OR

(b) more than 1 m wide.

Pipe Sizing and Design: - Sprinkler heads located as per Para 9.4.5 to 9.4.10 shall be connected with pipe lines permanently charged with water. Depending upon location of sprinkler heads and site conditions, sprinkler heads may be connected with range and distribution pipes. A number of options have been indicated in Figure-12.

The pipes connecting the sprinkler heads are to be sized depending upon number of sprinkler heads and arrangement of their connection. Main elements of a sprinkler installation are shown in Figure-11. Various pipes connecting the sprinkler headsare termed as below:

(a) Range Pipe
(b) Distribution Pipe
(c) Main Distribution Pipe
(d) Riser

Sizes of pipes are to be calculated from various tables and hydraulic calculationsgiven in IS: 15105.

Pipe sizes shall be determined using one of the following methods:

a) **Pre-calculated system:** applicable only where light and ordinary occupancies where the aggregate floor plate area (in one or more floors combined) is 5000 m^2 or less (except where gridded or looped layouts areused).
Pre-calculated pipework is applicable only to the extensions of old pre- calculated systems.

b) **Fully calculated system**: applicable for
   i) Light and ordinary occupancies where the aggregate floor plate area (inone or more floors combined) exceeds 5000 m^2.
   ii) High hazard occupancies,
   iii) Storage occupancies, and
   iv) All occupancies where conventional and special sprinklers are used likeESFR, LD, EC, intermediate, etc.

Some guidelines relating to pre-calculated system are given below:

a) Pipe less than 25 mm diameter is not to be used.
b) There shall not be more than 6(Six) sprinklers in any range.
c) Range and distribution pipe nominal sizes shall be selected from Table 9.4and Table 9.5 respectively.

TABLE 9.4

RANGE PIPE NOMINAL SIZES FOR VARIOUS PIPE LAYOUTS IN MODERATE/ORDINARY HAZARD INSTALLATIONS

	Range Pipe Layout	**Pipe Nominal Bore (mm)**	**Maximum Number of Sprinklers to be fed by Pipe of size listed**
	(1)	(2)	(3)
(a)	(1) Range(s) at remote end of each distribution pipe spur in end feed layout:		
	(i) Last two ranges in two end-side layout	25	1
		32	2
	(ii) Last three ranges in three end-side layout	25	2
		32	3
	(2) Last range in all other layouts.	25	2
		32	3
		40	4
(b)	All other ranges in case of1(i), 1(ii) & (2) above	25	3
		32	4
		40	6

TABLE 9.5

DISTRIBUTION PIPE NOMINAL SIZE IN MODERATE/ORDINARY HAZARDINSTALLATIONS AND MAXIMUM NUMBER OF SPRINKLERS

Distribution Pipes	**Type of Layout**	**Distribution Pipe Nominal (mm)**	**Maximum Number of Sprinklers to be fed by Pipe size listed**
(1)	(2)	(3)	(4)
(a) At extremitiesof the Installation	Two end side layouts	32	2
		40	4
		50	8
		65	16
(b) Last three ranges	All other layouts	32	3
		40	6
		50	9
		65	18
(c) Between design points	All	To be calculated as per **10.4.4** (b) of IS15105	

and the Installation Control Valve		

Typical pipe sizes for sprinkler installation have been shown in Figure-13.

Components of sprinkler system:- Following types of valves are used in theinstallations:

(a) Stop Valves
(b) Test Valves
(c) Drain Valves
(d) Flushing Valves
(e) Check Valves
(f) Installation Control Valves
(g) Pre action valves
(h) Subsidiary valves

The location of above valves shall be as under:

Test Valve. - For testing hydraulic alarm or electric alarm by drawing water from downstream side, test valve shall be connected with downstream of the water flow alarm.

Drain Valve: - For drainage of system, drain valve 50 mm diameter shall be provided down stream of Installation Control Valve or any subsidiary stop valve.

A common valve can perform the functions of test and drain. The outlet shall be connected with a 50 mm diameter G.I. drain pipe along with riser pipes as shown in figure No. 3 and 4.

Flushing Valve:- If the water used for sprinkler is not potable, flushing valves shall be provided at the end of a distribution pipe. The valve size shall be same as distribution pipe. Valve outlet shall be fitted with a brass plug and extended to not more than 3 m above floor.

Check Valve:- Check valve shall be provided where more than one water supply is available and same shall be fitted on each water supply pipe.

Subsidiary Stop Valve:- Subsidiary stop valve which shall be of the same diameter as the pipe line in which they are fitted shall be provided to controlwater supply to sprinklers of highly sensitive areas like computer rooms.

Installation Control Valve (ICV)**: -** A sprinkler installation shall be fitted with a suitable Installation Control Valve to control the water supply to the installation. The valve set shall comprise of:

(a) a main stop valve.
(b) an alarm valve.
(c) a water motor alarm.

The alarm valve shall be fitted immediately downstream of the main stop valve of each

building/block and before any connection is taken off to supplyany part of the installation.

The Installation Control Valve shall be placed externally in the vicinity of the main entrance of the building protected at an easily accessible place so that the alarm bell sound is heard by the inhabitants/passer-by. The valve shall be secured open by a pad locked or rivetted strap and protected against impact damage.

If there are genuine constraints in locating the Installation Control Valve outside the buildings, this may be located inside the building in the vicinityof main entrance (subject to approval of authorities concerned). Installation Control Valve in such cases, shall be located away from any exposure to damage and personnel shall be normally available in the vicinity of thelocation to get alerted by alarm operation. Also, electrically operated sirens interfaced with the opening of the alarm valve of ICV, shall be provided outside the building. In no case, Installation Control Valve shall be provided inside basement or inside pump room.

A plan of the risk with the position of Installation Control Valve shall be placed in a conspicuous location. A location plate shall be fixed near the Installation Control Valve bearing the following words in raised letters:

SPRINKLER
ALARM

Water motor alarm: Water motor alarm shall be provided very close to the alarm valve. Strainer shall be fitted between the alarm valve and the motor nozzle connection. The water outlet shall be positioned so that any flow of water can be seen. The alarm device shall provide audibility level of 85 dB above the back ground noise IeveI.

Pressure Gauges: - Pressure gauges shall be provided immediately aboveand below each alarm valve.

Stop cock shall be provided before pressure gauges for removal without interruption of water supply of the installation. Pressure gauges shall be as per IS: 3624.

SPRINKLERS TYPE

Sprinklers shall be as per IS: 9972 and following types:

According to type of discharge *(Refer Figure - 15):*

a) Conventional pattern
b) Spray pattern
c) Side wall pattern

According to mounting pattern:

a) Pendent sprinkler
b) Up right sprinkler
c) Horizontal sprinkler

Ceiling sprinkler According to Release Mechanism:

a) Fusible element sprinkler

b) Glass bulb sprinkler

According to Orifice Size:

a) 10 mm
b) 15 mm
c) 20 mm
d) 25 mm

According to Temperature Rating:

Sprinkler shall have one of the following temperature rating and shall becorrespondingly color coded:

(a) Fusible Link Type

Temp. Rating °C	Color Code
68/74	Natural
93/100	White
141	Blue
182	Yellow
227	Red

(b) Glass Bulb Type

Temp. Rating	Color of bulb Liquid
57	Orange
68	Red
79	Yellow
93	Green
141	Blue
182	Mauve
204/260	Black

SELECTION OF TEMPERATURE RATING

Temperature rating of a sprinkler should not be less than 30° C more than the highest anticipated temperature of the location of installation. Under glazed roofs or where there are roof sheets of PVC or similar plastic material, sprinkler shall be rated 73° C to 100°C.

SELECTION OF ORIFICE SIZE

In moderate hazard applications, sprinklers of orifice size 15 mm shall be used.

Table-9.6 Types of sprinkler			
S. No.	**HAZARD CLASS**	**SPRINKLER PATTERN**	**NOMINAL ORIFICE NOT LESS THAN MM**
(1)	(2)	(3)	(4)
i)	Light	Standard, Spray, Flush, Sidewall types	10-15
ii)	Ordinary	All except sidewall types	15
iii)	High	Standard, spray pattern only	15-25
iv)	Storage	Standard, spray pattern only	15-25

SIZE OF INSTALLATIONS

The protected floor area to be controlled by any one Installation Control Valve shall not exceed 12000 m^2.

As far as possible one area shall be controlled by one Installation Control Valve. If the area is quite large, more than one Installation Control Valve should be planned. Details of area controlled by an Installation Control valve shall be exhibited near it.

If there are more than one block in a campus, each block shall be providedwith different Installation Control valve.

PROTECTION OF SPRINKLERS

Any sprinkler installed in a position of risk or accidental damage shall be fitted with a metal guard suitable for sprinkler service.

WATER SUPPLY ARRANGEMENT FOR SPRINKLER

Pump- Details of pumps to be installed for sprinkler installation are given in Appendix-A. For large installations, separate jockey pump shall be provided for sprinkler system. All pumps shall have common discharge header. If two electrical pumps are to be provided one non-return valve shall be provided in the header such that sprinkler pump will not feed other system.

Water Storage Tank- The water storage tank shall be combined for other firefighting system and sprinkler installation and the capacity shall be as given in Appendix 'A'.

SPRINKLER ANNUNCIATION PANEL AND ALARM

Electrically operated alarm shall be provided for indication of operation of sprinkler in an area. Water flow switches shall be installed in main distribution pipes which shall be wired to sprinkler annunciation panel. In the event of operation of a sprinkler, the flow switch will operate and give signal to the annunciation panel to indicate operation of sprinkler in the area. This will initiate an electrically operated alarm. The system shall

be independent of fire alarm system and compatible with BMS. Necessary potential free contacts for use in BMS should be provided.

Construction Details

(i) The Panel shall be fabricated out of not less than 2 mm thick MS sheet and powder coated after 7 tank treatment process and shall be totally enclosed dust damp and vermin proof. Suitable knockout shall be provided for the entry of cables. The panel shall be designed such that the equipment for power supply, battery charging are housed in independent compartments. Sealed maintenance free batteries shall also be accommodated inside the panel.

(ii) Indicating lamps control switches, buttons and fuses shall be suitably located in the front and properly labeled.

(iii) The indicating lamps shall be LED type of following colors. The flow switch operation conditions shall be indicated by twin lamps.

(a) Red to indicate flow switch operation.

(b) Amber to indicate fault condition.

(c) Green to indicate healthy condition.

