

VOLUME-2
PART- I
Section-19
Fire Protection System

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19. Fire Protection System

19.1 Scope of Work

The intent of these specifications is to define and cover the scope of work under this section which includes the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance testing, acceptance testing, training of Purchaser's personnel, handing over to Purchaser and guarantee for trouble free operation of Fire Protection System for Keyi Hydro Electric Project, Arunachal Pradesh as per the specifications hereunder, each complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

It is not the intention to specify the minute details/smallest items to deliver a functional system or to define the standard manufacturing practice but to outline the performance, constructional, operational and guaranteed requirements. It is the responsibility of the contractor to ensure these requirements.

19.2 Scope of Supply

Scope of work under this section covers provision of labours, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation & commissioning, performance testing, acceptance testing, handing over to purchaser, training to Employer's engineers and guarantee of performance of Fire Fighting System as per the specification furnished hereunder each complete with all accessories, spare parts and warranting a trouble free safe operation of the installation as detailed below.

The scope also covers all the equipment & accessories required for completion of the system to give the desired performance even though specifically not mentioned in this specification.

- 2 (two) nos. of centrifugal type fire pump of 100% capacity along with suction filter, duplex filters, necessary pipes/valves for filling twin fire water tank.
- 2 (two) nos. of centrifugal /booster pump-motor sets of 100% capacity along with suction filter, duplex filters & necessary pipes/valves for supplying pressure water to water hydrants in powerhouse & switch yard etc. One pump motor should be DC Power driven for safety.
- 1 (one) no. jockey pump to maintain water pressure in the system.
- High velocity emulsifier spray system for fire protection of two (2) nos. 15 MVA, 3-phase, 11/132kV, ONAN cooled Generator Step up transformer along with temperature sensors, deluge valve, actuated by auxiliary pipeline and main pipeline with suitable nozzles. ALTERNATLY Nitrogen Injection Fire Protection system may be considered.
- Fire hydrant system for powerhouse including switchyard with necessary piping, valves, hose reel, fire hydrant cabinets etc.
- A bank of portable chemical fire extinguishers (CO₂, DCP & foam type) & sand buckets for all types of fires likely to happen at the location of placement at all the applicable locations in the machine hall and at all the buildings housing electrical and mechanical panels.

- All piping including embedded and exposed piping, valves, fittings and associated accessories necessary for the system.
- Aspirator type/linear heat detector type fire detection system complete with ancillary devices and remote display & alarm for generators, control room, DG room, communication room, offices and other necessary areas.
- Necessary pressure sensors in the fire piping lines.
- Manual pull stations and notification devices such as fire horns/ alarms/ hooters/ bells, light or text display etc. distributed strategically throughout the plant for manual intervention and audible and visual alarm as per approved drawings and bill of materials.
- Alarm panels and misc. items for the firefighting system including
 - Local alarm panels as required throughout the plant,
 - One (1) main fire alarm panel located in central control room,
- Coordination and provision of necessary contacts and/or ports for integration with plant SCADA system.
- Spare parts as per the clause "Spare Parts" of this section.
- Tools and instruments as per the clause "Tools and Instruments" of this section.

19.3 Specific Exclusion

Any major civil work excluded. However, support system/foundation requirement for pipe support etc. is in the scope of the Contractor.

19.4 Codes and Standards

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / International Standards as given below except where modified and/or supplemented by this specification.

NFPA 851	Recommended practice for fire protection for hydroelectric generating plants.
NFPA 72	National Fire Alarm Code
NFPA10	Standard for portable fire extinguishers
NFPA13	Standard for the installation of sprinkler systems
NFPA 14	Standard for the installation of stand-pipe, private hydrants, and hose systems
NFPA 15	Standard for water spray fixed systems for fire protection
NFPA 20	Standard for the installation of stationary fire pumps for fire protection
NFPA 75	Standard for the protection of electronic computer/ data processing equipment
NFPA1221	Standard for the installation, maintenance, and use of emergency services
	communications systems

