IS 15525 (2004): Gaseous Fire Extinguishing Systems - IG 100 Extinguishing Systems [CED 22: Fire Fighting]

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गैसीय अग्नि शमन पद्धतियाँ — आईजी 100 शमन पद्धति

Indian Standard

GASEOUS FIRE EXTINGUISHING SYSTEMS — IG 100 EXTINGUISHING SYSTEMS

ICS 13.220.10

BUREAU OF INDIAN STANDARDS
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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Fire Fighting Sectional Committee had been approved by the Civil Engineering Division Council.

The objective of this standard is to provide to the users of IG 100 systems with specific requirements for the control of fires of Class A and B type. It does not cover the design of explosion suppression systems.

It is important that the fire protection of a building or plant be considered as a whole. IG 100 total flooding systems form only a part, though an important part, of the available fire protection facilities. It should not be assumed that the installation of an IG 100 total flooding system necessarily removes the need to consider supplementary measures, such as the provision of portable fire extinguishers or mobile appliances for first aid or emergency use, or measures to deal with special hazards.

Controlled inert atmospheres are recognized as effective for extinguishing Class A and Class B fires where electrical risks are present. Nevertheless, it should not be forgotten, in the planning of comprehensive schemes, that there may be hazards for which this technique is not suitable, or that in certain circumstances or situations there may be danger in its use requiring special precautions.

Indian Standard

GASEOUS FIRE EXTINGUISHING SYSTEMS — IG 100 EXTINGUISHING SYSTEMS

1 SCOPE

1.1 This standard sets out specific requirements for the design and installation of total flooding fire extinguishing systems employing IG 100 gas extinguishant. This standard is applicable to single supply as well as distributed supply systems.

1.2 This standard complements various general requirements applicable to all types of gaseous fire-extinguishing systems (Halocarbon as well as Inert gas systems) listed in IS 15493. As such, both these standards should be read together before designing a system. Where requirements in both the standards differ, this standard shall take precedence.

1.3 This standard covers systems operating at nominal pressures of 15 MPa at 15°C and 20 MPa at 15°C only.

1.4 Before using IG 100, nature of fire and fire spread shall be studied for suitability of extinguishment as high discharge time of 60 s may not be suitable for rapid spreading fires.

2 REFERENCES

The standards given below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and the parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
7285 : 1988	Specification for seamless steel cylinders for permanent and high pressure liquefiable gases (*second revision*)
15493 : 2004	Gaseous fire extinguishing systems — General requirements

3 GENERAL INFORMATION

3.1 Application

IG 100 total flooding system is designed to develop a controlled atmosphere in an enclosed space yielding a reduced oxygen concentration, which will not sustain combustion. The appropriate IG 100 concentration shall also be maintained until the temperature within the enclosure has fallen below the reignition point.

3.2 The minimum IG 100 concentration necessary to extinguish a flame and the minimum oxygen concentration necessary to support combustion have been determined by experiments for several surface-type fires particularly those involving liquids and gases. For deep-seated fires, longer soaking times may be necessary but are difficult to predict.

3.3 It is important that residual oxygen concentrations are not only reached and maintained for a sufficient period of time to allow effective emergency action by trained personnel. This is equally important in all classes of fire since a persistent ignition source can lead to a recurrence of the initial event once the IG 100 has dissipated.

4 GAS CHARACTERISTICS AND PROPERTIES

4.1 IG 100 is a colourless, odourless and electrically non-conductive gas with a density approximately the same as that of air.

4.2 IG 100 gas is nitrogen and its specification and physical properties are shown in Table 1.

4.3 IG 100 system can be used for extinguishing fires of all classes within the limits specified in **4** of IS 15493.

4.4 IG 100 gas shall comply with the specification as shown in Table 2.

4.5 Toxicological information for IG 100 gas are shown in Table 3.

4.6 Fill Pressure

The fill pressure of the IG 100 cylinder shall not exceed the values provided in Table 4 for systems operating at 15 MPa and 20 MPa respectively.

