BUREAU OF INDIAN STANDARDS

SUPPLEMENTARY AGENDA

Panel for Fire & Life Safety, CED 46:P2 : Ninth Meeting

Friday, 19 January 2024 : 1030 h

In Physical Mode

Auditorium, Manak Bhavan, Bureau of Indian Standards, 9 Bahadur Shah Zafar Marg, New Delhi 110 002

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Item 4 COMMENTS RECEIVED ON PART 4 'FIRE & LIFE SAFETY' OF SP7 : 2016

4.1.1 The additional comments received on the above Chapter of NBC 2016 are as follows:

Sl No	NAME OF THE COMMENTATOR	SUBJECT MATTER	BRIEF OF COMMENTS
16	Shri Rakesh Chauhan, Chief Operating Officer, ALP Aeroflex (I) Pvt Ltd., Gurgaon	Materials used for insulation including around ducts, and the non-combustibility defined in IS 3808 at a temperature of 750 C.	Details are given in **Annex 19A** and **Annex 19B.**
17	Shri G. Vinod, Chief Electrical Inspector, Govt. of Kerala	Clarification w.r.t Installation of rooftop DG Sets in Buildings Contradiction in NBC 2016 & NEC 2023	Details are given in **Annex 20.**
18	Shri H. R. Ranganath, Maple Engg-Design Services (India) Pvt. Ltd.	List of additions / details to be added in the modified version -2025	Details are given in **Annex 21.**
19	Shri Ashok Tewari Executive Director/Electrical Delhi Metro rail	(1) Updation methodology to be followed for Metro rail specific provisions on fire and life safety (2) Methodology for indigenization of metro specific	

Sl No	NAME OF THE COMMENTATOR	SUBJECT MATTER	BRIEF OF COMMENTS
	Corporation Ltd.	international standards for various Electromechanical, Air-conditioning, Tunnel Ventilation, BMS etc. systems (3) Feasibility of developing an **Indian Metro Code** on the lines of NFPA-130 which is the mother standard referred for planning and designing of Metro systems	
20	Dr. Joyeta Ghoshal and Mrs. Aditi Naryananan, APCO Worldwide, New Delhi	Challenges regarding fire safety in buildings due to poor electrical infrastructure and regulatory frameworks	**Inputs on Part 4** of NBC 2016 in BIS' format **are awaited** and will be tabled separately. They have shared the following 2 reports supported by APCO: 1) IMPACT REPORT- Impact assessment of fire incidents and implications for safety standards and regulations in India (see **Annex 22.**) 2) KNOWLEDGE PAPER- Identifying Gaps and Needs to Enhance Fire Safety in India (see **Annex 23.**)
21	Inputs of Shri T.R.A. Krishnan	Revised Table 7 Revised Clause 5 Revised clause E-6 (based on the comments on Part 4 from the users)	Based on the last meeting of the Panel, Shri T.R.A. Krishnan who had then readily agreed to the request to updating the Notes and the Table 7; as also the Clause 5 on Fire Protection, had provided his inputs (on **clause 5**, **Table 7** and **E-6 of Part 4**) which were shared with the members of SubGroup constituted under the Panel in the last meeting, as below: • Shri S K Dheri (Convener) • Fire Advisor, GoI • Shri Santosh Warick • Shri Aman Sharma • Delhi Fire Services - Shri Atul Garg, Director

Sl No	NAME OF THE COMMENTATOR	SUBJECT MATTER	BRIEF OF COMMENTS
			• Shri Tarak Chakraborty • Shri T. R. A. Krishnan • Shri Shashikant Jadhav (Spaceage Consultants, Mumbai) • Shri Sandeep Goel (Co-ordinator) The inputs are in **Annex 24A, Annex 24B** and **Annex 24C** respectively**.**

The Panel may **CONSIDER**.

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ANNEX 19

COMMENTS OF M/S ALP AEROFLEX ON PART 4 AND PART 7/HVAC

A) A query/comment has been received from M/s ALP Aeroflex India which relates to Clause **12.1.9.1**, page 65, of **Part 8**: Building Services, **Section 3 Air Conditioning, Heating & Mechanical Ventilation**; and the clause reads as follows:

"

12.1.9 Installation of Insulation Works

12.1.9.1 Material

Selection of material shall be as per design requirement, such as, fibre glass, closed cell flexible elastomeric foams, expanded/extruded polystyrene (EPS/XPS) and polyurethane foam (PUF). The guidelines for insulating with fibre glass are given below; for other insulation materials, manufacturers, recommendations for installation should be followed.

"

Further, the commentator indicates the following:

1. All types of insulation material including fiber glass, NBR (Nitrile Butyle Rubber), Expandable Polystyrene Insulation (EPS) and Extruded Polystyrene (XPS), etc., have been recommended.
(BIS' Observation: *"such as" is NOT AN EXHAUSTIVE LIST***)**

2. However, IS3808:1979 is referred in the code as accepted method for testing non-combustibility of building material. This standard method is flawed as it tests combustibility at 750 deg C which is suitable for testing of only hot insulation material. Temp range for cold insulation is much lower than 750 deg C. Reference may be made to temp range of some of the leading and popular polymer based insulation material (NBR – 105 deg C; EPDM – 125 deg C; EPS – 80 deg C; XPS – 74 deg C).
(BIS Observation: *As per clause 12.1.9.1, the manufacturer's recommendations to be followed. The material specifying agency thus needs to satisfy himself accordingly in line with other cross referred Parts of NBC, including the Part 5 Building Materials in which clause 4 addresses the requirement for New or Alternative Materials)*

3. All other material except fiber glass fail to qualify the test IS3808:1979. Hence this clause (12.1.9.1) contradicts the clause no 3.4.8.3.5 (NBC Vol-1, Chapter-4, page 25) and favors only one insulation generic material **which is fiber glass** over other insulation material.

Cl 3.4.8.3.5 of Part 4 reads as below:

3.4.8.3 Duct work

....

.....

3.4.8.3.5 The materials used for insulating the duct system (inside or outside) shall be of non-combustible type. Any such insulating material shall not be wrapped or secured by any material of combustible nature.

4. In cold insulation application, that is general HVAC comfort (office, residences, etc) as well as process application (manufacturing, pharma, dairy, etc), using modern HVAC systems (VRF, Chiller systems, etc) EPDM (Ethylene Propylene Diene Monomer) based insulation material is widely used by leading HVAC manufacturers and practicing professionals. However, due to above stated anomaly, EPDM solution is not considered in many projects where compliance to above building code is mandatory.

B) Earlier, they had indicated the following too:

Please note the fire reaction of EPDM / NBR are -

1. When subjected to flame for 30 sec and flame removed the material extinguishes by itself in less than 10 sec and does not spread or aid the fire.
2. It does not release flammable vapours when subjected to fire or heat.
3. It does not cause any flaming drops when subjected to fire or heat

Question – In such a case will NBR / EPDM elastomeric foam be considered Non – combustible ? please clarify.

C) Further, now they have indicated the following:

We appeal to you to consider SUITABLE provisions in the existing building code to allow use of EPDM based modern solutions considering:

1. IAQ plays important role in determining the wellbeing of the occupant. Elastomeric closed cell foam is free from VOCs. Dust, fibers and other pollutants, making it an ideal insulation solution.

2. Globally, in developed countries like USA, Japan, etc, approach is making duct/duct insulation fire retardant and use EPDM solutions widely. They use technologies to prevent spread of fire transmission and smoke.

3. There are international standards formulated such as ASTME84, UL94, BS476 Part 6&7, FM approval class 4929, EN13501 (single burn index), ISO 5659-2, IMO Resolution MSC 61(67) for surface spread of flame, fire propagation, smoke density / toxicity, self-extinguishing, non drip features. Any (or combination of suitable) of those standards may be used to test the efficacy of the EPDM solutions.

Existing standard IS3808:1979 may be restricted as a method to test the efficacy of insulation material such as fibre glass for hot insulation only. To strengthen our appeal for EPDM material we hereby share few critical advantage of EPDM material as separate annexure.

1) In continuation to the above, for your ready reference, the supporting documents from M/s ALP India as per list below is made available again for access through

https://drive.google.com/drive/folders/1zPINxMouvj6AatN91EROqrD-QrA0oN-t?usp=sharing

1. NBC 2016 (Vol 1 & Vol 2 Relevant Pages).
2. IS3808: 1979 Standard Copy.
3. ASTM E84 Standard Copy
4. BS476 Part 6&7 Standard Copies.
5. FM Class 4924 Standard.
6. ISO 5659- Part 2
7. IMO Res. MSC 61(67)
8. EPDM: Superior, Non-Polar, Non-Toxic, Energy Conserving Insulation for HVAC Industry
9. Global Reference Project Reference List (AEROFLEX EPDM)
10. Comparative (EPDM Vs Fiber Glass)
11. Life Cycle Cost Analysis (EPDM Vs Fiber Glass)

2) Further, inputs from other Code users to address suitably the use of EPDM material is also made available in the drive.

inputs from Shri Sandeep Goel, Member, CED 46:P2 on the above:

On aspect of the Insulation, non-combustibility and fire properties, our review and assessment is as follows:

1. Out of the options available for items to be used as thermal insulation material in NBC Chapter 8, Clause No. 12.9.1 to 12.9.4, only particular categories of Mineral Wool fall under non-combustible material as per the standard referred in Chapter 4- Fire & Life Safety Clause No.2.7 definition for combustible material.
2. All other materials including, EPS, PUF, FEFs, etc. are combustible as per the referred standard and hence can't be used as per NBC 2016.
3. NBC 2016 Chapter 11- Approach to sustainability highlights the health hazards related to use of mineral wool and chapter 8, Clause No. 7.2.7.2 (C) recommends the use of non-hazardous material for use as thermal insulation.
4. NBC 2016 Chapter 11 – Approach to sustainability highlights that mineral wool is a hygroscopic material and cannot regulate moisture well, whereas in Chapter 8, Clause No. 7.2.7.2(a), recommendation is to use a non-hygroscopic material.
5. Because of the hygroscopic properties of mineral wool, the thermal conductivity of the material is not stable thereby having an increase in thermal conductivity with water vapour ingress and in Chapter 8, Clause No. 7.2.7.2(b), NBC 2016 recommends to use a material which has a stable low thermal conductivity.
6. In Chapter 8, Clause No. 6.3.3(b)- NBC has banned the use of Fibrous material and mineral wool is a fibrous material for Hospitals and Food Processing Industry. So in case of hospital projects across the country, there is no material which complies to NBC 2016.

Combining all the requirements of NBC 2016 for use of thermal insulation material, there is no material which complies with the NBC 2016 in totality.

The standards in other countries, like British standards and European standards refer to Fire Safe material for use in buildings rather than non-combustible materials and there are standards formed to elaborate a fire safe material. Example: BS 476 Part 7 – for spread of flames (adopted by BIS as IS 13286) and BS 476 Part 6 for Fire Propagation – under development by CHD 27 committee).

There are a products and items available in every room inside a building which are combustible like furniture, blinds / curtains, etc. The insulation material should be chosen to make sure that it does not add on to the fire in case there is any and the material importantly should not drip while burning and should be of self-extinguishing in nature. The smoke

released should be non-toxic so as to enable safe escape of occupants and occupants should not fall unconscious due to toxicity of smoke.

NFPA also recommends material based on Flame Spread Index and Smoke Developed Index as per ASTM E 84.

ASHRAE 90.1 refers to the use of Insulation material in compliance with ASTM E 84 as per NFPA mentioned values.

MODIFICATION REQUIRED:

It is proposed to review EN 13501 towards SBI – Single Burning Item and addresses the aspects towards:

Heat Release, Smoke Production, Burning Droplets (expressed in d0, d1 or d2 where Index d0: No Burning Droplets at all, d1: Burning Droplets that extinguish within 10 seconds, d2: Burning Droplets don't extinguish with in 10 seconds. Further Toxicity of the smoke is also under consideration to be included. The classification as per SBI is Non Combustible material are classified as Class A, all other material are classified as Class B up to Class F. The highest being class B and the lowest being class F. Other parameter is Smoke where s1, s2 and s3 is established. Where s1: Very Low Speed of Smoke Development , s2: 4 x s1 and s3: 6 x s1. Droplets is experienced as above. Therefore Products are classified as an example : EN 13051 SBI: B-s1-d0.

Limitation of BS 476 is not to address Smoke Density, Smoke Toxicity and Dripping.

It is noted from ALP query and appeal as follows:

There are international standards formulated such as ASTME84, UL94, BS476 Part 6&7, FM approval class 4929, EN13501 (single burn index), ISO 5659-2, IMO Resolution MSC 61(67) for surface spread of flame, fire propagation, smoke density / toxicity, self-extinguishing, non-drip features. Any (or combination of suitable) of those standards may be used to test the efficacy of the EPDM solutions.

Towards reply on the above, it is agreed on the limitation posed by NBC Part 4 Clause no 3.4.8.3.5 "The materials used for insulating the duct system (inside or outside) shall be of non-combustible type. Any such insulating material shall not be wrapped or secured by any material of combustible nature " where IS3808:1979 is referred in the code as accepted method for testing non-combustibility of building material.

The Panel should review, assess and formulate the aspects of surface spread of flame, fire propagation, smoke density / toxicity, self-extinguishing, non-drip features for the

insulating material. As part of Standard Development this is to be taken to be developed and explained accordingly.

These are my inputs and views. I would look forward from inputs from Mr. Amor on the above. Please also share the inputs of members of the HVAC Panel.

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FILE INDEX

S. NO.	SAMPLE DESCRIPTION	TEST	TESTING LAB	TESTING AGENCY / LAB	TEST METHOD	TEST REPORT DATE
1	15 MM THICK OPEN CELL ACCOSOUND	AIR EROSION TEST	intertek Total Quality. Assured.	INTERTEK, 3933 US ROUTE 11, CORTLAND, NEW YORK 13045	ASTM C1071-19	20.10.2021
2	ALPFLEX	Heat Release Rate (Cone Calorimeter Method) & Smoke Production Rate (Dynamic Measurement)	warringtonfire	WARRINGTON FIRE U.K.	ISO 5660-1:2015+A1:2019	14.10.2021
3	AEROCELL-G.C, 32MM THICK AEROCELL NITRILE RUBBER ELASTOMERIC FOAM LAMINATED WITH GLASS CLOTH ON ONE SURFACE	Flammability Test (HB & V-0)	SPECTRO® Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	UL-94	14.10.2021
4	AEROCELL-AM (BIOFLEX)	DETERMINATION OF IN VITRO CYTOTOXICITY EFFECT	Liveon Biolabs	LIVEON BIOLABS PVT. LTD. PLOT NO. 46 & 47, II PHASE, WATER TANK ROAD, KIADB INDUSTRIAL AREA, KARNATAKA-572106	ISO 10993	02.07.2021
5	AEROCELL-AM (BIOFLEX)	INTRACUTANEOUS REACTIVITY TEST OF POLAR & NON-POLAR EXTRACTS (SKIN IRRITATION TEST)	Liveon Biolabs	LIVEON BIOLABS PVT. LTD. PLOT NO. 46 & 47, II PHASE, WATER TANK ROAD, KIADB INDUSTRIAL AREA, KARNATAKA-572106	ISO 10993	11.07.2021
6	AEROCELL-AM (BIOFLEX)	SKIN SENSITIZATION	Liveon Biolabs	LIVEON BIOLABS PVT. LTD. PLOT NO. 46 & 47, II PHASE, WATER TANK ROAD, KIADB INDUSTRIAL AREA, KARNATAKA-572106	ISO 10993	06.08.2021
7	15MM THICK OPEN CELL ACCOSOUND	DENSITY & THERMAL CONDUCTIVITY	SHRIRAM Shriram Institute for Industrial Research	SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	ASTM D 1622 & ISO 22007 (Part II)	06.09.2021
8	OPEN CELL ACCOSOUND (ACOUSTIC INSULATION PRODUCT)	ANTIFUNGAL PROPERTY	SHRIRAM Shriram Institute for Industrial Research	SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	ASTM G 21-15	30.08.2021

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9	AEROCELL NITRILE ELASTOMERIC RUBBER FOAM WITH ONE SIDE SILVER CLAD	Water Vapour Diffusion Resistance (μ-Value)	SPECTRO® Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	ASTM E96-2016	18.08.2021
10	Aerocell-AM (Bioflex) Nitrile Elastomeric Rubber foam with One side Glass Cloth	Water Vapour Diffusion Resistance (μ-Value)	SPECTRO® Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	ASTM E96-2016	17.08.2021
11	Aerocell - ALU	Horizontal BURNING TEST; HB 50W (20 mm) VERTICAL BURNING TEST; V-0, V-1 or V-2	UL	UL India Pvt. Ltd. Kalyani Platina, 3rd Floor, Block I, EPIP Zone, Phase II, Whitefield, Bangalore – 560066, India	UL 94	13.08.2021
12	Aerocell Nitrile Elastomeric Rubber Foam	Aging Condition @-50 Degree C (Shrinkage in Dimension)	IRMRA Helping Rubber World in Building Better Future	INDIAN RUBBER MANUFACTURERS RESEARCH ASSOCIATION, THANE-400604	ISO 23529	09.08.2021
13	OPEN CELL ACCOSOUND (ACOUSTIC INSULATION PRODUCT)	ANTIMICROBIAL PROPERTY	SHRIRAM Shriram Institute for Industrial Research	SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	ASTM E 2180-18	30.07.2021
14	AEROCELL-AM (BIOFLEX) NITRILE RUBBER ELASTOMERIC FOAM	MOISTURE RESISTANCE FACTOR, μ-VALUE	SPECTRO® Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	ASTM E96-2016 & DIN 52615	18.05.2021
15	ALPFLEX	METHODS FOR FIRE TESTING ON BUILDING MATERIALS, DETERMINATION OF IGNITABILITY & FLAME PROPAGATION HEAT RELEASE & SMOKE RELEASE	ignis labs	IGNIS LAB, QUEANBEAN AUSTRALIA	AS, NZ 1530.3-1999	28.10.2020
16	AEROCELL	SURFACE BURNING TEST	element	ELEMENT	ASTM E 84	27.10.2020

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17	ACCOSOUND-15MM	METHOD FOR CLASSIFICATION OF THE SURFACE FLAME SPREAD	warringtonfire	WARRINGTON FIRE U.K.	BS 476: PART 7: 1997	29.09.2020
18	AEROCELL ALU EN NITRILE BASED ON ELASTOMERIC FOAM (EMBOSSED)	MOISTURE RESISTANCE FACTOR, μ-VALUE	SPECTRO® Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	ASTM E96-2016	17.09.2020
19	OPENCELL ACCOSOUND BASED ON ELASTOMERIC	SHRINKAGE DIMENSION IN ALL THREE DIRECTION AT 85°C	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	BY HOT AIR OVEN	24.07.2020
20	OPENCELL ACCOSOUND BASED ON ELASTOMERIC	SHRINKAGE DIMENSION IN ALL THREE DIRECTION AT -20°C	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	DEEP FREEZER	24.07.2020
21	AEROCELL/AEROCELL-AM BIOFLEX NITRILE RUBBER ELASTOMERIC FOAM	SHRINKAGE DIMENSION IN ALL THREE DIRECTION AT 105°C	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	BY HOT AIR OVEN	24.07.2020
22	15MM THICK ACCOSOUND	FLAMMABILITY TEST, CLASS HBF OR HF1 OR HF2	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	UL 94	20.07.2020
23	25MM THICK ACCOSOUND	FLAMMABILITY TEST, CLASS HBF OR HF1 OR HF2	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	UL 94	20.07.2020
24	50MM THICK ACCOSOUND	FLAMMABILITY TEST, CLASS HBF OR HF1 OR HF2	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	UL 94	20.07.2020

25	NITRILE RUBBER INSULATION FOAM (AEROCELL/AFLEX)	UL-94 V0	SPECTRO® Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	UL 94-2018	04.07.2020
26	10MM THICK ACCOSOUND	SOUND ABSORPTION COEFFICIENT & NRC VALUE	ARAI® Progress through Research	ARAI, S. NO. 102, VETAL HILL, OFF PAUD ROAD, KOTHRUD, PUNE-411038	ASTM C-423 / ISO 354	30.06.2020
27	15MM THICK ACCOSOUND	SOUND ABSORPTION COEFFICIENT & NRC VALUE	ARAI® Progress through Research	ARAI, S. NO. 102, VETAL HILL, OFF PAUD ROAD, KOTHRUD, PUNE-411038	ASTM C-423 / ISO 354	30.06.2020
28	25MM THICK ACCOSOUND	SOUND ABSORPTION COEFFICIENT & NRC VALUE	ARAI® Progress through Research	ARAI, S. NO. 102, VETAL HILL, OFF PAUD ROAD, KOTHRUD, PUNE-411038	ASTM C-423 / ISO 354	30.06.2020
29	50MM THICK ACCOSOUND	SOUND ABSORPTION COEFFICIENT & NRC VALUE	ARAI® Progress through Research	ARAI, S. NO. 102, VETAL HILL, OFF PAUD ROAD, KOTHRUD, PUNE-411038	ASTM C-423 / ISO 354	30.06.2020
30	NITRILE RUBBER BASED ELASTOMERIC FOAM	FTIR TEST	SPECTRO® Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	SOP/CHE/00-FTIR Spectrometer	30.06.2020
31	ROHS-2 NITRILE RUBBER ELASTOMERIC FOAM	FTIR & ROHS TEST	SPECTRO® Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	SOP/CHE/00-FTIR Spectrometer & IEC 62321	23.06.2020
32	INSULATION PRODUCTS, 15MM ACCOSOUND NITRILE RUBBER	DENSITY	SPECTRO® Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	ASTM D 1667-2005	23.06.2020

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33	INSULATION PRODUCTS, AEROCELL/BIOFLEX NITRILE RUBBER	DENSITY	SPECTRO® Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	ASTM D 1667-2005	23.06.2020
34	AEROCELL/AEROCELL-AM BIOFLEX NITRILE RUBBER ELASTOMERIC FOAM	FIRE PROPAGATION FOR PRODUCTS	warringtonfire	WARRINGTON FIRE U.K.	BS 476 PART 6 : 2009	19.06.2020
35	AEROCELL/AEROCELL-AM BIOFLEX NITRILE RUBBER ELASTOMERIC FOAM	SURFACE SPREAD OF FLAME	warringtonfire	WARRINGTON FIRE U.K.	BS 476 PART 7 : 1997	19.06.2020
36	AEROCELL/AEROCELL-AM BIOFLEX NITRILE RUBBER ELASTOMERIC FOAM	CLASS 0 SUMMARY REPORT	warringtonfire	WARRINGTON FIRE U.K.	BS 476 PART 6 & 7	19.06.2020
37	AEROCELL/AEROCELL-AM BIOFLEX NITRILE RUBBER ELASTOMERIC FOAM	FLAMMABILITY TEST COMBINED REPORT	warringtonfire	WARRINGTON FIRE U.K.	BS 476 PART 6 & 7	19.06.2020
38	INSULATION SHEET	HCFC/CFC FREE TEST	SGS	SGS INDIA PVT. LTD., 250, UDYOG VIHAR, PHASE IV, GURGAON-122015, HARYANA.	US EPA 5021A	07.05.2020
39	NITRILE RUBBER SHEET & TUBE-AEROCELL AM (BIOFLEX)	UL GREENGUARD	UL GREENGUARD	UL ENVIRONMENT	GREENGUARD GOLD	06.03.2020
40	NITRILE RUBBER SHEET & TUBE-AEROCELL	UL GREENGUARD	UL GREENGUARD	UL ENVIRONMENT	GREENGUARD GOLD	06.03.2020