ISO 9001	Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing
TAC	Tariff advisory committee, India
IS: 1684	Code of practice for fire safety of buildings (General), Firefighting equipment & its maintenance
IS: 1646	Code of practice for fire safety of buildings (General), Electrical Installations
IS: 9972	Specification for automatic sprinkler heads
IS: 2189	Code of practice for installation of automatic fire alarm system, using heat sensitive type fire detectors
IS: 2175	Specification for heat sensitive fire detectors for use in automatic electric fire alarm system
IS: 5290	Specification for landing valves (internal hydrants)
IS: 4927	Specification for unlined flax canvas hose for fire fighting
IS: 903	Specification for fire hose delivery, hose couplings, branch pipes, nozzles and nozzle
IS: 325	Three phase Induction motor
IS: 933	Specification for portable chemical fire extinguishers
IS: 2878	Specification for fire extinguisher- Carbon di-oxide
IS: 1239	Mild steel tubes, tubulars and wrought steel fittings
IS: 3589	Specification for electrically welded steel pipes for water, gas and sewerage (200 mm to 2000 mm).

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted subject to approval of the Employer. In such case, copies of the English version of the standards adopted shall have to be submitted along with the bid.

19.5 Reference drawings and documents & interfacing

- For the scheme of Fire Fighting System refer tender drawing enclosed.
- For layout of powerhouse, refer tender drawing enclosed.

19.6 Special design and layout condition

Firewater shall be catered from fire pumps located in the powerhouse.

Water shall be pumped from tailrace by the pumps to the fire piping system.

One delivery pipe shall run from fire pumps shall be connected to 100NB/150NB (tentative) deluge valve header located at transformer yard for HV Spray systems for Generator Transformers.

One 100/150NB ring pipes shall cater transformer HVWS system and fire hydrant system in powerhouse and switchyard.

100/150NB riser pipes from the common header shall be laid for fire hydrant requirement at various floors.

The scheme indicated in the drawing is indicative & for general guidance only.

The Fire Fighting system shall have smoke sensors, temperature detector bulbs, deluge valves, water sprinkler system, pipes, pumps, fire hoses, portable fire extinguishers, control panels etc. to complete the system. Alarm cabling between detectors and panels with conduits and signal cabling between panel etc. with tray or conduits shall also be done by Contractor.

The type of firefighting arrangement for various equipment with sensing devices is given below. It is the responsibility of Contractor to complete the system in all respects.

Sl. No.	Equipment	Fire sensing device	Firefighting arrangement
1.	Oil pressure unit of governor and main inlet valve	Temperature detectors Manual pull stations	Portable type fire extinguishers of applicable class.
2.	UCB, SSB and excitation cubicles	Aspirator type smoke detection system	Fire extinguishers of applicable class
3.	Generator transformers and other oil filled transformers	Temperature sensing bulbs Temperature detectors Manual pull stations	Automatic High velocity Water (HVW) spray system (Deluge system)/ hydrant
4.	Control, computer and communication Room	Aspirator type smoke detection system/ Photo-electric/ detectors/ ionization/ detectors Manual pull stations	Portable fire extinguishers of applicable classes and fire hydrants
5.	Offices	Aspirator type smoke detection system/ Photo-electric/detectors/ionization detectors, Manual pull stations	Portable fire extinguishers, fire hydrant
6.	Outdoor transformer yard area, switchyard		Portable fire extinguisher and fire hydrants
7.	Generator	Photo-electric detectors/ ionization detectors/ heat detectors.	Fire sensors, portable fire extinguishers

Each fire alarm system shall consist of one central unit receiving the signals from the detectors grouped in lines for each supervised area separately. The supervised area shall be the same or part of the corresponding fire-fighting zone defined by the building.

All alarms coming from the detectors shall be line wise transmitted to the main fire alarm panel. The alarms of this system shall be transferred first to the pertaining panels for alarming and releasing and then be transferred to the main fire alarm panel for each line. A general mimic with reduced details shall be installed in the main control building.

19.6.1 Basic Design Requirement, Dimensions and Ratings

The firefighting system shall be designed in accordance with applicable NFPA/TAC standards. Dimensions and rating of various equipment/ system shall be as per prescribed in the relevant NFPA/TAC Code.

