be verify by visual inspection, documentation and measurement that delivered items are comply with technical specification, as per approved materials and good physical conditions. Materials delivered to site shall be free from defects and adequately protected against site conditions.

List of verify and inspection during delivery stage as per Table 2: -

***Table 2: Verify and Inspection***

| Verify and Inspection | Description |
|---|---|
| Visual Inspection | • good physical conditions<br>• free from defects<br>• adequately protected<br>• |
| Documentation | • Delivery Order<br>• Quality Assurance<br>• Technical Data<br>• |
| Measurement | • Size and dimension<br>• Orientation of equipment and Plant Layout |

### 1.2.3 Installation Stage

#### 1.2.3.1 Visual Inspection

List of visual inspection and testing during installation as per Table 3:-

***Table 3: Visual Inspection of Sprinkler System***

| Inspection / Test Name | System/Component | Objectives |
|---|---|---|
| Visual Inspection | Pumps House/Room | Verify that all pumps house/room components are installed as per approved shop drawings approved material list, installation method statement and free from installation effects. |
| | Water Tank | Verify inlet pipe, capacity and tank compartment |
| | Pump Set | Verify the alignment of shaft, mounting, Inertia block & spring isolator |
| | Piping | Verify types of pipe, protection and colour coding.<br>Verify the length of pipework between alarm valve and water alarm gong |
| | Incoming Pipe | Verify inhibitors |
| | Test Pipe Location | Verify of pipe for actual point test location at every design point |
| | Flow Meter | Verify for pump dry running protection |
| | Flow Switch | Verify the numbers and functionality |
| | Hanger And Supports | Verify hanger and supports as per drawing and technical specification |
| | Pipe Sleeves | Verify all the pipe sleeves with the right size. |
| | Fire Seal | Verify seal thru any floor, wall or partitions using non-combustible or fire resistant sealant material |
| | Breeching Inlet | Verify the types of breeching inlet |
| | Sprinkler Heads | Verify arrangement of sprinkler head as per drawing and technical specification.<br>To verify the quality/defect.<br>To verify product code (Red 68°c, Yellow 79°c & Blue 141°c) |

### 1.2.3.2 Testing

List of inspection and testing works during installation as per Table 4;

***Table 4: Test List in Installation Stage***

| Test name | System/Component | Objectives |
|---|---|---|
| Hydrostatic Pressure Test | Piping | Verify integrity of all pipes, joints and fittings. |
| Pipe Flushing and Leak Test | Piping | Verify integrity of all pipes, joints and fittings, pipe internally clean and water quality are acceptable |
| Cable Continuity Test | Electrical Cabling | Verify cable continuity effectiveness |

a. Hydrostatic Pressure Test

All pipes, valves, fittings, etc. shall be tested to operation of 14 bar or 1.5 times the working pressure whichever is higher for period of 48 hours. All tests shall be done in accordance to ASME B31.9.

During the pressure test, all welding joints, bends, fitting and valves shall be visual checked for any leaks or deformations for the entire piping system.

Pressure drop allowable not more than 5% from the tested value for the period of testing.

b. Pipe Flushing and Leak Test

All pipes shall be flushed before pressure test. Flushing will be done by a fresh potable water or dry compressed air wherever water flushing is not desirable to clean the pipe of all dirt, debris or loose foreign materials. No leakage of any kind will be permissible during testing. Flushing will be continued till the inside of the pipe is fully cleaned to the satisfaction of the S.O. Test reports shall be submitted to S.O after completion of flushing procedures. As a minimum, the test records shall contain detail of testing and the results.

c. Cable Continuity Test

Cable continuity test shall be performed on each power cable by ohmmeter method. Perform an acceptance test on cables, including terminations and joints, after cable system installation and before the cable system is placed into service. In accordance with ANSI/IEEE 400, by means of direct voltage (dc) and recorded in the relevant testing form.

d. Test Pipe

All design point shall be tested to verify the adequate pressure of severe conditions.

### 1.2.4 Functional Performance Test

All Functional Performance Test shall commence after all inspection and testing during installation stage has been completed. List of functional performance test as per Table 5:-

***Table 5: Sprinkler Inspection and Test List***

| Inspection / Test Name | Objectives |
|---|---|
| Pump Automatic Operating Test (Duty and Standby Electric/Diesel, Jockey Pump) | Verify the pump functionality and performance as per design data included pump cut in/cut off using flow switch setting pressure, flow rate, RPM, control valve and alarm gong, current and voltage. |
| Noise Level Test | Verify the noise level is within permissible range or to detect abnormal operation |
| Testing of electrical wiring | Verify the continuity of power supply |
| Essential power supply for electric pump Inspection | Verify the continuity of power supply in the event of power failure. |
| Battery for diesel pump Inspection | Verify battery capacity as per design |
| Fuel Storage Inspection | Verify the storage capacity as per design. |
| The furthest and highest sprinkler head performance Test | Verify the operating pressure of pump as per design. |
| Design Point Test | Verify the water pressure as per design |
| Automatic Air Release Valve (AARV) Test | Verify no air pocket in the pipe line |

Detail method statement for testing shall be submitted conforming to the test requirements in this specification. All components shall be installed as per approved working/shop drawings, approved material list and free from defects.