5 SAFETY OF PERSONNEL

In addition to the provisions specified under IS 15493, the following requirements shall also apply.

5.1 Protection of Occupants

IG 100 total flooding systems shall not be used in design concentrations greater than 52 percent (corresponds to injected concentrations of 74 percent) in normally occupied areas, unless means

Table 1 Physical Properties of IG 100

(*Clause* 4.2)

Sl No.	Property	Value
(1)	(2)	(3)
i)	Molecular mass	28.02
ii)	Boiling point at 0.1 MPa, °C	– 195.8
iii)	Freezing point, °C	– 210
iv)	Critical temperature, °C	– 146.9
v)	Critical pressure, MPa	3399
vi)	Specific volume of superheated vapour at 0.1 MPa and 20°C	0.858

Table 2 Specification for IG 100

(*Clause* 4.4)

Sl No.	Specification	Requirement
(1)	(2)	(3)
i)	Purity	99.6 percent by volume, *Min*
ii)	Moisture	50 (×) 10^{-6} by mass, *Max*
iii)	Oxygen	0.1 percent by volume, *Max*

NOTE — Other contaminants may include hydrocarbons, CO, NO, NO_2, CO_2, etc. Most are less than 20 × 10^{-6} by mass, *Max*.

Table 3 Toxicological Information for IG 100

(*Clause* 4.5)

Sl No.	Property	Value
(1)	(2)	(3)
i)	No observed adverse effect level (NOAEL)	43 percent
ii)	Lowest observed adverse effect level (LOAEL)	52 percent

NOTE — These values are the functional equivalents of NOAEL and LOAEL values which correspond to 12 percent minimum oxygen for the no-effect level and 10 percent minimum oxygen for the low-effect level.

Table 4 Fill Pressure of IG 100 Containers

(*Clause* 4.6)

Sl No.	System	Property
(1)	(2)	(3)
i)	15 MPa storage container	Filling pressure at 15°C
ii)	15 MPa storage container	Maximum container working pressure at 55°C
iii)	20 MPa storage container	Filling pressure at 15°C
iv)	20 MPa storage container	Maximum container working pressure at 55°C

NOTE — Figure 1 (*see* page 7) should be referred for further data on pressure/temperature relationship.

are provided to ensure safe egress of personnel prior to the discharge of the inert gas mixture.

5.2 In areas, where there is a likelihood of significant difference between gross and net volumes of the enclosure, utmost care shall be exercised in proper system design.

5.3 Though exposure to the concentration levels of oxygen and carbon dioxide (10 to 15 percent and 4.5 to 5 percent by volume respectively) is normally considered to produce a negligible risk to the personnel, contain provisions like personnel training, warning signs, pre-discharge alarms, and discharge inhibit switch shall be put in place. In addition, adequate ventilation facilities shall be available to exhaust the trapped gases following extinguishment process.

5.4 Maximum safety precautions and safety limits that are associated with the use of IG 100 are as shown in the Tables 5 and 6. Since a fire can be expected to consume oxygen and form decomposition products, personnel shall treat any fire situation as an emergency and promptly exit the enclosure.

5.5 Additional provisions as shown in Table 7 shall apply to account for failure of safeguards (*see* **5.1** to **5.4**) to prevent accidental exposures to the humans present within the enclosure.

6 ENCLOSURE STRENGTH AND VENTING FACILITIES

6.1 Venting shall be provided at levels as high as possible in the enclosure. Strength and allowable pressures for average enclosures may be in conformity with the following guidelines. The building requirements for the type of enclosure and from venting required can also be calculated from the relevant specifications.

6.2 Free venting facilities shall be provided for the enclosure and the equation for the venting area required shall be as follows:

$$A = (5 \times 10^{-4})(QP^{-0.5})$$

where

A = free venting area, m^2;

Q = IG-100 agent discharge rate, m^3/ min; and

P = allowable strength of the enclosure, kPa.

