Design Criteria for Water Based Fire Fighting System

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Fire and Safety Measures:

The Fire and Safety Measures in a high rise building can broadly classified in to the two major categories:

•Preventive Measures.

•Protective Measures.

(A) Preventive Measures: Are those measures which are taken care off during designing of a building structure and does not need any energy consumption. These measures are directly affect the architecture and construction value of the building. These system are installed during the design and as a part of the building. The best example of the preventive measures are.

(i) The Fire resistance of building structure.
(ii) Fire and Smoke venting for smoke extraction.
(iii) The internal means of evacuation.
(iv) Isolation from neighboring Structure.
(v) Access for out side emergency services.
(vi) Site Planning.
(vii) Compartmentation of internal structure.

(B) Fire Protection: Are those measure which are taken care off during after designing of building structure and does need energy consumption for activation. These measure are further classified in a general way under following heads:

(i) Portable fire extinguishers
(ii) Fixed fire aid fire fighting equipments like hose reels.
(iii) Fire Hydrant Installation.
(iv) Manual/Automatic Fire detection and alarm systems.
(v) Fixed Automatic Fire Fighting systems.
- (a) Water Sprinkler system.
- (b) CO_2 Fire Fighting System
- (c) FM 200 Fire Fighting System

(vi) Mobile Fire Fighting System.

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Codes and local Bye Laws:

A wide variety of rules and regulations are existent regarding fire safety of buildings both nationally and internationally. Although all codes and local bye laws in respect of fire safety are based on the same theme, they differ vastly in their method of applications. Fire regulations can be broadly divided in three categories

- Mandatory/obligatory
- Recommendatory

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The code of practice series of BIS vide IS 1641 to IS 1648 provides sufficient guide lines on national basis, as given below:

Code of practice for fire safety of buildings (General)

1641-60 :	General principles and fire grading
1642-60 :	Materials and details of construction
1643-60 :	Exposure Hazard
1644-60 :	Personal hazard
1645-60 :	Chimneys, flues, flue pipes and hearths.
1647-60 :	Electrical installations
1647-60 :	Non-electric lighting equipment oil and gas heaters and burners of small capacity
1648-61 :	Fire fighting equipment and its maintenance including construction and installations of fire proof doors.

CLASSIFICTION OF BUILDINGS BASED ON OCCUPANCY

(As Per National Building Code 1983)

In respect of making passive or active fire fighting provisions, buildings are classified in following groups:

Residential Educational Institutional Assembly Business Mercantile Industrial Storage Hazardous

Group	Type
A	Residential
B	Educational
C	Institutional
D	Assembly
E	business
F	Mercantile
G	Industrial
H	Storage
J	Hazardous

GENERAL PRINCIPLES OF FIRE GRADING OF BUILDINGS

(Abstracts From IS : 1641-1960)

(A) Fire Hazards

Fire safety of buildings shall be considered from three aspects and protection shall accordingly be provided against the following three types of fire hazards:

1. Personal Hazard.
2. Internal Hazard.
3. Exposure Hazard.

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(a) Personal Hazard: Possibility of loss -or damage to life, referred to as 'personal hazard'.

The consideration of *'personal hazard'* is naturally of paramount importance and requires the provision of liberally designed and safe fire proof exits or escapes in all buildings and particularly those having more than one storey.

(b) Internal Hazard; Possibility of fire occurring and spreading inside the building itself, referred to as 'Internal hazard' ; and

Internal hazard' concerns damage or destruction of the building and influelences directly 'personal hazard'. The internal hazard is directly related to the fire load which *in* turn, enables the building to be graded when considered along with the duration of the fire.

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(c) Exposure Hazard; Possibility of fire spreading from an adjoining building or buildings or from across a street or road, referred to as 'exposure hazard' .

'Exposure hazard' deals with the risk of fire spreading into a building through the open air from a fire in other buildings, from stacks of combustible material, etc ; or into a division or compartment of a building through the open air from a fire in other division or compartment of the same building. It does not include the risk of fire entering a building, division or compartment directly through separating or diversion walls or floors or through vertical shafts, such as staircases.