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41	AEROCELL ALU	UL GREENGUARD	GREENGUARD	UL ENVIRONMENT	GREENGUARD GOLD	06.03.2020
42	AEROCELL GC	UL GREENGUARD	GREENGUARD	UL ENVIRONMENT	GREENGUARD GOLD	06.03.2020
43	AEROCELL-SILVER CLAD	UL GREENGUARD	GREENGUARD	UL ENVIRONMENT	GREENGUARD GOLD	06.03.2020
44	NITRILE RUBBER ELASTOMERIC FOAM	FTIR TEST	SPECTRO Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	SOP/CHE/00-FTIR Spectrometer	06.03.2020
45	AEROCELL NITRILE INSULATION FOAM	WATER VAPOUR TRANSMISSION RATE & WATER VAPOUR DIFFUSION RESISTANCE (μ-VALUE)	SPECTRO Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	EN 13469-2016 & EN 12086	04.03.2020
46	AEROCELL NITRILE INSULATION FOAM (BIOFLEX)	FUNGI RESISTANCE & BACTERIAL RESISTANCE	SPECTRO Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	ISO 846 :2019	29.02.2020
47	AEROCELL NITRILE INSULATION FOAM	WATER VAPOUR TRANSMISSION RATE	SPECTRO Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	EN 13469-2016	26.02.2020
48	NITRILE RUBBER FOAM (BIOFLEX) AEROCELL	FUNGAL RESISTANCE	SHRIRAM Shriram Institute for Industrial Research	SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	ASTM G-21-15	12.02.2020

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49	AEROCELL NITRILE INSULATION FOAM	THERMAL CONDUCTIVITY @ 30°C	SPECTRO Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	EN 12667-2001	05.02.2020
50	NITRILE RUBBER FOAM (BIOFLEX) AEROCELL	ANTIMICROBIAL ACTIVITY OF NITRILE RUBBER FOAM (BIOFLEX) AEROCELL	SHRIRAM Shriram Institute for Industrial Research	SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	ASTM E 2180-07	30.01.2020
51	AEROCELL NITRILE FOAM	THICKNESS & WIDTH VARIATION BEFORE & AFTER AGING (-40°C)	IRMRA Helping Rubber World in Building Better Future	INDIAN RUBBER MANUFACTURERS RESEARCH ASSOCIATION, THANE-400604	CUSTOMER PROCEDURE	20.01.2020
52	9MM C-0 SHEET	WATER VAPOUR PERMEABILITY	SHRIRAM Shriram Institute for Industrial Research	SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	ASTM E 96/ E96M-16	18.12.2019
53	AEROCELL CLASS 0 NBR SHEET	THERMAL CONDUCTIVITY @ 20°C	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	ASTM C 518	18.11.2019
54	AEROCELL CLASS 0 NBR SHEET	THERMAL CONDUCTIVITY @ 25°C	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	ASTM C 518	18.11.2019
55	AEROCELL CLASS 0 NBR SHEET	THERMAL CONDUCTIVITY @ 30°C	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	ASTM C 518	18.11.2019
56	AEROCELL CLASS 0 NBR SHEET	THERMAL CONDUCTIVITY @ 0°C	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	ASTM C 518	18.11.2019

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57	AEROCELL CLASS 0 NBR SHEET	THERMAL CONDUCTIVITY @ 10°C		NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	ASTM C 518	18.11.2019
58	AEROCELL CLASS 0 NBR SHEET	THERMAL CONDUCTIVITY @ 40°C		NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	ASTM C 518	18.11.2019
59	OPENCELL ACCOSOUND BASED ON ELASTOMERIC	FLAMMABILITY TEST, HBF, HF1, HF2 (AFTER AGING)		NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	UL-94	11.11.2019
60	OPENCELL ACCOSOUND BASED ON ELASTOMERIC	FLAMMABILITY TEST, HBF, HF1, HF2 (NORMAL)		NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	UL-94	05.11.2019
61	AEROCELL INSULATION SHEET 19MM	DETERMINATION OF OPTICAL SMOKE DENSITY BY A SINGLE CHAMBER TEST & ANALYSIS OF TOXIC GASES		SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	ISO 5659-2	26.10.2019
62	ACCOSOUND SHEET BASED ON ELASTOMERIC FOAM	THERMAL CONDUCTIVITY @ 20°C		NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	ASTM C 518	22.10.2019
63	ACCOSOUND SHEET BASED ON ELASTOMERIC FOAM	THERMAL CONDUCTIVITY @ 25°C		NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	ASTM C 518	22.10.2019
64	NBR SHEET WITH ONE SIDE ALU FOIL	FLAMMABILITY TEST		NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	UL-94 (HB)	30.09.2019

65	ONE SIDE LAMINATION WITH ALUMINIUM FOIL	BLEEDING & DELAMINATION TEST	SPECTRO® Analytical Labs Limited	SPECTRO, S-1, GNEPIP, SURAJPUR INDUSTRIAL AREA, PHASE V, KASNA, GREATER NOIDA-201308	ASTM C 1224-2001	25.09.2019
66	NBR SHEET WITH ONE SIDE ALU FOIL	FLAMMABILITY UL94	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	UL 95 V0	24.09.2019
67	AEROCELL NITRILE BASED ELASTOMERIC FOAM	THERMAL CONDUCTIVITY @0°C	ISO 9001 nitra ORGANISATION	NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	ASTM C 518	16.04.2019
68	AEROCELL CLASS 0 INS. SHEET BASE ON NBR	WATER VAPOUR RESISTANCE FACTOR µ-VALUE	SHRIRAM Shriram Institute for Industrial Research	SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	ASTM E 96	29.03.2019
69	AEROCELL WITH ALUMINIUM FOIL	WATER VAPOUR RESISTANCE FACTOR µ-VALUE	SHRIRAM Shriram Institute for Industrial Research	SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	ASTM E 96	15.01.2019
70	RUBBER FOAM AEROCELL	WATER VAPOUR RESISTANCE FACTOR µ-VALUE	SHRIRAM Shriram Institute for Industrial Research	SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	ASTM E 96	15.01.2019
71	AEROCELL NITRILE BASED ELASTOMERIC FOAM	FLAMMABILITY TEST	SHRIRAM Shriram Institute for Industrial Research	SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	UL 94	07.01.2019
72	AEROCELL NITRILE INS. FOAM	ROHS TEST	SGS	SGS INDIA PVT. LTD., 250, UDYOG VIHAR, PHASE IV, GURGAON-122015, HARYANA.	IEC 62321	13.09.2018

73	AEROCELL NITRILE RUBBER FOAM	WATER VAPOUR RESISTANCE FACTOR µ-VALUE		SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	ASTM E 96	13.09.2018
74	AEROCELL NITRILE RUBBER BASED ELASTOMERIC FOAM	WATER VAPOUR RESISTANCE FACTOR µ-VALUE		SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH, 19-UNIVERSITY ROAD, DELHI-110007	ASTM E 96 - 16	27.07.2018
75	AEROCELL NITRILE RUBBER BASE ELASTROMERIC FOAM	DENSITY		NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	ASTM D 1056	24.07.2018
76	AEROCELL NITRILE RUBBER BASE ELASTROMERIC FOAM	THERMAL CONDUCTIVITY @20°C		NORTHERN INDIA TEXTILE RESEARCH ASSOCIATION, SEC-23, RAJNAGAR, GHAZIABAD-201002	ASTM C 518	24.07.2018

ANNEX 20

CLARIFICATION SOUGHT BY SHRI G. VINOD, CHIEF ELECTRICAL INSPECTOR, GOVT. OF KERALA W.R.T INSTALLATION OF ROOFTOP DG SETS IN BUILDINGS – CONTRADICTION IN NBC 2016 & NEC 2023

Subject: Department of Electrical Inspectorate – Installation of Roof Top DG Sets in Buildings - contradiction in National Building Code, 2016 & National Electric Code,2023 - Clarification requested-Regarding

Ref:
1. National Building Code -2016 & National Electric Code -2023
2. Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2023

Please refer to the above. Your attention is invited to the above subject regarding installation of roof-top DG sets, in which conflict exists between NBC 2016 and NEC 2023.

In notes of clause 6.3.1 of Part 2, section 1 (ELECTRICAL INSTALLATION OF STAND-BYGENERATING STATIONS) of National Electrical code of India 2023, it is mentioned that " In case of roof top Gen-sets, OEM shall be informed in advance and the recommended pre-installation check list shall be followed". Also in notes of 6.3.5.1, it is mentioned as "In case of Fuel Tank of Gen-sets on roof top, Specific Rules mandatory as per Local Fire Authority and Petroleum Rules shall be followed in respect of placement and capacity."

But ,Part 8, sub section 4.3.1 of section 2 of The National Building Code, 2016 states that "The emergency power supply (such as generating sets) should not be allowed to be installed above ground floor or below the first basement level of the building". Hence inconsistency is present regarding the installation of DG set on roof top, as NEC 2023 and NBC 2016 has contradictory clauses as given above. Besides, as per regulation 14 (2) of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2023, the relevant standards including National Electrical Code and National Building Code shall be followed to carry out the purpose of the regulations. Therefore, it is requested to give necessary clarification on this matter.

Yours faithfully,

(Incoming) Date 10-01-24 &Out

MAPLE Engg-Design Services (India) Pvt. Ltd.,

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NBC 2016 PART 4 Fire and Life Safety Services –CED 46:P2/A-2.9

Subject ;- Ninth Meeting of the Panel for Fire and life safety

List of additions / details to be added in the modified version -2025

Section/ Part -3

- Clause no 4.6(c) and 4.6.1.4 (c) –fire driveway - width & turning radius for different building height to be included. The distance of dive way from building line/ edge to be mentioned.
- Clarity to be indicated for building Entrance area canopy height for movement of fire tender.

Section / Part -4

1. **Clause no 2.38 & E- 1 High rise building** – 15 m and above some state fire authorities mention 18/ 24 m and above , needs clarity.
2. **Clause no 2.2.4 Fire tower** – Basement to terrace level requirement to be clearly mentioned in the section, since the interpretation by fire authorities varied from state to state.
3. **Clause no 2.2.4 Fire tower** – Door between fire lift lobby and staircase, is this to be 2 hr fire rated or can it be normal door , clarity required.
4. **Clause no 5.1.2.2 (h) and Clause no 5.1.3(h)** Installation Control Valve location inside the pump room – it should preferably be outside the building area (podium level) / ground level for ease of identification of activation in case of fire condition .

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5. **Table 7 & Clause no 5.1.1 Portable First Aid Fire Extinguishers** – Type of extinguishers, its capacity etc to be mentioned with respect to the area for better clarity.
6. **Table -7 Pump capacity** (1 working + 1 standby) for terrace tank to be included in the table to achieve minimum pressure of 3.5 bars @ top most hydrant valve for all types of building occupancy.
7. **Table -7 Terrace tank** requirement for industrial, Hazardous , storage type buildings to be deleted / removed since these are with sloped roofs and have external automatic fire hydrant system from the common pump house in the campus along with required fire water storage to meet the requirement.
8. **Clause no H-4 (c) Activation water curtain system** can be done through motorized control valve interfaced with fire alarm system, this to be added along with automatic deluge system aa an optional method.
9. **Clause E-4 (k) Refuge area** – Drinking water point can this requirement be removed in residential projects, since this area adjoins the flat from common corridor.
10. **Clause no 4.9 Battery backup** detail for fire alarm to be indicated
11. **Clause no 4.6.2 Smoke Exhaust and Pressurization of Areas Below Ground** :- Normal operation, air changes schedule shall

be as given in Part 8 Building Services, Section 3 Air conditioning, Heating and Mechanical Ventilation of the Code but in part -8 section 3 there is no value indicated for normal mode operation for basement. Normally 6 ACH is being considered in the design needs clarification.

General:-

1. Fire signage's details to be added for better clarity.
2. Sprinkler and Hydrant system:- Preferred pipe material to be mentioned (for light hazard (apartment) PVC pipe).
3. Fire shaft door fire rating to be indicated.
4. External fire hydrant points locations with respect to the perimeter coverage distance to be mentioned for different type of hazards.
5. There is no clarity on lift well pressurization for passenger/fire lifts.

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6. In basement, normal/ smoke mode ACPH for fresh air not indicated.
7. During fire, the minimum time required to evacuate smoke is not clear.
8. **Electrical Installation :-** Clause no 3.4.6.2 power supply to fire equipment to be through Fire survival circuit integrity cables meeting the test requirement as indicated in Electrical section Part 8 clause no the cable material Aluminum or Copper not clearly indicated. As per our understanding copper to be used to withstand survival test at 750 Deg C needs to be clarified and clause 3.4.6.2 to be suitably modified

2.1.14 *Cable, Circuit Integrity* — A cable which continues to function, that is, maintains the continuity of the circuit under circumstances of fire (against a specified temperature and period of the test).

NOTE — For circuit integrity cable requirements reference may be made to accepted standard [8-2(2)], which prescribes a fire survival test at 750°C for 3 h.

2.1.14 *Cable, Circuit Integrity* — A cable which continues to function, that is, maintains the continuity of the circuit under circumstances of fire (against a specified temperature and period of the test).

NOTE — For circuit integrity cable requirements reference may be made to accepted standard [8-2(2)], which prescribes a fire survival test at 750°C for 3 h.

2.1.15 *Cable, Flame Retardant (FR)* — A cable which is flame retardant as per the accepted standard [8-2(3)].

2.1.16 *Cable, Flame Retardant Low Smoke and Halogen* (FR-LSH) — A cable which is flame retardant and emits low smoke and halogen as per the accepted standard [8-2(3)].

2.1.17 *Cable, Flexible* — A cable containing one or more cores, each formed of a group of wires, the diameters of the cores and of the wires being sufficiently small to afford flexibility.

2.1.18 *Cable, Metal-Sheathed* — An insulated cable with a metal sheath.

2.1.19 *Cable, PVC Sheathed-Insulated* — A cable in which the insulation of the conductor is a polyvinylchloride (PVC) compound; with PVC sheath also providing mechanical protection to the conductor core or cores in the cable.

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New item:- Type of Fire protection system for EV charging area to be included. Location of EV station can be either in the Basement or in the upper floors /MLCP

Alternate Member:-

H R Ranganath
Executive Director
Mob: +91 98450 11824

MAPLE Engg-Design Services (India) Pvt. Ltd.,

This report examines the physical, economic, health, social, psychological and environmental impacts of fire incidents in India and brings out significant implications for safety standards, policies and regulations for future.

Impact assessment of fire incidents and implications for safety standards and regulations in India

Final Report

Submitted by

Green Globe

August 2023

Table of Contents

Disclaimer: The material and information contained in this report is based on the primary data collected from victims and eyewitnesses and interviews with fire officials and experts. This is also supplemented with the secondary data from media reports and published articles. The damage estimates from fire incidents are arrived at by using the primary and secondary data and suitable assumptions. These estimates are only indicative of the actual damage that would have been caused by fire and is likely to be an underestimation of the total damage. Hence, the contents of the report should be treated as general information on the subject and we are not liable for the accuracy, completeness, legality, and reliability of this information.

Executive Summary

Fire impacts people, places, properties and the environment around the globe. Fire destroys everything in its path and the resulting losses and impacts are huge and widespread. It can have long-lasting consequences for those caught in it as well as the cascading shocks for people and systems. As per the National Crime Records Bureau, between 2001 and 2020, India recorded more than 370,000 deaths and 39,000 serious injuries due to fire incidents. Besides death and injuries, there have been devasting physical, economic, health, psychological and environmental impacts of these incidents. Yet, there is a lack of formal studies or research reports in India that capture these impacts in detail for their severity and consequences.

This study is an endeavour to address the research gap by examining the economic, social, health and environmental impacts of fire in residential, commercial and public buildings. Six case studies, from Mumbai, Ahmednagar, Surat and Delhi, have been chosen for in-depth analysis of these impacts. The analysis brings out significant implications for safety standards, policies and regulations and the behavioural change needed as a society.

The loss of life is the most obvious and the most serious physical impact of fire. The percentage of fatalities in the fire incidents is typically very high (91%) among the total affected, compared to other types of accidents or disasters. This makes the fire incident a very serious disaster with little chance of survival for those who get physically harmed by fire.

Besides loss of life, there is severe damage to property and assets leading to huge economic impacts, which include replacement or repair costs for damaged assets and equipment, shutting down operations and moving out temporarily, loss of work days and loss of output and revenue. Average economic losses estimated for the selected fire incidents in the report serve a good purpose to bring to light different types of losses and a way to account for them. These are only indicative estimates and may actually be an underestimation of overall economic impacts in the absence of exact numbers. However, they reflect the complex settings in which people live and operate and get severely impacted during fire incidents.

Estimates of economic impacts are further used to extrapolate for losses from fire incidents reported in 2020 across the country. The extrapolation exercise is based on assumptions and provides indicative values of the total losses. This exercise is useful to highlight the urgency of the issue to the policy makers and regulators and the need to further strengthen the fire safety norms and their enforcement. It may also prove useful for awareness building among people living and working in unsafe environments and neglecting basic safety precautions.

Besides physical and economic losses, fire leads to serious health impacts for the victims. During a fire incident, major causes of fatal and non-fatal injuries are burn injuries due to fire

or exposure to highly inflammable material, smoke and toxic gases. Toxic vapours can work like poison if inhaled or absorbed by the skin. Respiratory tract may get burnt due to inhaling hot gases and eventually lead to death. Patients with pre-existing medical conditions have a higher probability of death and increased days of hospitalization. The physical impact of fire is accompanied by psychological trauma. Loss of hope, fear, negative approach towards life, sleeplessness, sadness, confusion, agitation, anger, aggression, etc., are indicators of this trauma. Survivors of fire incidents suffer from acute stress disorder, post-traumatic stress disorder, severe depression and anxiety.

During fire incident, the natural environment gets impacted through pollution of air, water and soil. Air is contaminated by emission of smoke and gases that further diffuse into water or land. Water gets contaminated due to toxic and other burned materials. Buildings that contain highly inflammable materials like chemicals and synthetic materials like plastic tend to have greater environmental impact due to toxic contents in the smoke. It is necessary to measure the exact concentrations of these pollutants at the time of the fire incident. It is further necessary to understand how different materials inside the houses and commercial spaces are a potential threat due to their toxicity and hazardous nature during fires.

Discussion on fire impacts brings out critical implications for safety standards and their enforcement as well as the policy push and regulations required to build a strong prevention mechanism. Four pillars of action have been identified for this purpose, namely, understanding the risk, strengthening risk governance, investing in risk reduction and preparedness with focus on ‘build back better’. The existing database and reporting mechanisms for fire incidents need to be urgently strengthened for efficient information access and analysis. The overhauling of the governance and reporting structure on fire safety is required along with thorough assessment and revision of the existing standards and their strict enforcement. Investment in fire prevention needs to be undertaken with upgradation of the materials and equipment and strengthening the networks of fire stations. Awareness of the fire risk is lacking either due to the casual attitude, ‘it won’t happen to me’ type negligence or overlooking safety issues as upgradations come at a cost. To overcome this, fire safety needs to become a mass movement to create awareness and bring about behavioural change.

During the last two decades, big changes are happening around us in terms of design and construction of new mixed-use buildings, high-rises and skyscrapers, new materials being used for interior designing and modifications inside premises to create more space. Equipment currently used to fight fires in such establishments is grossly inadequate. Fire safety norms, rules and regulations also need constant revision and upgradation to account for new construction material. Efforts should also be made to ‘build back better’ when rehabilitation of fire affected premises is done, so that people do not come back to the same hazards.

1. Introduction

"We all live in a house on fire, no fire department to call; no way out, just the upstairs window to look out of while the fire burns the house down with us trapped, locked in it."
-Tennessee Williams

Fire impacts people, places, properties and the environment in all countries around the globe. Fire destroys literally everything in its path and the resulting losses and impacts are huge and widespread. The effects of fire are not just immediate but can have long-lasting consequences for those caught in it as well as cascading shocks for communities and systems. The quote from the celebrated poet Tennessee Williams above might be a metaphor on life, but it vividly captures the destruction, desperation and helplessness associated with fire incidents.

Around the globe, millions of fire incidents and thousands of deaths are recorded every year. In 2017, as per Global Diseases Burden published in the BMJ Injury Prevention Journal, 9 million fire incidents and 0.12 million deaths were recorded across the world, out of which 1.6 million incidents were recorded in India alone[1], with 27,027 deaths[2]. However, the Accidental Deaths and Suicides in India (ADSI) data has recorded 13,159 deaths in 2017 (almost 36 deaths per day)[3]. Keeping the data anomaly aside, between 2001 and 2020, India has recorded more than 370,000 deaths and 39,000 serious injuries as reported by the National Crime Records Bureau[4].

Given the number of fire incidents reported each year in the country and the reported causes[5], such as, electrical issues like short circuit, gas cylinder blasts, firecrackers, manufacturing involving combustible materials, etc., systematic analysis of these incidents and their overall impacts is the need of the hour. As a developing economy and empathetic society, we need to study how fire affects people, communities, businesses and systems and what can be done to raise awareness and bring about fundamental changes to fire safety norms and measures and their implementation at the policy, regulatory, compliance and community level.

This report brings to the forefront different types of impacts faced by individuals, communities and businesses upon facing man-made fire incidents, the magnitude and

[1] https://timesofindia.indiatimes.com/india/every-5th-fire-death-in-world-is-in-india-study/articleshow/72920852.cms
[2] James SL, et al. (2020), Global Injury Morbidity and Mortality from 1990 to 2017: Results from the Global Burden of Disease Study 2017, Injury Prevention, BMJ Journals, http:// dx. doi. org/ 10. 1136/ injuryprev- 2019- 043494
[3] Accidental Deaths and Suicides in India (ADSI) database, National Crime Records Bureau. Available at: https://ncrb.gov.in/en/accidental-deaths-suicides-in-india?page=1
[4] Ibid.
[5] Accidental Deaths and Suicides in India (ADSI) database, National Crime Records Bureau. Available at: https://ncrb.gov.in/en/accidental-deaths-suicides-in-india?page=1

severity of these impacts and the systemic and behavioural changes needed to prevent fire incidents and minimize their burden on the economy and society. The analysis brings out significant implications for safety standards, policies and regulations and the behavioural change needed as a society.

2. Context

Fire is one of the most destructive disasters that affects individuals and communities. Disasters can be natural or man-made. Disasters may occur suddenly like an earthquake, high-rise fire or industrial accident or may occur over a period of time, like a pandemic or climate change. While many disasters are a result of natural causes, disasters like fire are human-induced or man-made in layman terms.

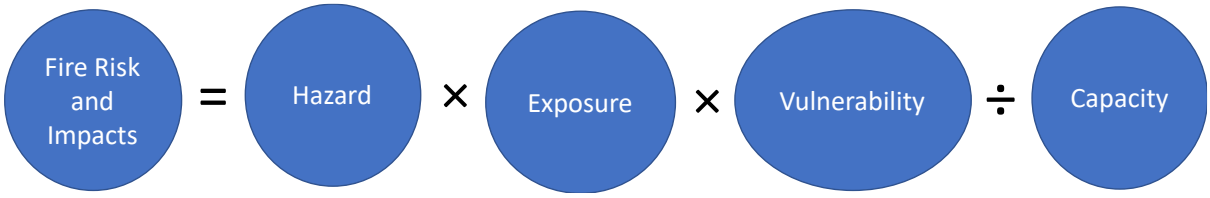
It is important to understand the common terms of usage in literature before analysing a fire incident as a disaster. United Nations Office for Disaster Risk Reduction (UNDRR)[6] describes any disaster as a serious *disruption* of the functioning of a community or society at any *scale* due to a *hazardous*[7] event interacting with conditions of *exposure*[8], *vulnerability*[9] and *capacity*[10] leading to human, material, economic, health and environmental losses and impacts. The impacts of disaster can be localised and *short-term* or can spread widely and have *long-term* and *cascading* effects. Disaster *damage* usually occurs almost immediately during and after the disaster. It can be quantified or described as the destruction of physical assets, equipment, appliances, sources of livelihood and basic services like electricity or water supply. Disaster *impact* is the aftermath of the event causing (mostly) negative effects like death, injuries, diseases, trauma, loss, etc. The typology of impacts captures physical, economic, social, health, psychological and environmental impacts.

The highlighted terms above need to be examined in the light of fire as a disaster. Fire incidents, as described in this report, are human-generated and not natural events like forest fires. Hence the assessment of impacts of fire incidents will focus on the hazards from human activity that would create a fire risk and given the exposure of people living and working in

[6] https://www.undrr.org/
[7] Hazard is a natural or human activity that may cause loss of life, injury or other health impacts, property damage, economic disruption or environmental degradation. Available at: https://www.undrr.org/terminology/hazard
[8] Situation of people, infrastructure, housing, production capacities and other tangible human assets in the hazard-prone area. Available at: https://www.preventionweb.net/terminology/exposure
[9] Conditions determined by physical, economic, social and environmental factors or processes that increase the susceptibility of an individual, community or assets to the impacts of hazards. Available at: https://www.preventionweb.net/terminology/vulnerability
[10] Combination of all strengths, attributes and resources available within an organization, community or society to manage and reduce the disaster risk and strengthen resilience (ability to adapt, transform and recover). Available at: https://www.preventionweb.net/terminology/capacity and https://www.preventionweb.net/terminology/resilience

unsafe environments and their vulnerability to fire, several types of impacts on individuals, communities, businesses would occur.