Value of P for various construction types is shown in Table 8. (For exceptionally tight enclosures, value of P shall be trebled.)

Table 5 Maximum Safety Precautions

(*Clause* 5.4)

Sl No.	IG 100 Design Concentration Percent by Volume	Requirements			
		Inhibit Switch and Time Delay	Egress in 30 s, *Max*	Safety Interlock	Lock-off Valve
(1)	(2)	(3)	(4)	(5)	(6)
i)	Below NOAEL < 43	Required	Not required	Not required	Not required
ii)	Between NOAEL and LOAEL 43 and 52	Required	Required	Required	Not required
iii)	Above LOAEL > 52	Required	Not applicable	Not required	Not required

Table 6 Safety Limit

(*Clause* 5.4)

Sl No.	Safety Limit	IG 100 Design Concentration[1)]	Residual Oxygen Concentration[1)]
(1)	(2)	(3)	(4)
i)	NOAEL	43	12
ii)	LOAEL	52	10

[1)]Percentage by volume.

Table 7 Human Exposure to IG 100 Agent

(*Clause* 5.5)

Sl No.	Exposure	IG 100 Agent Concentration (Percent)			
		Up to 43	Between 43 a..d 52	Between 52 and 62	More Than 62
(1)	(2)	(3)	(4)	(5)	(6)
i)	Oxygen concentration (percent) in sea level equivalent	12	Between 12 and 10	Between 10 and 8	Less than 8
ii)	Status of space	Normally occupied	Normally occupied	Normally occupied	Normally unoccupied
iii)	Exposure time	Not more than 5 min	Not more than 3 min	Not more than 30 s	No exposure permitted

Table 8 Allowable Strength of the Enclosure for IG 100

(*Clause* 6.2)

Sl No.	Construction Type	Typical Structures	Allowable Load on Enclosure kPa
(1)	(2)	(3)	(4)
i)	Light	Light weight partitions, glazing	1.25
ii)	Normal	Brick	4.50
iii)	Vault	Reinforced concrete	5.00

7 EXTINGUISHING AGENT SUPPLY

7.1 Quantity

a) The amount of the IG 100 in the system shall be at least sufficient for the largest single hazard protected or group of communicating hazards that are to be protected simultaneously.

b) *Quantity requirements (reserve)* — Same quantity as that of main quantity requirements shall be available as reserve. However, if the replenishing of agent supply takes more than 7 days at the site of installation, advice may be sought from the authority concerned on further quantity to be kept available as reserve.

c) *Uninterrupted protection* — Reserve supply and main supply should be permanently connected to the distribution piping and arranged for easy changeover to enable uninterrupted protection.

d) The quantity of the IG 100 required shall be further adjusted to compensate for any special conditions, such as unclosable openings, forced ventilation, the free volume of air receivers that may discharge into the risk, altitude (substantially above or below sea level) or any other causes for the extinguishant loss.

7.2 Total Flooding Quantity

a) The amount of IG 100 required to achieve the design concentration shall be calculated from the following equations and this figure shall need further adjustment as stated in **7.1**(d).

$$M = 4.303 \frac{V}{S} V_S \log_{10}\left(\frac{100}{100 - C}\right)$$

where

M = total flooding quantity, kg;

C = design concentration, percent by volume;

V = net volume of the hazard, m^3;

V_S = volume of the structural/similar permanent objects in the enclosure that gas can not permeate, in m^3;

S = $K_1 + K_2 (T)$, where K_1 and K_2 are constants specific to the agent used and T is minimum temperature inside enclosure; and

S_R = specific volume of superheated agent at 27°C, m^3/kg.

Specific volume constants for the IG 100 gas are K_1 = 0.799 68 and K_2 = 0.002 94.

