



CRITICAL ANALYSIS OF FIRE SAFETY IN PUBLIC & PVT HOSPITAL IN DELHI NCR

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ABSTRACT Fires can be devastating, especially in a hospital where a large number of people who need to be evacuated may be vulnerable – immuno compromised, on life support, and incapable of moving on their own. There are special requirements that must be met with while evacuating such people in case of fire emergencies. But before that – “fires must be prevented”.

KEYWORDS : Fire Safety, NBC 2016, Prevention , safety

INTRODUCTION

Fire safety in hospitals is a very important aspect of hospital architecture and maintenance. However, the work done so far to measure these fire safety norms is meager and needs urgent attention. Hospital authorities do not pay much importance to this aspect of internal threat in a health care facility imparting directly to cause dent on patient safety. The present paper gives an outline of parameters to be measured or looked into for fire safety in high rise hospital buildings and nursing homes more than 15 mts., up to 30 mts. of height that the owners and Doctors may use it for self- evaluation and can think of long- term and short term measures to be adopted to improve fire safety. Fires can be devastating, especially in a hospital where a large number of people who need to be evacuated may be vulnerable – immuno compromised, on life support, and incapable of moving on their own. There are special requirements that must be met with while evacuating such people in case of fire emergencies. But before that – “fires must be prevented”.

AIM :

To ascertain common pitfalls in fire safety in hospitals with a view to recommend measures for improving the fire safety in hospitals in India.

OBJECTIVES :

1. Critical analysis of Fire Safety Status in Hospital in Delhi NCR.
2. Comparison of Fire Safety Status in Pvt Vs Public Hospital in Delhi NCR.
3. Gap analysis of Fire Safety Status in Hospital in Delhi NCR .
4. Recommendation for Fire Safety Status Improvement in Hospital in Delhi NCR.

MATERIAL AND METHODS

A study conducted by Dr Neerav et al at AIIMS highlighted various aspect of fire safety in hospital. His study revealed a large number of drawbacks in structure and facility required for fire safety in hospital. The National Building Code (NBC) part-IV – 2016 “Fire & Life Safety”, an accepted Indian standard, has been studied regarding various aspects of building design, materials to be used for construction and various architectural parameters from the point of view of fire safety.

The NFPA (National Fire Protection Association – USA) hand book and NFPA – 101 (Life Safety Code – 2006)² has been studied emphasizing the three basic aspects of Fire Safety, i.e., Prevention, Protection and Life Safety. In addition, the relevant portion of Delhi building by-laws , Delhi Fire Prevention and Safety Rule- 1986, Delhi Fire Safety Prevention Act (1987) and Bureau of Indian Standards (BIS) for fire protection fixed installations and portable devices like IS -2189,IS-3384, IS-15105 , IS-884 are also included¹.

The 'part 4' of 'National Building Code of India – 2016' on 'Fire & Life Safety' covers the requirements for fire prevention & life safety in relation to fire and fire protection of buildings. The Code specifies construction, occupancy and protection features that are necessary to

minimize danger to life and property from fire¹.

Buildings on the basis of occupancies have been divided into different groups in the chapter. Hospitals have been classified as sub-division C-1 under Group C for Institutional Buildings with some specific requirements applicable for this category in addition to the general requirements common for all occupancies.

The NBC gives detailed guidelines for Construction Materials, General Requirements for all buildings, Life Safety, Fire Protection, Specific Occupancy wise Requirements and specific requirements for buildings above 15 meters.

A check list has been developed on the basis of methodology as mentioned above. This check list contains parameters along with their standard values which provide a clear understanding of fire safety norms in a high rise hospital. When this list will be filled up, it will reflect the gap; thus, areas where there is no need of further action and also those areas where corrective measures need to be adopted are identified. The list were easy to understand and requires only factual and objective observations to be filled up, in terms of data observed at site related to fire safety evaluation.

Study Design – Descriptive & comparative study.

Sample Size – One Public and Pvt Sector hospital in India.

Statistical Analysis : By SPSS software .