Fire risk and impacts, in a human-generated setting[11], are a function of the following equation[12]:



It is important to understand at the outset that fire, as dealt with in this report, is not an accident but a disaster. People become victims of an accident when they happen to be exposed to a certain hazard by chance in a particular setting, which is not induced by them, by default or design. For instance, in a road accident, a person becomes a victim by simply being there at that spot and subjected to someone else's rash and negligent driving. In case of fire, people are not just the victims of a fire incident but are directly or indirectly either the perpetrators or silent spectators due to negligence, carelessness and not adhering to norms and safety standards. Therefore, fire incidents need to be treated as disasters occurring as a result of the design of people or design of environment of their creation.

People are not only the victims of fire but also direct or indirect perpetrators and silent spectators due to negligence, carelessness and disregard for safety norms. Hence, fire incidents are disasters occurring from designs of people or designs of the environment of their creation.

There are a number of reasons why individuals and communities face fire risk and resultant impacts. The fire hazard in the living or working space is always present in the form of electrical wiring, heating, air-conditioning systems, other gadgets, gas cylinders, industrial machinery, chemicals and so on. The hazard is magnified by exposure to the living and working conditions in the houses, apartment buildings, industrial factories, offices, restaurants and hotels, etc. Exposure might be due to the presence of large number of people in the same residential or commercial area at the same time, ill-defined entry and exit routes, absence of emergency exits, inflammable material used in processes or decorations, etc. Vulnerability further adds to the exposure and increases the risk and impacts. This vulnerability is on account of factors like least awareness about fire hazard, absence or inadequacy of fire-fighting equipment, installations or repairs done disregarding rules,

[11] Houses, buildings, industries, infrastructure, services, etc.
[12] Adapted from UNDRR Global Assessment Report 2015

regulations or norms, poor maintenance, gross negligence and so on. When hazard is combined with exposure and vulnerability, fire risk and resultant impacts are amplified. The risks and impacts can be reduced, mitigated or minimized by improving the capacity of individuals, communities, businesses and systems to take precautions to reduce exposure, minimize vulnerability and control the hazards causing fire.

Since fire is a disaster that can be mitigated or prevented through the careful analysis of factors causing hazard, exposure and vulnerability and understanding ways to increase our capacity or resilience, it is imperative to study these factors in great detail. This report examines, in quantitative and qualitative terms, various types of impacts caused by fire incidents in India. For this purpose, six separate fire incidents have been chosen carefully for further analysis and the physical, economic, social, health, psychological and environmental impacts are identified and measured, to the extent possible. These impacts relate directly and indirectly to the factors causing hazard, exposure and vulnerability to fire. The report highlights not just the impacts but their relation with these factors in order to present a strong case to the policy makers and regulators to treat fire incidents as human-induced disasters and take urgent and active steps to mitigate them.

3. Study objective and scope

The main objective of this study is to examine the economic, social, health and environmental impacts of fire incidents in residential, commercial and public buildings in India by analysing selected case studies.

Six incidents across the country have been selected to measure the physical, economic, health and other impacts of fire using the primary and secondary data. Besides death and injuries, there are devasting physical, economic, health, psychological and environmental impacts experienced by those who are direct or indirect victims of fire incidents. Yet, there are hardly any formal studies or research reports in India that capture these impacts in detail for their severity and consequences. There is further lack of awareness among the people with the common belief that 'it will not happen to me'. This leads to a highly casual and negligent behaviour regarding fire safety and preventive measures[13]. This study is conducted to fill this research gap and analyse different types of impacts of fire incidents.

The scope of the study includes:

- Analysis of six major fire incidents in three states (Maharashtra, Gujarat and Delhi)

[13] https://www.financialexpress.com/money/fire-safety-are-commercial-and-residential-spaces-in-india-safe-enough/2637244/

- The six selected incidents include a residential building, private hospital, government civil hospital, commercial complex housing a coaching centre, budget hotel and a commercial market
- Typology of analysed impacts:
    - Physical impacts (lives lost, disability, injuries and damage to property)
    - Economic impacts (Value of life lost, loss of income and livelihoods, business losses, opportunity costs, cost of repairs/replacements)
    - Health impacts (burns, respiratory impacts, mental illness treated by medical practitioner)
    - Social and psychological impacts (trauma, anxiety, anger)
    - Environmental impacts (toxic emissions, contamination)
- Analysis of quantitative and qualitative indicators related to the impacts
- Analysis of post-fire investigations by public authorities and information given by victims and eyewitnesses
- Study of compensation and insurance mechanism
- Investigating preventive measures implemented (if any) post-fire incidents
- Identifying implications for fire safety standards, policies and regulations

4. Methodology

The methodology used for this study is described below.

4.1 Selection of case studies

For impact assessment of fire incidents, a sample of six case studies were chosen from across the country. Identification of the cases was based on the newspaper reports and articles available in the public domain.

Table 1 shows the list of fire incidents selected as case studies for further analysis.

Table 1: List of fire incidents chosen as the sample

Building Name	Type of Building	Location	Date of incident
Takshashila Arcade	Commercial Building	Surat	May 24, 2019
Arpit Hotel	Commercial Building	Delhi	December 2, 2019
Dreams Mall & Sunrise Hospital	Commercial/hospital	Mumbai	March 26, 2021

Civil Hospital	Public hospital	Ahmednagar	November 7, 2021
Sachinam Heights	High-rise residential building	Mumbai	January 22, 2022
Mundka Building	Commercial Building	Delhi	May 13, 2022

Six cases were selected carefully based on the following criteria:

- Year in which the incident occurred: Incidents between January 2019 and June 2022 were identified for inclusion in the sample. Incidents prior to 2019 were not considered since there would be a loss of recall value on the part of concerned authorities, affected parties and eyewitnesses. Very recent incidents, post June 2022, were also not considered since the reports on the cause of fire and damage estimates might still be under process.
- Type of establishment: Once the time frame of the incidents was determined, cases were selected on the basis of the type of establishment. Residential buildings, commercial buildings with different end-uses and hospitals were chosen keeping in view the recent fire incidents and different types of impacts to be captured. Industrial sites were not chosen for this study, since the types of impacts for industrial fires and the safety norms and regulations applicable to these sites are also different.

4.2 Data collection and analysis

Primary and secondary data were used to analyse physical, economic, health, social, psychological and environmental impacts of the fire incidents. Secondary information collected on impacts focussed only on the human-generated fires and not natural incidents like forest or wildfires.

Detailed literature review was carried out to gather secondary data on the following:

- Data on fire incidents and associated mortality and injuries in India
- Information published on the selected case studies in media reports and articles
- Published reports and articles on physical and economic impacts of fire incidents
- Published reports and articles on health and social and psychological impacts in the aftermath of fire incidents
- Published reports and articles on environmental impacts of fires

Primary data were collected through the surveys and interviews with different stakeholders associated with the six case studies. Field team involved in this study gathered information from the following sources:

- Representatives of owners/management where access was given to the field team

- Victims of fire incidents (building residents, shop owners) who suffered from the direct losses and impacts
- Friends and neighbours of families who lost members during the incidents (interviews carried out keeping the sensitivity of issue in mind)
- Chief fire officers (CFOs) and fire officials at six fire stations in whose jurisdictions the fire breakouts were reported
- People and businesses in the close vicinity who were eyewitnesses or involved in the rescue efforts

The field team could not meet the families of the deceased directly, since the fire brigade officials were unable to share details of the victims and their addresses. In the residential building, the families that lost members to the fire were yet to come to terms with their loss and were under severe trauma. The team was advised by neighbours not to disturb these families for an interview. Thus, keeping in mind the severity of the loss for the victims' families and in order to maintain their privacy, no direct interviews were conducted with the families of the deceased victims.

The impacts of fire incidents are varied and not captured entirely in reports filed by the fire officials[14]. Information related to health, social and psychological impacts faced by the victims is also not recorded in official or other documents available in the public domain. Hence, key informant interviews (KIIs) were carried out to complement the information gathered through secondary data sources and primary data collected from the incident sites. Interviews were carried out with experts from the following fields:

- Fire auditor and electrical systems expert
- Doctor operating a burns clinic and hospital
- Psychiatrist treating patients with exposure to fire incidents
- Insurance expert to understand the process through which fire-related claims are settled

Data gathered through the primary and secondary sources were analysed using the descriptive statistical and analytical tools. Several assumptions, backed by practical evidence, were used to estimate some of the economic impacts. For indicators, where primary data were not available, secondary sources and assumptions were used to estimate their magnitude. For qualitative indicators, available information in the public domain was used to understand their nature.

[14] Different authorities including the fire brigade, police, inspection teams from public works departments, fire auditors, municipal authorities and insurance companies carry out assessments post fire incidents. Reports prepared by them are not collated under one single authority or organization. Hence, it is difficult to access all the information about the cause of fire, victims, number of injured, nature of investigations, etc. There is also a general reluctance to share official documents due to legal and other considerations.

5. Impact assessment and analysis

This section describes the impacts of fire incidents on people, places and properties. It captures a range of impacts beginning with the most obvious and tangible physical impacts to direct and indirect economic impacts as well as not so tangible health symptoms and illnesses, social and psychological consequences and the broader environmental effects related to fire and smoke. Table 2 table depicts the types of impacts caused by fire and the indicators used to identify and measure each of them in quantitative and/or qualitative terms. This is a blanket list of possible indicators that would point out to the types of impacts that victims of a fire incident might face. It is prepared by reviewing the available literature, media reports carrying interviews of victims, eyewitnesses and fire service officials and the experience of other disasters like floods, which have similar types of impacts.

This study has captured most of these indicators, to the extent possible, through primary and secondary data and some assumptions based on the available evidence base.

Table 2: Impacts of fire incidents with relevant indicators

Physical	Economic	Health	Social and psychological	Environmental
• Loss of life • Loss of property and equipment • Damage to property and equipment	• Cost of premature death • Cost of disability • Replacement cost of property and equipment • Repair cost of property and equipment • Cleaning up costs • Time taken to restart the business • Loss of revenue - short to medium-term • Capital expenditure for installation or upgradation of fire safety system • Number of days without work for employees	• Burns due to fire • Effect on eyes • Asthma attack • Breathlessness, runny nose and other respiratory distress • Cardiovascular stress • Mental health issues reported to medical practitioner • Cost of treatment • Number of working days lost • Disease burden	• Trauma and anxiety • Feeling of loss and helplessness • Loss of sleep, need for medication • Business sentiment affected in the vicinity • Anger at not being able to protect people and business • Feelings towards establishment for negligence • Community participation for help during fire and immediate aftermath	• Local air pollution • Toxic fumes in the aftermath • Water contamination • GHG emissions

	• Loss of income for employees			

5.1 Physical impacts

Fire incidents are a global phenomenon. Between the year 2013 and 2017, an average of 3.5 million fire related accidents have been reported globally on an annual basis by the CITF[15] or the International Association of Fire and Rescue Services[16]. The mortality from fire is quite high with more than 180,000 deaths per year[17], with 95% of the deaths and burn injuries occurring in the low- and middle-income countries[18].

As per the ADSI database, India recorded 386,631 cases, 369,633 deaths and 36,833 injuries related to fire incidents between 2001 and 2019[19]. Cause-wise breakdown of these cases is given in the database only till year 2013, post which the reporting format has changed. Based on its analysis, 15.6% of these incidents happened due to the explosion of cooking gas cylinders or stove. Around 5% cases have been reported due to electrical short circuit and 1.6% were due to fireworks explosions. 71% of the cases do not have a specific cause attributed to them in the database. However, they may be due to a combination of the above reasons and the exact cause may not have been determined upon investigations or may not have been updated in the official records.

Although the official statistics have not been able to identify the exact causes of fire in 71% cases, fire officials and experts reveal that electrical short circuits as one of the main causes of fire. For instance, according to the Chief Fire Officer of Mumbai Fire Brigade and the technical committee on Safety Manual for man-made disasters, nearly 70% fire incidents in Mumbai due to electrical short circuits[20,21]. Data presented by the Mumbai Fire Brigade showed that 12,112 fire incidents out of 17,257 in Mumbai city in 2019-22 were owing to short circuits[22]. Data accessed by RTI activists also reveals that 1,568 fires were reported from high-rise buildings in the city between 2008 and 2018, with short circuit being the cause in

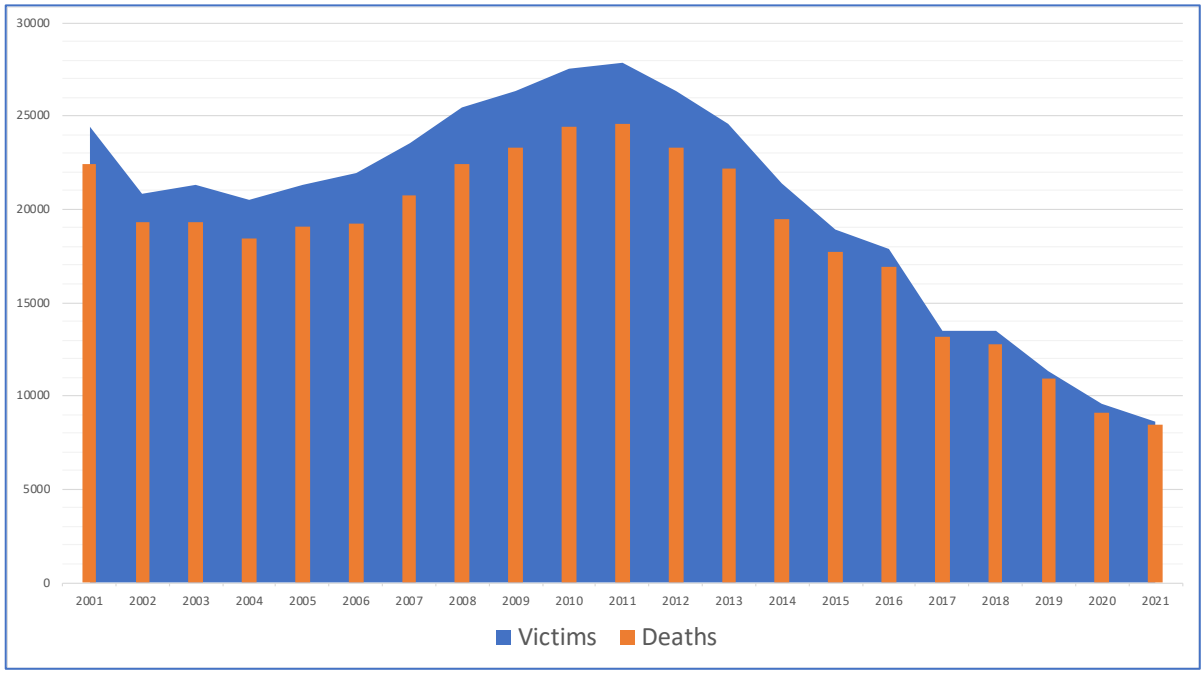
[15] Comité Technique International de prevention et d'extinction de Feu
[16] NIDM (2020), Fires in India: Learning Lessons for Urban Safety, National Institute of Disaster Management, Ministry of Home Affairs, Government of India
[17] World Bank (2020), Urban Frame: Urban Fire Regulatory Assessment & Mitigation Evaluation Diagnostic, GFDRR, The World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/34671
[18] https://www.undrr.org/publication/fire-risk-reduction-margins-urbanizing-world
[19] Accidental Deaths and Suicides in India (ADSI) database, National Crime Records Bureau. Available at: https://ncrb.gov.in/en/accidental-deaths-suicides-in-india?page=1
[20] https://timesofindia.indiatimes.com/city/mumbai/short-circuit-is-most-common-cause-of-blaze-in-bldgs-fire-chief/articleshow/94799120.cms
[21] https://indianexpress.com/article/cities/mumbai/nearly-70-of-fire-incidents-due-to-electric-short-circuits-8281725/
[22] https://timesofindia.indiatimes.com/city/mumbai/short-circuit-is-most-common-cause-of-blaze-in-bldgs-fire-chief/articleshow/94799120.cms

most cases[23]. In Gujarat, short circuits in air conditioner units have been identified as one of the main causes of fires in households[24]. Similarly, fires triggered by short circuits claimed 300 lives in Telangana in six years and were responsible for five major incidents in Hyderabad as per the news reports[25]. In a study carried out on hospital fires in India, electrical short circuit was the cause in 53% cases and other electrical causes like defects in battery or cables were responsible for 20% other cases[26]. Hence, among all the causes, electrical short circuits need special attention from policy makers and regulators.

Loss of life and injuries:

The loss of life is the most obvious and the most serious physical impact of fire. In India, among the total number of identified victims during the fire incidents, an average of 91% have died and only about 9% have survived with burn or other injuries as seen in Figure 1 below. It shows the total number of victims with direct physical impacts and the number of deaths among them for the period 2001 to 2021. The percentage of fatalities in the fire incidents among those suffering from the physical impacts is very high (91%), compared to other types of accidents or disasters. This makes the fire incident a very serious disaster with little chance of survival for those who get physically harmed by fire.

Figure 1: Total victims and number of deaths in India due to fire incidents (2001-2021)

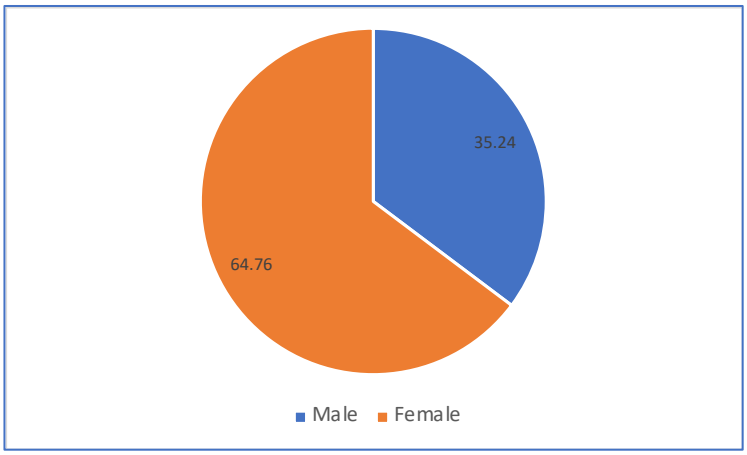


[23] https://timesofindia.indiatimes.com/city/mumbai/short-circuit-is-cause-of-most-fires-shows-data/articleshow/89066561.cms
[24] https://m.facebook.com/indianfireservices/photos/gujarat-accounts-for-indias-10-deaths-due-to-home-firesthis-is-something-every-h/2665048860412054/?locale2=ko_KR
[25] https://timesofindia.indiatimes.com/city/hyderabad/fires-triggered-by-short-circuit-snuffed-out-300-lives-in-6-years-in-telangana/articleshow/97264065.cms?from=mdr
[26] https://aimdrjournal.com/wp-content/uploads/2021/06/CM1_OA_Sajad-Hussain-Bhat-edit-CM.pdf

Source: ADSI Database, 2001-2021

Yet another interesting dimension is the gender composition of the casualties between 2001 and 2021, where more number of females have died compared to males among the direct victims of fire as shown in Figure 2. Unsafe cooking environment, exposure to gas cylinders and cooking stoves that are not maintained well and poor electricity connections at home might be the contributing factors for more number of female deaths[27,28]. However, the proportion of female victims in the death tally has steadily decreased from 62.7% in 2001 to 46.7% in 2021.

Figure 2: Gender composition (%) among the deceased (2001-2021)

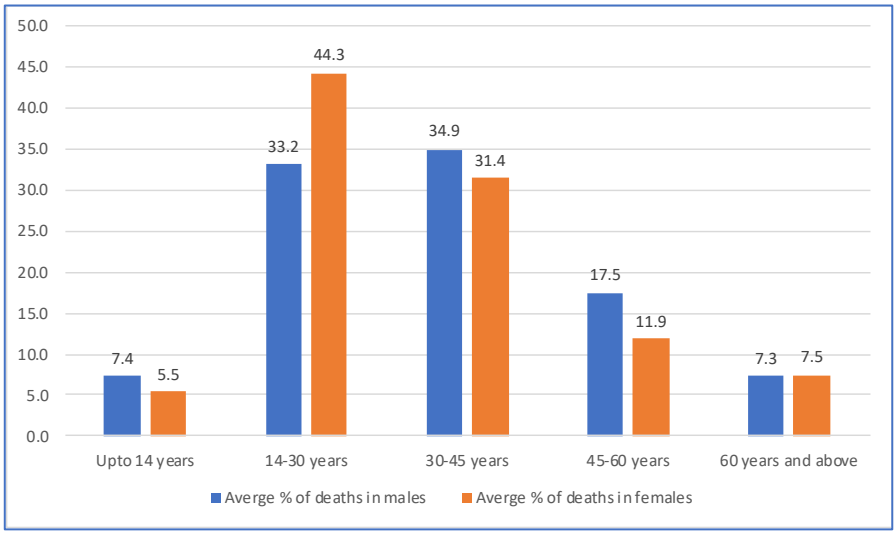


Source: ADSI Database, 2001-2021

Among females, around 44.3% of average deaths between 2001 and 2020 happened in the age group of 14-30 years (Figure 3). The second highest average number of deaths were recorded in females of 30-45 years. Females below the age of 14 years had, on an average, the least percentage of deaths among all female victims. For the males, between 2001 and 2020, the highest percentage of deaths were also recorded in the age group of 30-45 years followed by 14-30 years. Percentage of deaths was the least among senior males, 60 years and above.

[27] https://www.who.int/publications/i/item/9789240047136
[28] https://www.undrr.org/publication/fire-risk-reduction-margins-urbanizing-world

Figure 3: Average percentage of deaths in males and females



Source: ADSI Database, 2001-2020

The state-wise data from 2001-2021 indicates (Table 3) the highest percentage of deaths due to fire in Maharashtra followed by Madhya Pradesh and Gujarat. Karnataka, Uttar Pradesh and Chhattisgarh also had a significant share of total deaths from fire incidents in India. Although Delhi is only a union territory, it has a significant share of 1.5% among the all India deaths.

Table 3: State wise deaths as a percentage of all India deaths

State	% of deaths among all India deaths (2001-2021)
Maharashtra	21.8
Gujarat	10.3
Delhi UT	1.5
Madhya Pradesh	13.1
Tamil Nadu	8.9
Karnataka	6.9
Uttar Pradesh	5.6
Chhattisgarh	5.0
West Bengal	3.8
Bihar	2.3

Source: ADSI Database, 2001-2021

Some critical observations on loss of life in the case studies are discussed below:

- In the 6 case studies selected for this report (detailed description of which is available as Annexure to this report), significant number of lives were lost due to fire. The fatalities include people (residents, business owners, patients, facility users) trapped

in the premises of the building on fire and individuals involved in rescue operations (security guards).