IG 100 is a non-liquefied gas at 150 bars. It may also be noted that this equation provides an allowance for the normal leakage from a tight enclosure.

b) The agent requirement per unit volume of protected space can also be calculated by using Table 9 for various levels of concentration corresponding to the temperature within the protected enclosure.

NOTE — Quantity of the agent shall be the highest of the values calculated from the provisions contained in **7.2**(a) and **7.2**(b) above.

7.3 The actual quantity of IG 100 gas storage required and the resultant residual oxygen and carbon dioxide concentrations produced shall be determined in the following manner, which shall further be subject to changes for pressure change due to elevation (*see* **7.4**).

7.3.1 *Enclosure Volumes*

The net enclosure volumes are calculated using the following equations:

a) $V_{Max} = V_g - V_s$

b) $V_{Min} = V_{Max} - V_o$

where

V = maximum net volume of the enclosure, m^3;

V_g = gross volume of enclosure, m^3;

V_S = volume of the structural/similar permanent objects in the enclosure that gas can not permeate, m^3;

V_{Min} = minimum net volume of enclosure considering the maximum anticipated volume of the occupancy related to the objects in the enclosure, in m^3; and

V_o = volume of the occupancy related objects in the enclosure that gas can not permeate, for example, furniture fittings, etc, in m^3. (This value shall be ignored if the volume is less than 25 percent of the maximum net volume V_{Max}.)

7.3.2 *IG 100 Parameters*

The required IG 100 gas quantity, number of cylinders, actual injected concentration etc, are calculated using the following equations:

a) *IG 100 agent quantity (Theoretical)*

$M_{th} = V_{Max} \times C_1$ .... (1)

where

M_{th} = theoretical IG 100 quantity, in m^3;

V_{Max} = maximum net volume of the enclosure, in m^3; and

C_1 = appropriate injected concentration.

b) *IG 100 Containers*

The number of containers required shall be as follows after rounding off as appropriate:

$N = M_{th} / M_c$ .... (2)

where

N = number of containers;

M_{th} = theoretical IG 100 quantity, in m^3; and

M_c = quantity of IG 100 agent per container, in m^3.

Standard containers with standard filling pressures should be adopted to facilitate logistics.

c) *Actual Quantity of IG 100 Agent*

The actual quantity of the agent is determined as per the equation below:

$$M_A = N \times M_c \qquad \text{......... (3)}$$

where

M_A = actual quantity of IG 100 storage, in m^3;

N = numeral of containers; and

M_c = quantity of IG 100 agent storage container, in m^3.

d) *Actual IG 100 Injected Concentration*

The actual injected concentration of the agent based on the actual quantity of the IG 100 agent storage is calculated as below:

$$C_{AI} = M_A / V_{Max} \qquad \text{......... (4)}$$

where

C_{AI} = actual IG 100 injected concentration;

M_A = actual quantity of IG 100 storage, in m^3; and

V_{Max} = maximum net volume of the enclosure, in m^3.

e) *Concentration Levels of Oxygen (–) and CO_2 (+) for the Injected Concentration*

Lastly, it is required to adjust the number of IG 100 agent containers, where necessary, by compensating for ambient pressure change due to location elevation as per **7.4** and round off the number as before. The equation in such cases will be as follows:

$N_1 = N \times$ atmospheric correction factor

where

N_1 = adjusted number of containers, and

N = initial number of containers.

7.4 Atmospheric Correction Factors

It shall be necessary to adjust the actual IG 100 agent quantity for altitude effects. Depending upon the altitude, atmospheric correction factor shall be applied as per the Table 10. The adjusted IG 100 agent quantity is determined by multiplying the number of IG 100 containers by the ratio of average ambient enclosure pressure to standard sea level pressure.