(iv) The test buttons to test the indication lamps shall be provided.

(v) The panel control shall be microprocessor type.

(vi) The primary function of the panel shall be to respond automatically to theoperation of one or more flow switches to give alarm and to indicate area/areas where the device has activated. The operation of one or more flow switches shall result in simultaneous alarm given by the following:-

(a) External alarm hooter(s) (provided outside the building to be protected).

(b) A visible indication on panel.

(c) Audible alarm on panel itself (common for all zones)

(vii) The panel shall indicate the fault within the system and immediate faultwarning shall be given by an audible and visible signal on the panel in case of open circuit, short circuit and earth fault in cable between flowswitch and annunciation panel.

(viii) The panel shall be complete with mimic diagram for the areas covered by different flow switches. The layout of mimic diagram shall be got approved from Engineer-in-Charge.

(ix) Battery backup with trickle cum boost charger shall be provided for operation of the system. Indication of mains failure and the state of charge of the batteries shall be provided. The batteries shall be sealed maintenance free. The capacity of the battery shall be 12 Volt, 2 Nos. 24Ah each. All standard accessories shall be provided.

INSTALLATION

The installation shall be carried out as per Chapter 7 and 11. Followingadditional points are to be taken care for sprinkler installations:

For fixing sprinkler heads, 15 mm diameter M.S. Socket is to be welded to range pipes at the locations as per drawings. Dead plug shall be fixed in the socket.

If sprinkler head is to be provided away from range pipe, M.S. Pipe nipple of suitable size be used to extend the sprinkler head and socket is welded at desired location.

After completion of work in sections, pressure testing at 7.5 kgf/cm^2 pressure shall be carried out for 24 hrs.

After completion of the entire work, pressure testing of entire pipe work shallbe carried out for 24 hrs. at a pressure of 7.5 kgf/cm^2. The drop of pressure up to 0.5 kgf/cm^2 shall be accepted.

The lines shall be flushed before completion of building work so that any foreign matter which might have entered the system is taken out. The pressurization pump (Jockey Pump) be operated and valves opened at different locations.

During occupation of the building, sprinkler heads shall be provided in place of dead plugs. Teflon tape shall be used on threaded portion. The sprinkler heads shall be properly tightened in the socket.

When all sprinklers heads are installed, pressure is built up in the system by pressurization pump slowly and in case no leak is found, desired pressure is developed and maintained. In case any leak is detected, the same shall be attended before pressurizing the system further.

COMMISSIONING

As soon as the work is complete, the system shall be commissioned andmade available for use in accordance with Para 11.6.

Spare Sprinklers to be Kept in Stock :

A stock of spare sprinklers shall be maintained in the premises so that prompt replacement is possible after the operation/damage of sprinkler heads. The spares shall be kept in an easily accessible location under conditions where the temperature does not exceed 38°C.

The guidelines as in Table 9.7 shall be followed in respect of stocking spare sprinkler heads.

Spanners or wrenches for the sprinklers shall also be kept along with the spare sprinklers in readiness.

Table 9.7

Guidelines for stocking spare sprinkler			
S. No.	HAZARD CLASS	All state capitals and within 200Km thereof	Other locations
(1)	(2)	(3)	(4)
i)	Light	5 sprinklers of each type	15
ii)	Moderate/Ordinary	15 sprinklers of each type	25
iii)	High & storage	30 sprinklers of each type	50
Note- When there is more than one installation within a complex, the above quantity shall also be increased in proportion. Each type of sprinkler used in the installation such as conventional or spray or ceiling/flush or sidewall sprinklers and appropriate temperatures shall be stocked as per the above requirements.			

10. ELECTRICAL WORK

SCOPE

This chapter covers the requirements for the electrical worms associated with firefighting installations, namely, motors, switch boards, power cabling, control wiring, earthing and remote control-cum-indicating panels.

GENERAL

(i) Unless otherwise specified in the tender specifications, all equipment and materials for electrical works shall be suitable for operations on 415 V / 240 V + 10% (3 phase/single phase), 50 Hz AC system.

(ii) All electrical works shall be carried out complying Central Electricity Authority (Measures Relating To Safety and Electric Supply) Regulations, 2010 and NEC 2011, as amended up to date.

(iii) All parts of electrical works shall be carried out as per appropriate CPWD General Specifications for Electrical works, namely, Part I (Internal) 2013, Part II (External) 1994 work, and Part IV (Sub-station)- 2013 all as amended up to date.

(iv) All materials and components used shall conform to the relevant IS specifications amended to date.

POWER SUPPLY

Power supply to following systems and equipment, where provided, shall be from normal and emergency (standby generator) power sources with changeover facility:

a) Fire pumps
b) Pressurization and smoke venting; including its ancillary systems such as dampers and actuators.
c) Terrace pump
d) Fireman's lifts (including all lifts).
e) Exit signage lighting.
f) Emergency lighting.
g) Fire alarm system.
h) Public address (PA) system (relating to emergency voice evacuation and annunciation).
i) Magnetic door hold open devices.
j) Lighting in fire command center and security room.

The generator shall be capable of taking starting current of all the fire and life safety systems and equipment as above. Where parallel HV/LV supply from a separate substation fed from different grid is provided with appropriate transformer for emergency, the provision of generator may be waived inconsultation with the Authority.

The electric supply to the pumping set(s) shall be entirely independent of all other equipment in the premises that is even when the power throughout the entire premises is switched off, the supply to the pump shall continue to be available un-interrupted. This can be achieved by taking the connection for the pump(s) from the incoming side of the main L.T. breaker. In case, where parallel HV/LV supply from a separate substation fed from different grid is provided with appropriate transformer for emergency connected to a common bus bar, the connection may be taken through the bus bars.

The power supply to the panel/distribution board of these fire and life safety systems shall be through fire proof enclosures or circuit integrity cables or through alternate route in the adjoining fire compartment to ensure supply of power is reliable to these systems and equipment. It shall be ensured that the cabling from the adjoining fire compartment is protected within the compartment of vulnerability. The location of the panel/distribution board feeding the fire and life safety system shall be in fire safe zone ensuring supply of power to these systems.

Circuits of such emergency system shall be protected at origin by an automatic circuit breaker so set as to permit the motor to be overloaded during an emergency to the maximum limit permissible by the manufacturer. Further, the no volt coil/the under voltage release of that circuit breaker shall be removed. Master switches controlling essential service circuits shall be clearly labeled.

Independent supply shall be provided for water supply pumps if installed in the same pump house.

If the fire pump house is away from the sub-station building, the route of the cable shall not pass under the building or permanent structure. Cable shall be laid along the route which is safe from fire.

Sufficient spare power shall always be available to drive pumping sets at all times throughout the year. Suitable capacity ACBs/SDFUs shall be provided in the electrical panel for extending supplies to fire pumps. Such switches shallbe suitably marked "FIRE SWITCH" and shall not be switched-off without permission/intimation to appropriate authority. In case any maintenance/repair work is to be carried out on the electrical panel where from supplies to fire pumps have been extended, alternative arrangement shall be made to ensure that power supply to fire pumps continue to be available for operation any time.

MOTORS

The motors shall be squirrel cage AC induction type. The motors shall be suitable for continuous duty and rating necessary to drive the pump at 150 percent of its rated discharge with at least 65 percent rated head. The motorshall be totally enclosed fan cooled type confirming to protection clause IP 21 of IS: 4691. The class of insulation shall be 'F'. The synchronous speed shall be 1500/3000 rpm as per requirement of the pump. The motor shall conform to IS:325.

MOTOR STARTER

(i) The motor starter shall conform to IS: 1822 "Motor starters of voltage not exceeding 1000 volts" and shall be air insulated and suitable for 415 V, $\pm$ 10%, 50 Hz, 3 phase AC supply and shall be integrated in the panel.

(ii) Starter for the motor shall be direct on line (D.O.L) for motors up to and including 7.5 H.P. rating and automatic star-delta type for motors of higher ratings unless otherwise specified in the tender specifications. However, for main Fire Pump & Sprinkler Pump Soft Starters may be used.

(iii) Each starter shall be provided with the following protections: -

(a) Thermal overload on all the three phases with adjustable settings,

(b) Independent single phase preventer. (Current sensing type).

(iv) Adequate number of extra NO/NC contacts for interlocks, indicating lamps, remote operation etc. shall be provided on the starter/ contactor.

(v) Under voltage/No volt trip shall not be provided.

SWITCH BOARDS

(i) The main switch board shall be floor mounted, free standing or wall mounted cubical type and shall be factory built fabricated by one of the approved switch board manufacturer. The board shall be fabricated from 2.0 mm thick CRCA sheet and powder coated after 7 tank treatment process. The board shall be fabricated with IP 42 degree of protection. It shall be suitable for termination of the incoming cable(s) from bottom.

(ii) The capacity of switch gear shall be suitable for the requirements of motor fed/ controlled. Starting currents shall be duly considered.

(iii) Switch fuse units shall be used up to and including 32 A and SDFU shall be usedfor 63 A and above. ACB shall be used for 630 A and above ratings.

(iv) All Switch fuse units/SDFUs shall be of AC 23 duty as per IS: 4064-1978 as amended up to date. They shall be complete with suitable HRC cartridge type fuses.

(v) Switch boards shall house starters for motors with independent current sensing type single phase prevent or for each starter.

(vi) Volt meter with selector switch, a set of indicating lamps and fuses for voltmeter and lamps shall be provided. Ammeter with CTs, and selector switch shall be provided with each motor starter. Instruments shall be flush mounted with the panel and have a class index not higher than 1.0. The instruments and accessories shall be provided whether or not specifically indicated in the tender specifications.

(vii) The fabrication of switchboard shall be taken up only after the drawings for the fabrication of the same are approved by the Engineer-in-charge.

(viii) Switchboards shall be fabricated as per specifications indicated in sub-para above.

(ix) The layout shall be designed for convenient connections and inter- connections with the various switchgear. Connections from individual compartments to cable alleys shall be such as not to shutdown healthy circuits in the event of maintenance work becoming necessary on a defective circuit.

(x) Care shall be taken to provide adequate clearances between phase bus bars aswell as between phase bus bars, neutral and earth.

(xi) Where terminations are done on the bus bars by drilling holes therein, extra cross section shall be provided for the bus bars. Alternatively, terminations may be made by clamping.