Fire Safety Checklist

Significant building parameters related to fire safety to be known before assessment

1. Name & address of the building
2. Type of Occupancy
3. Occupancy sub division
4. No. of floors
5. Height
6. Area of largest floor
7. No. of basement
8. Basement area
9. Type of construction
10. Type of building
11. Bed facility
12. Interior finish

Based on the above building parameters a check list addressing the standard requirement in accordance with Delhi fire safety rule- 2010, NBC IV -2005, NABH guidelines and Bureau of Indian Standards, was developed, which was used as a tool to evaluate the fire safety measures that follows as in appx A.

RESULTS

Two hospitals (one public & Pvt) in Delhi NCR were studied under various heads in table no 1-17.

Table 1 : Access to building

| Access to building (NBC - 3.4.6.1) | Recommended | Public hospital | Private hospital |
|---|--------------|-----------------|------------------|
| 1. Width of main street on which building abuts | 12 meter | Yes | Yes |
| 2. Width of main entrance | Min. 4.5 m | Yes | Yes |
| 3. Clear head room | 5.0 m | No | Yes |
| 4. Load bearing capacity of access road | 45 Tonnes | Yes | Yes |
| 5. Turning radius of perimeter road | 9 meters | No | No |
| 6. Open space around the building | Unobstructed | Yes | Yes |

In buildings or sections occupied by bed-ridden patients where the floor area is over 280 m², facilities shall be provided to move patients in hospital beds to the other side of a smoke barrier from any part of such building or section not directly served by approved horizontal exits or exits from the first floor (floor 2) of a building to the outside. The exits in public hospital was there but blocked and maximum travel distance was more than 70 mtrs as shown in table no 2. All required exits that serve as egress from hospital or infirmary sections shall be not less than 2 m in clear width including patient bedroom doors to permit transportation of patients on beds, litters, or mattresses. The minimum width of corridors serving patients bedrooms in buildings shall be 2400 mm.

Table 2 : Fire Exits

| Exits | | Pub Hosp | Pvt Hosp |
|---|---|----------------------------|----------|
| 1. Number (4.6.2-NBC) | Any area > 500 sq. m should have min. 2 exits | Yes but blocked by almirah | Yes |
| 2. Location (NBC 4.5.3) | Remotest possible | Yes | Yes |
| 3. Signage | Green, illuminated with circuit on independent supply | Yes but illuminated | Yes |
| 4. Capacity | No. of Unit width (500) mm. should be sufficient enough so that total occupants must evacuate from a floor within 2.5 minutes | No | Yes |
| 5. Max.travel distance (NBC 4.5.2) | Less than 30 meters | No, its more than 70 mtrs | Yes |
| 6. Dead end travel | Maximum 6 meters | No | No |
| 7. Door height (NBC 4.7.2) | Min. 2 meters | Less than 2 mtrs | Yes |
| 8. Door width (NBC 4.7.2) | Min. 1 meter | Yes | Yes |
| 9. Corridor and passages (NBC 4.8) | 2.4 m for pt's ward & 1.5 for others | Yes | Yes |
| 10. Status | Every exit, exit access or exit discharge to be continuously maintained free of obstruction | No | Yes |
| 11. Horizontal exit | Recommended | No | Yes |
| 12. Provision of Escape routes – escape stair | Recommended | No | Yes |

Compartmentation & smoke management system is also an important component of fire safety. The assessment done as in table 3.

Table 3 : Compartmentation & Smoke Management System

| | | Pub hosp | Pvt Hosp |
|---|--|----------|----------|
| Compartmentation (6.3.3.1&5 - NBC) | Area > 280 sq m in bed ridden cases At an area 500 sqm in OPD – shall be divided into compartment by fire resistant wall | No | Yes |
| Smoke Management System | | | |

| | | | |
|--|--------------------------------|-----|-----|
| • Ventilation | Natural | Yes | Yes |
| • Whether natural ventilation is relied | Yes | Yes | Yes |
| • Details of vent for stairwell & lift shaft | Open building | Yes | Yes |
| • Mechanical ventilation | Required in closed buildings | No | Yes |
| • No of air changes | 12 per hour | No | Yes |
| • Whether mechanical ventilation is coupled with automatic detection | Recommended in closed building | No | Yes |