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(B) Fire Load

Fire load is the amount of heat in kilo-calorie which is liberated per square meters of floor area of a compartment by the combustion of the contents of the building and any combustible parts of the building itself. The amount of heat is used as the basis for grading of occupancies.

The fire load is determined by multiplying the weight of all combustible materials by their calorific values and dividing the figure by the floor area under consideration.

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Example: A building or a section containing n no. of combustible material having quantity in kg. q1, q2, q3….qn & having calorific valve, C1, C2, C3….. up to Cn in kcal/kg over an area of X m^2 . Then the fire load is calculated as.

$$\text{Fire Load} = \frac{\sum q1 \times C1 + q2 \times C2 + \dots + qn\text{-}1 \times Cn\text{-}1 + qn \times Cn}{X} \quad kcal/m^2$$

Calorific value: the amount of heat liberated when the unit mass of combustible material undergoes to complete combustion.

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The calorific value of some common combustible material are as follows:-

Sr. No.	Substance	Calorific value. Kcal/kg
1	Coal, (Lignite)	291
2	Charcoal	7235
3	Wood and straw	4749
4	Crude fuel oil	10422
5	Kerosene	11038
6	Coal-tar oil	11138
7	Water Gases	3536
8	Coal gas	4006
9	Hydrogen	34136
10	Paraffin wax	11256

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(C) Grading of Occupancy by Fire Load:

As for as Internal hazard concern i.e. possibility of fire occurring and spreading inside the building. It is directly related to Fire Load. The Occupancies shall be graded in to three classes as follows:

(a) Occupancies of Low Fire Load.

(b) Occupancies of Moderate Fire Load.

(c) Occupancies of High Fire Load.

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(a) Occupancies of Low Fire Load:

The fire load of an occupancy shall be described as low if it does not exceed an average of 275 000 kcal/m^2 of net floor area of any compartment, nor an average of 550000 kcal/m^2 on limited isolated areas, provided that storage of combustible material necessary to the occupancy may be allowed to a limited extent if separated from the remainder and enclosed by fire resisting construction of an appropriate grade.

(b) Occupancies of Moderate Fire Load:

The fire load of an occupancy shall be described as moderate if it exceeds an average of 275000 kcal/ m^2 of net floor area of any compartment but does not exceed an average of 550 000 kcal/m^2 nor an average of 1 100 000 kcal/$m^2$0n limited isolated areas, provided that storage of combustible material necessary to the occupancy may be allowed to a limited extent if separated from the remainder and enclosed by fire resisting construction of an appropriate grade.

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(c) Occupancies of High Fire Load:

The fire load of an occupancy shall be described as high if it exceeds an average of 550000 kcal/m^2 of net floor area of any compartment but does not exceed an average of 1100 000 kcal/$m^2$0f net floor area, nor an average of 2200 000 kcal/m^2 on limited isolated areas.

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The TAC i.e. Tariff Advisory Committee Further elaborate on the degree of hazard inside the occupancy and classified the degree of hazard under following four heads:

- Light hazard.
- Ordinary Hazard
- High Hazard- A
- High Hazard -B

We can mathematically express the listed degree of hazard in terms of fire load. If X $kcal/m^2$ is the Fire load of a net floor Area than for

Light Hazard the value of $X = 0 \leq X \leq 275000$ $kcal/m^2$

Ordinary Hazard the value of $X = 275000 < X \leq 550000$ $kcal/m^2$

High Hazard-A the value of $X = 550000 < X \leq 1100000$ $kcal/m^2$

High Hazard-B the value of $X = 1100000 < X$ $kcal/m^2$

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Hydrant System:- The Hydrant System is a Systematic arrangement of pipe Network with in the occupancy to facilitate, for Fire Fighting operation with water as an Extinguishing media.

The major component of a hydrant system are as follows:-

- Static water tank/ terrace tank.
- Pump House
- Water Mains.
- Stand post/water monitors.
- Hose Box.
- Accessories (Control Valve, Sluice Valve ,NRV etc)

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Water Supply:

Water for the hydrant service shall be stored is an easily accessible surface or underground lined reservoir or above ground tanks of steel, concrete or masonry. The effective capacity of the reservoir above the low water level (defined hereunder), or above the top of the pump casing (in case of flooded suction) if the same is higher than the low water level, for the various classes of occupancies and size of hydrant installations shall be as indicated in table 1.