(xii) Provision shall be made for proper termination of cables at the switchboards such that there is no strain either on the cables, or on the terminators.Cables connected to the upper tiers shall be duly clamped within the switchboard.

(xiii) Identification labels shall be provided against each switchgear and startercompartment, using plastic/aluminum engraved labels.

(xiv) Metallic danger board conforming to relevant IS shall be fixed on each electrical switchboard.

SYSTEM CONTROLLER

For controlling operation of pumps as per Para 2.4.1.14 and indicating fault, system controller shall be provided. The system controller shall consist of relays, timer, contactors etc. and shall be designed to operate the fire pumps with interlocking and fault indication as described in Para 2.4.1.15. Annunciation window shall be provided to indicate following faults:

(i) Low water level in UG tank

(ii) Low water level in terrace tank.

(iii) Main pump failed to start.

(iv) Main pump failed during operation.
(v) Diesel pump failed to start.
(vi) Diesel pump failed during operation
(vii) Supply to Main Pump failed
(viii) Supply to Pressurization Pump failed
(ix) Supply to Terrace Pump failed.

Suitable sensors, differential pressure switches, monitors shall be provided at respective locations. The control system shall be operational on 12 Volt/24 Volt DC starting batteries of engine. Battery chargers shall be provided to ensure thatthe batteries remain charged. Batteries shall be sealed maintenance free type.

REMOTE INDICATING PANEL

(i) The remote indicating panel shall be provided in the fire control room. This panel shall have necessary status indication of all electric motors.
(ii) Back indication to show the status of operation of all the motors, pressure in the system, water level in underground and overhead tank etc. shall be provided.
(iii) Panel shall be fabricated from not less than 1.6 mm thick CRCA sheet and powder coated after 7 tank treatment process. The panel shall be dust,damp and vermin proof. This shall be of wall mounting type. This shall be complete with necessary termination arrangements, multicore cables, tag blocks, control transformer, designation plastic labels, double earth studsetc. as required.

POWER CABLING

(i) Unless otherwise specified, the power cables shall be XLPE insulated, PVC outer sheathed aluminum conductor, armoured cables 1100 V grade. The power cables shall be of 2 core for single phase, 4 core for sizes up to and including 25 sq.mm for 3 phase and 3-1/2 core for sizes higher than 25sq.mm for 3phase.
Alternatively, XLPE/PVC insulated copper cable (single core/multicore armoured/un-armoured) of grade 1100 V shall be used.

For main power cable(s) from LT Room to Fire Pumps Panel, if the cable(s) is taken in cable trench duly filled with sand & with proper distancing from other cables within the cable trench, or in fire rated shaft, then the cable(s)of above type be used. However, if the cable(s) is likely to be exposed to fire, then fire survival cable(s) shall be used.

(ii) Power cables shall be of sizes to meet the starting and running current of motors fed and shall be as approved by the Engineer-in-Charge, after taking into consideration the load, the length of cabling.

(iii) Cables shall be laid in suitable metallic trays suspended from ceiling, or mounted on walls. Cable ducts shall not be provided in pump rooms. Cable trays shall be of perforated steel sheet with adequate structural strength andrigidity. Necessary supports and suspenders for cable trays shall be provided by the contractor as required.

CONTROL WIRING

(i) Control wiring shall be done using ISI marked PVC insulated and PVC sheathed, 2.5 sq.mm, 250 V grade, armoured multi-core copper conductor cable. The control cable shall also be laid in the same manner as power cable.

(ii) The number and size of the control cables shall be such as to suit the control system design adopted by the contractor.

(iii) Runs of control wires within the-switchboard shall be neatly bunched and suitably

supported/clamped. Means shall be provided for easy identification ofthe control wires.

(iv) Control wiring shall correspond to the circuitry/sequence of operations and interlocks approved by Engineer-in-Charge.

EARTHING

(i) Provision of earth electrodes and the type of earthing shall be as specified in the tender specifications.

(ii) The earth work shall be carried out in conformity with CPWD Specifications for Electrical works (Part-I), Internal 2013.

(iii) Metallic body of all motors, medium voltage equipment and switch boards shall be connected by two separate and distinct earth conductors to the earth stations of the installations. Looping of such body earth conductors is acceptable from one equipment, or switch board to another.

(iv) The size of earth conductors for body earthing of equipment shall be 2 Nos. 6 mm dia copper wire/2 Nos. 25 x 3 mm G.I. strip

(v) Armoring of cables shall be connected to the body of the equipment/switch board at both the ends. Compression type glands shall be used for all such terminations in the case of PVC/ XLPE cables.

PAINTING

All panels shall be supplied with the manufacturer's standard finish paintingor as indicated in the Schedule of Work.

11. INSTALLATION, TESTING AND COMMISSIONING

SCOPE

This chapter covers the requirement of Installation, testing and commissioning of firefighting system.

PREPARATION AND APPROVAL OF DRAWING

On award of the work, the contractor has to prepare working drawings as per Para 1.17.2 and submit to the Engineer-in-charge for approval. The work is to be executed as per approved drawings. The stage of approval of drawings is therefore very important. All drawings should be carefully and critically examined before approval. The requirements of various components of firefighting system have been described in previous chapters dealing with the components. However, generally following points are to be taken care while examining and approving the drawings.

Site survey should be carried out in detail.

In addition to building plans, layout plan along with landscape plan/horticulture plan and other services plans should be consulted while deciding route of underground pipes from pump house and around the building.

As far as possible, underground pipe are not to be laid under road, pavement, building and long open spaces. The locations along road, foot path in earth may be preferred.

The location of yard hydrants, fire service inlet and fire service connection are to be decided based on consideration of Para 2.4.1.8 to Para 2.4.1.10. However necessary adjustments are to be made so that these components do not become hindrance in vehicular movement and entrance to the building. Requirement of other building services are also to be given due consideration. Symmetry should be maintained for aesthetic considerations.

Pipe sizes are to be decided in accordance with provision of Para 2.4.1.2 and4.5.4.

Pump House:-The layout of equipment in pump house is very important fromoperation and maintenance considerations. The requirement of pumps and engine have been described in Chapter 5 and 6. In case other equipment i.e.

water supply pumps etc. are to be installed in the same pump house, sufficient space shall be left for them as well. The dimensioned foundation drawing of pumps should be available for marking in the pump room layout. The layout is to be prepared in such a way that it should be possible to maintain any equipment without disturbing the adjoining equipment. Electrical panels are to be installed at a location which is easily accessible near the entrance to the pump house and there should be no possibility of water dripping over or near the electrical panel. Typical layout of fire pump house is shown in Figure -10.

Terrace Pumps:- The location of pumps and terrace pipe may be decided keeping in view location of terrace tanks for firefighting and other services. The pipe line should not cause undue hindrance for movement of maintenance personnel at the terrace.

Electrical Panel :- Complete wiring drawing, layout etc. are to be examined to ensure that provisions of agreement are incorporated in the drawing. Sizes of various panel and mounting arrangement may be decided keeping in view ease of operation and aesthetic consideration as well.

INSTALLATION:-

The requirements of installation of various components have been describedin previous chapters. However, following precautions are to be taken during execution of thework.

The pump and motor/engine are to be perfectly aligned on the base plate sothat there is no vibration during operation. All nuts, bolts, washers shall be of adequate size and galvanized.

The pipe supports should be decided in a way that the weight of pipes and valves are not transferred to the pumps and supports do not cause hindrancein movement inside the pump house. As far as possible, floor supports may be provided in pump house.

All valves shall be installed at a height and in a position that their operation by right hand is conveniently possible.

All pressure gauges should be installed so that the dial is vertical and is visible while entering the pump house.

Electrical panels should not be installed at floor level. The panels shall be sufficiently raised above ground level. If panels are to be mounted on wall, an angle iron frame shall be provided so that at least 75 mm space is left behind the panels. The panels shall be easily approachable.

Cable trays are to be used for laying of power and control cable inside pumphouse. No cable is to be laid at floor level/in trench. Cable tray layout should give neat appearance. All cable tray shall be adequately supported from the ceiling/floor.

Drain pump shall be installed in the sump provided as per Para 3.2.2 (viii). The pump shall operate automatically for which water level sensor shall be provided.

In no case any structural member i.e. RCC wall, column, beam and floor are to be damaged during installation. Mechanical fasteners are to be used for grouting support.

U.G. tank wall is not to be used for any support. No pipe/cable is to cross the pump house below ground level. Openings above ground level are only to be used for this purpose.

The engine installation work shall be carried out in accordance with the requirement of engine manufacturer and be got approved by the manufacturer or their authorized service center. The exhaust pipe shouldbe suitably extended outside the pump house so that smoke does not effect nearby structure. Fuel tank shall be properly supported and located in a way that the same does not cause hindrance in movement in the pump house.

While excavating for laying of external pipes, suitable sign board/ barricading shall be provided to ensure that no person falls in the trench.

The width and depth of trench shall be adequate for laying the pipe 1m below ground level.

No earth or any other matter is to be allowed to enter the pipes. The ends shall be kept closed always.

The anticorrosive treatment is to be applied on the entire length laid underground in accordance with Para 7.5. The treatment is not to be damaged.

Pressure testing is to be carried out in sections before filling the earth back in the trench.

The earth filling is to be done in layers of 20 cm each and properly rammed so as to avoid possibility of settlement. Surplus earth/ malba shall be removed from the site by the contractor.

Where pipes crossing road likely to have heavy traffic, additional protectionover pipe shall be provided to ensure that pipe is not damaged. However, semi-circular RCC Pipes shall be provided over cast iron pipes at road crossings.

External hydrants and fire service connection/ inlet shall be located parallel to the nearby road/ foot path so as to give proper appearance. Foundation shall be raised from below ground level and shall be properly plastered in plumb. The hydrants shall be facing the road/ approach. There shall be no obstruction in approaching the hydrants for operation.

Risers shall be parallel to the wall and in plumb. Adequate supports shall be provided from the wall. Opening around the pipe in slab shall be filled with CCand finished with plaster.

Internal hydrant shall be provided in the center and facing outside for ease ofoperation. Sufficient space shall be provided around the handle for operation. There shall be no

hindrance in moving the first aid hose reel.

Terrace pipes shall be supported on CC pedestals of adequate height. The pipe route shall be such as no hindrance is created in movement at the terrace. Pipes shall be sufficiently raised above terrace. It is to be ensured that water proofing isnot damaged during laying of pipes.