Table 4 : Portable Fire Extinguishers

| Portable Fire Extinguishers3 (I.S. 2190) | | Public hosp | Pvt Hosp |
|--|--------------------------------------|---|----------|
| 1. No | One for 100sq m | Not adequate | Yes |
| 2. Type | Two (water co2-9lts) , (co2—4.5 lts) | Yes but adequate in number and most of them expired | Yes |
| 3. All ISI approved | Recommended | Yes | Yes |
| 4. Mounted , located & clearly marked by luminous signs for ready access (5.1.11 NBC) | Recommended | No | Yes |
| 5. Fully charged, operable all the time | Mandatory | No | Yes |
| 6. Regular inspection | Monthly | No | Yes |
| 7. Annual maintenance check & documentation | Recommended | Yes | Yes |
| 8. Periodic hydrostatic testing & record maintenance | Recommended | No | Yes |
| 9. Distribution | At every 15 meters | No | Yes |
| 10. Training for employees expected to use during emergency as first hand device principle | Recommended | Yes , but only on paper | Yes |

Table 5 : First-Aid Hose Reels⁶

| First-Aid Hose Reels (IS-884 & NABH) | | Public hosp | Pvt hosp |
|---|-------------------------------|-------------|----------|
| • No. | One for 2000 sqm | No | Yes |
| • Bore & length | 25 mm in dia., 30 m in length | No | Yes |
| • Size & type of nozzle | 6.5 mm ,shut off type | No | Yes |
| • Connected directly to riser or hydrant outlet | Recommended | No | Yes |
| • Maintenance & Testing | Annual | No | Yes |
| • First aid Fire- fighting appliances must be in working conditions | Recommended | No | Yes |
| • First aid equipment cabinets | Recommended | No | Yes |

Table 6 : Automatic fire detection and alarming system & MOEFA

| Automatic fire detection and alarming system (IS 2189) | | Public hosp | Pvt Hosp |
|--|-------------------------------------|-------------|----------|
| • Type of detectors | Smoke n heat | No | Yes |
| • The standard to which detectors conform | Is11360 & NABH (smoke) IS2175(heat) | No | Yes |
| • Power back-up | Recommended | No | Yes |
| • Annual inspection tests & documentation | Recommended | No | Yes |

| | | | |
|---|-------------|----|-----|
| MOEFA. (manually operated electrical fire alarm) (k 11.1.1 & NABH) – (unified building bye- laws) | Recommended | No | Yes |
|---|-------------|----|-----|

Table 7 : Public Address System & Automatic Sprinkler System

| Public Address System & Automatic Sprinkler System | | Public hosp | Pvt Hosp |
|--|---|------------------------|----------|
| Public Address System. (C-5 NBC) Between various floor & fire control room at entrance | Recommended | Yes but not functional | Yes |
| Automatic Sprinkler System⁵ (IS .15105 & NABH) | Recommended at every floor in building with height > 15 m | No | Yes |

Table 8 : Internal Hydrants and Yard Hydrants

| Internal Hydrants and Yard Hydrants ⁴ (I.S.-3844 & NABH) | | Public hosp | Pvt Hosp |
|---|---------------------|-----------------|----------|
| • No of int. hydrant | At every 30 meter | Yes but limited | Yes |
| • on each floor | Recommended | Yes but limited | Yes |
| • in basement | Recommended | Yes but limited | Yes |
| • on terrace | Recommended | Yes but limited | Yes |
| • type of hose | RRL | Yes but limited | Yes |
| • size (bore) of hose | 63 mm | Yes but limited | Yes |
| • length of hose | 15 meter | Yes but limited | Yes |
| • no of hoses provided near each hydrant | Two | Yes but limited | Yes |
| • provision of branch pipe | Recommended | Yes but limited | Yes |
| • size of nozzle fitted to branch | 20mm | Yes but limited | Yes |
| • functional status | Permanently charged | Yes but limited | Yes |
| • maintenance & testing schedule and documentation | Regular | Yes but limited | Yes |