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TABLE-1

Nature of Risk	Capacity of Static Storage Exclusively reserved for hydrant service.
1. Light Hazard	Not less than 1 hour's aggregate pumping capacity with a minimum of 1,35,000 liters.
2. Ordinary Hazard	Not less than 2 hour's aggregate pumping capacity
3. High Hazard-A	Not less than 3 hour's aggregate pumping capacity
4. High Hazard-B	Not less than 4 hour's aggregate pumping capacity

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Example : If a occupancy consider as high hazard A and the discharge requirement for the pump delivery is 114 Liter / sec, then the capacity of static water tank may be calculated as:

Capacity of static Water Tank= 3x114x60x60 Liter

= **12,31,200.** Liter

Pumps

Pumps shall be exclusively used for firefighting purposes, be of a type approved by the Committee, and shall be :-

- Electric Motor or Steam Turbine driven centrifugal pumps.

or

- Compression ignition engine driven centrifugal pumps.

or

- Vertical turbine submersible pumps.

or

- Quadruple acting reciprocating steam pumps.

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The size and capacity of pumps may be determine as per the table given below

Nature of Risk	Number of Hydrants	Pump Capacity in Liters/ Sec. (M3/hour)	Delivery pressure at pump discharge end at rated capacity in kg/cm^2
1. Light hazard	i) Not exceeding 20	27 (96)	5.6*
	i) Exceeding 20 but not exceeding 55	38 (137)	7
	i) Exceeding 55 but not exceeding 100	47 (171)	7
	i) Exceeding 100	47 (171) Plus 47 (171) For every additional 125 Hydrants or part thereof.	7/8.8

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Nature of Risk	Number of Hydrants	Pump Capacity in Liters/ Sec. (M3/hour)	Delivery pressure at pump discharge end at rated capacity in kg/cm2
2. Ordinary Hazard	i) Not exceeding 20	38 (137)	7
	i) Exceeding 20 but not exceeding 55	47 (171)	7
	i) Exceeding 55 but not exceeding 100	76 (273)	7
	i) Exceeding 100 Plus 76 (273) For every additional 125 Hydrants or part thereof.	76 273)	7/8.8

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Nature of Risk	Number of Hydrants	Pump Capacity in Liters/ Sec. (M3/hour)	Delivery pressure at pump discharge end at rated capacity in kg/cm2
3. High Hazard-A	i) Not exceeding 20	47 (171)	7
	i) Exceeding 20 but not exceeding 55	76 (273)	7/8.8
	i) Exceeding 55 but not exceeding 100	114 (410)	7/8.8
	i) Exceeding 100 Plus 114 (410) For every additional 150 Hydrants or part thereof.	114(410)	7/8.8/10.5

Nature of Risk	Number of Hydrants	Pump Capacity in Liters/ Sec. (M3/hour)	Delivery pressure at pump discharge end at rated capacity in kg/cm2
4. High Hazard (B)	i) Not exceeding 20	Two of 47 (171)	7
	ii) Exceeding 20 but not exceeding 55	Two of 76 (273)	7/8.8
	iii) Exceeding 55 but not exceeding 100	Two of 114 (410)	7/8.8
	** iv) Exceeding 100 (410) Plus one of 114 (410) for every additional 200 Hydrants or part thereof.	Two of 114	8.8/10.5

Example : If a occupancy consider as ordinary hazard and the discharge and pressure requirement of pump at delivery side are 2800 lt./mini and 7 kg./cm² respectively then the capacity of pump may be calculate as

$$\text{capacity of pump} = \frac{100 \times Q \times P}{60} \text{ Watt}$$

where Q is discharge in Ltr./mini.