8 CONCENTRATION REQUIREMENTS

8.1 Fire Extinguishing Concentration

a) The minimum design concentration of the IG 100 agent for Class A surface fire hazards shall be the extinguishing concentration with a loading of 20 percent as a safety factor.

b) The minimum design concentration of the IG 100 agent for Class B hazards shall be the extinguishing concentration (determined by Cup Burner test) with a loading of 30 percent as a safety factor.

c) *Combustible solids* — The minimum injected concentration of IG 100 agent for surface type class A risks shall not be less than 40 percent by volume which yields, on a free efflux basis, a residual oxygen concentration of 14 percent by volume in the enclosure.

9 APPLICATION RATE AND DISCHARGE TIME

9.1 Rate of Application

The design application rate shall be based on the quantity of IG 100 (M_A) [*see* **7.3.2**(c)] for the desired concentration (*see* **8.1** or **8.2** as the case may be) and for the time allotted to achieve the design concentration (*see* **9.2**). The oxygen and CO_2 concentrations, however, shall be within the limits as specified in **5.3**.

9.2 Duration of IG 100 Discharge

a) The discharge time period is defined as the time required to discharge from the nozzles 95 percent of the agent mass at 27°C, necessary to achieve the minimum design concentration based on a 20 percent safety factor for flame extinguishment.

b) The minimum theoretical injected concentration, that is, 34 percent by volume shall be achieved within one minute and the actual injected concentration [that is the above plus a suitable safety factor, adjustment for container : rounding off] shall be achieved within 2 min. 95 percent of the minimum design quantity of the agent shall be released within 60 s.

c) Flow calculations performed in accordance with **12** or in accordance with the listed pre-engineered systems shall be used to demonstrate the discharge time requirements stated above.

d) For explosion prevention systems, the

Table 9 Total Flooding Quantity (IG 100)

[*Clause* 7.2(b)]

Sl No.	Temperature °C	Specific Vapour Volume m³/kg	Mass Requirements of IG 100 per Unit Volume of Hazard kg/$V_{Enclosure}$ Design Concentration (Percent by Volume) *C*							
	T	*S*	34	38	42	46	50	54	58	62
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	– 40	0.682 5	0.523	0.601	0.685	0.775	0.872	0.977	1.091	1.217
ii)	– 35	0.697 1	0.512	0.589	0.671	0.759	0.853	0.956	1.068	1.191
iii)	– 30	0.711 8	0.501	0.576	0.657	0.743	0.836	0.936	1.046	1.167
iv)	– 25	0.726 4	0.491	0.565	0.644	0.728	0.819	0.917	1.025	1.143
v)	– 20	0.741 1	0.481	0.554	0.631	0.714	0.803	0.899	1.005	1.120
vi)	– 15	0.755 7	0.472	0.543	0.619	0.700	0.787	0.882	0.985	1.009
vii)	– 10	0.770 4	0.463	0.533	0.607	0.686	0.772	0.865	0.966	1.078
viii)	– 05	0.785 0	0.454	0.523	0.596	0.674	0.758	0.849	0.948	1.058
ix)	0	0.799 7	0.446	0.513	0.585	0.661	0.744	0.833	0.931	1.038
x)	5	0.814 3	0.438	0.504	0.574	0.649	0.731	0.818	0.914	1.020
xi)	10	0.829 0	0.430	0.495	0.564	0.638	0.718	0.804	0.898	1.002
xii)	15	0.843 6	0.423	0.486	0.554	0.627	0.705	0.790	0.883	0.984
xiii)	20	0.858 3	0.416	0.478	0.545	0.616	0.693	0.777	0.868	0.968
xiv)	25	0.872 9	0.409	0.470	0.536	0.606	0.682	0.764	0.853	0.951
xv)	30	0.887 6	0.402	0.462	0.527	0.596	0.670	0.751	0.839	0.936
xvi)	35	0.902 2	0.395	0.455	0.518	0.586	0.659	0.739	0.825	0.920
xvii)	40	0.916 9	0.389	0.448	0.510	0.577	0.649	0.727	0.812	0.906
xviii)	45	0.931 5	0.383	0.440	0.502	0.568	0.639	0.715	0.799	0.892
xix)	50	0.946 2	0.377	0.434	0.494	0.559	0.629	0.704	0.787	0.878
xx)	55	0.960 8	0.371	0.427	0.487	0.550	0.619	0.694	0.775	0.864
xxi)	60	0.975 5	0.366	0.421	0.479	0.542	0.610	0.683	0.763	0.851
xxii)	65	0.990 1	0.360	0.414	0.472	0.534	0.601	0.673	0.752	0.839
xxiii)	70	1.004 8	0.355	0.408	0.465	0.526	0.592	0.663	0.741	0.827
xxiv)	75	1.019 4	0.350	0.402	0.459	0.519	0.584	0.654	0.730	0.815
xxv)	80	1.034 1	0.345	0.397	0.452	0.511	0.575	0.645	0.720	0.803
xxvi)	85	1.048 7	0.340	0.391	0.446	0.504	0.567	0.636	0.710	0.792
xxvii)	90	1.063 4	0.335	0.386	0.440	0.497	0.559	0.627	0.700	0.781
xxviii)	95	1.078 0	0.331	0.381	0.434	0.491	0.552	0.618	0.691	0.770
xxix)	100	1.092 7	0.326	0.375	0.428	0.484	0.544	0.610	0.681	0.760