TESTING

Initial Testing

During laying of pipes, the same shall be subjected to 10 kgf/cm^2 hydraulic pressure for a period of 24 hours, in sections.

After completion of the work, all vaIves/ fittings shall be installed in positionand entire system shall be tested for 24 hours at a pressure of 10 kgf/ cm^2. The drop of pressure up to 0.5 kgf/cm^2 shall be accepted.

Final Testing

After completion, all operation checks as per Para 2.4.1.14 shall be carried out for automatic operation of the systems. For this purpose, landing valvesmay be opened at different locations. The exercise shall be repeated coupleof times to ensure trouble free operation of the system.

Flow Test: - The design flow of pumps shall be checked. The pump shall be operated after opening a number of landing valves at different locations. Design pressure is to be maintained in the pump house. Water discharge is tobe measured by drop in level in UG tank for a certain period. All pumps shall be tested one by one. The flow rate shall be not less than as specified while maintaining the design pressure in pump house.

INSPECTION BY LOCAL FIRE OFFICER

After completion of the work and testing to the entire satisfaction of Engineer-in- Charge, the installation shall be offered for inspection by Chief Fire Officeror his representative. Testing as desired by the Fire Officer shall be carried out. The contractor will extend all help including manpower during testing. The observations of Chief Fire Officer shall be part of the agreement. These shall be attended by the contractor. Nothing extra shall be paid for testing asabove.

COMMISSIONING

Flushing the System: Before commissioning, the entire system shall be flushed to ensure that any earth/ foreign matters which might have enteredduring installation are taken out. For this, pump may be operated and valvesopened at different locations.

As soon as the work is complete, the system shall be commissioned and made available for use. Requirement of firefighting installations is equally important during occupation of the building. If the building is to be occupiedin part, firefighting system of building completed shall be commissioned by isolating the system of under construction portion of the building.

The firefighting system shall be maintained and manned from the very first day of its commissioning.

Any defects noticed during the warranty period shall be promptly attended by the contractor and availability of the system at all time is to be ensured.

APPENDIX —B

TERMINOLOGY

For the purpose of these Specifications, the following definitions shall apply:

1. **Air Release Valve:** A device by which the trapped air inside a riser main is expelled by water as the system is being charged.

2. **Air Vessel**: A cylindrical vessel installed in the wet-riser system at the bottom and top levels to counteract the water hammer effects.

3. **Authority concerned:** An Organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving or accepting equipment, materials, an installation, or a procedure.

4. **Automatic Fire Detection and Alarm System:** A system comprising components and sub-systems required for automatically detecting smoke, heat or fire, initiating an alarm and other actions as appropriate. This system also includes manually operated electronic fire alarm (MOEFA) system.

   Note- MOEFA System (with or without automatic fire detection and alarm system) includes all or some of the components such as manual call stations (initiating an alarm for fire and other actions as required), talk-back system and public address system.

5. **Automatic Sprinkler System:** A system of water pipes fitted with sprinkler heads at suitable intervals and heights, and designed to actuate automatically, control or extinguish a fire by the discharge of water.

6. **Building, height of:** The vertical distance measured in the case of flat roofs, from the average level of the ground around and contiguous to the building or as decided by the Authority to the terrace of the last liveable floor of thebuilding adjacent to the external wall; and in the case of pitched roofs, up to the point where the external surface of the outer wall intersects the finished surface of the sloping roof; and in the case of gables facing the road, the mid- point between the eaves level and the ridge. Where the building is located in a sloped terrain, height shall be determined from the lowest level (that is approachable by the fire service vehicles) to the terrace level. Architectural features serving no other function except that of decorations, shall be excluded for the purpose of measuring heights.

7. **Down-Comer:** An arrangement for firefighting within the building by means of down-comer pipe connected to terrace tank through terrace pump, gate valve and non-return valve and having mains not less than 100 mm internal diameter with landing valves on each floor/landing. It is also fitted with inlet connectionsat ground level for charging with water by pumping from fire service appliancesand air release valve at roof level to release trapped air inside.

8. **Dry Riser**: An arrangement of firefighting within the building by means of vertical rising mains not less than 100 mm internal diameter with landing valves on each floor/landing which is normally dry but is capable of being charged with water usually by pumping from fire service appliances.

9. **Fire Compartment:** A space within a building that is enclosed by fire barrier orfire resistant walls on all sides, including the top and bottom.

10. **Fire Pump**: An electric/diesel pump installed at static water tank to charge the wet riser systems.

11. **Fire Resistance Rating:** The time that a material or construction will withstand the standard fire exposure as determined by the fire test done in accordance with the standard methods of fire tests of materials/structures as per the accepted standard.

12. **Fire Service Connections**: This is a 4-way collecting breeching with blank caps (without non-return valve) fixed to a 150 mm diameter pipe which is connected to the fire tank for filling from external source:

13. **Fire Service Inlet**: A 2- or 3-way collecting head with non-return valves fitted to the down comer/wet riser main, so that in case of need, fire service can directlypressurize the system with their pump.
14. **Foot Valve**: A valve fixed in the suction strainer of the fire pump which opens onlyinwards to allow in-rush of water into the pump suction and fire pump when the fire pump is actuated automatically/manually.
15. **High Rise Building**: A Building 15 m or above in height (irrespective of its occupancy).
16. **Hose Reel:** Firefighting equipment, consisting of a length of tubing fitted with a shut-off nozzle and connected to a reel, with a permanent connection to a pressurized water supply.
17. **Jockey Pump**: A pump of small capacity which is set to come into operation, automatically with drop in static pressure in the system and to automatically stop when the pre-set pressure is attained.
18. **Landing valve**: An assembly comprising valve(s) and outlet(s) connection from a riser system.
19. **Priming Tank**: A small tank erected in/over the pump house above the firefighting pumps to keep the pump casing and suction of the fire pump permanently flooded.
20. **Pressure Switch:** A switch connected on delivery line of fire pump or in the body of hydro-pneumatic tank at pre-set pressure level so designed to automatically start the fire pump or jockey pump, as the case may be, when thepressure in the system falls below the pre- set level.
21. **Pump Panel**: Panel comprising starting, stopping and indicating devices of firepumps.
22. **Stand-by Pump**: A pump of same capacity as fire pump, driven by a dieselengine or connected to any other alternate source of electric supply.
23. **Static Water Tank:** Underground or surface water tank, constructed to store water for firefighting purpose.
24. **Terrace Pump**: An electricity driven pump, located on the terrace connected to a terrace tank with gate valve on suction side and to the internal hydrant system with non-return valve on delivery side.
25. **Terrace Tank**: A concrete/masonry/plastic steel tank constructed or erected on terrace of building for firefighting purpose.
26. **Wet-Riser:** An arrangement for firefighting within the building by means of vertical rising mains of not less than 100 mm internal nominal diameter with landing valves on each floor/landing for firefighting purposes and permanently charged with water from a pressurized supply.
27. **Wet-Riser-cum-Down Comer:** An arrangement for fire lighting within the building by means of vertical rising mains of not less than 100 mm. internal diameter with landing valves on each floor/landing connected to terrace tank for firefighting purpose, through a terrace pump, gate valve and non-return valve near the tank and to a fire pump, gate and non-return valves, over the static tank.

INTRODUCTION

This appendix cover suggestive guidelines for maintenance and operation of

the Wet Riser System.

OBJECTIVE:-

(i) To keep the entire system fully operational and functional at all times.

(ii) In case full system cannot be kept functional for unavoidable reason, as much as possible, the installation shall be retained functional by isolating the defective section.

MAINTENANCE REQUIREMENT OF SYSTEM COMPONENTS

For maintaining firefighting system following points are to be taken care of:-

To ensure availability of water in UG tank and terrace tank all the time and tomaintain the tanks in clean condition.

To ensure that the piping system is free from leakage. Any portion found tobe leaking is to be isolated, rectified and connected with healthy systemin shortest possible time.

To ensure that all pumps are in good running condition. Any pump found to bedefective is to be isolated by closing valves and attended immediately and put in to service in minimum time.

All pump glands shall be maintained in efficient working condition and the packing renewed as required to maintain the efficiency.

All working parts shall be kept clean and lightly oiled. Any necessary repairs shall be put in hand and carried out immediately.

To ensure availability of power for electrical pumps, working of starters,switch gear and other electrical components.

To ensure healthiness ofdieselengine starting system, battery voltage, battery charger and availability of adequate diesel for engine operation.

To check all landing valves of internal and external hydrants, isolating valvesand replace the defective ones whenever necessary

To check automatic operation of entire system by opening landing valves at different locations.

To conduct fire drill at regular interval.

PERIODICAL TESTING

For achieving the objectives of Para C.1.1 and meeting the requirement of Para C.2 periodical testing and checking the system is essential. Various activities and their duration have been tabulated in Table C.1.

PROCEDURE

Though the firefighting system operation is automatic, however for daily checking and attending to the system in case of operation, a trained pump operator shall be available round the clock.

Operation and Maintenance instructions shall be available in the pump room and fire control room.

Water for firefighting purpose is not to be used for any other purpose. However in order to avoid stagnation, the same shall be changed / cleaned regularly.

Maintaining Diesel Engine is very important for the system operation sinceduring fire, power supply is deliberately or un-deliberately switched off. Annual Maintenance Contract (AMC) of engine shall be given to the authorized service center of engine manufacturer. Adequate diesel should either be available in the pump house or nearby so that operation is not discontinued for want of diesel.

Hydrant Mains / Ring Mains shall be tested once a fortnight with a pump delivering at its maximum pressure. A running test with two or more hose lines each 30m long operating shall be carried out.

If any out let is found to be defective and replacement is not easily available the whole assembly should be removed and be replaced by blank off plate so that the system remains operational.

Hose reels shall be subjected to regular inspection to ensure that all valve are functional, out let nozzle not choked. At least once in a year the same shall be subjected to operation to ensure that hose reel is in good condition and that the coupling joints are water tight. Flow should also be checked for the leakage of hose reel.

All hydrants shall be examined systematically once a week to ensure that valves and spring catches are maintained in good condition.

Spare washers shall be kept for hydrant valve seats.

Cut-off valves shall be thoroughly overhauled annually to remove sludge and other foreign matter collected in the valve seating.

All isolating valves shall be checked for operation. The valves in closed position be opened and closed couple of times and the valves in open position be closed and opened couple of times so that when required, the valves perform their function.