Pis pressure in kg/cm²

$$\text{capacity of pump} = \frac{100 \times 2800 \times 7}{60} \text{ Watt}$$

$$= 32666 \text{ watt}$$

$$= 32666 / 746 = 43.78$$

$$\simeq 40 \text{ HP}$$

Water Mains:

The hydrants mains shall be normally laid underground and shall be of anyone of the following types:

(a) Cast Iron doubles flanged pipes conforming to the following standards:

Types of Pipes	Class of Pipe	I.S. Specification
i) Horizontally Cast Iron pipes	B	IS: 7181
ii) Vertically Cast Iron Pipes	A	IS: 1537
Iii) Centrifugally Cast (Spun) Iron pipes	A	IS: 1536

(b) Wrought or mild steel pipes (galvanized or un galvanized) of 'Medium' grade conforming to IS: 1239 or IS:3589 having welded joints and coated and wrapped as per IS:I0221.

(c) Underground PVC ‘Class 4” pipes conforming to IS:4985 and HDPE pipes conforming to IS: 4984.

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TABLE 3 (FOR LIGHT HAZARD OCCUPANCIES)

Number of hydrants in the whole system	Size of Mains mm	Percentage of all mains including terminal mains and risers*.
1 to 20	100	100%
21 to 55	125 100	45% 55%
56 to 100	125 100	60% 40%

TABLE 3A (FOR ORDINARY HAZARD OCCUPANCIES)

Number of hydrants in the whole system	Size of Mains mm	Percentage of all mains including terminal mains and risers*.
1 to 5	100	100%
6 to 20	125 100	40% 60%
21 to 55	150 125 100	20% 35% 45%
56 to 100	150 125 100	25% 40% 35%
Exceeding 100	See N.B. 3(a) and 3 (b) hereunder	

Example:

A Ordinary hazard occupancy having the dimension 250x350 m2 having total length of water mains about 1200m. In its periphery. If the total no. of hydrant points in the occupancy are 30 then the percentage of piping 350m can be calculate as follows:

The length of water mains having dia 150mm = 20% of the 1200mt. = 240m.

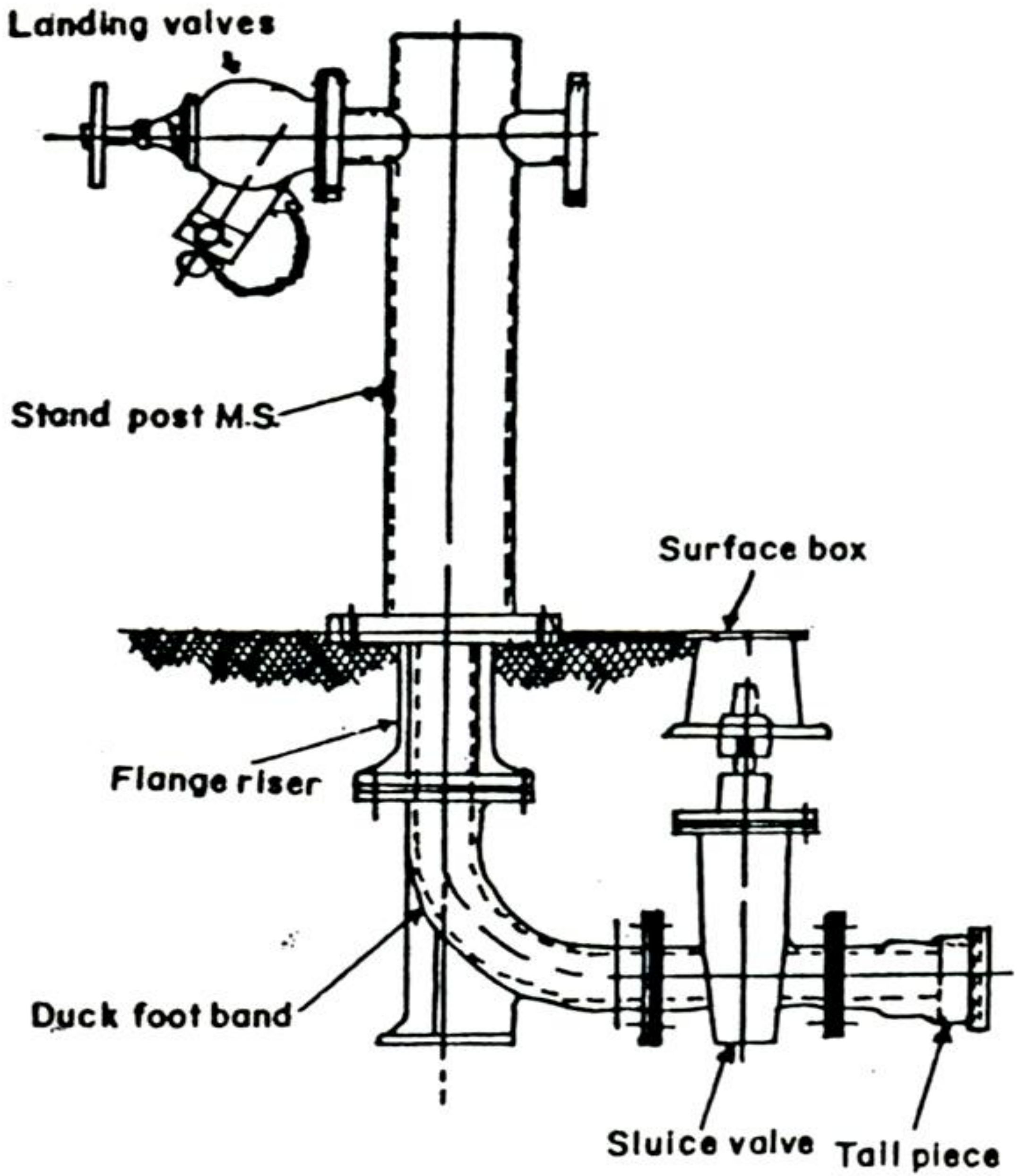
The length of water mains having dia 125mm = 35% of the 1200mt. = 420m.