discharge time for agents shall ensure that the minimum inerting design concentration is achieved before concentration of flammable vapours reach the flammable range.

e) When an extended discharge is desired to maintain the design concentration for the specified period of time, additional quantities of agent can be applied at a reduced rate. The initial discharge shall be completed within the limits as specified above. Performance of the extended discharge shall be demonstrated by test.

f) Where containers are situated remote from the protected enclosure, extended transit time will be apparent. Authorities concerned shall be consulted before locating the containers in such cases.

9.3 Retention Time

Following the discharge of the agent into the enclosure, at least 80 percent of the design concentration (or inerting concentration as the case may be) shall prevail within the enclosure, when measured after 10 min of discharge.

Table 10 Atmospheric Correction Factors

(*Clause* 7.4.3)

Sl No.	Equivalent Altitude m	Enclosure Pressure mm Hg	Atmospheric Correction Factor
(1)	(2)	(3)	(4)
i)	– 920	840	1.11
ii)	– 610	812	1.07
iii)	– 300	787	1.04
iv)	0	760	1.00
v)	300	733	0.96
vi)	610	705	0.93
vii)	920	678	0.89
viii)	1 220	650	0.86
ix)	1 520	622	0.82
x)	1 830	596	0.78
xi)	2 130	570	0.75
xii)	2 440	550	0.72
xiii)	2 740	528	0.69
xiv)	3 050	505	0.66

10 STORAGE CONTAINERS

The IG 100 storage containers shall comply with the following in addition to various requirements contained in IS 15493.

a) The containers used in IG 100 systems shall be seamless cylinders conforming to IS 7285 designed, fabricated, inspected, certified and stamped in accordance with the requirements of Chief Controller of Explosives, Nagpur.

b) The design pressure shall be suitable for the maximum pressure developed at 55°C or at the maximum controlled temperature limit.

c) The storage containers shall have reliable means of indicating their pressure.

d) The storage containers shall have reliable means of indicating the variation of container pressure with temperature. A pressure/ temperature chart (*see* Fig. 1) attached to the container, is acceptable.

e) The requirements of authorities having jurisdiction for containers may take precedence over the requirements of this standard, if their specifications are more stringent.

11 DISTRIBUTION SYSTEM

The IG 100 distribution system shall comply with the following in addition to various requirements contained in IS 15493.