- For instance, the victims in Ahmedabad Civil Hospital and Sunrise Hospital in Dreams Mall, Mumbai, were mostly critical COVID-19 patients in the intensive care unit (ICU). Pre-determined medical conditions would have been an added factor for fatality[29].
- In Sachinam Heights, the residential building, majority of the deceased were between the age group of 20-45 years. One of the guards of the building lost his life while trying to rescue residents. There were 2 senior citizens and most of the victims were females.
- Takshashila Arcade in Surat had a coaching centre located on part of the terrace and it witnessed 22 deaths of students, in the age group of 18-20.
- The number of deaths reported in the official reports for Arpit hotel and Mundka building in Delhi are much lesser than what is being shared by the eyewitnesses.
- Loss of life during fire is often the result of burns but more so the result of inhalation of toxic gases in the thick black smoke. The number of deaths are observed to be much higher in case of toxic gas inhalation than burn injuries[30], a fact corroborated by the doctor running the burns hospital, who was interviewed for this study. Majority of the deaths in each case study were also due to the suffocation from smoke.
- The effect of smoke intensifies if the building does not provide proper ventilation. In Ahmednagar Civil Hospital, single entrance in the ICU trapped the smoke within the ward, leading to the death of some patients.
- In case of Arpit Hotel in Delhi, the complicated locking system of windows in rooms did not allow the smoke to be released from the room and hence led to suffocation and deaths. Guests in the rooms were not able to unlock the windows. However, this could also be due to loss of sense created by the smoke coming into the room[31].
- Another cause of death was the jumping from buildings to save lives. Many students of Takshashila Arcade coaching centre jumped from the 4th floor terrace to save their lives. Many of them suffered serious injuries and died. A similar situation occurred in Arpit hotel in Delhi where some guests lost their lives while trying to jump from the building.
- The physical impact of fire injuries not only cause immediate casualties but can also lead to long-term suffering after fire exposure and eventual loss of life[32]. One of the residents of Sachinam Heights lost three family members, 2 of whom died during the incident and one member died after being in the hospital for almost 10 months. Similar cases would have occurred across the country, but we do not have the granular data to examine the same. Beyond a few days, even media reports do not capture

[29] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1653772/pdf/amjph00486-0069.pdf
[30] Ibid.
[31] Fire Accidents in Building – Case studies, IJETT (May 2014) http://ijettjournal.org/volume-11/number-4/IJETT-V11P236.pdf
[32] http://ijettjournal.org/volume-11/number-4/IJETT-V11P236.pdf

deaths from fire incidents which happen much later after prolonged suffering and hospitalization.

- Many fire victims suffer from injuries such as burns, fractures, etc. The nature of injuries can be minor or long-lasting. In the case studies, no instances of disability have been reported. However, the literature suggests that there might be long-lasting effects including permanent burn marks, permanent damage to lungs, cardiovascular problems, etc.[33]
- Sometimes even the fire personnel may lose their lives or suffer from injuries. For instance, 4 firemen were killed in the rescue operation in an office building in Kolkata[34]. 6 firemen suffocated to death in an elevator while on a rescue mission to put out fire in a high-rise building in Thane[35]. While saving children from the coaching centre in Surat, two fire department personnel got injured. One had a fracture in his hand and the other had facial burns. Similar injuries were reported by the fire officials in Mumbai in the Sunrise Hospital case.

Loss or damage to property and assets:

- Besides loss of life and injuries, fire incidents lead to huge property losses[36]. In the six case studies, severe damages (beyond repair) were reported for the following:
  - ✓ Grounds and fences
  - ✓ Walls and flooring
  - ✓ Electrical and lighting systems
  - ✓ Communication systems
  - ✓ Electrical appliances
  - ✓ Melting of air conditioning systems
  - ✓ Doors and windows
  - ✓ Elevators
  - ✓ Interiors and furnishings
  - ✓ Life-saving hospital equipment in the ICU wards
- Majority of the properties/establishments were either closed down permanently after the incident or temporarily, for a few months, disturbing daily lives and businesses. In Mumbai, the entire mall was affected by level-4 fire. As per the fire officials, 60% of the property was caught in fire and only 40% could be saved. The mall has been completely shut since then due to legal issues and many shop owners are not able to use their property at all, leading to a huge loss.

[33] Ibid.
[34] https://timesofindia.indiatimes.com/city/kolkata/four-firemen-among-9-people-killed-in-kolkata-high-rise-inferno/articleshow/81402615.cms
[35] https://www.ndtv.com/india-news/thane-six-firemen-die-in-elevator-accident-403320
[36] Fire Accidents in Building – Case studies, IJETT (May 2014) http://ijettjournal.org/volume-11/number-4/IJETT-V11P236.pdf

- In Sachinam heights, the fire started on the 19th floor, which was completely destroyed. Heavy smoke damaged walls and surfaces of 16th to 18th floor, each of which have 8 apartments. Residents between floor 16 and 18 saw huge damages to the house interiors and equipment. Every asset and equipment on the 19th floor was gutted in fire. The entire building was closed for 5 months and all residents had to shift to rented houses or with relatives.
- In some cases, the damages were intensified due to the presence of highly inflammable materials within the premises. The property damage in Arpit Hotel intensified due to the storage of cleaning chemicals in drums on the ladders and staircases and extensive use of wooden furniture.
- Expensive equipment were not spared from fire in some cases. In both Civil and Sunrise Hospitals, fire engulfed the entire floors and destroyed all the medical machinery and equipment. The ventilator machines in ICU where Covid-19 patients were admitted were completely destroyed by the fire.
- In commercial complexes, fire started at one end can destroy other shops, godowns or factories within the building. For instance, a CCTV manufacturing company lost all its stock due to fire in Mundka, Delhi and incurred hugh economic losses.

5.2 Economic impacts

Physical impacts of fire lead to huge economic losses. In fact, economic loss is one of the most significant impacts caused by a fire incident[37]. Across the globe, billions of dollars are lost directly or indirectly as a result of the number of fire incidents[38]. According to a report by the World Bank, if even one percent of the global GDP (US $ 85 trillion) is estimated to be the cost from fire accidents, the absolute cost would be around US $ 850 billion per year[39].

In the United States, National Fire Protection Association (NFPA) has compiled the data on total cost of fire from 1980 to 2014[40]. The total cost was calculated as the total net expenditure on fire + total net losses due to fire accidents. The total cost in 2014 was US $ 328.5 billion (1.9% of GDP). The total expenditure was US $ 273.1billion and total loss was US $ 55.4 billion. The total cost of fire also showed an increasing trend of almost 50%[41]. These costs include the impacts of both wildfires and human-induced fire incidents. Nevertheless, it is significant that this database is maintained to get the general sense of the economic loss related to fires.

[37] https://www.sciencedirect.com/science/article/abs/pii/S0957582022006085
[38] https://www.emerald.com/insight/content/doi/10.1108/PRR-12-2018-0033/full/html#sec002
[39] https://openknowledge.worldbank.org/handle/10986/34671
[40] https://www.nfpa.org//-/media/Files/News-and-Research/Fire-statistics-and-reports/US-Fire-Problem/RFTotalCost.pdf
[41] Ibid

In India, we are concerned with the number of human-induced fire incidents affecting residential, commercial and public buildings in densely populated areas, as seen in the case studies chosen for this report. Even hospitals were not spared from fire and led to unfortunate loss of lives. Yet, there are no official estimates or studies trying to measure the economic impact of such fire incidents. This section measures these impacts based on the limited data gathered through primary sources and making suitable assumptions, where required.

Estimation exercises to capture economic losses from fire incidents serve a good purpose to bring to light different types of losses and a way to account for them. They reflect the complex settings in which people live and operate and interrelationships that get impacted severely during fire incidents.

Fire imposes a huge economic loss for those who lost a family member and also those who had to endure injuries and bear the cost of treatment and rehabilitation. It is, therefore, important to estimate a number that denotes the monetary value of the life lost or the cost borne by a healthy individual due to injuries or disability. In order to estimate the value of life, the standard approach used by insurance companies to estimate the value of the insured life is used here[42]. For estimating the loss due to injuries, assumptions have been made to estimate the cost of treatment for the injured. Data on disabilities due to fire incidents are not available on official portals and no disabilities were reported in the six case studies either.

Few general observations about economic impacts of fire incidents are discussed here. They are important in measuring the monetary value of the impacts:

- The overall economic cost of a fire incident is due to the severe damage caused to property, assets and equipment. They are either totally destroyed and beyond repair or can be repaired but with a significant cost. Hence, the economic cost of property, asset and equipment damage is the cost of replacement or repairs.
- The immediate effect of fire is to shut down operations permanently or temporarily depending on the damage. The inability to operate results in sudden loss of revenue[43].
- Recovering from fire incidents takes significant amount of time depending on the damage to the property and effect on human life[44]. The time taken to rebuild a life depends on the number of days/weeks/months it might take for an individual to recover from injuries. The injuries can be physical or psychological impacting the ability of an individual to work[45]. Similarly, the time taken to make a business

[42] Human life value calculator available at: https://sites.uni.edu/thompsona/Human%20Life%20Value%20Spreadsheet.xlsx
[43] https://elitefiresecurity.co.uk/how-fire-affects-business/
[44] https://www.academia.edu/39822581/The_Impact_Of_Fire_Outbreak_On_The_Well_Being_Of_A_Business
[45] https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1215.pdf

operational in the same premises or at an alternative location needs to be considered while estimating the economic impacts[46].

- Time taken to restart a business also reflects the number of workdays lost for individuals or small businesses. The number of lost working days highlights the revenue lost for those days[47]. The loss of revenue can be estimated by multiplying the days of work lost times the average wage and fringe benefit costs per day of work, depending on the data availability.
- Revenues take time to get to the pre-tragedy level even after the business becomes operational for some time[48]. Loss of equipment during the fire tragedy can lead to non-fulfilment of order and eventual loss of revenue. The customers can also drift away to competitors after the incident and might not come back. The event can lead to long-term trauma resulting in lack of confidence or eagerness to work. This can lead to low levels of attention towards work and gradual loss of revenue. This is true for both individual workers and entrepreneurs.
- For an employer, the number of days an employee does not come to work due to injury leads to loss of productivity and therefore economic burden[49]. Loss of productivity implies the value of lost output due to absence of an employee that exceeds the daily wage of that employee[50]. The value of lost output increases exponentially with the number of days' employees remain absent from work.
- Apart from the economic impacts at the micro level, it is also important to consider economic consequences at the macro level. In case of a fire incident, governments provide monetary compensation to the affected individuals or their families. This cost is included in the expenditure borne by the state governments in India as fire safety is a state subject. Insurance companies also have to bear the burden of a pay-out to settle insurance claims after fire.

There are, thus, numerous economic impacts and they need to be measured systematically and to the extent possible to reflect the serious loss of value incurred due to fire incidents. For the six case studies, economic impacts have been measured using the information obtained during the site visits and interviews with fire officials and victims. This information is supplemented with the generic information available in the public domain and suitable assumptions based on literature review. Economic impact, estimated here for each case, is expected to serve as a pointer to the extent of losses expected from similar other incidents.

[46] https://www.academia.edu/39822581/The_Impact_Of_Fire_Outbreak_On_The_Well_Being_Of_A_Business
[47] https://www.researchgate.net/publication/264040573_Estimates_of_the_Incidence_and_Costs_of_Fire-Related_Injuries
[48] https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1215.pdf
[49] https://nimhans.ac.in/wp-content/uploads/2019/02/BD_7-India-Injury-Report_0.pdf
[50] https://files.core.ac.uk/pdf/2612/81859059.pdf

Table 4: Economic loss at Sachinam Heights (Residential high-rise):

Category of loss	Amount (in INR)	Assumptions
Loss of human life	7,20,00,000	Number of deaths = 13 Median age = 40 years Average annual income at age 40 = INR 4.0 lakhs[51] Total remaining work span = 20 years Annual income increase = 4.6%[52] Discount rate for future income streams = 10%
Damage to flats on floor 19 (complete destruction)	6,00,00,000	Damage in each flat = INR 75 lakhs reported by residents No. of flats = 8
Damage to flats on floors 16-18 (partial damage)	4,80,00,000	Average damage in each flat = INR 20 lakhs reported by residents No. of flats = 24
Cost of alternative accommodation for all families	1,57,50,000	Total number of flats = 105 Number of months = 5 Average rent paid per month = INR 25,000
Repair costs for common areas including upgradation of fire systems and electrical wiring	1,10,00,000	Reported by the society office
Total economic loss	20,67,50,000 **Amount in INR Crores = 20.675**	

Table 5: Economic loss at Sunrise Hospital and Dreams Mall (Mixed-use large commercial complex)

Category of loss	Amount (in INR)	Assumptions
Loss of human life	7,20,00,000	Number of deaths = 11 Median age = 50 years Average annual income at age 50 = INR 4.8 lakhs Total remaining work span = 10 years Annual income increase = 4.6% Discount rate for future income streams = 10%

[51] https://www.india-briefing.com/news/guide-minimum-wage-india-2022-19406.html/
[52] https://economictimes.indiatimes.com/jobs/india-set-to-witness-highest-salary-hike-in-world-in-2023-pakistan-among-lowest-five/articleshow/95106398.cms?from=mdr

Damage to hospital property	10,00,00,000	Reports available in public domain
Damage to shops	30,00,00,000	Average damage = INR 5 lakhs as reported by owners No. of affected = 600 (assuming damage to 60% mall premises as per official reports)
Cost of relocation	66,00,00,000	Total number of shops = 1100 Number of months = 12 Average rent paid per month = INR 50,000 for similar commercial premises
Charges to be paid by owners collectively to get permissions to reopen mall (mall owners had not paid these dues)	20,00,00,000	Unpaid property tax with interest = INR 16 crores Unpaid electricity bill with interest = INR 3 crores Water charges for common areas with interest = INR 1 crore
Total economic loss	1,30,57,00,000 **Amount in INR Crores = 130.57**	

Table 6: Economic loss at Ahmednagar Civil Hospital (Single-use building)

Category of loss	Amount (in INR)	Assumptions
Loss of human life	6,09,00,000	Number of deaths = 11 Median age = 40 years Average annual income at age 40 = INR 4 lakhs Total remaining work span = 20 years Annual income increase = 4.6% Discount rate for future income streams = 10%
Damage to hospital property and cost of repairs and rebuilding	5,00,00,000	Reports available in public domain
Total economic loss	11,09,00,000 **Amount in INR Crores = 11.09**	

Note: No data available on loss of revenue to the hospital when ICU was shut for months after the incident.

Table 7: Economic loss at Takshashila Arcade (Mixed-use small commercial building)

Category of loss	Amount (in INR)	Assumptions
Loss of human life	10,60,00,000	Number of deaths = 22 Median age = 18 years Average annual income at age 25 = INR 3 lakhs Total remaining work span = 36 years Annual income increase = 4.6% Discount rate for future income streams = 10%
Cost of treatment for the injured	16,00,000	Number of injured = 16 Average cost of treatment = INR 1 lakh (based on information obtained from medical practitioners)
Damage to shops (repairs and replacement cost)	3,80,00,000	Average damage = INR 20 lakhs as reported by owners No. of affected shops = 19
Damage to coaching class	2,00,00,000	Based on information obtained in site visits
Cost of relocation	45,60,000	Total number of shops = 19 Number of months = 12 Average rent paid per month = INR 20,000 for similar commercial premises
Total economic loss	17,01,60,000 **Amount in INR Crores = 17.016**	

Table 8: Economic loss at Arpit Hotel (Budget hotel with limited operations)

Category of loss	Amount (in INR)	Assumptions
Loss of human life	9,41,00,000	Number of deaths = 17 Median age = 40 years Average annual income at age 40 = INR 4 lakhs Total remaining work span = 20 years Annual income increase = 4.6% Discount rate for future income streams = 10%
Damage to hotel	12,00,00,000	Average value taken from the reported figure ranging between INR 10-15 crores
Loss of business (including payment to employees, suppliers)	3,00,00,000	Average annual turnover of budget hotels estimated from available information in public domain

Total economic loss	24,41,00,000 **Amount in INR Crores = 24.41**	

Table 9: Economic loss at Mundka building (Mixed-use commercial building with large business units)

Category of loss	Amount (in INR)	Assumptions
Loss of human life	11,49,00,000	Number of deaths = 27 Median age = 30 years Average annual income at age 30 = INR 4 lakhs Total remaining work span = 30 years Annual income increase = 4.6% Discount rate for future income streams = 10%
Cost of treatment for the injured	12,00,000	Number of injured = 12 Average cost of treatment = INR 1 lakh (based on information obtained from medical practitioners)
Damage to building (complete destruction)	1,25,00,00,000	Based on reports available in public domain – average value taken
Total economic loss	1,36,61,00,000 **Amount in INR Crores = 136.61**	

Interpretation of the economic costs estimated for the case studies:

- The losses estimated above serve the purpose of understanding the typical losses experienced by high-rise residential buildings, large commercial complexes like malls, small commercial establishments with multiple users like small shops, public and private hospitals and coaching classes involving higher footfalls and greater density of people in a limited space at any given point in time.
- These estimates are only indicative and based on the available data and assumptions. They may be gross underestimations of the actual loss since there would be many medium- to long-term losses that are hard to put monetary values on in the absence of robust data and reporting systems. Business owners typically underestimate the losses depending on the nature of business. Residents also find it tough to keep exact account of all the losses. There would be work days lost, productivity loss and overall impact on business sentiment which is quite difficult to capture.
- Yet, such estimation exercises serve a good purpose to bring to light different types of losses and a way to account for them. They reflect the complex settings in which people live and operate and interrelationships that get impacted severely during fire

incidents. People in the same environments also get impacted differently. However, the average estimation, like the above exercise, does indicate the overall economic impact.

- Estimations of economic impacts can be used to extrapolate for losses for a particular region, when the purpose is to draw the attention of policy makers and regulators and highlight the urgency of strengthening fire safety norms and their enforcement. They can also prove useful for awareness building among people living and working in unsafe environments and neglecting basic safety precautions to be taken.
- There are no official records or studies carried out by government entities, academic institutions or NGOs to understand what is the cost of a fire incident. This analysis may help to bring about the interest in pursuing impact assessment of fire incidents on a bigger scale.

5.3 Extrapolation of economic impacts

Based on the economic impacts estimated for the case studies, as discussed above, the total economic impacts of fire incidents in India for the year 2020 have been estimated below using the following assumptions:

- Number of fire incidents considered for extrapolation for year 2020 include 208 fires in commercial buildings, 5391 fire incidents in residential buildings and 53 incidents in public buildings.
- For extrapolating the economic impacts on commercial buildings in the country, Mundka Building case study has been used. This case represents a typical mid-sized mixed use commercial building with business units. The average economic losses for the damage suffered by such a commercial building have been estimated at Rs. 12 Crore based on the case study findings.
- For extrapolation of economic impacts on residential buildings, Sachinam Heights case study is considered as a representative of a typical multi-story or high-rise building found in urban areas. The economic damage costs considered for extrapolation are Rs. 6 Crores towards destruction of the floors which caught fire, Rs. 5 Crores towards damage of other floors, Rs. 1 Crore considered as the average cost of alternative accommodation for all affected families (in the absence of the exact number of families relocating) and repair costs of Rs. 1 Crore. The total damage estimate for a typical residential building is, thus, estimated at Rs. 13 Crore for purposes of extrapolation.
- In case of a typical public building, the damage estimates of Ahmednagar civil hospital have been used for extrapolation. Different equipment and assets would be damaged in a public building in the event of a fire. The average estimate of this loss is taken as Rs. 5 Crores based on the case study findings.

- The loss of human life is the most serious impact of a fire incident. 9110 people lost their lives in 2020 on account of fire. The average value of the lost human life is estimated in the case study using the following assumptions:
    - Median age = 40 years
    - Annual average income at age 40 = Rs. 4 lakh based on the minimum wages earned by people in India[53]
    - Total remaining work span = 20 years
    - Annual income increase = 4.6%
    - Discount rate for future income streams = 10%

  Based on these assumptions, the average value of lost life is Rs. 0.6 Crores.

The following table shows the extrapolation of economic loss due to fire incidents in 2020. The total losses are estimated at Rs. 77,232 Crores.

Table 10: Extrapolation of economic impacts

Type of establishment	Damage estimates for equipment, assets per building (Rs. Crore)	Case used for extrapolation	Number of cases for extrapolation	Total damages extrapolated (Rs. Crore)
Commercial building	12.0	Mundka Building, New Delhi representing a typical mid-sized commercial building	208	2496.0
Residential building	13.0	Sachinam apartments, Tardeo representing a typical multi-storeyed building	5391	64692.0
Public building	5.0	Civil Hospital, Ahmednagar representing a typical public building	53	265.0
Loss of human life value (Rs. Crore)	0.6	Average age 40 years when life lost representing the typical age found in case studies	9110	5466.0
Grand Total (Rs. Crore)				**77232.0**

[53] https://www.india-briefing.com/news/guide-minimum-wage-india-2022-19406.html/

While using the extrapolated values for policy analysis or awareness generation, care should be taken to consider the following important aspects:

- Such extrapolation exercises are based on several assumptions, which may underestimate the overall economic losses in the absence of exact figures for losses suffered in each incident.
- The extrapolated values for economic losses should be taken as indicative values to reflect the magnitude of loss suffered by people due to fire.
- There were 3661 fire incidents in 2020 which were not classified due to lack of information on exact cause of fire or inconclusive reports of the fire incidents. Hence, they have not been considered in the above extrapolation exercise. If the exact nature of these incidents was known, they could have been accounted for in this exercise and this would push up the total economic losses manyfold.

5.4 Health, social and psychological impacts

Health of an individual is greatly affected by a fire incident. The impact can be traumatic both physically and psychologically[54]. The immediate physical impact and trauma can result in fatality or injuries and the effect can be immediate or over a period of time. The death ratio in a fire accident is much higher than injuries as seen by the all India data earlier in the report. During a fire incident, major causes of fatal and non-fatal injuries are burn injuries due to fire in a building or exposure to highly inflammable material, smoke and toxic gases[55]. In fact, more deaths occur due to exposure to toxic smoke than burns as seen in the case studies and also shared by the doctor running a burns hospital.

Most deaths during fire incidents occur not due to burn injuries but due to the inhalation of toxic gases released from the highly inflammable materials present in residential and commercial premises.

The physical effects of symptoms from a fire incident can be felt within a few hours or can take longer time[56]. The effects are experienced by people caught inside the buildings as well as people in the nearby premises and fire professionals too. In the first 24 hours of the incident, an individual can experience the following symptoms,[57]

- ✓ Coughing
- ✓ Irritation in throat, respiratory tract, eyes and nose

[54] https://www.cpsc.gov/s3fs-public/fireinj2009.pdf
[55] https://www.researchgate.net/publication/264040573_Estimates_of_the_Incidence_and_Costs_of_Fire-Related_Injuries
[56] https://academic.oup.com/eurpub/article/16/3/252/469827
[57] https://academic.oup.com/eurpub/article/16/3/252/469827

- ✓ Ear aches
- ✓ Humming in ears
- ✓ Shortness of breath
- ✓ Vertigo

Fire victims may experience either minor or major burns on their skin[58]. Burn are termed as minor or major depending on the degree of burns on an individual[59,60]. Table 11 briefly describes the burn types and treatment for them.

Table 11: Types of fire burns and treatment

Type of burn	Depth	Surface area on the body	Treatment
Minor	Mostly superficial	< 10%	It usually does not require surgical intervention.
Major	Penetrates the skin	>10% (It can differ as per the age group of the person)	The degree of penetration decides the severity of burn and treatment required.

In case of minor burns, a person can be released the same day after initial treatment or can be hospitalized for a few days depending on the presence of any additional health condition. In majority of the fire incidents, most of the victims suffer from minor burns and are released after hospitalization for a few days[61]. On the other hand, major burn injuries cause fire-related deaths. A significant number of deaths due to major burns happen on the premises only. Additionally, some of the victims succumb to their burn injuries within 24 hours of reaching the hospital and some die eventually after receiving treatment for prolonged periods or due to long-term additional complications like pulmonary problems, infections, sepsis or organ failure[62]. Survivors of the burns can have long-lasting burn marks on their bodies, which also remind them of the incident and cause trauma.

As discussed, studies have shown that majority of deaths during fire are not due to burn injuries but smoke inhalation[63,64]. The smoke produces toxic gases that are extremely dangerous to people and can be fatal within minutes of inhaling. Tiny burned, partially burned or unburned particles are also present in the smoke. These particles can get parked in the lungs, cause irritation to the eyes and affect the digestive system. Toxic vapours formed can work like poison if inhaled or absorbed by the skin. Respiratory tract can get burnt due to inhaling hot gases and eventually lead to death. In addition to inhaling toxic gases or particles,

[58] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1653772/
[59] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7224101/
[60] https://www.cdc.gov/masstrauma/factsheets/public/burns.pdf
[61] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1653772/
[62] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7224101/
[63] https://www.emerald.com/insight/content/doi/10.1108/PRR-12-2018-0033/full/html#sec002
[64] https://www.nfpa.org/News-and-Research/Publications-and-media/Press-Room/Reporters-Guide-to-Fire-and-NFPA/Consequences-of-fire

drop in the oxygen level during fire can deteriorate health conditions, as seen in Table 12 and result in death[65].