The length of water mains having dia 100mm = 45% of the 1200mt. = 540m.

Hydrant Points:

The hydrant point is the vertical riser having elevation of one meter from the ground level with female instantaneous coupling having dia 63mm. It is connected with the water mains.

The calculation of hydrant point is made on the basic of degree of hazard. Once we know the length of water mains inside occupancy then from the maximum distance criteria we are able to calculate the no. of hydrant points inside of the occupancy.



Landing valves
Stand post M.S.
Surface box
Flange riser
Duck foot band
Sluice valve
Tail piece

Example: Suppose an occupancy having the length of water mains is X-meter then the no. of hydrant points may be calculated as follows:-

- In case of light hazard no. of hydrant points = X /60
- In case of ordinary hazard no. of hydrant points = X/45
- In case of High hazard-A no. of hydrant points = X/30
- In case of High hazard-B no. of hydrant points = X/25

In calculating the number of hydrants in the system, a double headed hydrant shall be counted as two, a fixed monitor of 63mm size having nozzle bore of 32mm shall be counted as three a fixed monitor of 75mm size having nozzle bore of 38mm shall be counted as four and a monitor of 100mm size having nozzle bore of 45mm as six hydrant points

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Risers:

The Risers are the vertical pipe work having main dia of 100mm starts rising from ground level to the top most floor of the building. These are the part of water mains and having same material as of the water main.

The risers are further design on the basis of degree of hazard as well as the types of occupancies. The minimum distance between two riser inside a building shall be 45m in case of light hazard and ordinary hazard and for every 30m there should be one riser in case of high hazard.

The Risers are further divided into following heads.

1. Dry Riser.
2. Wet Riser
3. Wet Riser cum Down comer.

1. **Dry Risers**: Dry Riser are vertical pipe work having minimum dia 100 mm connected from water mains at ground level to the top most floor of the building. These Risers are Dry in normal position. These Risers are normally installed in light hazard occupancy/building.