19.6.2 Design Consideration

- The fire alarm and control system shall invariably be a looped conduit system so that in case conduit and all the conductors get severed at any point, the initiating device circuit, signal line circuit and notification appliance circuit shall remain functional.
- The implementation of the communication technology for fire signalling system shall be such that it eliminates the risk of missing even a single fire alarm signal.
- The time delay between the activation of an initiating device and the automatic activation of a local fire safety function shall not exceed ten (10) seconds.
- Detectors shall be fixed at strategic locations and arranged in zones to facilitate proper indication of fire location, transmission of audio-visual signals to fire control panels and actuation of the appropriate firefighting system.
- The equipment and all its components shall be corrosion resistant and all the system devices/ components shall be located and mounted so that accidental operation or failure is not caused by vibrations or jarring.
- Necessary smoke and heat venting shall be planned for areas identified by fire risk evaluation, carried out by the Contractor, where either the heat or smoke or both shall be vented from its place of origin directly to the outdoors. The Contractor shall ensure the necessary co-ordination with ventilation contractor for the same to ensure proper functioning in emergency situations.

19.7 Performance Criteria and Guarantee

The Fire Fighting System along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions as per NFPA/ TAC norms. It is the responsibility of the contractor to supply the equipment as per guaranteed technical particulars and shall guarantee the reliability and performance.

19.8 Design and Construction

19.8.1 Pumps/Control Panel

The design head for pumps shall be sufficient to pump the water into overhead tank or maintain required pressure in the hydrant system in case there is not twin tank. Each pump shall have 100 % capacity to meet the requirement for firefighting.

Pumps shall be of continuous duty centrifugal with electric motors with class F insulation, anchor bolts and other mounting materials. The pumps shall be suitable for 415 V+10%, 50 HZ +5% with contacts for remote operation / indication.

The material of pump impeller and casing shall be stainless steel and cast iron respectively.

The speed of pumps shall not be more than 1450/1500 rpm. Pump bearings shall be water lubricated. The suction strainer of raw water pumps shall be bronze or brass.

The fire pump shall start automatically when one of the deluge valves of automatic fire protection system for transformer operates due to pressure drop in the system. The jockey pump will start automatically, if the water pressure in the system falls below the normal set level. Both the pumping sets shall act as standby to each other and shall start in case of the other pumping set failing to start or meet the water requirements of the system. An indication at local and remote panel for start/stop of pumps shall be provided.

A floor mounted type bottom cable entry suitable for indoor installation control panel shall be supplied.

The incoming to the panel shall be controlled by MCCB of adequate capacity. 2 nos. of MCCB of adequate capacity shall be provided for control of 2 (two) pumps.

The control panel shall have degree of protection not less than IP 42 as per IS 13947.

Necessary Ammeter, voltmeter & selector switches, space heater shall be provided.

The MCCBs controlling the pumps shall be provided with overload protection, short circuit protection & Single phasing prevention. The incoming MCCB shall be provided with overload & S/C protection.

19.8.2 Strainers

Twin basket strainers or line filters of suitable capacity shall be provided by Contractor with pumps with the provision of alarms to indicate choking of filters. Necessary duplex strainer with valves shall be provided in the pump delivery lines.

19.8.3 Distributing Manifold

A water header in powerhouse, Control block, transformer yard and Switchyard shall be laid to distribute the firewater to deluge system for transformers, wet sprinkler system for mechanical and electrical utility areas, Hydrants at various floors. Size of pipe for water header shall be sufficient to suit the requirement.

19.8.4 Piping and Valves

All required pipes, flanges, fittings, supports, fasteners, and related material shall be supplied as part of this contract. Minimum pipe wall thickness shall be as per relevant standard for medium duty pipes. All water pipes shall be painted with minimum 2 layer of red oxide primer.

19.8.5 Fire detection devices

Aspirating type smoke detection system-

Aspirator/air sampling type smoke detection system, based on laser-based technology, shall be provided with network of air-sampling pipe, drawing air continuously from the area under its coverage, by efficient aspirators. The detection chamber, located suitably, shall have series of internal filters removing dust and dirt from the sampled air. Care should be taken to protect the optical surfaces in the chamber from contamination and error free performance.

Suitable pipe work for drawing the sample air continuously from protected area shall be laid and the Contractor shall critically study the configuration of the areas and the associated problems for designing and installing the smoke detection system.

The detectors, their associated control and cables shall be thoroughly designed so that no interference is created in proper operation of the system. Suitable interfaces shall be provided for supervision of the real time data through plant SCADA.

Automatic fire detectors-

The detectors spacing and rating shall be in accordance with the applicable standards/codes and shall have UL approval. The smoke detectors shall be designed with minimum effect of environmental conditions like air velocity, altitude, humidity, temperature, colour of smoke, electrical and mechanical influences like abnormal pressure or vibration and the influence of aerosols and any particulate matter. It shall be plug-in type with detector base containing terminals for making connections.