All hose boxes/hose stations shall be inspected externally once every week to ensure that the equipment installed therein is intact. Further, the hose boxes/hose stations shall be cleaned internally and externally once amonth.

When the hose gets worn out at the tail end of the coupling(s), it is permissible to cut the end(s) of the hose. However should the lengths of the hose after cutting(s) fall below 90 percent of its original, the hose shall be discarded.

A hose register shall be kept showing Information such as date purchased, date brought into use, date cut (if reduced in length), is useful. Any hose becoming inefficient through use, neglect or from any other cause, shall be discarded.

Fire protection hose shall 'not be used for purposes other than fire protection and drill.

Hose pipes and their couplings shall be checked to ensure there is no

leakage during their use. The female coupling cam tooth mechanism be operated and lubricated for ensuring ease of operation.

Power supply to the pump house is not to be discontinued for any reason. Alternative arrangement shall be made in case any feeding switch gear is under repair / replacement.
It has to be ensured that there are no obstructions in front of the hydrants impending accessibility

FIRE DRILL

For making the users familiar with the system, Fire Drills shall be conducted for high rise buildings, in accordance with the fire safety plan, at least once every three months for buildings during the first two years. Thereafter, fire drills shall be conducted at least once every six months.

All occupants of the building shall participate in the fire drill. However, occupants of the building, other than building service employees are not required to leave the floor or use the exits during the drill.

A written record of such drill shall be kept on the premises for a three years period and shall be readily available for fire brigade inspection.

For other buildings, fire drill shall be carried out once in six months.

Local fire service and nodal officer-in-charge of various parts of the building shall be involved in conducting fire drill. Operation of the system shall be demonstrated so that all users are confident of the system and aware of their duties and responsibilities during fire.

For further details, Annexure D- Guidelines for fire drill and evacuation procedures for high rise buildings of *Vol-1, Part-4 of NBC 2016 may be referred*.

TABLE C.1

PERIODICAL TESTING AND MAINTENANCE CHART

S. No.	**System Component**	**Activity**	**Duration**
1.	Water Tanks	(i) Level Check	Daily
		(ii) Cleaning	Once in a year
2.	Pumps	(i) Running	Daily (for min. 5 minutes)
		(ii) Test flow	Annually
		(iii) Lubrication	Quarterly
		iv)Gland packing check	Weekly
		Electrically Driven Pumps:	
		i) Bearing grease cup	Weekly
3.	Engine	(i) Running	Daily (for 5 minutes)

		(ii) Lubrication	Quarterly
		(iii) Battery Status	Weekly
		(iv) Fuel Tank check	Daily
		(v) Servicing	As per engine manufacturer's recommendations.
4.	Motor	(i) Running	Daily
		(ii) Starter contact checking	Weekly
		(iii) Insulation Resistance	Half yearly
5.	Hydrant Mains / Ring Mains	i)Testing	Fortnightly
6.	Piping	(i) Pressure	Daily
		(ii) Flushing	once in a year
7.	Hydrants	examination	Weekly
8.	Valves (Landing, Cut -off and Isolation)	(i) operation and oilingif necessary (ii) Overhauling of all Cut- off valves	Monthly Annually
9.	Valves (Suction and Delivery)	(i) Examination	Half yearly
10.	Electrical Panels and Control System	(i) Operation	Monthly
		(ii) Connection and system components	Quarterly
11.	Hose boxes	i) External Inspection ii) Internal and External cleaning	Weekly Monthly
12.	Hose Reel and Hose Pipes	(i) Physical check	Monthly
		(ii) Operation check	Annually
		(iii) Replacement	Depending upon physical condition.
13.	Fire Brigade Connections/ Inlet	(i) Physical check	Monthly.
		(ii) Operation check	Annually
14.	Instantaneous Coupling	(i) Physical check	Monthly.
		(ii) Lubrication	Once in Six months.
15.	Painting	(i) Out Door	Once in a year.
		(ii) In Door	Once in two years.

APPENDIX-D

MAINTENANCE OF AUTOMATIC SPRINKLER SYSTEM

Maintenance of other firefighting installation has been described in Appendix- 'C' which hold good for sprinkler installations also. In addition following points shall be taken care.

Sprinkler shall not be re-conditioned or repaired. Used and/or defective sprinklers shall be replaced by new ones.

Sprinklers shall not be painted after installation.

Spare Sprinklers - A stock of spare sprinklers shall be kept in Fire Control Room so that prompt replacement is possible after operation/damage of a sprinkler head. A minimum of 5% of the installed capacity or 25 sprinklers of all types whichever is more shall be kept in stock. Spanners for sprinklers and Teflon tape shall also be kept along with spare sprinklers inreadiness.

As far as possible, the installation shall be maintained in operating condition byblanking off pipe work feeding the inoperative part or parts where work is taking place.

The inoperative part, if defective shall be attended to and connected with the operative system.

Action following sprinkler operation

Following the operation of sprinklers, the operated head shall be replaced with new ones and water supply shall be restored.

The sprinklers in the vicinity of the operated sprinklers shall also be checked fordamage by heat or any other cause and replaced if necessary.

The sprinkler pump shall not be shut off until complete extinguishment of the fire. The starting of the pump shall be automatic but the stopping of the pump after an extinguishment shall be manual.

All piping shall be examined to determine its conditions at least once a year.

All Installation Control Valves and associated equipment shall be serviced and tested annually.

Discharge test of sprinklers shall be carried out at least once in six months. D.1.10Manual testing of the system shall be carried out once in six months.

When normally opened valves are closed following system operation or test, suitable procedure shall be instituted to ensure that they are re-opened.

The entire system shall flushed at least once in a year. D.1.13The sprinkler bulbs shall be kept free from paint or dust.

MAINTENANCE GUIDELINES

Following guidelines shall be followed for sprinkler maintenance.

Maintenance and testing shall be carried out ina planned and systematic manner and records kept.

Only trained personnel shall be engaged in the work. Contract with qualified agency for service, test and operation is recommended.

Other firefighting installations are operated manually i.e. to operate a first aid hose reel or internal/external hydrant a person is required. As such during fire, when the system is in operation, somebody in the building is aware of it. In caseof sprinkler operation, no one will come to know. For looking after sprinkler installation following personnel shall be availableat all hours.

(a) A trained pump operator shall be available in the pump room.

(b) Depending upon the size of installations at least two or more trained personnel shall be available in fire control room.

APPENDIX—E

LIST OF RELEVANT INDIAN STANDARDS

S. No	IS No.	Title
1)	lS-8757	Glossary of terms associated with Fire safety
2)	IS-884	Specification for first-aid hose reel for firefighting
3)	IS-901	Specification for couplings, double male and double female instantaneous pattern for firefighting,
4)	IS-902	Specification (for suction hose couplings for firefighting Purposes (third revision)
5)	IS-903	Specification for fire hose delivery couplings, branch pipe,nozzles and nozzle spanner. (fourth revision)
6)	IS-904	Specification for two and three- way suction collecting heads for firefighting purposes.
7)	IS-907	Specification for suction strainers, cylindrical type for firefighting purpose. (second revision)
8)	IS-908	Specification for fire hydrant, stand post type. (second revision)
9)	IS-909	Specification for underground fire hydrant. Sluice valve Type
10)	IS-636	Specification for Non percolating flexible firefighting delivery hose.
11)	IS-7637	Glossary of terms for firefighting equipment.
12)	IS-937	Specification for washers for water fittings for firefighting purposes.
13)	IS-1641	Code of practice for fire safety of buildings (general):General Principles for fire grading and classification.
14)	IS-1642	Code of practice for fire safety of buildings (General) : Details of construction. (second revision)
15)	IS-1643	Code of practice for fire safety of buildings (general) 'Exposure hazard. (first revision)
16)	IS-1644	Code of practice for fire safety of buildings (general):Exit requirements and personal hazard. (second revision)
17)	IS-1646	Code of practice for fire safety of buildings(general): Electrical installations. (third revision)
18)	IS-2871	Specification for branch pipe, universal for firefighting purposes.
19)	IS-2930	Functional requirements for hose Iaying tender for fire brigade use.
20)	IS-5290	Specification for landing valves.
21)	IS-8090	Specification for couplings, branch pipe, nozzle, used in hose reel tubing for firefighting.
22)	IS-8442	Specification for stand post type water and foam monitor for firefighting (first revision)
23)	IS-9972	Specification for automatic sprinkler heads. (first revision)
24)	IS-11101	Specification for extended branch pipe for fire brigade use
25)	IS -12349	Fire protection Safety sign.

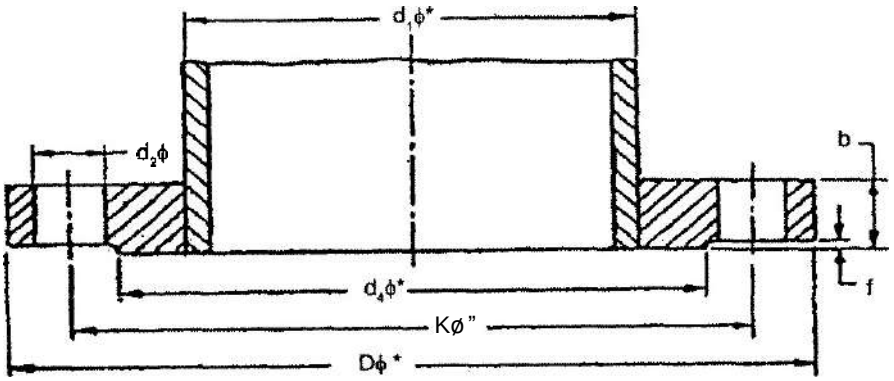
26)	IS -12407	Graphic symbols for fire protection plan.
27)	IS -9668	Code of practice for provision and maintenance of watersupplies and firefighting.
28)	IS -3844	Code of practice for installation and maintenance ofinternal fire hydrants and hose reel on premises.
29)	IS -12585	Specification for thermoplastic house (Textile Reinforced) for Water General purpose.
30)	IS -10221	Code of practice for coating and wrapping of underground mild steel pipe lines. (first revision)
31)	IS-15105	Design and installation of fixed automatic sprinkler fire extinguisher system-Code of Practice.
32)	IS -325	Three phase induction motors.
33)	IS-1822	AC Motor starter for voltage not exceeding 1000 volts.
34)	IS -3624	Pressure and vacuum gauges.
35)	IS-1520	Horizontal centrifugal pumps for clear, cold, fresh water.
36)	IS-1239	Mild steel tubes, tubulars and other wrought steel fittings.
37)	IS -3589	Specification for Steel pipes for water, and sewage
38)	IS -6392	Steel pipe flanges.
39)	IS -778	Specification for copper alloy gate, global and check valves and water works purpose (fourth revision)
40)	IS -2592	Recommendation for methods of measurement or fluidflow be means of orifice plates and nozzles.
41)	IS -732	Code practice for electrical wiring installations.
42)	IS 900	Code of practice for installation and maintenance of induction motors.
43)	IS -1248	Direct acting electrical indicating analogue electrical Measures and their accessories general requirement instruments.
44)	IS-2516	A. C. Circuit breakers for voltages not exceeding 1000 volts.
45)	IS -4047	Heavy duty air break switches and composite units of air break switches and fuses (for voltage not exceeding 1000 volts.
46)	IS -2208	HRC cartridge fuse links up to 650 volts.
47)	IS -1554 (Part I)	PVC insulated (heavy duty) electric cables for workingvoltage up to and including 1100 volts.
48)	IS:1536	Specification for Centrifugally Cast (Spun) Iron pressure pipes for water, gas & sewage (first revision)
49)	IS 1537	Specification for Vertically Cast Iron pressure pipes for water, gas & sewage (first revision)
50)	IS:1538	Specification for Cast Iron Fittings for pressure pipes for water, gas & sewage (third revision)
51)	IS:780	Sluice valve for water works purposes (50 to 300 mm size)
52)	IS:13095	Butterfly valves for general purpose.
53)	IS:13039	Code of practice for provision and maintenance of External Hydrant System (first revision)