Table 9 : Pumps Arrangements

| Pumps Arrangements (IS 3844) At Ground Level | | Public Hospital | Pvt Hospital |
|--|--------------------------------------|-----------------------------|--------------|
| 1. No of pumps | Two (one electric & one diesel) NABH | Yes but only one (electric) | Yes |
| 2. Standby | One | No | Yes |
| 3. Jockey pump | One | Yes but not functional | Yes |
| 4. Size of suction & delivery of each pump | Suction 6 inches, Delivery 6 inches | No | Yes |
| 5. Output of each pump | 2280 lts /min | Yes | Yes |
| 6. Type of suction | Positive | Yes | Yes |
| 7. Pump control panel | Recommended | No | Yes |
| 8. Electrical supply | Dual | Single | Yes |
| 9. Back up | Recommended | No | Yes |
| 10. Max. head against which the pump can operate | To cover total height | No | Yes |
| 11. Automaticity | Recommended | No | Yes |
| 12. Air vessel | Recommended | No | Yes |
| 13. Test drain | Recommended | No | Yes |
| At Terrace level | Not recommended | Yes | Yes |

Table 10 : Captive Water Storage for fire fighting Underground

| Captive Water Storage for fire fighting. (table 23-NBC) Underground | | Public hosp | Private hospital |
|---|-----------------------------|---------------|------------------|
| • Capacity | 1.5 lacks lts | No Only 10 KL | No Only 30 KL |
| • Replenishment (5.1.6-nbc) | 1000 lts/minute Dual supply | No | No |

| | | | |
|--|--------------|-----|-----|
| • Approach | Approachable | Yes | Yes |
| • Provision for fire brigade collecting head | Four x 63 mm | No | Yes |
| • Overhead | 20,000 lts | No | Yes |

Table 11 : lift

| Lifts.(ANNEX -C-1.5-NBC) | | Public hosp | Private hospital |
|--|---|--------------------------------------|------------------|
| • Max. no. of lifts in one lift banks | 4 | No (horizontal spread, single story) | Yes |
| • Pressurization of lift shafts & lift lobby | 25-30 pa in case of closed lift shaft | No | Yes |
| • Type of doors fitted to lift car & landing | Fire resistant (1 hr) | No | Yes |
| • Communication system installed in lift car | Recommended | No | Yes |
| • Fire men's grounding switch installed | Recommended | No | Yes |
| • Power back up thru manual changeover to all lift | Recommended | No | Yes |
| Fire lift (4.15 - NBC) | | | |
| • No | One per 1200sq meter | No | Yes |
| • Loading capacity of lift car | Not less than 545 kg /(8) persons | No | Yes |
| • Floor area of lift car | Min. 1.4 sq. m. | No | Yes |
| • Electrical supply & automaticity | Separate circuit with automatic change over | No | Yes |
| • Speed | In 1 minute, it should reach from top to gr. Floor | No | Yes |
| • Signage | To be displayed conspicuously in fluorescent paint as fire lift | No | Yes |

Table 12 : Standby power supply & Emergency and escape lighting

| Standby power supply | | | |
|---|---------------------------------|----|-----|
| • Functions maintained on it -- lift, fire pump & emergency light | All the three | No | Yes |
| • Separate electrical circuit | Recommended | No | Yes |
| • Generator –automatic or manual | Automatic | No | Yes |
| Emergency and escape lighting (4.16.2-nbc) | | | |
| • Intensity | 10 lux central line floor level | No | Yes |
| • Time taken in switch over | 1 second | No | No |
| • Back up period | Min.1.30 hrs | No | No |
| • Perfect maintenance so as serviceable all the time | Recommended | No | No |

Table 13 : Refuge Area & Fire officer

| Refuge Area.(4.12.3 ,table 20- NBC) | | Public hosp | Pvt hosp |
|---------------------------------------|---|-------------|----------|
| • Provision | Recommended | No | Yes |
| • Total area floor wise | Above 24 feet height 15 sqm or 0.35 sqm per person related to occupancy of two floor, whichever is higher | No | Yes |
| Fire officer ANNEX-C-(C-6)NBC | | | |
| • Formal position | Recommended | No | No |
| • Qualification & experience | Recommended | No | No |
| • Duties | <ul style="list-style-type: none"> To maintain fire fighting equip. in good working cond. all the time Prepare fire order, operational plans & get them promulgated | No | No |

| | | | |
|--|---|--|--|
| | <ul style="list-style-type: none"> Regular training to occupants in use of fire fighting equipments. Liaison with city fire brigade | | |
|--|---|--|--|