Provision of visual indication of detector's alarm condition shall be visible from a distance of six (6) m and visually different from indications of other conditions. The openings of the smoke entry shall be at least thirty (30) mm below the ceiling level assumed to be smooth and flat.

Manual pull stations-

The manual pull stations shall preferably be located at access ways within a distance of 1.5 m from the exit doorway opening at each exit on each floor and distance to the nearest pull station measured horizontally on the same floor shall not exceed 50 m. The coded manual pull station shall produce at least three (3) repetitions of the coded signal, with each repetition to consist of at least three impulses.

The lever of the manual pull stations shall get locked after manual activation till it is reset.

19.8.6 Fire suppression system

Hydrant systems and hose reels-

Fire hydrants and its components shall be designed and installed in conformity to relevant code/standards. Hose reels with shut-off nozzle shall preferably be installed in recesses so that they do not

form obstruction on a route of escape and shall be located in accessible positions at each floor level adjacent to exits in corridors on exit routes.

The spacing of hydrants shall not be more than 20m from each other in alternate side. Hose reel brackets shall be firmly fixed to the wall so that the casual knocks or during stresses does not render it from being non-functional. The space requirement, location, maximum overall size, component case, water supply for hose reels, materials, appliances etc. shall be in accordance with relevant standards. The hose stations shall be so positioned so that two streams can be directed to any location.

Water sprinkler and spray systems for generator step up transformer-

The system shall be designed as a ring main network of projectors around the generator transformers and water under pressure shall be directed to the projector network through deluge valves from the pipe network laid exclusively for the HVW spray system. The system shall consist of deluge valve, heat detector (quartzoid bulb), projectors, pipings & supports and shall be suitable for operation automatically as well as by remote and local manual control. The following transformers are covered by HV water spray system:

- 15 MVA, 11/132 kV, ONAN, three -phase Generator transformer 2 nos.

The generator transformers shall be placed in transformer yard as shown in the enclosed drawing.

The layout of piping and the location of nozzles and supporting structures shall be such that the adequate electrical clearances from phase to ground are maintained.

The details of various components of HV water spray system are as below:

a) Temperature Sensing Elements:

The temperature sensing elements shall be of fixed temperature type or rate of rise temperature type. The sensing element shall be suitable for actuating the pneumatic system, which controls the flow of water through respective deluge valve. The selected fixed operating temperature of the sensing elements shall be 79 deg. C.

The contractor shall design the locations and number of temperature sensing elements for each installation so as to envelope the equipment efficiently for initiation of the fire protection arrangement.

b) Deluge Valve and Assembly:

Deluge Valve shall be water pressure operated manual reset type. The Deluge Valve shall be closed water tight when water pressure in the heat detector pipe work is healthy and the entire pipe work shall be charged with water under pressure upto the inlet of the Deluge valve. On fall of water pressure due to opening of one or more heat detectors, the valve shall open and water shall rush to the spray water network through the open Deluge valve. The valves shall be manually reset to initial position after completion of operation. Each Deluge Valve shall be provided with water motor gong which shall sound an alarm when water after realizing through the Deluge valve, is passes through the water motor.

Each Deluge valve shall be provided with a local panel, which will enable manual electrical operation of the valve. In addition to this, each Valve shall be provided with local operation latch. Test valves shall simulate the operation of Deluge valves and shall be of quick opening type.

c) Projectors/Nozzles:

Emulsifying projectors/nozzles made of anti-corrosive material with sufficient spraying capacity for extinguishing fire shall be provided.

The water spray system for transformer shall be designed to deliver minimum of 10.2 lpm/m² of exposed surface of transformer. Necessary factor of 1.6 shall be considered for over lapping of zones, misdirection, wastage etc. to calculate actual water requirements.

Complete details of projectors indicating the number of projectors, discharge capacity of each projector and water discharge velocity shall be indicated in the tender.

The system design shall be in accordance with relevant standards. All sprinklers etc. shall be UL approved make.

Portable fire extinguishers-

Portable and wheeled type chemical fire extinguishers shall be provided as ready means for dealing effectively and immediately with fire in the powerhouse area. Following types of fire extinguishers shall be provided.