IS : 6392 - 1971

TABLE 17 PLATE FLANGES FOR WELDING

(Clauses 4.1 and 5.1)

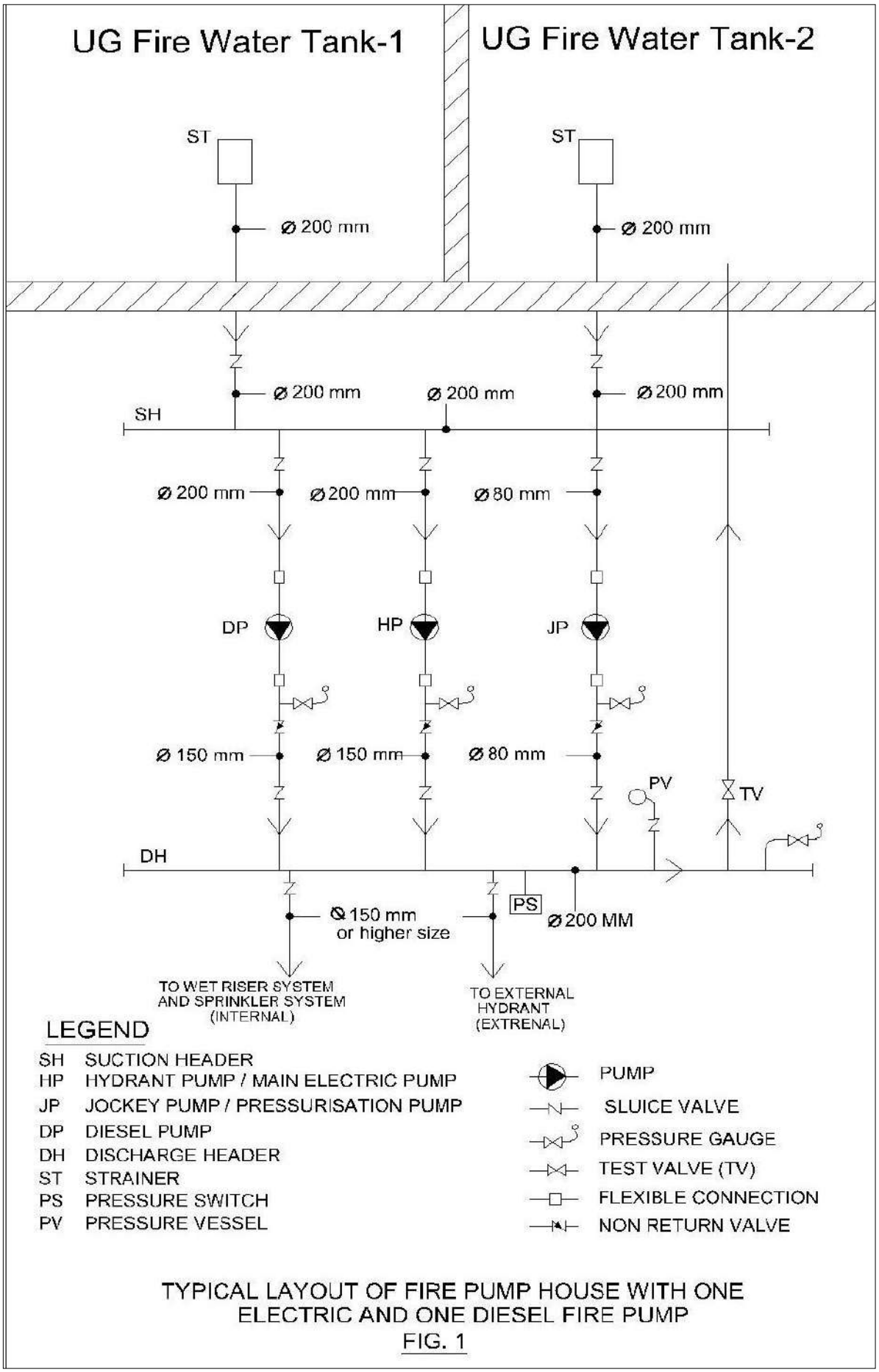
Nominal Pressure 1.6N/mm^{2}All dimensions in millimeters



* These dimensions are not to scale

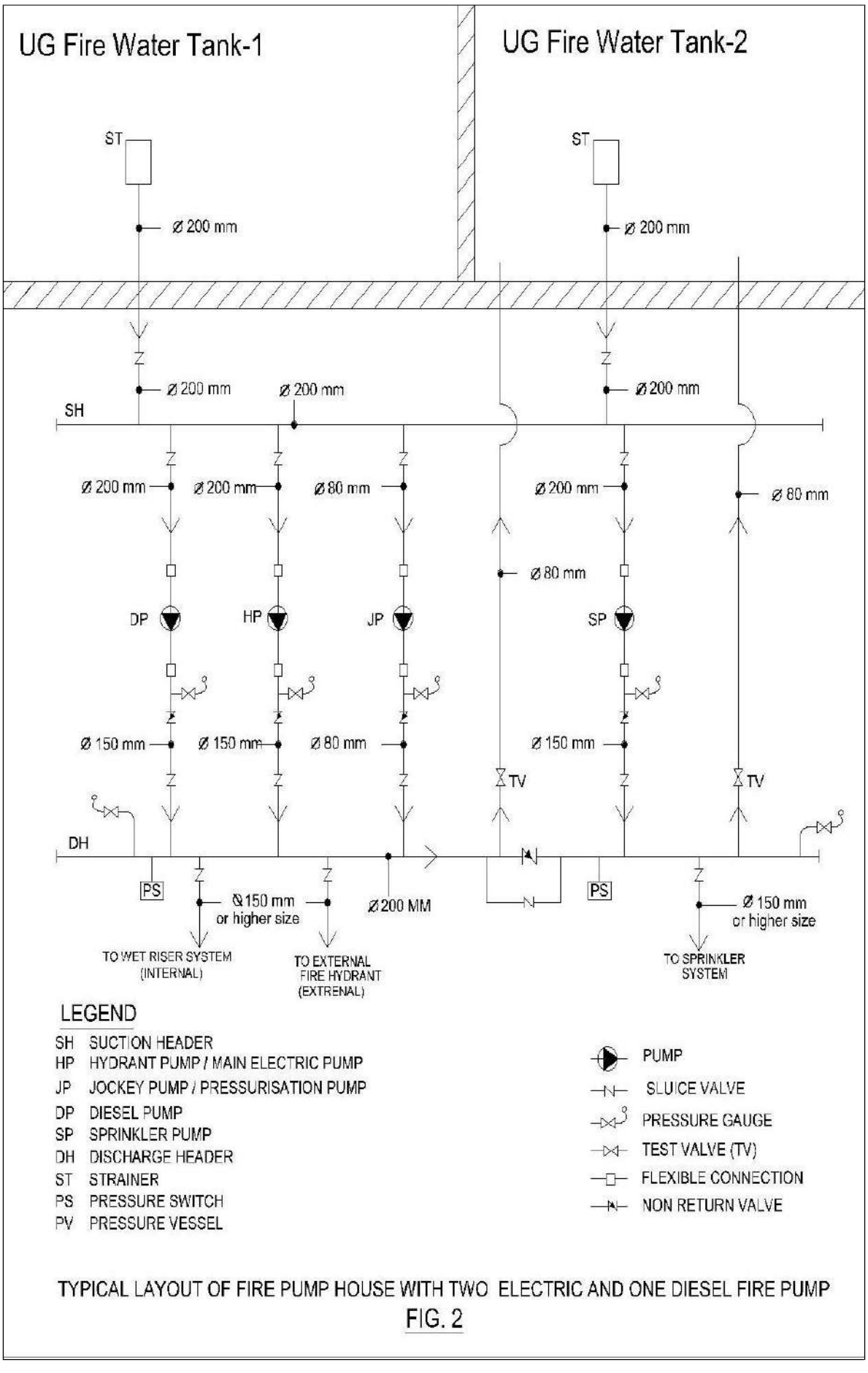
Nominal Size	Pipe outer diameter d1ø	Flange		Raised Face		Bolting	Drilling		
		Dø	b	d4ø	f		No.	d2ø	Kø
10	17.2	90	14	40	2	M12	4	14	60
15	21.3	95	14	45	2	M12	4	14	65
20	26.9	105	16	58	2	M12	4	14	75
25	33.7	115	16	68	2	M12	4	14	85
32	42.4	140	16	78	2	M16	4	18	100
40	48.3	150	16	88	3	M16	4	18	110
50	60.3	165	18	102	3	M16	4	18	125
65	76.1	185	18	122	3	M16	4	18	145
80	88.9	200	20	138	3	M16	8	18	160
100	114.3	220	20	158	3	M16	8	18	180
125	139.7	250	22	188	3	M16	8	18	210
150	168.3	285	22	212	3	M20	8	22	240
175	193.7	315	24	242	3	M20	8	22	270
200	219.1	340	24	268	3	M20	12	22	295
250	273	405	26	320	3	M24	12	26	355
300	323.9	460	28	378	4	M24	12	26	410