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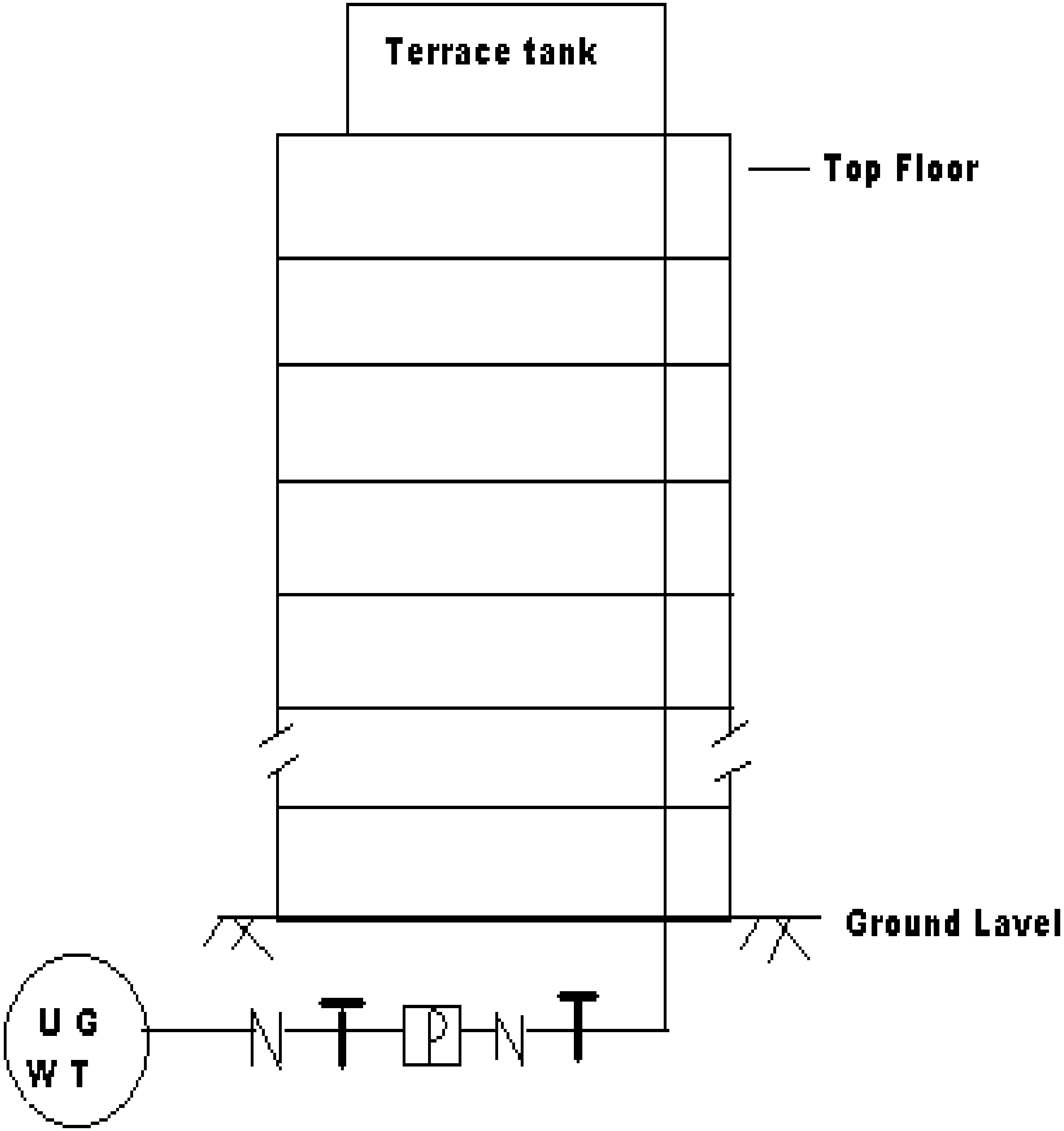

Dry Riser

U G W T - Under ground water tank
P - Pump
T - Control valve
N - Non returning valve

2. Wet Risers: Wet Risers are vertical pipe work having minimum dia 100mm connected from water mains at ground level to the gravity Pressure. These Risers have 24 hrs. water supply for the Fire Fighting Operation. These riser are mainly installed in medium hazard occupancy.