Table 12: Below normal oxygen level and impact on health

Level of oxygen	Health condition
<17%	Impairment in judgement and coordination
<12%	Headache, dizziness, nausea and fatigue
<9%	Unconsciousness
<7%	Respiratory and/or cardiac arrest

Physiologically, a fire injury can affect the respiratory system of an individual that can result in longer stay in the hospital or eventual death. Respiratory failure due to inhalation of toxic gases can require ventilator support which can further cause complications like pneumonia[66]. Inhalation of toxic gases prevent proper utilization of oxygen at the tissue level enhancing the state of hypoxia. As the oxygen transportation gets affected, other organs in the body do not receive enough oxygen and can eventually start to fail resulting in cardiovascular, neurological or respiratory stress[67]. Furthermore, inhalation of irritants like particles and gases from fire can result in asthma-like symptoms. High exposure to such irritants can eventually develop lifelong Asthma in fire victims[68].

Patients with existing medical conditions, such as, pulmonary problems, cardiovascular issues or diabetes have a higher probability of death (immediate or delayed) or increased number of days in the hospital. The chances of an elder person to die from a fire injury is much higher than other age groups due to the underlying age-related health conditions[69].

Fire and smoke has a direct effect on the eyes of an individual. In most cases, victims feel irritation in the eyes due to smoke and particles which can further lead to burning of the eyes[70]. This can be treated within few days of the incident. However, severe cases of eye burn require longer treatment. The physical complications of an eye burn depend on the degree of the burn. For example, eye burn due to chemical substances like alkali from plaster affect cornea of the eye and can lead to scarring, infection and eventual blindness[71]. Eye burns are very common in facial burns and can eventually lead to blindness.

[65] https://www.emerald.com/insight/content/doi/10.1108/PRR-12-2018-0033/full/html#sec002
[66] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5879861/
[67] Ibid
[68] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4261306/
[69] https://journals.sagepub.com/doi/pdf/10.1177/2059513117707686
[70] https://onlinelibrary.wiley.com/doi/full/10.1034/j.1600-0420.2002.800102.x
[71] https://www.msdmanuals.com/home/injuries-and-poisoning/eye-injuries/burns-to-the-eye

Victims of a fire accident not only go through physical health problems but may have long-term psychological issues[72]. The quality of life is severely affected. Individuals suffer through a state of shock during and after the incident. This state of shock can result in decreased cardiac output and metabolic state. The severity of cardiac stress as a response to the injury determines premature mortality or prolonged morbidity[73] and severe trauma for a long time after the incident, causing further health problems. The state of the mind and situation during a fire incident force people to find various ways of escaping the fire. Many of them try to escape by jumping from buildings or running around in the building resulting in a stampede. This results in deaths for some and some endure injuries such as fractures. Those who witness such deaths also have a long-lasting impact on them.

Box 1: Loss of loved ones in fire and the extreme trauma: Case of a victim in Mumbai high-rise

Death, loss and grief are natural parts of life. But when death arrives suddenly and unexpectedly, such as with suicide or an accident, the overlap of the traumatic experience and the grief of the loss can overwhelm us. Traumatic grief is a relatively new term that combines trauma with bereavement or grief responses. It is provoked by the death of a significant other and includes symptoms similar to PTSD but specifically focused on the lost person, including intrusive, distressing preoccupation with the deceased, hyper-vigilant scanning of the environment for cues of the deceased, the wish to be reunited with the deceased, separation anxiety features, futility about the future, difficulty acknowledging the death, shattered world view, and anger together with impaired social functioning.

One of the residents of the Sachinam Heights in Mumbai lost 3 of his family members; wife (51 years), son (23 years) and niece, a doctor by profession (32 years). The resident himself recovered from a very critical condition but is still in a state of extreme traumatic grief after losing the family members. The son passed away after a week while the parents were still in the hospital. The father was not informed about the son's demise then and could not attend the last rites due to his own injuries. He further saw the niece suffering from severe lung damage and succumb to it after a prolonged battle for life for 6 months in the hospital. He lost his wife recently after nearly 10 months of suffering in the hospital post the fire incident. He has, thus, not had time to recover from his trauma and has suffered shocks, one after the other, over the past one year. There have also been pressures due to prolonged hospitalization and not having enough resources to afford very expensive treatment like lung transplant to save the niece.

He has not stepped out of home since the incident and refuses to interact with others. According to his neighbours, he has completely shut himself out from the rest of the world. Besides the extreme trauma of losing close family, he may also be suffering from "Survivors guilt"; a kind of guilt that develops in people who have survived a life-threatening situation. Another resident of the society, a senior citizen, shared that he also has been suffering from extreme trauma since the incident. He has had experiences of shock and disbelief and difficulty in focusing on the present moment. He advised the survey team not to approach the above-mentioned resident to talk about his loss since he is in a state of extreme trauma and should not be made to relive the experience.

The physical impact of a fire most often accompanies psychological impact from the trauma. The feeling of enduring a physical trauma, need for hospitalization due to physical complications and recovering from it can impact the victims mentally[74]. Loss of hope, fear, negative approach towards life, sleeplessness, sadness, confusion, agitation, anger, aggression, etc., are indicators of psychological trauma[75]. Sometimes, psychological impact can be present independently[76]. Being a part of the incident can itself trigger the psychological stress. Loss of family members, friends or belongings can be the added factors to the trauma. A few reported cases of mental trauma post fire incidents are shared as Annexure 2.

A number of studies have reported that survivors of fire incidents suffer from acute stress disorder, post-traumatic stress disorder (PTSD), severe depression and anxiety[77,78]. The symptoms of psychological distress can be observed since the onset of the incident up to 1 year and sometimes up to a few years. Acute stress is observed in victims immediately after the incident which can be due to the burns and pain endured. PTSD is mostly experienced in severe burns and observed after 3-4 months to 1 year of the incident. The victim may feel sad, angry, sleepless and try avoiding meeting people or interact socially. People also develop a tendency to blame others for the mishap. As per few studies, PTSD is more common among women due to incidence of facial burns and eventual trauma of disfigurement[79]. PTSD in children can further create an impact on their adult life. Apart from symptoms of fear, depression and shock, children can also feel anger and frustration due to being dependent on their parents completely for every day work[80]. They may feel worried about their complete recovery.

Treatment costs:

In addition to the physical and psychological distress, injuries from burn can have enormous cost of treatment. The cost related to burn injuries is among the highest and puts a stress on the family due to high out-of-pocket expenditure[81]. The overall burden is estimated through the average cost of treatment for particular health issues and loss of productivity[82] through

[74] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3471846/
[75] https://www.ncbi.nlm.nih.gov/books/NBK207191/
[76] Ibid
[77] https://www.researchgate.net/publication/348752250_Post-Traumatic_Stress_Disorder_Ptsd_Following_Burn_Injuries_A_Comprehensive_Clinical_Review/link/6010129c92851c13fe3a2f35/download
[78] https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0041532&type=printable
[79] https://www.researchgate.net/publication/348752250_Post-Traumatic_Stress_Disorder_Ptsd_Following_Burn_Injuries_A_Comprehensive_Clinical_Review/link/6010129c92851c13fe3a2f35/download
[80] Ibid
[81] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3187939/
[82] https://asthmarp.biomedcentral.com/articles/10.1186/s40733-016-0029-3

the number of days a person is missing from work due to these issues. In Table 13, average cost of treatment and the number of working days lost due to each impact are mentioned[83].

Table 13: Treatment costs for fire victims and average work days lost

Health impact	Average cost of treatment	Number of days of loss of work
Burns	- Minor burns – INR 1000 per visit - Major burns – approx. 60,000-80,000	- Minor burns – 1-2 days - Major burns- 6-8 weeks
Effect on eyes[84,85,86]	- Irritation in eyes – INR 1500 for eye drops - Eye burn – INR 1,25,000 for one eye	- Irritation in eyes- 0 to 7 days - Eye burn – 1.5 months
Asthma attack[87,88,89]	- Attack – INR 8000-9000 - Prolong asthma – INR 18,737 per year	- Attack – 5-6 days - Prolonged asthma – 17-18 days
Respiratory distress[90]	- INR 2,00,000	- 7-14 days
Cardiovascular stress[91]	- INR 2,00,000	- 6-7 days
Mental health issues[92]	- INR 10,000 – 15,000	- 10 – 33 days per year as per US average

Data source: Consultation with doctor and secondary literature

Some experiences from the case studies shared here:

- Most people in all six cases died due to suffocation from smoke. Some of them endured burns and few died while jumping off the building (students from the coaching centre in Surat). People had also suffered from non-fatal injuries in many cases.
- Out of the 22 casualties in Takshashila heights, 16 died due to suffocation, 3 died by jumping from the building and 3 died from fire-related burns. Around 16 students were admitted to the hospitals and one of them suffered from serious burn injury. An employee of one of the shops got burn injuries in the incident and was admitted to a private hospital for a month.

[83] https://scroll.in/article/944956/indias-burn-centres-suffer-from-lack-of-data-and-basic-facilities
[84] https://www.eye7.in/oculoplasty/
[85] https://www.amazon.in/Optrex-Itchy-Eye-Drops-10ml/dp/B001PMLWPY
[86] https://www.ncbi.nlm.nih.gov/books/NBK459221/
[87] https://scroll.in/article/944956/indias-burn-centres-suffer-from-lack-of-data-and-basic-facilities
[88] https://asthmarp.biomedcentral.com/articles/10.1186/s40733-016-0029-3
[89] https://www.lybrate.com/topic/bronchial-asthma-treatment
[90] https://www.lybrate.com/topic/acute-respiratory-distress-syndrome
[91] https://doi.org/10.1371/journal.pone.0262190
[92] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6497000/

- Two of the fire fighters rescuing students from Takshashila arcade suffered from injuries such as fracture and burns. Due to the intensity of fire and smoke, one of the firefighters at Arpit hotel fell unconscious and suffered from minor burns on his hand.
- In cases of Ahmednagar hospital and Sunrise hospital, maximum patients who died were on ventilator due to COVID-19. Weakened respiratory system due to COVID-19 resulted into most of the deaths. Additionally, in Ahmednagar hospital, many COVID-19 patients were elderly. Age and prevailing health condition were the factors contributing to death during fire.
- A number of victims in Mundka, Arpit hotel and Takshashila Arcade lost their lives or sustained injuries during escape. In Arpit hotel, a young mother with her child, as witnessed by a security guard, jumped off from the 4th floor while calling for help. The mother could not survive the fall and daughter died upon reaching the hospital.
- The thick black smoke and no electricity created a commotion among the residents of Sachinam heights. While trying to get down from the narrow staircases, many of them endured injuries. A 50-year-old woman from Sachinam Heights fell twice and was injured while trying to help her husband get out of the building.
- Some residents of Sachinam heights have not returned to their houses yet due to fear.

5.5 Environmental impacts

An important impact from fire incidents that needs consideration is the effect on the surrounding environment and emissions from fire. The environment gets polluted through different pathways such as air, water and soil[93]. Air is contaminated by emission of fire plumes such as smoke and gases that further diffuses into water or land. Water gets contaminated due to toxic materials and other burned materials[94]. Large amounts of water utilized to extinguish fire[95] and smoke also becomes contaminated and act as a pollutant[96]. In water scarce areas, excessive water spent in extinguishing fires is also a waste of a precious resource.

[93] https://firesciencereviews.springeropen.com/articles/10.1186/s40038-016-0014-1
[94] https://www.researchgate.net/publication/345342474_Environmental_Impact_of_Fires_-_Research_Roadmap
[95] Usually, water used by the firefighters contains fire-fighting foam made of highly fluorinated chemicals that are carcinogenic and can contaminate water. However, the fire brigades interviewed for this study reported using only water for spraying on fire and not any chemicals added to it.
[96] https://www.coopersfire.com/news/envrionmental-impact-of-fire/

Several hazardous substances are emitted during fire, such as, toxic vapours, particulates, metals, polycyclic aromatic hydrocarbons (PAHs), etc[97]. depending on the type of structure and inside contents. Buildings that contain highly inflammable materials like chemicals and synthetic materials like plastic tend to have greater environmental impact due to toxic contents in the smoke[98].

Air is the main source of contamination during a fire incident majorly caused by the fire plume containing soot and smoke. Soot is separated from fuel and gets accumulated on the walls of the building. Smoke contains particulate matter (PM), carbon monoxide (CO), carbon dioxide (CO_2) and chemicals such as nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), etc.[99] The type of PM and chemicals depends on the burning material/s, burn temperature and availability of oxygen. PM is in the form of small solid or liquid droplets containing organic compound and metallic content that can be easily inhaled due to its small size causing serious health issues[100]. It can enter eyes, nose and throat and cause irritation. It can also affect the pulmonary system causing bronchitis, asthma, respiratory infection and lung cancer. NO_2 is one of the nitrogen oxides formed during the process of combustion and is primarily a product of atmospheric chemical reactions with no taste but sharp odour[101]. High concentration of NO_2 can cause irritation in respiratory airways leading to symptoms, such as, breathlessness and coughing. Long exposure of the pollutant can lead to development of asthma, respiratory infections and damage to lungs. It can also pollute water bodies and decrease their nutrient value.

Hazardous substances present in the building materials, furniture, cooking systems, chemicals, steel and stored solvents release toxic gases during fire. They can cause harm to the pulmonary system and prove fatal for people with pre-existing morbidities like heart disease.

At high temperatures, incomplete combustion of fire in the buildings produces toxic fumes such as CO, PAHs and benzene. CO is formed due to incomplete combustion of carbon fuels such as wood, petrol, etc.[102]. It can dissolve in haemoglobin and make transportation of oxygen to other organs such as heart and brain difficult. It also prevents oxygen to diffuse into tissues. As a result of this property, it can be fatal for people with prevailing heart problems. At high concentration, it can cause dizziness, unconsciousness, asphyxia, confusion and finally death. PAHs are organic compounds or gases formed due to incomplete burning of oil, fuel, wood, garbage and other organic materials[103]. Exposure to PAHs can be through

[97] https://ww2.arb.ca.gov/resources/documents/combustion-pollutants-indoor-air-quality
[98] https://axaxl.com/-/media/axaxl/files/pdfs/fff/2019/axa-xl-whitepaper--fire--environmental-exposures--november-2019.pdf
[99] https://health.ny.gov/environmental/outdoors/air/smoke_from_fire.htm
[100] https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM
[101] https://www.epa.gov/no2-pollution/basic-information-about-no2#Effects
[102] https://www.epa.gov/co-pollution/basic-information-about-carbon-monoxide-co-outdoor-air-pollution#What%20is%20CO
[103] https://ww2.arb.ca.gov/resources/documents/combustion-pollutants-indoor-air-quality

inhalation of dust, consumption of food and water[104]. PAHs present in the air can contaminate soil which would then produce food containing PAHs. There is no certain value has been given to air quality for PAHs and is considered highly dangerous at all levels[105].

Benzene is present in building materials, furniture, cooking systems, oil, natural gas, chemical, steel and stored solvents[106]. Buildings that are newly constructed contain high amounts of benzene from recently decorated indoor environments in the form of materials and furniture. Main source of exposure to benzene is through inhalation followed by water and food. Mild form of inhalation can result in nausea, dizziness, headaches and insomnia. It reacts with other chemicals to form smog and can also contaminate water and soil. Another common pollutant is the Volatile Organic Compounds (VOC). The sources of VOC emissions are paint and other solvents, repellents, cleansers, disinfectants, wood preservatives, aerosol spray, stored fuel and automated products. Building with damage to their protective layer, during fire, release VOCs.

In case of fire incidents, the value of all major pollutants increases. Studies have shown an increase of 500 µg-m^3 in the level of $PM_{2.5}$ due to fire[107], which is 20 times higher than the minimum value recommended by the WHO. This shows the intensity of pollution and health as well as environmental hazard that a fire can create. Some of the above-mentioned pollutants indirectly possess a long-term effect on the environment by emission of greenhouse gases that further results in climate change. Hence, their emissions during fire are adding to the overall GHG emissions. Unfortunately, real-time measurements are not done at the sites of fire incidents to understand the concentrations of these pollutants at that time.

All the six case studies give a very clear picture about the release of toxic pollutants during the fire. It has already been mentioned that major cause of deaths has been suffocation from smoke. Most of the air pollutants mentioned above, such as, PM, CO, CO_2 and NO_2 directly affect respiratory system and causes asphyxia. Exposure to heavy concentrations of these pollutants is the cause of death during fire incidents. In case of Arpit Palace hotel in Karol Bagh Delhi, the evacuation process did not start for at least one and a half hours after the fire started. By this time, the smoke had already spread through the entire building causing many deaths. Most of the people died due to suffocation as there was no way to release the toxic smoke. Similarly, materials present in the buildings also affect the toxins in the smoke released from fire. In Takshashila Arcade, burning of wooden material on stairs would have

[104] https://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf
[105] Ibid
[106] https://emergency.cdc.gov/agent/benzene/basics/facts.asp
[107] https://www.researchgate.net/publication/349322135_Improving_the_Indoor_Air_Quality_of_Residential_Buildings_During_Bushfire_Smoke_Events

released pollutants that eventually resulted in respiratory distress and death of many students due to smoke.

Environmental impacts of fire incidents are, thus, very serious and can cause mortality, contamination and potential contribution to GHG emissions. It is necessary to measure the exact concentrations of these pollutants at the time of the fire incident. It is further necessary to understand how different materials inside the houses and commercial spaces are a potential threat due to their toxicity and hazardous nature during fires.

6. Implications for safety standards, policies and regulations

The discussion on different types of impacts caused by fire incidents and their measurement or articulation in the preceding section brings into focus crucial considerations and implications for safety standards and their enforcement, policy push to minimize the fire hazard, regulations to ensure adherence and a strong prevention mechanism.

This report started off by emphasising that fire should be treated, not as an accident, but as a disaster and fire risk is a function of hazard, exposure, vulnerability and capacity to deal with it. Using this argument, the policy and regulatory implications can be understood well by using the Sendai Framework for Disaster Risk Reduction and its four priority pillars as shown in Figure 4[108].

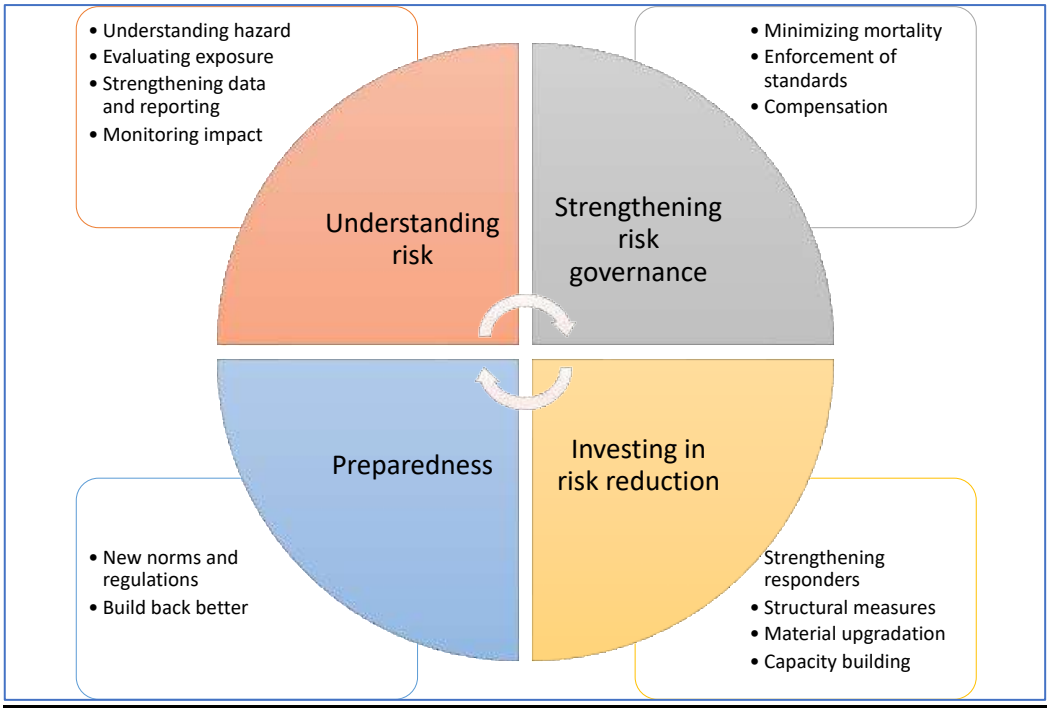
Understanding risk

- Understanding fire hazard characteristics: It is necessary to understand why people and places at particular locations and particular settings face greater risk of fire hazard than others. It might be due to the flaws at the design and construction stage, usage of low quality material and outdated technology, flammable characteristics of new materials used in construction and interiors, higher density of people and assets in smaller spaces (by design) and ignorance or open flouting of safety norms. Although it is common knowledge that a combination of these factors causes fire, thorough inspection and investigation of sites after fire incidents and releasing the findings in public domain is rarely done. On the contrary, there is reluctance or refusal to share reports even for academic or research studies. It is crucial that researchers and practitioners get an

[108] Sendai Framework for Disaster Risk Reduction (2015-2030) provides UN member states with concrete actions to protect development gains from the risk of disaster. The Framework focuses on adoption of measures to address three dimensions of disaster risk – exposure to hazard, vulnerability and capacity, in order to prevent creation of new risks, reduce existing risks and increase resilience. Available at: https://www.undrr.org/implementing-sendai-framework/what-sendai-framework#:~:text=The%20Sendai%20Framework%20focuses%20on,existing%20risk%20and%20increase%20resilience.

opportunity to study past incidents in a scientific manner and develop better understanding of the hazard characteristics.

Figure 4: Four pillars to mitigate and reduce fire risk



- Exposure of people and assets: There is a total lack of literature on the nature of exposure of people and assets to fire incidents in the country. Information on the types of impacts and their measurement or qualitative analysis is not available in the public domain in the form of reports or studies. Fire incidents are mere newspaper headlines with few details on the number of deaths or injuries or what was exposed and destroyed in fire. This report has highlighted some of these impacts and their quantification or articulation. But, more systematic studies with robust data are needed to examine fire incidents in great detail and understand the risk to people and assets.
- Strengthening database and reporting: The official databases on fire incidents in India, including the number of deaths, injuries and cause of fire need to be maintained in a more robust and systematic manner. The reported numbers across different sources vary greatly. Terminologies used to capture data are also not consistent. For instance, there is a huge gap between the total number of 'incidents' recorded (based on calls received at fire stations) and the number 'cases' recorded in the ADSI database. Total mortality figures do not match with the numbers split into sub-groups like males and females. There is also another serious issue with a gap between the official account and the reports of the eyewitnesses. Such gaps may compromise the understanding of nature and severity of fire hazards. The reporting structure needs to be strengthened urgently to capture information as efficiently and with as many details as possible.

- Monitoring impact indicators: There is no official database or exercise that monitors various impacts of fire incidents. Not all impacts can be easily measured but databases on the easily measurable indicators need to be maintained effectively. For instance, the data on physical loss of property and its valuation as per official norms can be recorded for each fire incident systematically. It will help the broad understanding of how much is at risk due to fires. Environmental impacts of fires is another neglected area where databases can be maintained with proper recording of pollutant concentrations at the site of fire. Fire services can record this with the use of portable equipment and make it a part of their response and rescue effort. Monitoring of environmental indicators will increase the understanding of exposure of people to toxic elements, since mortality during fire is often associated with them rather than the actual burning.