350	355.6	520	32	438	4	M24	16	26	470
400	406.4	580	36	490	4	M27	16	30	525
500	508	715	44	610	4	M30	20	33	650
600	609.6	840	52	725	5	M33	20	36	770
700	711.2	910	58	795	5	M33	24	36	840
800	812.8	1025	64	900	5	M36	24	39	950
900	914.4	1125	72	1000	5	M36	28	39	1050
1000	1016	1255	78	1115	5	M39	28	42	1170
1200	1220	1485	94	1330	5	M45	32	48	1390



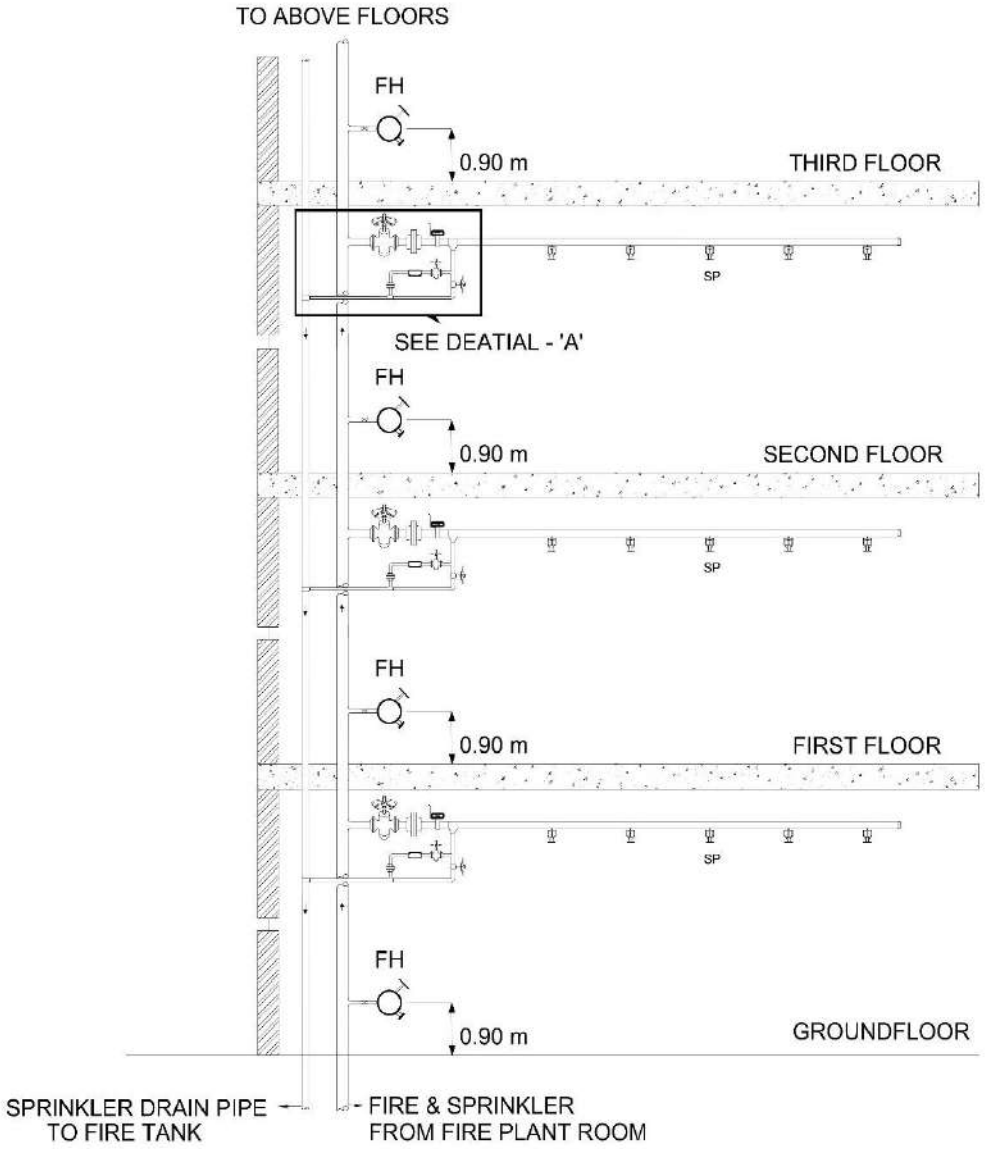
TYPICAL LAYOUT OF FIRE PUMP HOUSE WITH ONE ELECTRIC AND ONE DIESEL FIRE PUMP

FIG. 1



TYPICAL LAYOUT OF FIRE PUMP HOUSE WITH TWO ELECTRIC AND ONE DIESEL FIRE PUMP

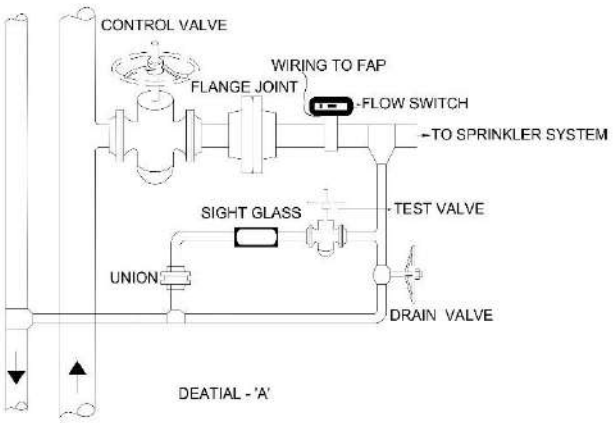
FIG. 2



ELEVATIONAL VIEW

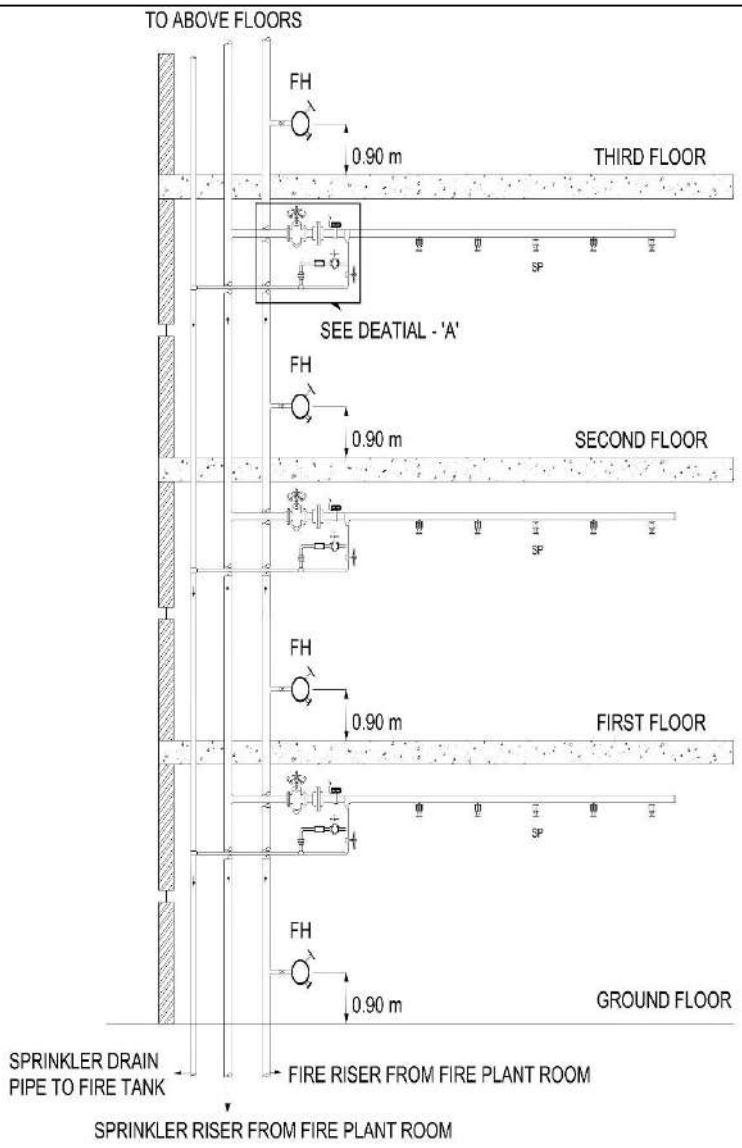
LEGEND

F-1	ELECTRICAL FIRE PUMP
F-2	DIESEL DRIVEN FIRE PUMP
F-3	JOCKEY PUMP
PV	PRESSURE VESSEL
FH	FIRE HYDRANT
	VALVE
	FLEXIBLE CONNECTION
	NON-RETURN VALVE
	SPRINKLER