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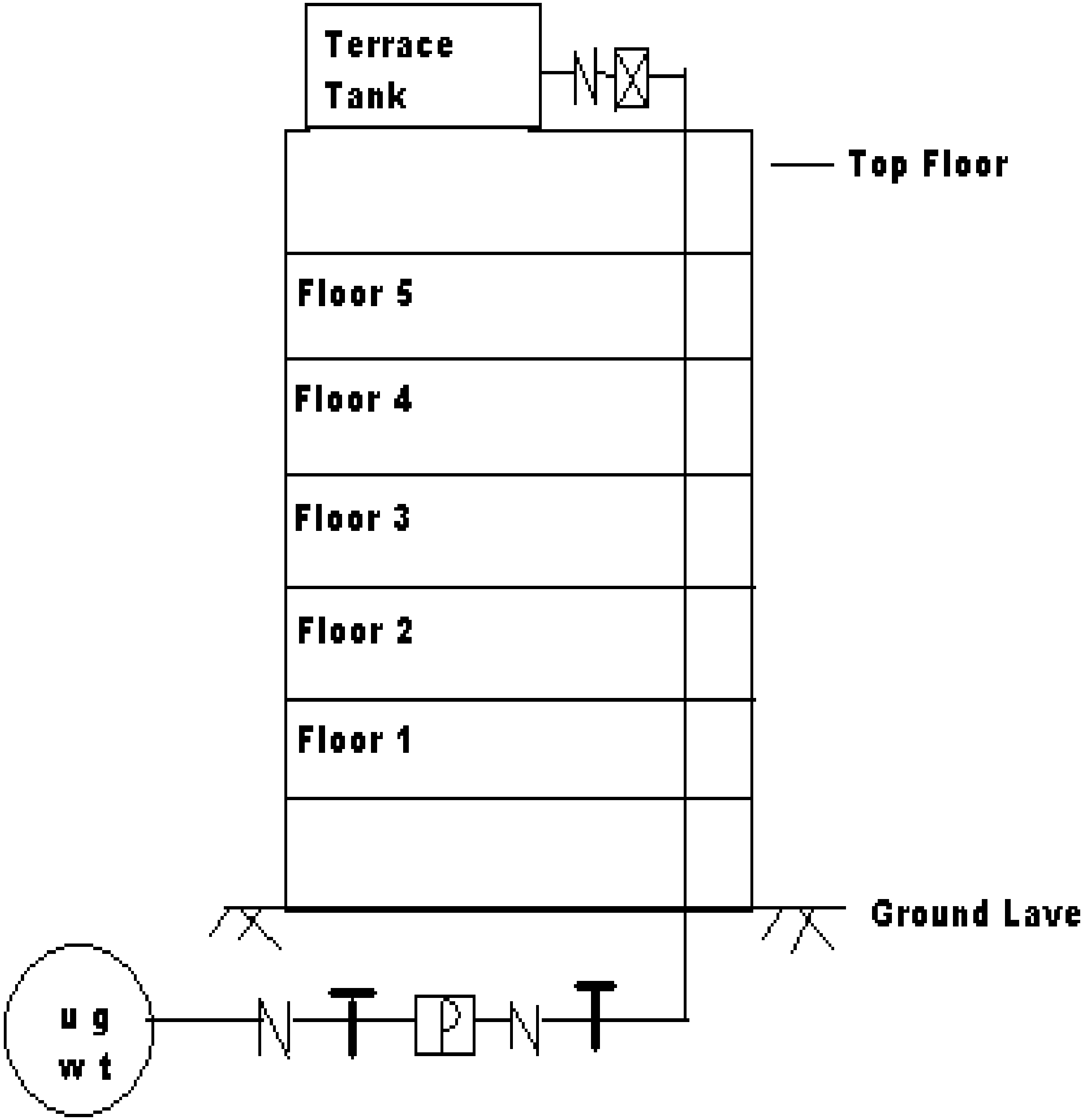

Wet Risers

U G W T - Under ground water tank
P - Pump
T - Control valve
N - Non returning valve

3. Wet Risers cum down comer: These are vertical pipe work parallel to building height having minimum dia of 100mm connected from water mains at ground level to the terrace tank with a efficient capacity pump at the terrace tank. These Riser have 24 hrs. water supply with a minimum pressure of 3 kg/cm^2 inside the building for Fire Fighting Operation. These Riser are mainly installed in high hazard occupancy.