Table 14 : Fire Control Room

| Fire Control Room ANNEX-C-(C-5) NBC | | Public hosp | Pvt hosp |
|---|--|-------------|----------|
| • Easily assessable (NABH) | Recommended | NO | Yes |
| • Provision of intercom | Recommended | NO | Yes |
| • Provision of public address system communicating various floor & facility | Recommended | NO | Yes |
| • Details of all floor plans | Recommended | NO | Yes |
| • Fire alarm panels | Recommended Control panel & manned, PA equipment should be connected with detection system or fire alarm system.(NABH) | NO | Yes |
| Fire order – annex E- (9.3.1-NBC) | | | |
| • trained man power deployment to meet fire fighting & evacuation | Recommended & must be well documented | Yes | Yes |
| Air conditioning (3.4.11-NBC) | | | |
| • Material & rating of supply duct | Non combustible | No | Yes |
| • Lagging /insulation | Non combustible | No | Yes |
| • Return duct (plenum) | Recommended | No | Yes |
| • Fire dampers | Recommended | No | Yes |
| • Fire detectors | Recommended | No | Yes |
| • Material of false ceilings | Non combustible | No | Yes |
| • Distribution of AHU | Separate | No | Yes |
| • Operation of AHU | Automatic | No | Yes |
| • Provision of Forced ventilation should be there | NABH | No | Yes |

Table 15 : Staircases

| Staircases (4.9.6 – NBC) | | Public hosp | Pvt hosp |
|--------------------------------------|---|--------------------------------------|----------|
| • Construction material | Non combustible For an area > 500sq.m | No (horizontal spread, single story) | Yes |
| • No | At least two stair cases One should open to exterior | No | Yes |
| • Width | 2.0 meter | No | Yes |
| • Width of treads | 300 mm | No | Yes |
| • Height of risers | 150 mm | No | Yes |
| • Wet riser system must be installed | Recommended by NABH | No | Yes |
| • No. of steps in one flight | Max. 15 | No | Yes |
| • Continuity | Continuous from ground to terrace | No | Yes |
| • Height of handrail | 1 meter | No | Yes |
| • Type of steps | Non skid | No | Yes |
| • Fire check doors at entrance | Recommended | No | Yes |
| • Stair case venting | Recommended in closed stair well | No | Yes |
| • Services passing through ducts | Not permitted | No | Yes |
| • Floor indication board | 0.5x0.5 m placed near landing | No | Yes |

Table 16 : Electrical safety

| Electrical safety | | Public hosp | Pvt hosp |
|-------------------|--------------------------------|-------------|----------|
| • Wiring | As per Indian electricity rule | Yes | Yes |

| | | | |
|--|-------------|-----|-----|
| • H.T. panel | Recommended | Yes | Yes |
| • L.T. Panel | Recommended | Yes | Yes |
| • Sealing of apertures for services at every floor | Recommended | No | Yes |
| • Transformer & switch gear location | Separate | Yes | Yes |
| • Separation of each other by 4 hrs resistive wall | Recommended | No | Yes |
| • Periodic checking of load & documentation | Recommended | No | Yes |

Table 17 : Fire tower & drill

| | | Public hosp | Pvt hosp |
|---|--|-------------|----------|
| Fire tower (4.13.1-NBC) | More than 24 m/eight storey's at least one F.T | NA | Yes |
| Fire drills (ANNEX-E –E-3) NBC | | | |
| • Frequency | Once in 3 month | Yes | Yes |
| • Documentation & preservation of records | Records to be preserved for 3 yrs | Yes | Yes |
| Lightening protection | Recommended | No | Yes |
| Provision of Forced ventilation should be there | Recommended by NABH | No | Yes |
| 4 way fire inlet must be present in case of emergency | Recommended NABH | Yes | Yes |