Strengthening risk governance

- Focus on minimizing mortality: Information gathered in the case studies reveals how most of the deaths occur due to smoke inhalation and stampede or jumping out of buildings to escape. These deaths could have been avoided if something as basic as opening of the windows was done on time without any hurdles (e.g. case of Arpit Hotel) or if the fire services could begin the rescue operations within short time (e.g. Arpit Hotel and Mundka building). Rescue efforts need to focus on how mortality from fire incidents can be reduced or minimized. Enforcement of rules and regulations through building codes, setting up firefighting systems and trainings given to firemen as well as communities need to have minimization of mortality as the primary objective to begin with. Examples of other disaster management systems (e.g. cyclone risk management in Odisha) show how deaths can be significantly reduced even when the economic impacts are unavoidable.
- Strict enforcement of safety norms and standards: All the six case studies point to flouting of rules, negligence and poor maintenance of fire-fighting equipment as the chief causes of the ensuing disaster. Fire incidents can be minimized if the safety norms and standards are strictly enforced. Cases like Dreams Mall or coaching centre on top of a building without proper access staircase point to the gross violations of all norms and standards. A lot has already been written about this in the media and reports. But it must be reiterated that strict enforcement is one of the most important measures to reduce fire hazard. This may require the overhauling of the entire governance and reporting structure on fire safety. But it needs to be carried out urgently by the policy makers and regulators. This may need a thorough assessment of the existing norms, compare them with international standards and bring about required revisions.
- Compensation and insurance mechanism: Fire risk management also revolves around compensation and insurance to aid the recovery and rehabilitation process. The compensation of INR 5 lakhs to victims' families is not even the tip of the iceberg as far as the overall magnitude of losses is concerned. The insurance uptake for properties is quite

limited. Many affected businesses denied having an insurance cover. The insurance expert also admitted that the process of claims was very lengthy. Research into insurance products and models and regulatory intervention is needed here as intrinsic part of the larger fire risk governance system and not as an external element.

Investing in risk reduction

- Strengthening capacity of responders: Given the growth of population in cities and towns and steady increase in the number of residential and commercial establishments, fire systems need to be upgraded to match with the requirement. This includes hiring and training more personnel, upgrading equipment, adopting new technology and strengthening the network of fire station within municipal boundaries. Case studies show how fire services lack the required machinery, including ladders, to undertake quick rescue. City landscape is rapidly changing with more skyscrapers being built for residential and commercial usage. Fire systems cannot deal with fire hazards at these places due to the outdated equipment. Till the time, capacity of fire responders is not strengthened, all the new establishments face a huge fire hazard.
- Structural and non-structural measures: Along with the upgradation of fire systems, structural and non-structural measures at residential and commercial establishments need to be implemented to reduce fire risk. Structural measures would obviously include using the latest technology for electrical wiring and metering, solutions recommended by experts to prevent spread of fire and maintaining and upgrading fire-fighting systems. But these will have to be accompanied by the non-structural measures like training security guards, conducting mock drills at regular intervals, inspecting and testing fire equipment at regular intervals, etc.
- Material upgradation: Majority of the fire incidents in recent years have been attributed to electrical short circuit. Hence, it is essential to follow the standards prescribed under the National Building Code of India (NBCI) to use safe electrical installations in residential and commercial premises. Part 8 (Building Services) and Section 2 (Electrical and Allied Installations) in the National Building Code of India contains provisions for safe electrical installations. This section is to be used together with Part 4 (Fire and Life Safety) containing list of emergency fire and life safety services[109]. Utmost importance is to be given to the installation of electrical wiring to prevent short circuits and associated hazards. Old residential and commercial buildings should undertake upgradation in terms of retrofitting or replacement of existing installations to meet the standards specified in NBCI. Besides safe electrical installations, choosing fire-retardant material is also important. For example, flame retardant chemicals[110] should be used for treatment of

[109] BIS (2016), Section 2 Electrical and Allied Installations, Part 8 Building Services, National Building Code of India 2016 – Volume 2, Bureau of Indian Standards
[110] Ammonium phosphates, ammonium sulphate and boron compounds

plywood that is widely used in residential and commercial spaces. Similar materials should be used for insulation[111], paints and coatings, electrical and optical wires[112] and cables coverings and electronic circuit board coverings[113,114].

- Capacity building of people at risk: Awareness and capacity building of people at risk of fire hazards is the key to reducing the risk. Awareness of the fire risk is lacking either due to the casual attitude, 'it won't happen to me' type negligence or overlooking safety issues, since the upgradations come at a cost. Incidents like hospital in Dreams Mall or coaching centre in a make-shift dome on top of a commercial building also points to the lackadaisical attitude towards safety and using facilities without awareness about the dangers involved. Capacity building at all levels is the key here. Safety rules, precautions and behaviour during emergencies needs to be taught at all levels from primary schools to adults working in the commercial buildings. Fire safety needs a mass movement like Swachh Bharat to create awareness and capacity among people that such risks are avoidable and need a behavioural change. People also need to be trained well on how to maintain electrical and cooking appliances, gadgets and systems at home. A few hundreds spent on regular maintenance will avoid losses worth millions of rupees and will save precious lives.

Preparedness and 'Build Back Better'

- New set of norms, rules and regulations: During the last two decades, big changes are happening around us in terms of design and construction of new mixed-use buildings, high-rises and skyscrapers, new materials being used for interior designing and modifications done inside premises to create more space for different functionalities. As discussed, these materials are also highly flammable and toxic and a potential fire hazard. Equipment currently used to fight fires in such establishments are grossly inadequate. Hence, the state fire acts and regulations need revision and upgradation. This is not going to happen overnight and would need more data and research into what changes are required. Academia, researchers and NGOs working in this area need to be involved in carrying out assessments, feasibility studies and testing of new technologies and methods. They can advise on how new set of rules and regulations can be formulated and implemented.
- Rehabilitation and reconstruction with 'build back better': When inspections are carried out at sites after fire incidents, efforts are not directed towards rehabilitation and reconstruction with the norm of 'build back better'. People are seen coming back to the

[111] Gypsum boards, perlite boards, calcium silicate boards and glass panels
[112] Copper with ideal level of thickness for handling large loads of electricity at a time
[113] https://indianrailways.gov.in/railwayboard/uploads/directorate/eff_res/camtech/Civil%20Engineering/YearWise//Handbook%20on%20Fire%20retarding%20materials.pdf
[114] https://www.meadmetals.com/blog/copper-electrical-connectors-conductivity

same premises with little upgradation. People settle back into the affected structures without proper inspection and NOC from fire services. Experience of Dreams Mall and Mundka building shows that fires have broken out in these premises even after they were closed. It clearly shows that people often go back to the same hazards despite losing precious lives and assets to fire due to lack of awareness about how to 'build back better'. For all fire sites, building back better should be the norm. For all new constructions, using the new technologies for fire safety should be the norm. People and assets should not be exposed to recurring fire hazards.

7. Conclusion

To conclude, this report is based on the analysis of fire incidents at six selected locations across three states in India. The study examines the economic, social, health and environmental impacts of fire in residential, commercial and public buildings and brings out significant implications for safety standards, policies and regulations and the behavioural change needed as a society.

Fires destroy lives, families, assets and young productive people are lost forever. India recorded more than 370,000 deaths and 39,000 serious injuries due to fire incidents during 2001-2020. Besides death and injuries, there have been devasting physical, economic, health, psychological and environmental impacts faced by the victims of these incidents. There is a lack of formal studies or research reports to capture these impacts in detail for their severity and consequences. The present study is an endeavour to address this research gap.

People and assets in residential and commercial buildings and common public spaces are acutely vulnerable to fire on account of factors like density of people in smaller spaces, use of inflammable materials, ill-conceived safety standards in constructions, poor maintenance, negligence and disregard for rules and safety norms. In recent years, we have witnessed serious instances of fires in high-rise residential buildings, commercial buildings, wholesale and retail markets, hotels, places of entertainment like theatres and hospitals, leading to loss of life and damage to critical infrastructure. As the built spaces see a surge and uses of electrical equipment and gadgets, cooking appliances, cooling and heating systems and inflammable material for storage and decoration, the fire risk and impacts are likely to intensify.

For impact assessment of fire incidents in this report, a sample of six case studies has been chosen to represent different types of establishments, such as, residential high-rise residential building, commercial buildings, a mall, public and private hospital and a small hotel. Primary data have been collected through the surveys and interviews with different

stakeholders and secondary information has been collected from published media reports and articles.

The loss of life is the most serious physical impact of fire. The percentage of fatalities in the fire incidents is typically very high (91%) among those affected. This makes the fire incident a very serious disaster with little chance of survival for those who get physically harmed by fire. Loss of life during fire often results from inhalation of toxic gases in the thick black smoke rather than the burns from exposure to fire.

Besides threat to life, there is severe damage to property and assets leading to huge economic losses. This might include replacement or repair costs for damaged assets and equipment, shutting down operations and moving out temporarily, loss of work days and loss of output and revenue. Average economic losses for the selected fire incidents have been estimated in the report using primary data and suitable assumptions. These are only indicative estimates of the actual loss and may be an underestimation of the overall economic impacts. However, they are useful in bringing to light different types of losses people suffer from in the complex settings they live and work in.

Estimates of economic impacts are further used to extrapolate for losses from fire incidents reported in 2020 across the country. The extrapolation exercise is based on assumptions and provides indicative values of the total losses. This exercise is useful to highlight the urgency of the issue to the policy makers and regulators and the need to further strengthen the fire safety norms and their enforcement. It may also prove useful for awareness building among people living and working in unsafe environments and neglecting basic safety precautions.

Along with physical and economic impacts, fire affects people psychologically. The feeling of enduring a physical trauma, need for hospitalization due to physical complications and recovering from it can impact the victims mentally. Loss of hope, fear, negative approach towards life, sleeplessness, sadness, confusion, agitation, anger, aggression, etc., are indicators of psychological trauma. Survivors of fire incidents suffer from acute stress disorder, post-traumatic stress disorder, severe depression and anxiety.

The natural environment also gets impacted during fire through pollution of different pathways like air, water and soil. Air is contaminated by emission of fire plumes such as smoke and gases that further diffuses into water or land. Water gets contaminated due to toxic and other burned materials. Buildings that contain highly inflammable materials like chemicals and synthetic materials like plastic tend to have greater environmental impact due to toxic contents in the smoke. It is necessary to measure the exact concentrations of these pollutants at the time of the fire incident. It is further necessary to understand how different materials inside the houses and commercial spaces are a potential threat due to their toxicity and hazardous nature during fires.

Impacts of fire incidents and their measurement or articulation in this report brings into focus critical implications for safety standards and their enforcement as well as the policy push and regulations required to build a strong prevention mechanism. Four pillars of action have been identified for this purpose, namely, understanding the risk, strengthening risk governance, investing in risk reduction and preparedness with focus on 'build back better'.

The case studies analysed in the report point to a serious lack of adherence to rules and safety standards as well as negligence and poor maintenance of fire-fighting equipment. What is needed is the overhauling of the entire governance and reporting structure on fire safety, with a thorough assessment and revision of the existing standards and their strict enforcement. The focus of these rules and standards must be to minimize mortality from fire. Compensation and insurance mechanism, as a part of the larger fire risk governance system, is also important for recovery and rehabilitation.

Investment in fire prevention requires upgradation of fire systems and equipment and strengthening the networks of fire stations. Structural and non-structural measures, such as, using latest technology for electrical wiring and metering, upgrading fire system, regular training of guards and mock drills at regular intervals, also need to be enforced and implemented at residential and commercial establishments to reduce fire risk. Fire safety norms, rules and regulations also need constant revision and upgradation to account for new construction material. Efforts should also be made to 'build back better' when rehabilitation of fire affected premises is done, so that people do not come back to the same hazards.

Finally, as a developing economy and society, we need to study how fire affects people, communities, businesses and systems and what can be done to raise awareness and bring about fundamental changes in fire safety norms and measures and their implementation at the policy, regulatory, compliance and community level.

Annexure 1: Case study reports

Mumbai Case study 1- Sachinam Heights

Fire incident location	Sachinam Heights (A wing)
Date and time of the incident	22nd January 2022 around 7 a.m. in the morning
City and State where incident occurred	Tardeo, Mumbai, Maharashtra.
Names of respondents and designation	• Fire brigade officials, Mumbai Fire Brigade Headquarters, Byculla • 6 residents of Sachinam heights • Society office manager.
Description of the building (A-wing)	• The building is the rehabilitation component of a redevelopment project of Gokul Das chawl (BMC chawl) being carried out by the Kamala Group. It was constructed in 2014. • Assistant municipal commissioner of the D-ward of the BMC said the building was given occupation certificate in 2015. • It is a ground plus 20-storey building located opposite Bhatia Hospital at Gowalia Tank. • There are eight flats on each floor of the building and 105 flats were occupied. • According to the respondents, all the residents of the building used to stay in the chawl and had good bond with each other. Most of them are from Konkan region of Maharashtra.
Description of fire incident (time, call to control room, response of fire brigade)	• The fire broke out early in the morning and many of the residents were asleep. • Residents of the Matrumandir building near Sachinam Heights saw the fire and smoke coming out of a flat and immediately called the fire brigade. • On being alerted, the fire brigade reached the incident spot within 15 minutes. However, major damage was already done by the fire and smoke that was produced due to the fire. • According to the fire brigade officials, it was a level 3 fire (major) and 13 fire engines along with 7 water jetties were rushed to douse the fire. • The fire is suspected to have spread through the electrical duct right through the length of the building, resulting in thick smoke all over. • The blaze was extinguished by 12.20 pm. It took around six hours to extinguish the blaze as reported by the fire officials. • Flat No 1904, where the fire burst out, was completely burnt, along with parts of corridors on the 19th floor. Some of the occupants of the floor got trapped and died. • Residents reported that suddenly the lights went off and there was huge thick black smoke in the passage of the building. Most residents ran down using the staircase. There was a commotion of residents trying to get out. Many were injured during this commotion. Some sustained injuries such as head injury, fracture including senior citizens.

	• The power supply of the building was switched off by the security guard when the fire broke out and many occupants were still asleep when the blaze erupted and hence could not be alerted in time. • A 50-year-old woman who lives on the fifth floor reported that she heard some noise like firecrackers and realized that something is wrong. She was scared and fell down twice while helping her husband to climb down the staircase. "I don't recall how I reached the open area," she said. • A woman who lived on the 14th floor of the building said she came to know of the blaze after being woken up by a friend, following which they rushed outside. • A fourth floor female resident said, "We came to know of the fire shortly after 7 am. When we came outside the building, there was a "fat-fat" sound outside a cabin (which presumably housed the AC compressor). There was smoke first and then there were flames," She mentioned that she used the stairs to come out of the building.
Cause of fire (according to respondents)	• According to the residents, no earthing in the building caused short circuit and the major reason for the rapid spread of fire was extremely cheap quality wiring used in the building. • Residents of the Matrumandir building near Sachinam Heights, who noticed the fire first, attributed the blaze to an AC compressor explosion. • A civic official said there were no eyewitnesses to ascertain from where the blaze began. • The cause of the fire is not yet identified by the fire department and hence the NOC from the fire brigade department is still pending. • Post the investigation by the fire department, it was identified that the duct doors wherein TV and internet wires are connected, were left open on many floors of the 20-storey building that led to the quick spread of fire. • As per an investigation reported in a newspaper, the rapid spread of fire in flat 1904 was due to interior work of wood. Interior alterations were made in the house by removing the kitchen wall.
Status of fire-fighting system inside premises	• Based on the report prepared by the fire brigade, - Building's firefighting system didn't work and audit report was not submitted. - The firefighting system was not used even for once since the apartment was built. - The fire alarm or hose pipes and reels were dysfunctional. • According to residents, there was fire-fighting system inside the premises but the security guards of the building had no training or knowledge about how to use firefighting equipment and hence could not take the required measures to reduce the fire from spreading further.
Immediate efforts to douse fire and rescue people	• Residents of Matrumandir Society, the building next Sachinam Heights came to the rescue of those stuck at Sachinam Heights. • On being alerted, the fire brigade reached the incident spot within 15 minutes. • Security guards also alerted the residents and switched off the main power supply. They joined in the rescue efforts immediately. • Heroic rescue efforts: Mr. Manish Singh, security guard of the 'B' wing lost his life while trying to rescue others.
Loss of life and injuries (no names, only age and gender)	• A total of 13 people (4 males and 6 females, 3 unidentified) have died till date. • One of the female residents of the building, died after getting treatment for 10 months.

<table>
<tr><td></td><td>

Major damage (loss of lives) was due to the thick black smoke (carbon) produced due to the fire rather than the burns from the fire.
Following are the details of the residents who lost their lives in the fire incident:

<table>
<tr><th>Gender</th><th>Age</th></tr>
<tr><td>Male</td><td>40</td></tr>
<tr><td>Female</td><td>45</td></tr>
<tr><td>Female</td><td>65</td></tr>
<tr><td>Female</td><td>70</td></tr>
<tr><td>Male</td><td>42</td></tr>
<tr><td>Female</td><td>35</td></tr>
<tr><td>Male</td><td>38</td></tr>
<tr><td>Male</td><td>23</td></tr>
<tr><td>Female</td><td>32</td></tr>
<tr><td>Female</td><td>50</td></tr>
</table>

Average age of people who died due to the fire comes to 44 years.

</td></tr>
<tr><td>Damage to property, equipment, etc.</td><td>

Losses amounting to Rs. 70-80 lakhs per flat on the 19th floor that was completely gutted in the fire.
The residents living on the 16th - 20th floor suffered huge losses (Approx. 5 lakhs per flat- 40 flats on these 5 floors) due to the thick black smoke that damaged the surfaces and walls of their houses completely. They were unliveable due the damages.
The wires and cables of the entire building were completely gutted.

From 16th – 20th floor
<table>
<tr><th>Items</th><th>High (Complete damage)</th><th>Medium</th><th>Low</th></tr>
<tr><td>Grounds and fence</td><td>✓</td><td></td><td></td></tr>
<tr><td>Foundation and support</td><td>✓</td><td></td><td></td></tr>
<tr><td>Flooring</td><td>✓</td><td></td><td></td></tr>
<tr><td>Walls (interior and exterior)</td><td>✓</td><td></td><td></td></tr>
<tr><td>Doors and windows</td><td>✓</td><td></td><td></td></tr>
<tr><td>Air conditioning system</td><td>✓</td><td></td><td></td></tr>
<tr><td>Electrical and lighting systems</td><td>✓</td><td></td><td></td></tr>
<tr><td>Communication systems</td><td>✓</td><td></td><td></td></tr>
<tr><td>Electrical appliances (TV, Geyser, Refrigerators, etc.)</td><td>✓</td><td></td><td></td></tr>
<tr><td>Elevator shaft/elevator</td><td>✓</td><td></td><td></td></tr>
</table>
Note: There were medium to low damages in the rest of the flats in the building as per the information received from the respondents.
</td></tr>
<tr><td>Rebuilding efforts (costs, time taken, alternate arrangements)</td><td>

Nearly 1.10 crores were spent from society’s funds (maintenance) and personal FDs were used for repairs.
Approximately Rs. 30 lakhs were spent on preventive measures which includes Fire safety instruments worth of Rs. 15-20 lakhs.
Wiring of the building costs Rs. 60-65 lakhs
Lift repairing (advanced lift facility) 10-15 lakhs

</td></tr>
</table>

	• The residents were shifted out of building after the incidents for 5-6 months (January to May, 2022). • They were staying in a chawl (Nana Shankar seth chowk), some stayed at their relatives' place and some were staying in rented places. • Several residents were provided makeshift shelter at the BMC's Jagannath Shankar Sheth Municipal School in Grant Road. The civic-run school is provided as a temporary accommodation to those who are still not able to go to their homes. Close to two dozen people stayed at the school for about a month.
Insurance and other compensation	• As compensation Rs. 5 lakhs from the State government and Rs. 2 lakhs from the Central government. • Local political leaders helped the residents (victims of fire accident) by requesting the hospitals to waive off the huge medical bills incurred for their treatment (Nair, Bhatia and Masina hospital). • The builder did not help in any way.
Preventive measures (suggested by respondents)	• New cables and wiring were installed. • Sub-meter with a connection that's outside the building was installed so that it is functional even after the main electricity supply of the building is switched off. • New advanced lifts that bring people to the lower floor and allow people to get out safely in case of emergency have been installed. • New fire pipes were installed, so that water reaches the building for extinguishing the fire since the Fire Brigade vehicles can't enter the building premises. • Training was provided to the security personnel. • BEST audit, FIRE audit, Electricity audit, and Structural audit was done by the respected departments. Other Govt. officials also did the audit of the building after the incident. • Approximately Rs. 30 lakhs were spent on all the above-mentioned preventive measures. • A survey was conducted by the fire brigade and BMC officials for awareness and sensitization in nearby areas after the incident happened.
Mental trauma suffered	• One of the respondents (a senior citizen) shared that he suffered from mental trauma for 4 months, had experiences of shock and difficulties in focusing on living a normal life. • He also advised us to not interview the secretary of the building. He said, "The secretary of the building is still in a state of extreme trauma after losing 3 members of his family to this fire incident." • Some residents of the building have not yet come back due to fear (trauma) instilled in them after the Fire accident.
Any other observations	• Some residents of the building alleged that three nearby private hospitals refused to admit the injured persons, demanded deposit money and their negative COVID-19 certificates. This caused delays in the injured getting treatment on time. • The victims were rushed to Bhatia Hospital on Grant Road, Masina Hospital, Nair hospital and few to Kasturba Hospital in Chinchpokali. • Unplanned construction and cramped spaces: No spacious road was there for the fire brigade vehicles to enter the building premises due to cramped gate and parking area of the building.

	• As per the residents, there was no water, electricity and security facilities given to the residents of chawl after promising the same for first few years after shifting. • The residents mentioned that all the committee members of the society resigned from the AGM on 6th November 2022 due to internal disputes over maintenance of the building.

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Mumbai Case study 2- Bhandup's Dream Mall and Sunrise Hospital

Fire incident Location	Dreams Mall & Sunrise Hospital • While the hospital is on the third floor of the mall, the second floor has a banquet hall and the first floor has shops for home décor and imitation jewelry. • The building, developed by HDIL, is also believed to be a disputed property referred to NCLT, said a source. That being the case, allowing a new business to operate from a contested premise is questionable, said a source. • There were long standing issues over the common area maintenance between the owners of the mall and the shop owners. • There were issues related to illegal alterations also by some the shop owners.
Date and time	26th March 2021, according to the respondent the fire started at midnight.
City and State where incident occurred	LBS Marg, Bhandup, Mumbai, Maharashtra
Names of the respondents and designation	• Deputy Chief Fire Officer, Mumbai Fire Brigade • Fire Officer, Vikhroli Fire Station, Mumbai • Fire brigade officials from Mumbai Fire Brigade, Byculla and Vikhroli Fire Station • 2 victims (advocates by profession who had their offices in the mall)
Description of the building	• Located close to Bhandup railway station, and at a prominent location on LBS Road, Dreams. • The three-storey mall houses Carnival Cinemas multiplex, a super specialty hospital, over 1,000 retail shops, a banquet hall and a food court. • The Mall has been falling apart gradually over the last three years. The multiplex and mall office has been closed. • There is no water in the toilets, no central air conditioning, no housekeeping or security services. • The elevators and escalators do not work. • Toilets are very dirty. • Ventilation is a challenge as the central air conditioning is not functional. Some shop owners desperate to get some fresh air have smashed the glass façade of the mall at some places. • With no security guarding the property, the mall has become unsafe especially for women after dark. • Sunrise Hospital was started as a COVID designated hospital on the 3rd floor of the mall. It had 300 beds and special permission to operate during Covid-19 pandemic.
Description of fire incident (time, call to control room, response of fire brigade)	• The Fire broke out on the first floor of the mall at around 12.30am and spread to Sunrise hospital. • According to the respondent, the back side of the mall caught fire. • It was a **level 4** fire according to the fire brigade officials and hence the fire engines from 4 different locations were called. • In all, 16 fire engines, 15 jumbo tankers, 3 regular water tankers, 2 aerial ladder platforms, 1 turn table ladder, 3 breathing apparatus vans were used. A fire hydrant near the site was also activated.