11.1 Piping Network

a) The piping shall withstand the maximum expected pressure at the maximum storage temperature, as follows:

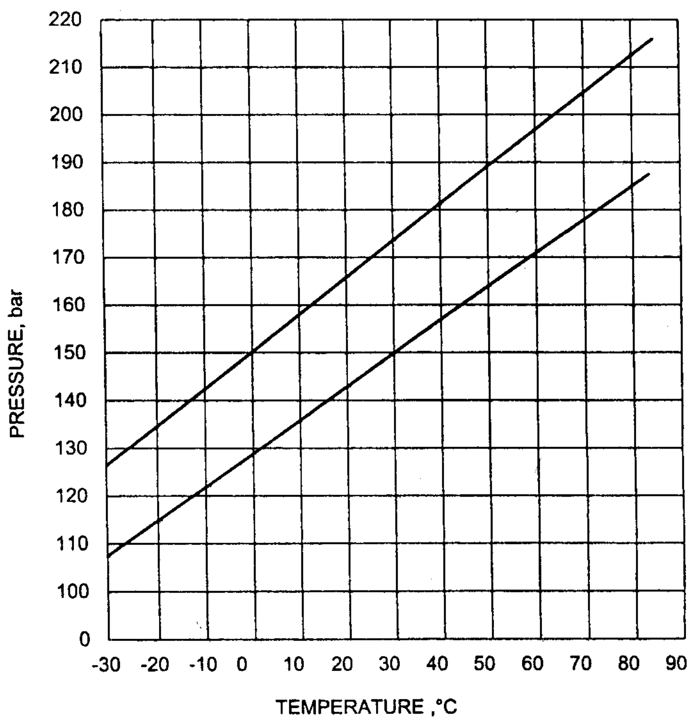

Fig. 1 Temperature/Pressure Graph for IG-100 Pressurized to 15 MPa and 20 MPa at 15°C

1) 13.5 MPa systems : 20 MPa at 55°C

2) 16.2 MPa systems : 25 MPa at 55°C

b) The piping shall withstand the maximum developed pressure at 55°C and shall be in accordance with IS 15493.

c) Carbon steel pipes and fittings shall be galvanized inside and outside or otherwise suitably protected against corrosion. Stainless steel pipes and fittings may be used without corrosion protection.

11.2 Piping Fittings

a) Pipe fittings shall comply with the requirements given in IS 15493.

b) Fittings shall be selected according to the wall thickness or schedule number of the pipe to which they are intended to be fitted.

11.3 Pipe Sizing

Pipe sizing is a complex issue, particularly when too small a bore results in excessive pressure losses while two large a bore reduces the flow velocity. This may also result in excess pressure drops and lower flow rates. The sizes can be checked using an approved computer flow calculation programne.

11.4 Nozzle Placement

a) The type of nozzles selected, their number and placement shall be such that the design concentration will be established in all parts of the protected enclosure and such that the discharge will not unduly splash flammable liquids or create dust clouds that could extend the fire, create an explosion, or otherwise adversely affect the contents or the integrity of the enclosure.

b) Nozzles shall be selected and located to protect an area less than its area of coverage. The area of coverage to the type of nozzle shall be so listed for the purpose.

c) Maximum nozzle height above floor level for a single row of nozzles is 4.5 m. Where ceiling height (of the protected enclosure) exceeds 4.5 m, an additional row of nozzles shall be provided for uniform and faster distribution of the agent within the enclosure.

d) Minimum nozzle height above the floor level of the hazard shall be 0.2 m.

e) In case of enclosures having no false ceiling, nozzles can be located on the ceiling anywhere within 0.5 to 5 m from the walls. In case of enclosures having false ceilings, deflector shields shall be used with each nozzle and also nozzles shall be so located (with an anticipation of dislodgement of false ceiling materials or any movable objects in the path of discharge) to prevent any damage thereto.

f) Nozzles shall be provided in all the concealed spaces, floor voids, ceiling voids, etc, besides the main area within the protected enclosure.