Table 18 : Process on fire prevention and fire safety

| Process on fire prevention and fire safety | Suggested Requirement as per NBC 2016, NABH & BIS | Public Hosp | Pvt Hosp |
|---|--|-------------|----------|
| Updated NOC from state Fire Department | | No | Yes |
| multi disciplinary safety committee with a senior person as the chairman of the safety committee. | | Yes | Yes |
| Firefighting installation approval | Obtained from district fire officer (NABH) | No | Yes |
| Training | Number of staff trained in Fire safety (a) In Critical area (b) In non critical area | Yes | Yes |
| Mock drill | Quarterly | Yes | Yes |
| Is any emergency evacuation plan prepared and practiced | Quarterly | Yes | Yes |
| Are staff members trained and familiar with their role in the emergency evacuation plan ? | | Yes | Yes |

Table 19 : Process on fire prevention and fire safety

| Process on fire prevention and fire safety | Requirement as per NBC 2016, NABH & BIS | Public Hosp | Pvt Hosp |
|--|---|-------------|----------|
| Number of fire incident happen in last one year and documented in file | To be documented | Minor 02 | Minor 01 |
| If yes number of patients / staff / visitors suffered any injury | To be documented | Nil | Nil |
| If yes financial loss to organization | To be documented | Nil | Nil |

Gap analysis of fire safety

In both Public and Pvt hospital a large number of gap found as shown in table 1 -17 . The hospital administration of both hospitals were aware about gaps but due to lack of fund and support from leadership. In govt hospital no fire officer posted because not authorised. One of the non tech officer is designated as fire officer. The fire drills in govt hospital happened only on paper while in pvt hospital it is done but on irregular interval. Govt hospital have no NOC from state Fire Department. Only the pvt hospital has done the third party audit.

DISCUSSION & RECOMMENDATION

Recommendation for Fire Prevention and Control Infrastructure:

1. The hospital should have an updated NOC from state Fire Department.
2. The hospital should have a multi disciplinary safety committee with a senior person as the chairman of the safety committee. The safety committee meetings should be held at least once in 3 months. The minutes of the meeting should be recorded and put up to the senior management.
3. The hospital should have a formally appointed Fire Safety Officer in-charge of all concerns related to Fire Prevention & Safety. The Fire Safety Officer should be preferably from Security Staff and should be aware of all fire safety protocols.
4. The organization must have a written plan for Fire Prevention and Safety and has a Fire Safety Manual approved by the safety committee.
5. The hospital should have an Emergency Command Centre that becomes functional immediately whenever there is an emergency. There is a written protocol and written constitution of the committee and the Fire Command Centre is update with the name of the members. A designated person should be responsible of informing all the Emergency Command members.
6. The Fire Safety Manual should have the following components:
 - Plan for fire prevention & control.
 - Systems for fire prevention & control.
 - Maintenance Schedules/ SOPs for systems related to fire prevention & control
 - Inspection protocols for fire safety installations.
 - Codes for announcement of fire related emergency, procedures and communication protocols for the same.
 - Responsibilities of different departments in case of fire.
 - Procedures, frequency & protocols for mock drills.
 - Constitution of Fire Fighting & Evacuation Teams.
 - Evacuation Plan.
 - Electrical Safety & System.

NABH & NBC 2016 recommend following recommendation should be done

1. Firefighting equipment like wet riser, hydrants, auto sprinkler, fire alarm system, fire extinguishers of all types and sizes should be available as per table below (adapted from NBC 2016).
2. Operational and maintenance plan for firefighting equipment including refilling of extinguishers.
3. Up to date fire drawings to be available. Where applicable, the fire drawings should also specify the location of fire dampers.
4. Fire detection and smoke detectors exist across all floors. The detectors shall be tested for functionality at regular intervals, and records maintained.
5. Central fire alarm system is installed at a location which is staffed 24/7.
6. Fire exit plan for each floor. Exit door should be openable and free from any materials which will obstruct way.
7. Fire Exit signage on all floors well illuminated/ self-glowing, as per NBC guidelines.
8. Emergency illumination system in case power goes.
9. Designated place for assembly of patients and staff in case of fire.
10. Mock fire drill records and schedule of conduct of drills.

CONCLUSION

Fire safety in hospitals is a very important aspect of hospital architecture and maintenance. However, the work done so far to measure these fire safety norms is meager and needs urgent attention. Hospital authorities should pay much importance to this aspect of internal threat in a health care facility imparting directly to cause dent on patient safety.

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