### 1.2.4.1 Switchboard and Power Supply

List of Switchboard and power supply inspection and test name are listed in Table 6. Detail method statement for testing shall be submitted conforming to the test requirements in this specification. Only competent person as in Electricity regulations 1994 shall conduct the switchboard testing.

***Table 6: Switchboard and Power Supply Inspection and Test Requirements***

| Inspection and Test name | Description |
|---|---|
| Switchboard General Inspection | • Verify physical switchboard components are as per specification.<br>• Check for tripping setting and system trip<br>• Check for wiring, motor insulation and record data.<br>• Check for cable terminal tightness.<br>• Check for equipment and panel grounding connection.<br>• Check for any sign for cable heating. Cable temperature shall be measured and verify against IEEE standards for temperature rise during full load.<br>• Check for voltmeter and ammeter function and accuracy record running voltage and ampere.<br>• Check for control circuit function as intended.<br>• Check for contractors, relays, ACB, MCCB, MCB, type, size and ratings as per specification. |
| Power Supply Test | • Verify that power supply parameters are within permissible range, safety protections are in place and physical condition of switch board and cabling works are acceptable as per specification and approved shop drawings.<br>• Verify rotation of equipment/phase sequencing according to manufacturer recommendation<br>• Verify phase protection relay installation and function.<br>• Switching from normal electrical to essential supply |
| Overcurrent and Earth Fault Protection | • Circuit breaker and Earth Fault Protection calibration and discrimination shall be conducted and coordinated between electrical contactors.<br>• Circuit breaker and Earth Fault Protection shall be tested against simulated leakage current.<br>• Inverse definite minimum time (IDMT) tripping delay shall be selected/programmed suitable for equipment starting overloading preventing nuisance tripping during starting. |

## 1.3 COMMISSIONING

Commissioning includes achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.

All completed test forms and test summary shall be submitted to S.O/S.O's representative for final review and approval. Having satisfied that all appropriate tests have been conducted and the performance of the installation meet the design objectives; S.O's representative will issue or recommends to the S.O for the issuance of Certificate of Practical Completion (CPC).

### 1.3.1 Handing Over Documents

After issuance of Certificate of Practical Completion, contractor shall submit all related project handing over documents as the following;

a) Test Report complete with fully verified Inspection checklist and Test Forms.
b) Defects List
c) Operation and Maintenance Manual which includes
    - *Manual/Standard Operating Procedures*
    - *Preventive Maintenance Schedule and Manual*
    - *Equipment/Product Engineering Data.*
    - *Operation set point (cut in/ cut off pressure, flow rate etc)*
    - *Switchboard overload setting and set points*
    - *Contractor and manufacturer contact details*
    - *Circuit Diagrams*
    - *Inventory List*
d) As-Built drawings
e) Schedule of System Familiarization Program to end users.

### 1.3.2 System Familiarization Program

In-class and practical System Familiarization Program shall be conducted to the personnel nominated by S.O within one (1) month of issuance of Certificate of Practical Completion. Program shall focus on:

- Overview of design concept and objectives
- Operation instruction & competency requirement
- Maintenance procedures
- Critical operating parameters monitoring
- Emergency response & safety procedures and
- Jabatan Bomba dan Penyelamat Malaysia requirement and procedures.

Contractor shall submit program modules and materials to S.O for approval prior to commencement of training. Particulars of trainee shall be recorded and send to S.O for records.

## 2.0 TESTING INSTRUMENTS AND ACCESSORIES

All permanent sensors and gauges use for measurement of temperature, pressure and flow shall be factory calibrated and all calibration certificates shall be submitted to S.O prior to testing works.

The contractor shall provide all necessary testing, calibrating instruments and labour required for the testing, adjusting, balancing and commissioning of the complete fire fighting system installed under the contract.

The contractor shall also allow for any necessary replacement of parts in order to achieve the conditions specified in the drawings and specification.

Testing instruments specification shall be but not limited as per Table 7.

***Table 7: Testing Instruments***

| Measurement | Type | Accuracy |
|---|---|---|
| Ampere | Clamp meter (instantaneous), Power/Energy logger (continuous) | 2.0% ± 5 digits (45-65Hz) |
| Voltage | Clamp meter (instantaneous), Power/Energy logger (continuous) | 1.5% ± 5 digits |
| Combined power, ampere, voltage, power factor and Energy | Power/Energy logger (continuous) | Active Power: ±(1.2% of reading + 0.005% of range) (For PF≥0.99); ±(1.2% of reading + 7 x (1-PF) + 0.005% of range) (from 0.6 PF to 0.98PF) |
| RPM Motor tester | Tachometer | 0.05% ± 1 digits |
| Pressure Gauge | Heavy Duty Shock Proof | ±0.05 of reading 15 |