TYPICAL SYSTEM OF PUMPING WITH ONE ELECTRIC, ONE DIESEL FIRE PUMP

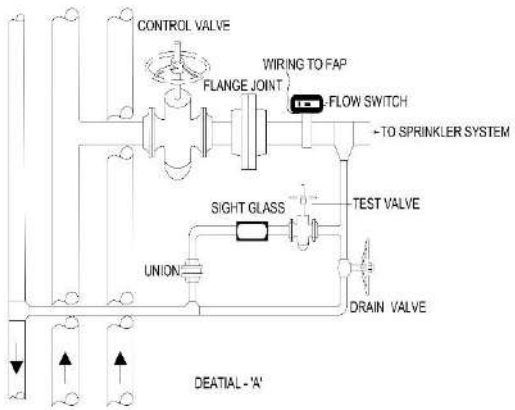
FIG.3



ELEVATIONAL VIEW

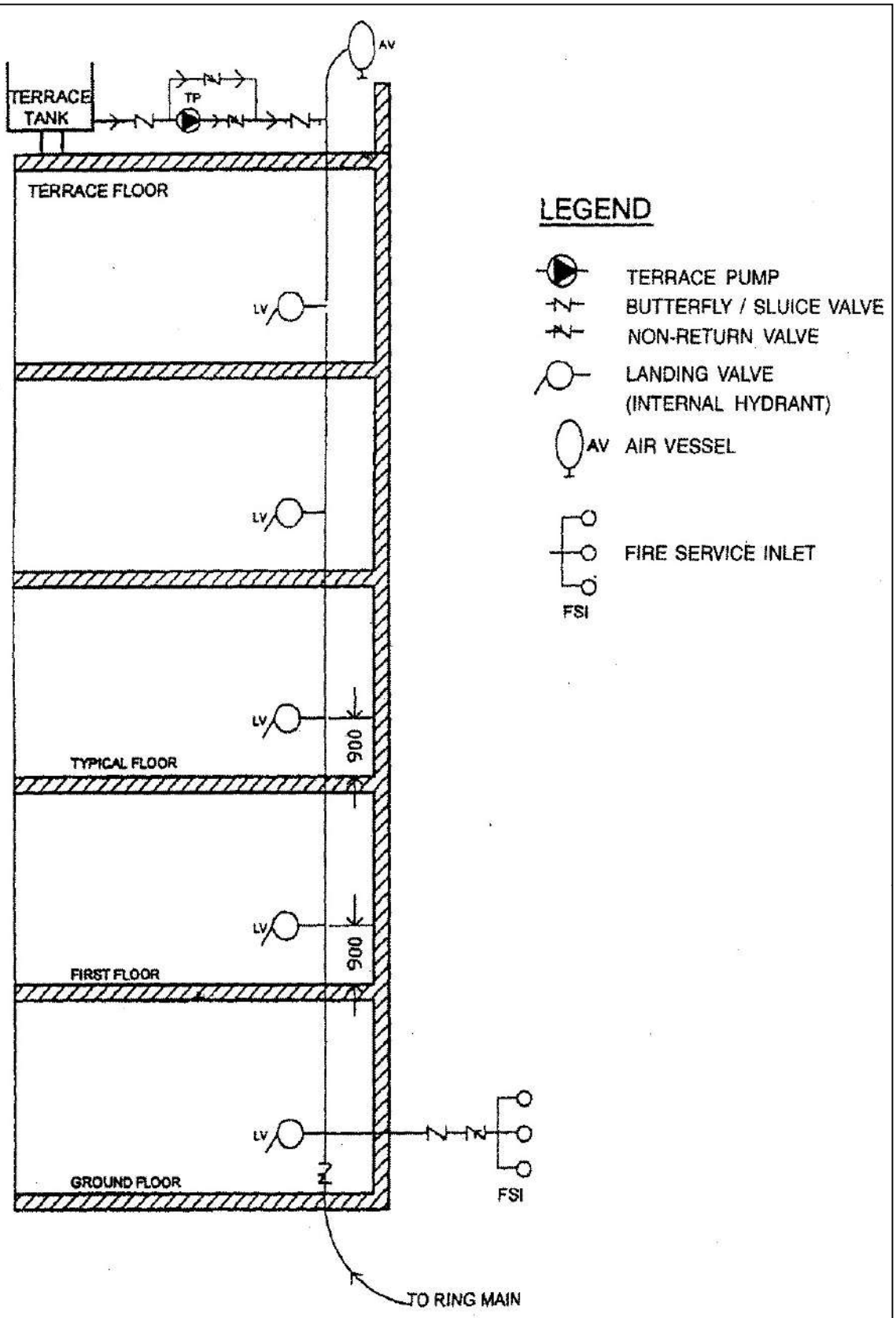
LEGEND

F-1	DIESEL DRIVEN FIRE PUMP
F-2	EL. HYDRANT FIRE PUMP
F-3	JOCKEY PUMP
F-4	EL. SPRINKLER PUMP
PV	PRESSURE VESSEL
FH	FIRE HYDRANT
FAP	FIRE ALARM PANEL
SP	SPRINKLER
	VALVE
	FLEXIBLE CONNECTION
	NON-RETURN VALVE
	SPRINKLER



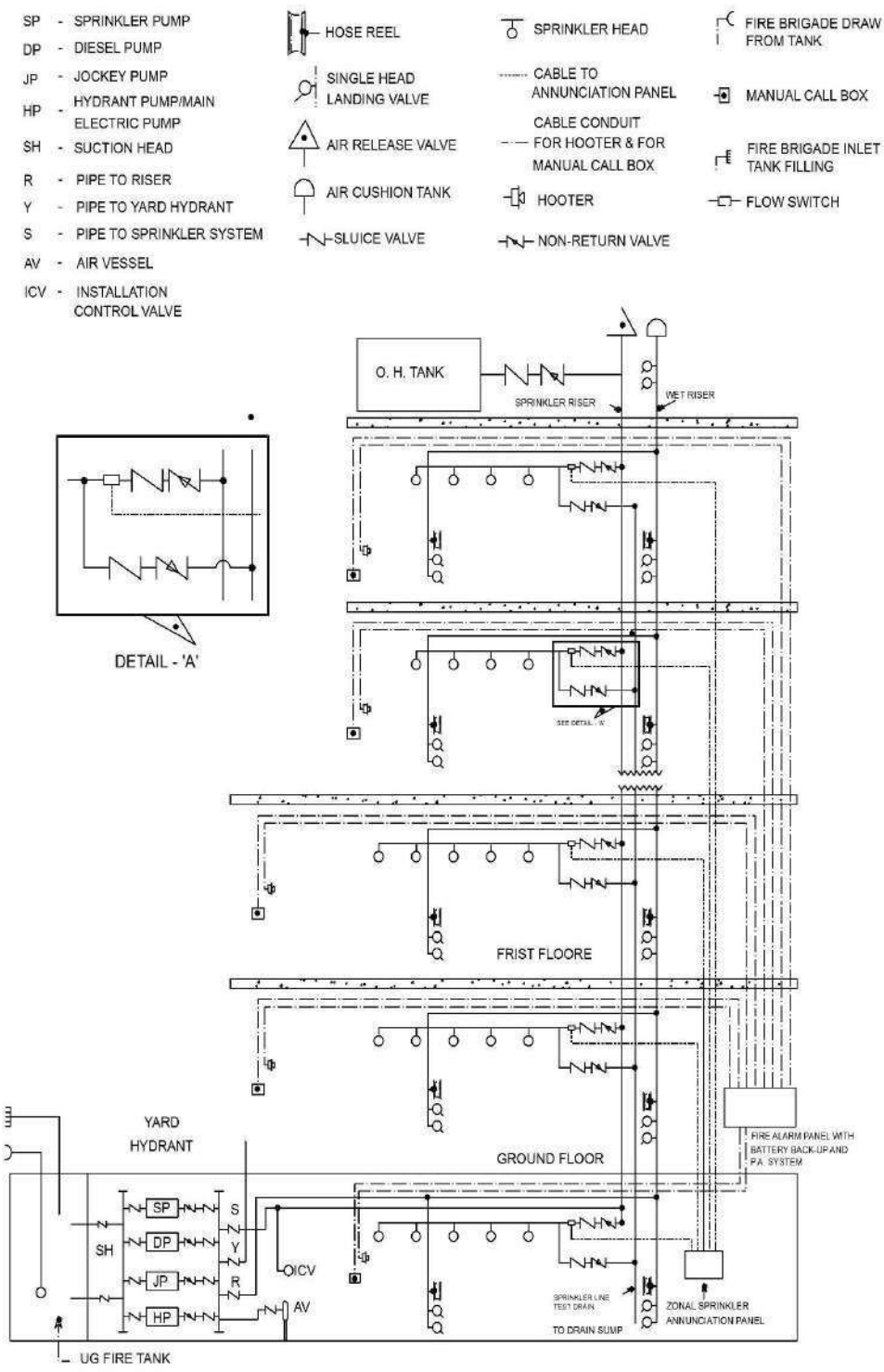
TYPICAL SYSTEM OF PUMPING WITH TWO ELECTRIC, ONE DIESEL FIRE PUMP

FIG.4



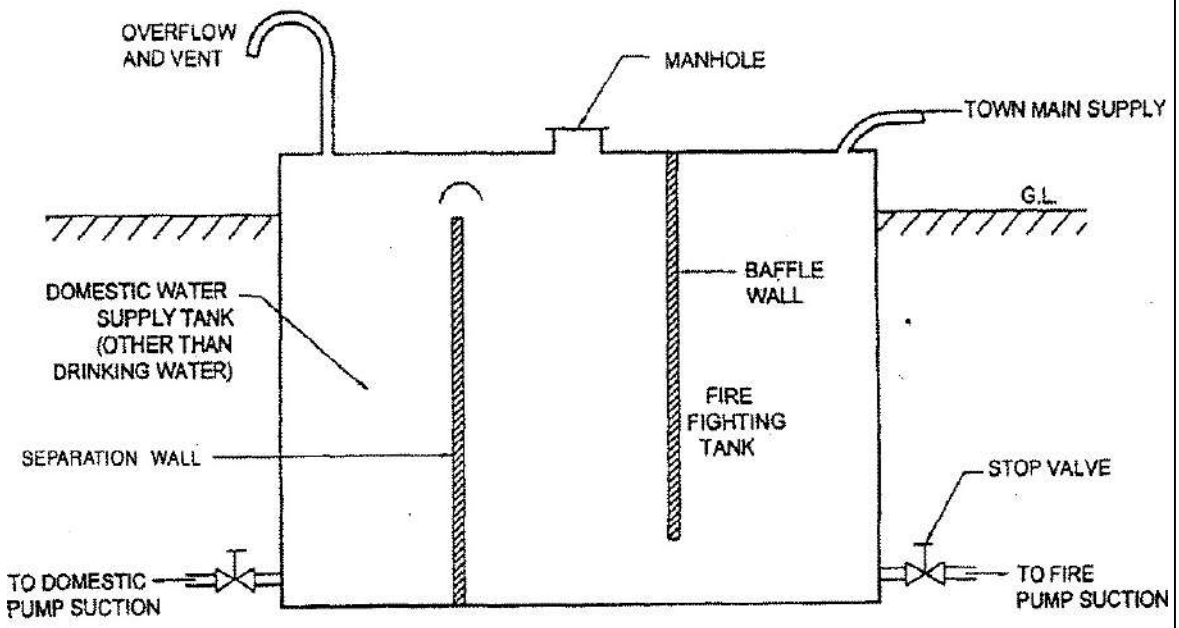
TYPICAL ARRANGEMENT OF DOWN COMER SYSTEM

Fig. 5



TYPICAL ARRANGEMENT OF WET RISER AND TOTAL SPRINKLER SYSTEM OF BUILDING

FIG. 6



TYPICAL ARRANGEMENT FOR PROVIDING COMBINED FIRE FIGHTING AND DOMESTIC WATER STORAGE TANK

Fig. 7