	• The fire engines had different water level tankers - 20 thousand, 16 thousand, 14 thousand, and 10 thousand liters respectively. • Filling points for fire engines were not near the mall and filling these water tanker engines took time, which also caused little delay to reach the location. • The fire at Sunrise Hospital **raged for over 40 hours** and claimed the lives of patients, including some on ventilator support. • The CCTV footage of the fire at Dreams Mall shows that smoke first entered through the rear end of the hospital at 11.10 pm, where private VIP suites are located. • The ICU, in which the majority of the patients who died were admitted, was only 25 meters from the point through which the smoke entered into the hospital.
Cause of fire (according to respondents)	• The reason behind the fire was a short circuit in a small shop on the first floor of the mall. • The fire could spread inside the hospital as none of the firefighting equipment was working on the day of the fire, the BMC report stated.
Official investigations and legal actions:	• BMC report held hospital management and officials of Mumbai Fire Brigade (MFB) accountable. - In May 2021, an investigation report prepared by the BMC, recommended action against MFB assistant divisional fire officer and the then chief fire officer for "not following the rules and carrying out a proper inspection" of the mall. - The report also recommended a departmental inquiry again the then chief fire officer (administration) for violating a fire brigade order. - According to the 2018 order, a notice issued to any establishment for non-compliance of fire safety norms should be signed by the chief fire officer. - The report said Kale had orally asked officers to send notices with their signatures without taking approval from the municipal commissioner, which was a violation of the 2018 order. - The report recommended that a criminal case be filed against the owners and management of Dreams Mall and Sunrise Hospital for not taking necessary precautions about safety of the premises and held them responsible for the incident. • The Mumbai police booked several people, including directors of Housing Development & Infrastructure Limited (HDIL) and directors of Privilege Health Care Services Private Limited (which owns Sunrise Hospital) among others, for culpable homicide not amounting to murder. - The directors maintained that the mall was being run by a court-appointed administrator since 2017. - The report also recommended action against a banquet owner on the second floor of the mall, as he had stored 45 LPG (liquefied petroleum gas) cylinders, despite having permission to only store two. - Two people, including the fire auditor, have been arrested so far but police is yet to file a charge sheet against them. - The proprietor of Pona Corporation and Privilege Healthcare CEO were arrested and produced before a local court. The police have added the charge of forgery against these two accused after they found that forged documents were used to obtain the No Objection Certificate for Sunrise Hospital located in the mall.

<table>
<tr><td></td><td>

- A bunch of five writ petitions are being heard at the Bombay High Court regarding the Bhandup mall fire.

</td></tr>
<tr><td>Status of fire-fighting system inside premises</td><td>

- According to the respondents, the fire system in the mall wasn't working at the time of the incident making it difficult for firefighters.
- Audit found inoperative fire-fighting systems at hospital after it got provisional OC.
  - While Mumbai Fire Brigade had granted the hospital a fire safety compliance report on July 22, 2020, its May audit report said that fire-fighting systems like wet riser, sprinkler pumps, booster pumps and pumps were non-functional at the hospital.
  - Right after Sunrise hospital, located on the third floor of Dreams Mall in Bhandup West, was issued a provisional occupational certificate (OC) to run a Covid-19 centre, an audit of the mall conducted last May by the Mumbai Fire Brigade had found that the mall and the hospital had inoperative fire-fighting systems.
  - The report had also recommended that the license of the private agency whose job was to service firefighting equipment should be cancelled by the director of the Maharashtra Fire Services and asked the chief fire officer to file a criminal case against the company.
  - An officer said that Pona Corporation is a government licensing agency that tested the fire system at the mall. It was on the basis of the go-ahead given by Pona Corporation that an NOC was given by the fire brigade. Pona Corporation gave the go-ahead in spite of there being no such systems in place.

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<tr><td>Immediate efforts to douse fire and rescue people</td><td>

- Nearly 96 people were rescued from the incident spot which included patients from the Sunrise hospital, the hospital staff, and relatives of the patients.
- In all, 78 patients were brought down with ladders and lifts or let out by firemen using the mall’s staircases.
- The hospital had 35 staffers on duty at time of incident.
- The maintenance staff began searching for the source of smoke in the hospital and the nursing staff began the evacuation process.

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<tr><td>Loss of life and injuries (no names, only age and gender)</td><td>

- 11 people (9 males and 2 females) died because of the fire and they all were COVID-19 patients admitted to the Sunrise hospital.
- Those who succumbed were declared dead on reaching the hospitals.
- The majority of the deaths were due to the smoke- thick black smoke and carbon released after the cables and wires caught fire. Asphyxia was cited as the reason.
- There were few people who got injured but not the fire officers.

</td></tr>
<tr><td>Damage to property, equipment, etc.</td><td>

Items	High (Complete damage)	Medium	Low
Grounds and fence	✓		
Foundation and support	✓		
Flooring	✓		
Walls (interior and exterior)	✓		
Doors and windows	✓		
Air conditioning system	✓		
Electrical and lighting systems	✓		
Communication systems	✓		

</td></tr>
</table>

	• The fire brigade was able to save 40% of the place, and 60 % of the place was under fire.
Approximate damage estimates	• The damage and total property loss suffered due to this fire was nearly rupees **10 crore.** • According to the respondent there was a huge property loss running into several crores.
Rebuilding efforts (costs, time taken, alternate arrangements)	• The two shop owners (our respondents) have suffered huge economic losses due to the fire accident and may have to pay nearly 20 lakhs (legal dues) to reopen their shops because the mall is closed now. • The mall owners have shifted to Nahur now and started another office.
Insurance and other compensation	• The victims (*owners of the shops; businesses*) who claimed the insurance, official fire report by the fire department was submitted to them. However, we were not able to meet them since we don't have their exact details. • Rs 5 lakh compensation was declared by the Maharashtra state government to the kin of each of the deceased.
Preventive measures (suggested by respondents)	• The respondents suggested that people should be self-aware and self-responsible and should take care of fire systems. • One of the respondents mentioned about the fire volunteers' one-day training conducted by the fire brigade. • In his opinion, fire safety should be added to the school and college syllabus, along with practical knowledge and steps to be taken by the citizens to prevent fire and to provide initial help in case of fire accidents. • The fire systems should be checked mandatorily on regular intervals. In every 6 months, the checking of the fire system and fire equipment should be done. • B form, an Electric audit should be done for these structures mandatorily on regular intervals.
Any other observations	• According to the respondent, the residents around the area mistakenly misled the fire engines reaching the location. The space was narrow for the engine and vehicles were also parked. This led to a considerable delay in the rescue efforts. • The basement, first and second floors of Dreams Mall had failed to get an 'all clear' from the fire department. However, the hospital housed inside it applied for and promptly got an 'NOC' from the very same department. "The fact that there were not enough ducts to let the smoke out after the fire started shows that the go-ahead was given without a rigorous fire safety audit," said an official. • As per the respondents, due to the political relations of mall owner, special permission was given to build a hospital on the 4th and top floors of the mall. • All the arrests were made by Mumbai Police on the basis of the details provided by the Mumbai fire brigade. • Since the fire emitted in the night, most of the shop owners were not present in the mall. Mahesh Dawda, a manager at a store, said he learnt about the blaze post-midnight. "When I reached the site, firefighting operations were underway and no one was being allowed inside." • The owners have not paid property tax, water tax for many years now. They haven't also carried out a structural audit.

	• Electricity of the mall has been cut off by the state department. - In July 2018, commission appointed by the court submitted a report which showed that Dreams The Mall company did not pay property tax worth Rs 15.92 crore till March 2018. It also did not pay electricity charges for common areas amounting to Rs 1.65 crore as of February 2017, and Rs 79.76 lakh in unpaid water charges and hence water and electricity has been cut off by the state utilities.
The miseries of the shop owners	• Shop owners who operate various businesses in the premises have been fighting since 2015 to restore basic facilities and services in the mall. The HDIL had formed the Dream The Mall Company Ltd with Rakesh Wadhwan and Sarang Wadhwan as directors in the subsidiary to manage the mall. • Shop owners say the company collected the property tax, water and electricity charges from them but did not pay to the government, inviting action from the Brihanmumbai Municipal Corporation, the Maharashtra State Electricity Distribution Company (MSEDCL). - In 2015, they started getting individual notices for unpaid property tax and that's when they realized what's happening. They were paying Common Area Maintenance to the company, but the company wasn't paying it to the BMC. - "Fearing that their premises might be sealed if they don't pay, some of them paid property tax dues again to the BMC," said Dilip Sawant, who runs an import-export business of printing machinery. • The mall has become a repository of garbage, filth and anti-social elements. - Sangita Sawant, who runs a software production company reported that, "The toilets do not have any water and as you can see the mall is so dirty. You imagine how difficult it is especially for women working here." - Nithin Bangera, who runs a logistics company from the mall since 2009 says that "During the day, when the mall is full of people, the place feels like a furnace due to lack of AC."
Information according to administrator Rahul Sahastrabuddhe appointed by the National Company Law Tribunal (NCLT) in 2018. (Based on news report)	• The Sunrise Hospital had not paid its dues worth lakhs of rupees and even carried out illegal construction, according to administrator Rahul Sahastrabuddhe. • He added that, "Sunrise Hospital, inside Dream Mall, was functioning as a Covid-19 treatment facility and owed money to BMC and the Electricity Board" • Some small shopkeepers were paying dues as ordered by the court, the big entities also did not. • Within Sahastrabuddhe's purview were the common areas of the mall, which were to be run with contributions from every small and big entity operating there. • Sahastrabuddhe's work depends on the contribution of every entity. There were several orders and even the court had said that every entity has to pay Rs 15 per square feet per month and still some big players like Sunrise Hospital, a bank and developers are not paying, he said. • Sunrise Hospital, according to Sahastrabuddhe, had more than 6,000 square feet of area and, going by the rate fixed by the court, they had to pay Rs 9 lakh per month. - "They had to pay Rs 3 crore which they did not. All this money was to run the mall. We have to appoint security guards, housekeeping staff. Had everyone complied with the order, this would not have happened," he said.

	• While Sunrise Hospital did not pay, they put up illegal structures which Sahastrabuddhe reported to the BMC. - "They put up barricades from the first floor, even though they are on the third floor. They had completely occupied the common area of the mall which was not supposed to be in their possession. He had pointed this to the fire brigade as well asking how they can grant an NOC to someone on the third floor when the mall does not have an NOC. "He had written a letter to the fire brigade in November 2020," said Sahastrabuddhe.
The hospital's response (Based on news report)	• The hospital on the other hand says that even though the hospital is inside the mall, it had nothing to do with the mall and blamed mall authorities for not being responsible enough. - Satyendra Tiwari, operations head at Sunrise Hospital, said, "The administrator is making a false accusation to run away from his responsibility. The hospital is completely de-linked from the mall. Even the Occupation Certificate is given by BMC separately to the hospital states the same." - "The hospital is not part of the mall. We pay our property and water bills separately and maintain it separately. The shopkeepers of the mall have moved court against the administrator for not paying the maintenance or water bills even after collecting the same. Neither there is water supply in the mall nor is it maintained after the NCLT handed the mall under his supervision in August 2018," Tiwari said. - "On the night of the fire too, fire brigade officials could not find water in the mall and water was supplied from the hospital. We don't have to pay him anything and even the legal documents with us say the same. He has not acted responsibly and that has led to such a mishap and is now creating unnecessary stories. Shopkeepers have been fighting with him in the court for the same. We have filed a police complaint against him and we hope that the police will take necessary action," he said. • Sunrise Hospital also denied the casualties were caused by the fire. - Nine of the victims were on ventilator and highly dependent on life-support systems, which became a key factor in the failure to evacuate them, the hospital's chief medical officer told. - He added, that the other two, Ambaji Patil (65) and his wife Sunandabai Patil (58), had died before the fire. - "We believe the casualties have not occurred due to fire, but either in transit or at other hospitals. This hospital was started in exceptional circumstances and has helped in saving many patients from COVID deaths. It is functioning with all due compliances like fire license, nursing home license, etc.," said the hospital.
Views of Shrikanth Swaminathan, a shop owner and member of the shopkeeper's association (Based on news report)	• There are more than 1,060 shops inside the mall and all of them are shut for one year now. It is surprising that there was another fire of such a large scale," said Swaminathan. • He further said that the mall started in 2009 and was constructed by HDIL infrastructures. Till 2015, it was the builder's responsibility to pay property taxes to the corporation. • The shop owners have been paying regular property bills since 2015 and the outstanding amount is what the builder has defaulted. - "Several litigation cases were filed against the builder as well following which the NCLT appointed an administrator to look after the mall," he said.

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Maharashtra Case study 3- Ahmednagar Civil Hospital

Fire incident	Civil Hospital
Date and time	6th November 2021. Around 11 a.m.
City and State where incident occurred	Civil Hospital, Ahmednagar, Maharashtra (120 km from Pune and 253 km from Mumbai.)
Date(s) of interview	24th November 2022.
Names of respondents and designation	• Fire brigade official- Ahmednagar • Hospital staff
Description of the building	• The civil hospital was built in 2016-17 under the National Health Mission, to treat pediatric, dialysis, burn, and orthopedic cases. • The ICU ward, located on the ground floor had been added to the hospital after the pandemic began. - In May 2020, as the Covid-19 pandemic raged across the country and cases spiraled upwards in Ahmednagar, with no government-run ICU in the district, one of the buildings of the civil hospital was converted into a Covid-19 ICU.
Description of fire incident (time, call to control room, response of fire brigade)	• The surgeon from the hospital directly called Chief Fire Officer (CFO) and immediate action was taken by the fire brigade. • The fire broke in the ICU ward near bed 17, 18 and 19. • The oxygen pipe was near the AC which were near bed 17, 18 and 19. Moreover, cooling pipes were passing through the false ceiling which was near to bed 17, 18 and 19. • One circuit caught fire which led smoke to spread on false ceiling and other circuits and wires in the room got fire. • Flames from the false ceiling led to the beds and curtains catching fire. Also the oxygen level in the emergency room led the fire to increase and spread rapidly. • There were 17 COVID patients in the ICU ward who were mostly senior citizens. Some of them were on ventilator or oxygen, were undergoing treatment. • There was black smoke in the hall. • When the fire bridge reached the location, they noticed that nothing was visible from outside as smoke was spread inside the room and had completely covered the glass windows.
Cause of fire (according to the respondents)	• The ACs were working continuously (in the oxygen Enriched Environment) which increased the heat and PCB circuit in the AC caught fire, as per the preliminary investigation. - "A short circuit was suspected to be the cause of the blaze, though it was yet to be confirmed", chief fire officer of the city civic body said.

	• District officials said that they suspected that the fire started from an overheated air conditioner, and smoke spread between the false ceiling and the main ceiling, before entering the ward. The heat from the fire and smoke melted the plaster of Paris of the ceiling, which collapsed suddenly, allowing smoke to spread quickly in the ward. • A committee was set up to understand the reason for the fire incident. The committee looked at all the possibilities to find out the root-cause behind the fire (short circuit, an explosion in ventilator machine, and other reasons). • The main reason for the fire has still not been officially shared by the committee. • Chemicals, ACs, sanitizers, false ceilings, walls, machinery, and other things, further added to the spread of fire.
Status of fire-fighting system inside premises	• According to the report by fire department, apart from fire extinguishers, the civil hospital lacked a concrete firefighting system and allegedly had no fire sprinklers, hydrants or even heat detector or smoke detectors. • There was no trained person appointed to handle fire system in the hospital. • There was no water facility at the incident site. The fire brigade needed 4-5 fire engines to extinguish the fire. • When the fire audit was conducted on 1/01/2021 it was noticed that, there is no fire hose pipe, sprinkle system, wet raise, down comer, yard hydrant, fire pump and fire service inlet. • Through audits from 2015 to a few months ago before the incident, the fire brigade had suggested that the hospital set up a robust firefighting system. However, on the day of the fire, firefighters found that “other than fire extinguishers, there was nothing,” said the CFO. • Other side of the story: A proposal to install a fire-fighting system in the hospital was moved from one department to another for eight months that year, as it awaited approval. The state government finally sanctioned Rs 2.60 crore to install a system on November 9, three days after the mishap killed 13 patients.
Immediate efforts to douse fire and rescue people	• According to Sub officer, the fire department team reached the hospital (3 km away) in less than 15 minutes after they got the call from the hospital. • They helped staff and relatives pull patients out. • According to the patients, relatives who normally waited in the corridor outside the ICU, they had been asked to step out as cleaning was going on. Many of them rushed back when they saw thick black smoke billowing from the ward and tried to rescue the patients. • The three patients who survived were lucky that their beds were positioned next to the exit.
Loss of life and injuries (no names, only age and gender)	• In total 11 people lost (4 women and 7 men) their life out of 17 patients. • The remaining six patients were shifted to other hospitals in the city by the state government officials.

<table>
<tr><td>Damage to property, equipment, etc.</td><td>
Severely damaged *(5 rating): The ICU and all the machinery were completely damaged. Walls were completely damaged and ACs melted, all the curtains were burnt, and windows were broken to let the smoke go out.
<table>
<tr><th>Items</th><th>High (Complete damage)</th><th>Medium</th><th>Low</th></tr>
<tr><td>Grounds and fence</td><td>✓</td><td></td><td></td></tr>
<tr><td>Foundation and support</td><td>✓</td><td></td><td></td></tr>
<tr><td>Flooring</td><td>✓</td><td></td><td></td></tr>
<tr><td>Walls (interior and exterior)</td><td>✓</td><td></td><td></td></tr>
<tr><td>Doors and windows</td><td>✓</td><td></td><td></td></tr>
<tr><td>Air conditioning system</td><td>✓</td><td></td><td></td></tr>
<tr><td>Electrical and lighting systems</td><td>✓</td><td></td><td></td></tr>
<tr><td>Communication systems</td><td>✓</td><td></td><td></td></tr>
<tr><td>Electrical appliances used in the ICU</td><td>✓</td><td></td><td></td></tr>
<tr><td>Any other items used in the ICU</td><td>✓</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Approximate damage estimates</td><td>Approx. crores but the amount was not disclosed by the CFO.</td></tr>
<tr><td>Rebuilding efforts (costs, time taken, alternate arrangements)</td><td>Expenditure of around 2.5 to 3 Crores for the repairing work due to the damage caused by the fire.</td></tr>
<tr><td>Insurance and other compensation</td><td>Maharashtra government has announced ₹5 lakh each compensation to the kin of the deceased.</td></tr>
<tr><td>Preventive measures (suggested by respondents)</td><td>Awareness by Fire Bridge must be conducted.
Renewal of the NOC by Fire Bridge in every 2 years.
Systems and equipment should be checked every 6 months.
There are different rules for residential and commercial buildings, according to the act. Everybody must follow the act/ rules given by the law.
There should be a water facility in the building (reserved water for the fire bridge).</td></tr>
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Red-Tapism	• Even after the Supreme Court directive of 2020, the installation of a firefighting system at the Ahmednagar hospital was slowed down by red tape. • A medical officer in the hospital pointed out that since this was the first time that proposals to install fire safety systems were being processed at such a large scale in the state, the functions of the PWD and the health department were unclear. As a result, the Ahmednagar hospital's file went back and forth between the hospital and the two departments for eight months. • The hospital underwent a fire audit in February 2021, conducted by the Pune-based India Automation and Fire Services. • The audit copy shows the hospital still had no fire safety system, apart from fire extinguishers, and that no firefighting training had been given to the staff. • The auditors prepared a list of items to be installed. • On April 27, 2021, the PWD submitted an estimate of Rs 2.60 crore to the hospital for this work. • The hospital forwarded the file to the health department on April 28, 2021, for approval. - "We sent the proposal twice to the health department. First they said few signatures were missing. Later, they returned the entire file and said PWD needs to provide a technical sanction first," an administrative officer in the hospital said. - The Ahmednagar hospital's file was returned to the PWD in June 2021. - It was only three months later, in October, that the PWD's chief engineer in Mumbai signed the proposal, thus granting it technical sanction. "By then Diwali holidays had neared," said Dr Yogesh Divte, from the hospital's administration department. - "We were going to send the file for administrative approval in health department after the holiday, but the fire occurred." • He argued that the PWD should have granted the proposal its technical sanction before sending it to the hospital in the first place, or processed it swiftly. • Ahmednagar's former civil surgeon said he had submitted multiple proposals to the health department, even before the Supreme Court order, to install fire equipment. "We were never sanctioned funds," he said. "I could not pay from my pockets."
Any other observations	• Amal Mohite, assistant engineer in Brihanmumbai Municipal Corporation who worked as an electrical engineer in Mumbai's Sion Hospital for over a decade, said hospitals with 50 or more beds should ideally have a dedicated electrical engineer. - But state health officials in Madhya Pradesh, Gujarat and Maharashtra told that the only hospitals in their states that had posts for electrical engineers were those that were attached to medical colleges, which were typically larger in size; rural hospitals, and even district hospitals, did not have such posts. • Mohite said that when small complaints like sparking, tripping, overheating are ignored, they tended to lead to fires. "A hospital is always growing, adding ventilators, ICUs, more equipment," he said. "The electrical load keeps

	increasing and regular audit is very important." While some corporate hospitals conducted electrical audits, Mohite said, most government hospitals in India did not. - To guard against fires in ICUs, it is crucial to ensure sufficient power supply, and adequate electrical wiring to carry high loads. - PWD's job to carry out electrical audits and upgrade wiring systems. • 2 medical officers and staff nurses were suspended after the fire incident.
Fire Safety Status of Hospitals in India Source: https://scroll.in/article/1021669/why-indian-hospitals-turn-into-raging-infernos	• Dr Rashmi Sharma, associate professor of community medicine at GMERS Medical College, Ahmedabad, co-author of a study on hospital fires in the Indian Journal of Community Medicine in 2020, said government hospitals were the most serious violators of fire safety regulations. "Of the 19 fire incidents that I studied since 2011, 90% occurred in government hospitals," she said. • At least 122 people have died in hospital fires since August 2020. Even Central government-funded hospitals lack certified fire safety systems. • Hospitals require particular caution when it comes to fire safety. Intensive care units, air-conditioned wards, operation theatres, paediatric or neonatal ICUs, and X-ray and dialysis rooms are prone to fires due to the presence of heavy equipment. "Oxygen-rich environment provides fuel to the fire," she said. • For this reason, hospitals should not use combustible materials, such as plaster of Paris, for walls or ceilings in wards – rather, they should use fire-resistant sheets, made of materials such as certain resins. "The wall material must be able to resist fire for at least two hours," he said. "That withholds progression of fire until the fire brigade comes." • It is also essential for a hospital to plan and manage its electrical loads. The International Journal of Community Medicine and Public Health study found that in 78% of the 33 cases it looked at, the fires started due to electrical problems. Air conditioners were "the most common source" of the fires. Almost a third of the fires originated in or near ICUs, the study found. • Manoj Choudhury, director of Edifice Consultants Private Ltd, an architectural and construction firm, echoed this idea. "A lot of designing is compromised to save cost," he said. "Government hospitals always go for the lowest bidder that will also dilute specification on quality. This is why public projects are prone to such mishaps." • Under the National Building Code of India, hospitals fall under the C1 category – such buildings must have special infrastructural arrangements for fire safety. • Thus, hospitals must by law have fire lifts for the fire brigade to use, fire alarms, smoke detectors on every floor, fire extinguishers and fire hydrants. Smoke outlets and air inlets must be provided in basement spaces, and ventilating ducts must be installed in multi-storey buildings. Electrical fittings and wirings must be installed in separate ducts that are sealed by non-combustible material. • "The National Building Code is comprehensive and detailed. But most hospitals don't even follow it," said Choudhury. "It is ignorance towards safety norms that causes fire mishaps." • In 2019, the Central government revised an existing model bill on fire safety, which many states had used as a framework for state-level laws. (Fire services

	fall under the state list, and the model bill was drafted to serve as an advisory document for states.) • The revised model bill included several new suggested provisions – including, for example, that buildings over 15 metres in height should be equipped with automatic sprinkler systems, fire alarms and fire extinguishers, and have a dedicated officer to oversee fire safety. • Fire officials from Maharashtra, Madhya Pradesh and Gujarat told that no state had yet fully adopted the provisions of the model bill into their own laws. • Rahul Kadri, partner and principal architect in IMK Architects, which has constructed hospitals in Mumbai, Hyderabad, Pune and Latur, explained that when a hospital space is modified into an ICU, it is necessary to ensure that there is enough power supply, and adequate electrical wiring to carry high loads. • "Each bed in an ICU needs ventilator, monitors, multiple machines," Kadri said. "The design and requirement of an ICU are different from normal wards, and their electrical load is always high." • Immediately after Bhandara Civil Hospital fire, which killed 10 babies, the public health department of Maharashtra had ordered all hospitals in the state to undergo fire safety audits. A total of 484 hospitals were audited initially, of which 90% were found to be functioning without a no-objection certificate, or NOC, from the fire department. An NOC is issued to a hospital once the fire department carries out an audit and certifies that a hospital has a firefighting system in place. • The Maharashtra government only sped up the process after the Ahmednagar fire in November. Since then, all the state's public hospitals have undergone a fire audit. Of the 525 government hospitals that have submitted proposals to install firefighting equipment, 451 have received approvals as of March, according to data from the state health department. • Of these, 131 hospitals will receive Rs 126 crore from the state public health department and 320 hospitals will receive Rs 92 crore from the District Planning and Development Council. But this is only the first step – most hospitals are yet to install firefighting systems. "The process of calling for tender will start now," a district health officer said. "It will still take several months."