- Hand portable foam type chemical extinguishers complete with initial charge. The fire extinguishers shall be complete with wall mounting arrangements.
- Wheeled portable foam type chemical extinguishers consisting of two nos. units, 10 m long high pressure hose and fittings mounted on cushion typed wheel trolley.
- Hand portable CO₂ cylinders complete with discharge valve of squeeze grip type or wheel type, 1 m high-pressure hose and discharge horn.
- Wheeled portable type CO₂ extinguishers consisting of two units CO₂ cylinder complete with valves, 10 m long high pressure hose and discharge horn, mounted on cushioned typed wheel trolley.
- DCP type extinguishers complete with brass nozzle and high-pressure discharge hose.

Hand portable type and trolley mounted foam type fire extinguishers shall fulfil the requirements of IS 9333 in respect of material, shape, construction and performance.

Dry powder type extinguishers shall conform to the requirements of IS: 2171, in respect of material, shape, construction and performance.

All fire extinguishers shall be subjected to anti-corrosive treatment and shall be painted and marked as per requirements of relevant standards.

All the equipment shall comply with relevant Indian Standard and approved by TAC.

19.8.7 Fire alarm and signalling system

Power supplies-

Fire alarm systems shall be provided with at least two independent and reliable power supplies, one primary and one secondary (standby), each of which shall be of adequate capacity for the application and performance of the fire alarm system. The Contractor shall coordinate with the plant DC system manufacturer in designing and supplying the necessary cables, connections, interfaces etc. for the secondary power supply of the fire alarm panel. The Contractor shall fully ensure that the changeover

from primary supply to secondary supply and vice-versa shall be fully automatic without affecting the transmission of signal via the fire reporting system upon operation of the initiating devices.

Fire alarm control panels-

The main fire alarm control panels shall provide automatic, supervised, multi zone detection and alarm system. Each fire alarm panel shall be of modular type, installed in a mounted steel cabinet with hinged door and cylindrical lock. The panels shall be clean, uncluttered and orderly assembled containing all necessary operating and supervising elements/ components, using a solid-state technique. The start-up shall be automatic after restoration of power either primary or secondary. Signals and LEDs/ LCDs together with visual annunciation shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system as an integral part of the control panel with suitable identification.

The operational features of the modules shall have at least the following. Other additional features required to make the system fully functional shall also be incorporated in accordance with relevant standards.

- monitoring electrical supervision of different circuits viz. initiating device circuits, circuits used for supervisory signal services viz. sprinkler water-flow, water level indicators etc.
- monitoring electrical supervision of power supply, transmitter tripping circuit integrity etc.
- monitoring of fire water filling pumps i.e. On/Off/Trip.
- trouble buzzer and trouble LEDs/LCDs against any fault due to loss of power supply, single break, open, or ground fault condition, panel fault and panel door open etc. impeding the normal functioning of the system.
- evacuation alarm signal switch and transmitter disconnect switch.
- confirmation or verification of all smoke detectors.
- monitoring and control of fire sprinkler system, release of deluge system and other fire extinguishing system.
- Control panels and field panels shall have suitable software programme enabling expansion and modification of the system without replacement of hardware or firmware viz. addition or deletion of zones etc.

An alarm condition in the circuit, which shall automatically annunciate in the mimic shall have at least the following functions to make the system fully functional. These alarms shall also be printed out.

- transmission of signal to the plant SCADA system.
- visual indication of the alarm device on the fire panel control panel display.
- continuous operation and sounding of alarm notification appliances as per the applicable standards.
- operation of smoke control system and de-activation of air handling units in the alarmed area.
- Automatic discharge of the respective fire suppression system with maximum 15 seconds delay for deluge system and 30 seconds for wet pipe system.

Provision of necessary contacts/ports for control, monitoring, and supervision and alarm functions shall be made in the fire alarm control panels for duplicating these functions in plant SCADA system.

Unacknowledged alarm signals shall not be interrupted if a fault on a fire detector circuit or a signalling line circuit occurs while there is an alarm condition on that circuit.

All major devices installed in the panel shall have 10% spare capacity. Fire alarms, supervisory signals and trouble signals shall be distinctively and descriptively annunciated.

19.8.8 Cables and Wires

Cables, wires and conduit raceways shall be in accordance with relevant standards. The cables shall be braided sheathed laid down in suitably sized conduits, electrical tubings, metal moulding or metallic race ways and shall offer protection against fire and mechanical injury as per relevant standards and specifications. The use of wire nut type construction for wiring shall be prohibited. Screw terminal boxes shall be preferably used. All the cables and wires shall be suitably tagged for proper identification by colour bands and by ferrules at junctions respectively.