g) Selecting the number of nozzles in a system shall take into account, the shape of the enclosure (area and volume), shape of the void (raised floor, suspended ceiling). Installed equipment in the enclosure/void (chimney effect), allowed pressure at the restrictor (pipe quality), obstructions, which may affect the distribution of the discharged agent and architectural considerations.

h) In hazards having suspended ceiling, consideration shall be given for having nozzles installed in the ceiling void (simultaneous discharge) in order to equalize the pressure during discharge, thus reducing the risk of unnecessary damaging ceiling tiles, etc.

j) In hazards having raised floor (not gas-tight) consideration shall be given for having nozzles installed in the floor void (simultaneously discharge) in order to equalize the pressure and obtain extinguishing concentration below the floor.

k) In hazards having suspended ceiling, nozzles for protecting rooms void shall be installed in such a way that the jets from the nozzles do not damage the ceiling plated excessively during discharge, that is, the nozzles to be positioned vertically with the discharge holes free of the ceiling tiles and/ or Escutcheon plates. For light weight ceiling tiles, it may be recommended to securely anchor tiles for a minimum of 1.5 m from each discharge nozzle.

m) The maximum distance between nozzles should not exceed 6 m and the maximum distance to wall/partition should not exceed 3 m.

12 HYDRAULICS OF THE SYSTEM

12.1 An approved hydraulic calculation method shall be employed to predict pipe sizes, nozzle pressure, agent flow rate, discharge per nozzle and the discharge time.

12.2 The various parameters described in **7.3.1**, **7.3.2**, **9.1** and **9.2** shall be considered to determine the following minimum limits of accuracy:

a) The weight of agent predicted by flow calculation to discharge from the nozzle should agree with the total weight of agent actually discharged from each nozzle in the system within a range of – 5 percent to + 10 percent of actual prediction.

b) The discharge time predicted by the flow calculation method should agree with the actual discharge time from each nozzle in the system within a range of ±5 s.

c) The accuracy of the calculated nozzle pressures *versus* actual pressures at each nozzle should be such that actual nozzle pressures in an installation will not fall outside the range required for acceptable nozzle performance.

d) The nozzle pressure should not fall below the minimum or above the maximum nozzle pressure required for the nozzle to uniformly distribute the agent throughout the volume from which nozzle's discharge is to protect.

13 COMMISSIONING AND ACCEPTANCE TESTING

13.1 Criteria for Acceptance

The completed IG 100 total flooding system shall be commissioned in accordance with IS 15493 and the system's performance proved by at least one of the following methods:

a) It is not normally recommended to conduct full-scale discharge test of IG 100 total flooding systems. Where the authorities concerned insist on full-scale discharge test, the tests shall be conducted in accordance with **14**.

b) Where a full discharge test using IG 100 is not insisted by the authorities concerned, the following procedure shall apply:

   1) Subject the distribution system to a hydrostatic pressure test of 1.50 times the calculated pipework's maximum developed storage pressure at 55°C, then purge the system to remove moisture and prove free passage.

   2) Subject the protected area to an enclosure integrity test in accordance with IS 15493.

13.2 Commissioning Certification

When the system commissioning is completed the installation agency shall issue a typical test certificate.

13.3 Where the system fails to comply with various provisions as stated above, the fault shall be rectified and, if necessary, the system retested.

14 IG 100 FULL SCALE DISCHARGE TEST PROCEDURE

14.1 This shall be in accordance with IS 15493.

14.2 Recommissioning

Restore all systems to a fully operational status.

14.3 Reporting

The following shall be reported:

a) Information identifying the system shall include:

   1) Installation, designer and contractor;

   2) Enclosure identifications;

   3) Enclosure temperature prior to discharge;

   4) Oxygen and carbon dioxide residual concentrations; and

   5) Position of sampling points.

b) Date and time of test.

c) Discharge time.

d) Concentration levels at each sampling point at 2 min and 10 min from the commencement of discharge.

e) System deficiencies.

f) Reference to this test method (*see* IS 15493).

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