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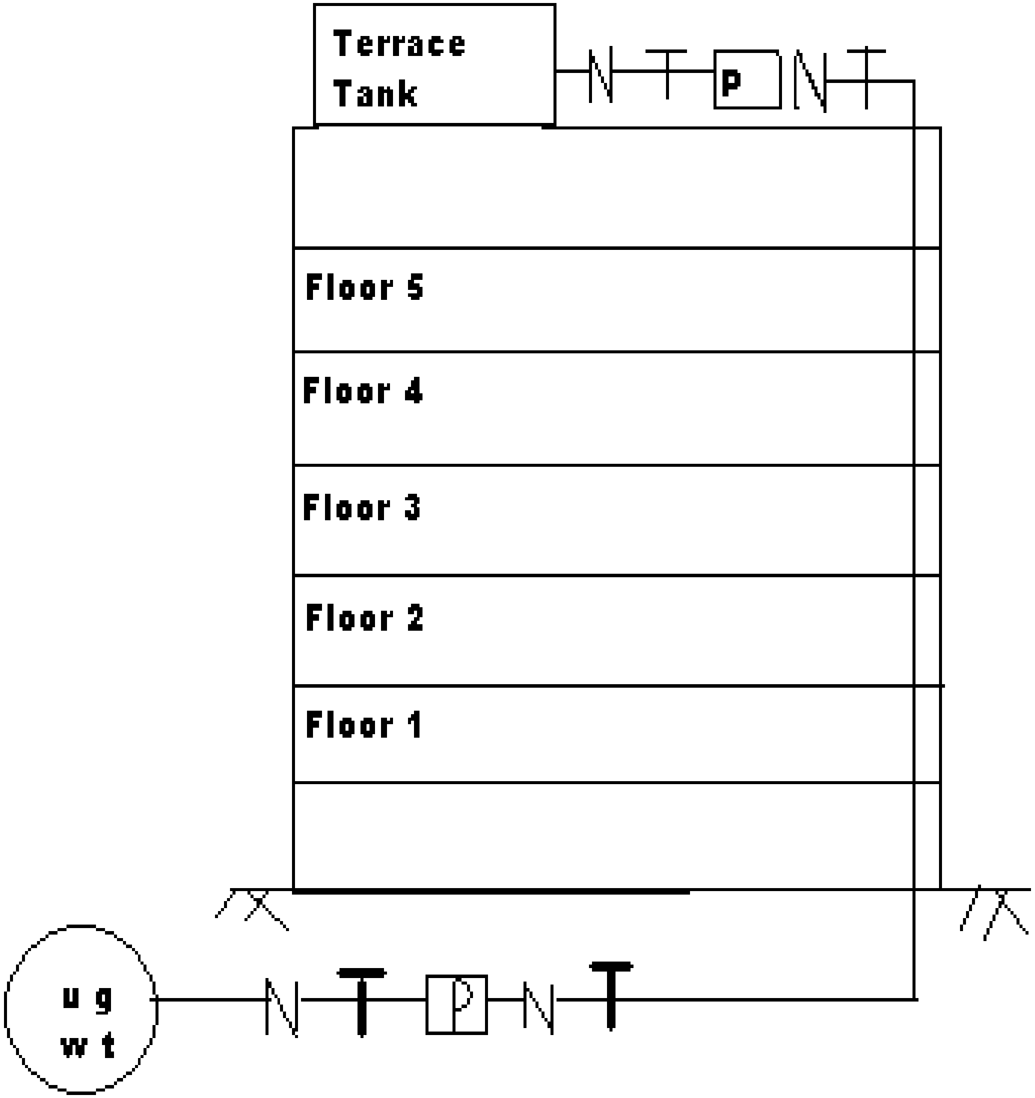

Wet Riser Cum Down Cummer

U G W T - Under ground water tank
P - Pump
T - Control valve
N - Non returning valve

Internal Hydrant: The Internal Hydrant are the points given by risers on each floor for Fire Fighting purpose. These points comprises of one landing valve, on/two female instantaneous couplings and one Hose box having two hose pipe of length 15m. with two long branch pipe.

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Hose Box

The hose box contain two hose pipe of length 15m. with 63mm dia. It is also equipped with two branch pipe. The pattern of branch pipe depends upon the location. Normally the long branch pipe for strong jet are placed inside the hose box.

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QUESTIONS?

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Thank You…