19.9 Spare Parts

19.9.1 General Spare Parts

The Contractor shall supply the general spare parts as per "General Technical Specification (GTS)". The supply of these spare shall be as per the list of spares for each component/ equipment/ item approved during detail engineering.

The spare parts mentioned here under are meant for use by the Employer during operation and maintenance stage and shall not be used as erection spares required during installation.

19.9.2 Specified Spare Parts

Mandatory spare parts shall be supplied in accordance with the list mutually agreed between the Owner and Contract, which is furnished by the Contractor in their final offers.

19.9.3 Recommended Spare Parts

The Contractor shall furnish the list of recommended spare parts as per clause no. 3 of "General Technical Specification (GTS)".

19.10 Tools and Instruments

In addition to the tool listed in general technical specification, the Contractor shall provide one set of all necessary special tools and maintenance equipment for repair and maintenance of the Firefighting system as recommended by the manufacturer.

A list of such tools shall be approved during detail engineering.

19.11 Drawings, Documents and Design Calculations

19.11.1 Design memorandum

The Contractor shall prepare and submit to the Employer a “Designed Memorandum” of the proposed equipment/system fulfilling the contract specification / requirements for approval prior to submission of drawing and documents. The memorandum shall include the design philosophy, methodology, system description, input parameters for design, standard and codes, design and selection criteria, equipment data, material specification, measure technical features, basic arrangement / layout etc.

19.11.2 Drawings and documents

The Contractor shall submit all the drawings and documents in accordance with General Technical Specification (GTS).

These drawings and documents shall include at least the following:

- Schematic drawings of entire fire protection system.
- Piping layout drawings.
- Automatic high velocity water spray system of generator transformers.
- Fire hydrant system.
- OGA & layout drawings of filling pump system.
- Complete list of fire safety control functions with complete sequence of operations detailing all inputs and outputs in the form of input/output matrix.
- Layout of fire detection system.
- Schematic & layout drawing of fire alarm system.
- O&M manual.
- Data sheet of all fire protection equipment.

19.11.3 Design Calculation

The Contractor shall submit the design calculation for following to the Employer for approval during detail engineering.

- Sizing of piping for distribution manifold
- Calculation for selecting the pump capacity and working head for pumps
- Deluge system for transformers
- Sprinkler system for mechanical and electrical utility areas and offices
- Calculation for nos. and type of automatic fire detectors and manual pull stations
- Number of indoor and outdoor hydrants provided.

19.12 Quality control and Assurance

The contractor shall submit a comprehensive quality control plan for Owner's review and approval.

19.13 Tests

19.13.1 Shop Tests

The pump, pipes, valves, Deluge system, sprinkler system, automatic detectors etc. to be supplied shall be routine tested as per relevant IEC/IS at the manufacture's works in presence of the Employer. The Contractor shall submit type test certificates and routine test reports of equipment.

19.13.2 Field Tests

After installation, the firefighting system shall be field tested for operational tests and leakage tests. If the system shall be tested in sections, the same applies for each section.

The Contractor shall prepare and hand over to the Employer details of all test results in a report in a mutually agreed format.

19.14 Installation and Commissioning

The supplier shall follow the requirements of Delivery, Installation and commissioning elaborated in "General Technical Requirements."

The Contractor shall furnish all labour, supervision, tools, supplies, bracing, spiders, shims and supports and all other provisions or materials necessary to assemble, erect, install, test and commission the equipment in a thorough workman like manner following the best modern practices.

The equipment and all its components shall be placed with great care and accuracy and shall be aligned correctly to provide an installation consistent with the close tolerances used in the erection of modern equipment. The Contractor shall establish the proper elevations and centrelines to which equipment is to be set.

All installation shall be done by skilled workers in a workmanlike manner. Pipe fixtures shall be spaced according to accepted standards and provisions made for thermal expansion and contraction of piping. Before installation all system components shall be checked for cleanliness and after installation, the systems shall be effectively flushed out with clean water and filled up for testing.

The power plant fire alarm system must be in any case, ready for operation prior to the commissioning of the first generating unit. The control block fire alarm prior to the main control building finish date.