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Surat Case study 4- Takshashila Arcade, Sarthana

Fire incident	Takshashila Arcade, Sarthana, • Twenty-two students died and others were injured in an academic coaching center- Smart Design Studio, located on the building's terrace. •
Date and time	May 24th, 2019. Between 3:45 p.m. and 4:00 p.m.
City and State where incident occurred	Surat, Gujarat
Names of respondents and designation	• Fire brigade official, Fire Brigade Headquarters, Surat • Shop owner in the complex
Description of the building	• It is a commercial complex in SarthanaJagatnaka with four storeys. • Smart Design Studio, a coaching center, was operating in a makeshift dome built on the terrace of the building. It was an illegal construction on the top floor of the building. • Around 120 students were registered at the coaching centre • There is a total of 19 shops in this building.
Description of fire incident (time, call to control room, response of fire brigade)	• Between 3:45 pm and 4:00 pm, the fire started on the ground floor near a staircase on the rear side of the building. - There were about 50 to 70 students in the coaching center at the time. - The students in the coaching center were trapped by the destruction of the wooden staircase. - Some of them were forced to take shelter on the roof. - There was very little time for the students to escape and hence forced many to jump off the building to escape flames and smoke. • At 4.30 pm the first eyewitness made an emergency call to the fire brigade. Apparently, the fire brigade attended promptly within minutes. But the media reports suggest that fire brigade arrived after 45 minutes. • The fire was serious. The fire brigade arrived with 19 fire engines and two hydraulic platforms. They doused the fire in an hour and rescued several students; however, several had jumped off the building to save themselves.
Cause of fire (according to respondents)	• An electrical short circuit in air conditioner started a fire on the ground floor near a staircase on the rear side of the building. • The fire quickly spread, engulfing the third floor and the makeshift dome on the terrace of the building i.e., the coaching center. • There was a wooden staircase which further led to the rapid spread of the fire. • The entire coaching class was made up of wooden flooring, wooden fittings, plywood flooring and tyres for the students to sit (around 50 of them). These are all inflammable materials that helped fire spread faster and reduce everything into ashes.

<table>
<tr><td>Status of fire-fighting system inside premises</td><td>

There was no fire safety equipment in the building.
The coaching class was not approved (illegal built).
Electricity power was taken illegally by the coaching class.
The building also had not received Occupation Certificate (OC) from Municipality.
The building did not have an emergency exit facility.
The people were not aware about how to use the firefighting equipment.

</td></tr>
<tr><td>Immediate efforts to douse fire and rescue people</td><td>

The eyewitness called the fire bridge immediately.
Apparently, the fire brigade attended promptly within minutes. But the media reports suggest that fire brigade arrived after 45 minutes.
They doused the fire in an hour (approximately) and rescued several students.
Locals helped in the rescue operation to save the stranded students and other occupants of the building.
The height of the building was 16.5 meters and the fire brigade's ladder was only 10.5 meters high. That’s why they failed to save those children immediately. However, the 2 of the firefighters went to the second floor of the building and saved lives of some children.

</td></tr>
<tr><td>Loss of life and injuries (no names, only age and gender)</td><td>

A total of 22 students died: 18 girls and 4 boys, aged between 15 and 22.

16 students died due to asphyxiation,
3 died as they jumped off the terrace of the building, and
3 succumbed to the fire-burns they sustained.
A further 16 students were admitted to hospital; a child was also hospitalized with burn injuries.

2 fire department persons were injured in this fire. One's hand was facture and the other's hand and face were burnt.
An employee of one of the shops was burnt in the fire and was treated in private hospital.

</td></tr>
<tr><td>Damage to property, equipment, etc.</td><td>

Two shops and several vehicles (4 two wheelers) parked near the building were also destroyed in another fire ignited by the blaze.
Severe (5 rating) damage to the staircase and overall passage areas of the 2nd – 4th floor.
As per the Shop-owner interviewed

There was a total loss of 26 lakhs in this fire for his shop.
The godown of the shop caught fire.
It took 3-4 hours to extinguish the fire.
One of his employees was burnt in the fire and it took him 1 month to recover. He had no insurance.
The property damage was severe (5 rating)

<table>
<tr><th>Items</th><th>High (Complete damage)</th><th>Medium</th><th>Low</th></tr>
<tr><td>Grounds and fence</td><td>✓</td><td></td><td></td></tr>
<tr><td>Foundation and support</td><td>✓</td><td></td><td></td></tr>
<tr><td>Flooring</td><td>✓</td><td></td><td></td></tr>
</table>
</td></tr>
</table>

Walls (interior and exterior)	✓		
Doors and windows	✓		
Air conditioning system	✓		
Electrical and lighting systems	✓		
Communication systems	✓		
Electrical appliances	✓		

- Property damage of another shop is mentioned below (based on news reports)

Items	High (Complete damage)	Medium	Low
Grounds and fence	✓		
Foundation and support	✓		
Flooring	✓		
Walls (interior and exterior)	✓		
Doors and windows	✓		
Air conditioning system	✓		
Electrical and lighting systems	✓		
Communication systems	✓		
Electrical appliances	✓		

- The coaching center property damage was severe (5 rating)

Items	High (Complete damage)	Medium	Low
Grounds and fence	✓		
Foundation and support	✓		
Flooring	✓		
Walls (interior and exterior)	✓		
Doors and windows	✓		
Air conditioning system	✓		
Electrical and lighting systems	✓		
Communication systems	✓		
Electrical appliances	✓		

Approximate damage estimates	• For one respondent shop-owner - loss of 26 lakhs in this fire.
Rebuilding efforts (costs, time taken, alternate arrangements)	• Repair amount was Rs. 12 lakhs as per the other respondent shop owners
Insurance and other compensation	• No insurance. • Gujarat Government announced the compensation of ₹4 lakh each to the families of children who died in the accident

Preventive measures (suggested by respondents)	• In case of such incidents to reduce, the building should have facilities such as an emergency exit, official permission for electric power, ELCB/MCB switches with Best Quality, municipal permission, official or security staff trained to use fire extinguishers.
Aftermath of the incident	• The police lodged FIR against the builder and arrested owner of the coaching class who was running the coaching centre in the Takshashila Arcade in Surat without any permission from any authority. • Ahmedabad Municipal Corporation and Vadodara Municipal Corporation issued notices to all premises housing children, containing orders to remain closed until they receive a fire safety compliance certificate • Later, the Government of Gujarat ordered the shutdown of all private coaching centers in the state until fire safety inspections are conducted. • The government also ordered a fire safety inspection of schools, colleges, coaching centers, hospitals, shopping malls and other commercial buildings.
Investigations and legal action	• The Surat Municipal Corporation officials ordered an investigation regarding the statutory permission, including fire safety of the building. • The Surat Urban Development Authority (SUDA) had approved the plan for a residential scheme on the site in 2001 but a commercial complex was built illegally in 2007. • Under the Gujarat Regularization of Unauthorized Development Act, the complex with its second floor was legalised in 2013. The third floor was not legally approved. • The coaching centre owner had also constructed a six-foot high makeshift dome illegally on the terrace to accommodate the students. • Charges were framed against 13 accused by a local court. • Police filed a 4,275 page chargesheet that included statements of 251 witnesses, reports of Forensic Science Laboratory and papers collected related to the investigation from SMC and state-run power distributor Dakshin Gujarat Vij Company Limited (DGVCL). • Those charged by the court include Jignesh Paghdar, administrator of the building Savji Paghdar, building owners Harsukh Vekariya, Dinesh Vekariya and Ravindra Kahar; Bhargav Butani, owner of the coaching class; executive engineers of Surat Municipal Corporation (SMC) Parag Munshi and Jayesh Solanki; deputy engineers of SMC Vinu Parmar, Himanshu Gajjar; deputy chief fire officer Sanjay Acharya, fire officer Kirti Modh and deputy engineer of Dakshin Gujarat Vij Company Limited Dipak Nail. • The case was registered under section 304 (culpable homicide not amounting to murder) and section 114 (abettor present when offence is committed) of the Indian Penal Code in Sarthana police station against coaching centre owner Bhargav Bhutani and builders of the complex -- Harshal Vekaria and Jignesh. • Charges were not framed against SMC junior engineer Atul Gorsawala as he had obtained a stay on the process. • Of all the accused charged today, Gajjar, Munshi, Gorsawala, Solanki, Parmar, Jignesh alias Jignal, Modh, Acharya and Naik are out on bail. • Butani, Savji, Kahar, Harsukh and Dinesh are currently in jail.

Any other observations	• "We expect the proceedings to speed up now and the verdict to be announced soon," said Jaysukh Gajera, father of one of the deceased students. • According to sources, the same building was issued notice for noncompliance of fire safety norms a few months back but the fire division officials did not pursue the notice and the building was not sealed. • The 2 damaged shops in this building did not receive any kind of compensation from anyone. • Now there are fire extinguishers on every floor. • Fire brigade personnel bear more mental trauma than physical injuries in such a tragic accident. Meditation classes can be provided to such officials.

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Delhi Case study 5- Hotel Arpit Palace

Fire incident	Hotel Arpit Palace, Gurudwara road, Karol Bagh, Delhi
Date and time	12th February 2019 at 3.00 a.m.
City and State where incident occurred	Central Delhi, India
Names of respondents and designation	• Fire Services official, Delhi. • 5 local respondents (eyewitnesses)
Description of the building and nearby premises	• The hotel had 5 floors, basement and a kitchen terrace. • The terrace had a restaurant operating. • The 5th and kitchen terrace were illegal constructions as the owner owners only had permission to build four storeys. • Most of the rooms in the hotel were unauthorized. • The building was covered on all sides with glass. • Karol Bagh itself is one of Delhi's major hotspots, home to innumerable hotels and guesthouses. It's a congested neighbourhood—the roads are always crowded and overhead wires dangle dangerously.
Description of fire incident (time, call to control room, response of fire brigade)	• The Fire broke out at 3 a.m. in the night. However, for a long time, no one was aware of the blaze as most of the guest were sleeping. • As per the respondents, the people staying in the hotel told the hotel staff that they are smelling something like short circuit but the hotel staff ignored it thus allowing the fire to spread rapidly. • When the hotel staffers finally woke up, they took the matter into their own hands instead of alerting. • According to the Delhi fire services dept., the fire bridge got call on 12th February 2019 at 4.35 a.m. about a fire incident at Arpit Palace. - Immediate action was taken by the fire department. However, by the time the fire brigade reached the spot, the fire had intensified. People were trapped inside and some were already dead. - 3 water tenders, 1 Bronto skylift and 1 water Bouser was sent to the location immediately. - The CATS – Centralized Accident and Trauma Service was also informed. - More than 100 firemen in 25 firetrucks rushed to the spot with special ladders for rescuing the people caught in the fire in higher floors. - Among the fire tenders was a "manually operated" skylift and it wasn't high enough to reach the upper floors, rendering it ineffective in rescuing many victims. By the time another skylift joined the operations, people were already jumping off the building. - Total 28 fire units were utilized for the operation. • The fire department lost time as they had to take a longer route to reach the hotel from the Prasad Nagar fire station, just less than two kilometres away.

	- Several cuts in the divider on Pusa Road were recently sealed because of which the firefighters had to take a longer route as reported by a local resident. - The fire official said that it led to a delay of three-four minutes, "but made a lot of difference between life and death". - It took fire brigade 1 hour to reach to the location. • There were about 60 guests occupying 35 out of 46 rooms. Apart from the guests, there were a dozen staff members. - People had come to attend a marriage in the hotel. - There was a party celebration on the 4th floor. • Guest were trapped inside the building. - Many guests chose to run upstairs in the hope of finding an exit but found themselves trapped between the burning corridors and the blazing fibre sheet over the rooftop terrace. - Since it was winter season, many guests had kept the windows locked from inside. The real problem began when they tried to open them. Though the building had openable windows its latches were extremely complicated. They needed to be pressed inward for the window to open but the panicked guests weren't aware of the system and found themselves trapped inside. • Though the building has 2 staircases, the same couldn't be utilized due to intense heat and poisonous smoke. • There was a power cut at around 5am. • The fire was brought under control by 7.30 am, and cooling operations began at 8 am. • The hotel is closed since 2019 after the fire broke out.
Cause of fire (according to respondents)	• According to the Delhi fire services dept., the cause of the fire was not established as yet and would require future investigation from the Delhi police. • According to Chief Fire Officer of the Delhi Fire Service, the first fire caught at about 2.30 am when there was an electricity fluctuation in the building. A spark was witnessed in the main electric meter, followed by a short circuit which led to the fire. • According to the local respondents (eye witnesses), the fire started at 3 a.m. in the night on the **first floor** but spread to the upper floors of the hotel. Short circuit was reason for the fire incident. • The fire gradually spread through the building until it became an inferno by 4.15 am. • The panels in the passages and the staircases were all made of highly inflammable wood. The presence of wooden panels in the walls and the floor of the corridors fuelled the fire and led to dense smoke. • The walls and carpet area were covered in Rexene, which is also very inflammable. Thus the fire spread even more throughout the hotel. • The roof consisted of a restaurant, the generator, the solar power panels and the kitchen, where there are many gas cylinders. The rooftop restaurant also had a large canopy made of plastic which helped spread the fire. • A **'significant delay'** in alerting the fire department, inflammable material used in the building, 'complicated' locking systems of the windows and the staff's inability to fight the flames resulted in a large number of casualties in the blaze at Hotel Arpit Palace in Karol Bagh, said Mr. Atul Garg,| Directorate General Fire Services, Delhi.

<table>
<tr><td>Status of fire-fighting system inside premises</td><td>

According to the respondents there was no firefighting system.
The hotel had taken fire clearance but it later made illegal constructions with wood and fibreglass panels.
Electrical systems were not properly fire-checked.
There was an emergency exit but it did not help anyone as the guests were unaware about its presence or location

</td></tr>
<tr><td>Immediate efforts to douse fire and rescue people</td><td>

The Delhi fire service control room got a call about the incident and immediate action was taken by the fire bridge.
The local people from the area tried to save the victims- by breaking the glass windows. They also tried using the staircase to save the victims from the fire incident.
The hotel employees tried to use the in-house firefighting equipment but failed. Either the staff was not trained to use the equipment or they were non-functional.

</td></tr>
<tr><td>Loss of life and injuries (no names, only age and gender)</td><td>

According to the local respondents, 35- 40 people died in the fire incident and 35 people were rescued safely. However, according to the fire brigade records and subsequent news reports, 17 people lost their lives in this incident.
According to eyewitnesses, most deaths were caused due to suffocation.

Since it was night time, many people in the hotel were sleeping so they died of suffocation in their sleep.
Guests were falling unconscious. There was no place for ventilation in building because of the glass windows. Hence, most people died because of smoke and fire.

Several people broke the glass of the hotel and jumped down. Many of them lost their lives.
The authorities said, the stairs were not wide enough to allow more than two people from running out together. There were no lights inside the building, which made it more difficult. This led to a stampede and people fell on each other. People suffered from injuries from the stampede.
At the time of the fire incident, the eyewitnesses and the injured people were so frightened that they were not in a position to describe the facts of the events.
Such was the intensity of the blaze that by the time the fire department arrived, a firefighter had fallen unconscious after inhaling smoke and received superficial skin burns on his hand as he entered the building.
Details of a few victims (deaths):
<table>
<tr><td>Name of the victim</td><td>Age</td><td>Description</td></tr>
<tr><td>Jayashree</td><td>53</td><td rowspan="3">Belonged to a 13-member family from Ernakulam in Kerala that rose early and were getting ready to leave for Haridwar when disaster struck. The family had taken five rooms on the second floor after attending a wedding in Ghaziabad.</td></tr>
<tr><td>Naliniamma</td><td>84</td></tr>
<tr><td>Vidhyasagar</td><td>59</td></tr>
<tr><td>Arvind Sukumaran</td><td>35</td><td rowspan="2">Two private firm executives from Tamil Nadu</td></tr>
<tr><td>Nandakumar</td><td>34</td></tr>
</table>

</td></tr>
</table>

	Mya Mya Htwe	45	Part of an eight-member pilgrim group from Myanmar. Tum was the tour guide
	Dawmla May	67	
	Tum Hla Sein	32	
	Suresh Kumar		Indian revenue service officer from Panchkula
	Rabia Jusufbhai	50	Lawyer from Ahmedabad
	Pranav Bhaskar	32	A Hyderabad-based techie from Patna
	Challapathi Rao	52	E.V.S.
	Shankar Narayan Sheshadri	52	Doctors
	Santosh Mahadev	35	
	Tara	Late 20s	Hotel's chef Tara has two sons and two daughters, the eldest is eight years old, and the youngest is one. He was the only bread winner of his house.

- Rakesh, a security guard at an office building near the hotel, was heading home at 4.30 am after his night shift when he saw the fire. He saw that the whole building was ablaze and a lady holding her child crying for help on the fourth floor. Then all of a sudden, she jumped out of the window to save herself and landed on the ground. The woman did not survive. Her daughter died as well after she was taken to the hospital
- Two bodies were not identified at the time of incident as per the reports.
- A 28-year-old woman, Chain Maya Nyan, was treated at Lady Hardinge Medical College for a severe back injury while jumping out of a window**.**
- Four survivors moved back to the Myanmar embassy.

Damage to property, equipment, etc.

- The fire was from 1st to 5th floor. Although the entire building was damaged, the maximum damage occurred on the upper floors. There was no fire in the basement and on the ground floor.
- The most affected area of the hotel was the rooftop restaurant.
- Fittings, fixtures, electrical installation, wooden paneling office and records, hotel allied material were completely damaged by the fire.

Items	High (Complete damage)	Medium	Low
Grounds and fence	✓		
Foundation and support	✓		
Flooring	✓		
Walls (interior and exterior)	✓		

	Doors and windows	✓		
	Air conditioning system	✓		
	Electrical and lighting systems	✓		
	Communication systems	✓		
	Electrical appliances (TV, Geyser, Refrigerators, etc.)	✓		
	Hotel allied material	✓		
	Elevator shaft/elevator	✓		
Approximate damage estimates	• Approximately there was loss of Rs. 10-15 Cr.			
Rebuilding efforts (costs, time taken, alternate arrangements)	• The hotel is shut since the fire incident. Hence, there is a huge opportunity cost including loss of employment for all the concerned people.			
Insurance and other compensation	• Delhi government announced Rs. 5 lakh compensation to the next of kin of those killed in the fire.			
Preventive measures (suggested by respondents)	• The staff should know how to use the fire extinguisher system and should get training on it. • There should be internal audit and fire audit done every year. • The wiring used should be good quality wiring. • There should be thorough checking of the fire systems before granting official sanction to any hotel. • The NOC of the hotel was not permitted by the Govt. of Delhi it was given by the Govt. of Haryana. • The Govt. should take strict action against the illegal construction. - Fire accidents are not uncommon in Indian cities, where builders often flout safety regulations. - Many structures, both old and new, lack proper fire exits. - Owners of commercial buildings have also been known to construct additional floors without the necessary permissions. - From rooftop restaurants to bars in the basement, most of the owners use commercial space beyond permissible limits in disregard of norms.			
Investigations and legal action	• The FIR in the case of fire in Karol Bagh's Hotel Arpit Palace said the hotel ignored the safety of its guests for its business. • For "their business", the "licensee and the management" of the hotel had ignored the safety of its guests, said the complainant, sub-inspector, in the FIR. - There was no panic alarm on any of the floors or in the restaurants of the hotel," the FIR read. - The FIR pointed out that there was only one emergency exit and that was found closed at the time of the incident. "Not a single person could escape through the emergency exit," sub-inspector's statement read. - "There was no proper signage to guide the guests to the emergency exit," the FIR further said. - The FIR said a kitchen operating from the restaurant rooftop, and another in the basement were "unauthorized". - "The management of the Hotel Arpit Palace knew that the use of inflammable materials in the building could endanger the safety of its			

	guests, and their inability to make any safety arrangements resulted in the death of 17 people", read the first information report (FIR) that listed six lapses inside the five-storey property. • There was extensive use of plastic and other inflammable material on the walls and partitions and on the "temporary structure erected" on the rooftop. • According to fire officers, the combustible material included wooden panels that burnt quickly and led to the quick spread of smoke in the building. • The FIR showed that the call to the police control room was received at 4.43 am on Tuesday. "Hotel mein aag lag gayi hai (there is a fire in a hotel)," the caller said. • The FIR said that 60 guests were occupying 35 of the 46 rooms of the hotel. Apart from the guests, there were about a dozen staffers too. • The hotel's general manager, Rajender Singh, 45, and 21-year-old manager, Vikas Kumar were arrested by Delhi police. • During the course of the investigation, the police found out that the licence to run the hotel was in the name of Rakesh Goel's brother Shardendu Goel, who lives in Karol Bagh's Bank Street. - Rakesh Goel was arrested on February 17, 2019 after information was received that he was travelling from Qatar by Indigo flight 6E 1702. The Immigration officials were alerted on the basis of a look-out circular and he was detained and handed over the Crime Branch. - A couple of days after the arrest of Rakesh Goel, owner of Arpit Palace Hotel, Crime Branch arrested his elder brother Shardendu Goel, licencee of the hotel. - Shardendu Goel was evading his arrest since February 12, 2019. He was accompanied by his advocate during his visit to the Crime Branch office. He was arrested after he failed to give satisfactory reply to the interrogators. - Rakesh Goel had earlier told the police that he had bought 435 square yards of land in 1988. He constructed the building in 1992 and started running the **guest house in 2000** after taking permission from several authorities. - The guest house was later converted into a hotel illegally. - He had permission to build only four storeys. The hotel was a 6 floor building and 2 floors were illegal.
Any other observations	• Most of the rooms in the hotel were unauthorized. • The hotel is shut since the fire incident. • The fire quickly spread due to wooden panels on the walls and floor of the hotel, and caused heavy smoke in the hallways. • Many guests attempted to avoid the smoke by staying in their rooms, but got trapped inside the rooms as the windows were locked with a complicated latch system. • There was LPG bank on the terrace and there were 9 cylinders which were cooled down to prevent explosion that otherwise would have made the situation worst. • According to the local respondents, the owner had taken Rs. 27 crores loan for the hotel and after a few days the hotel was going to be auctioned and sold. • The incident once again highlighted the poor state of fire safety standards across India, particularly in its major metropolises where high rents force many people to live in cramped, congested and ill-regulated conditions.

	• This incident lays emphasis for a comprehensive review providing the mandatory techno-legal framework for regulating building activity from planning, design to completion of construction. Mainly such laws are State Legislations as the State is competent to legislate and make laws on such subjects. • A comprehensive review of techno-legal regime of "Existing buildings" is essentially required.

Additional Notes

1. According to the official investigations, the source of fire was a spark from an AC in Room No 109, which later covered the entire building. https://www.ndtv.com/delhi-news/karol-bagh-hotel-fire-owners-of-arpit-palace-hotel-karol-bagh-delhi-violated-norms-police-1995553
2. Seventeen people were killed after a fire at Karol Bagh's Hotel Arpit Palace. Some of the victims were charred to death and others suffocated in the poisonous fumes, the reports said. https://www.ndtv.com/delhi-news/licence-holder-of-hotel-arpit-palace-arrested-over-karol-bagh-fire-1995943
3. After Karol Bagh Fire, Delhi Government To Revise Building By-Laws https://www.ndtv.com/delhi-news/after-karol-bagh-fire-delhi-government-to-revise-building-by-laws-1998020
4. The First Information Report (FIR) listed six lapses inside the hotel, and highlighted that the business and the licensees and the management of the hotel had ignored the safety of its guests. Issues noted were no panic alarm on any of the floors or in the restaurants, only one emergency exit that was locked, and no proper signage to guide the guests to the emergency exit. It also noted that the extensive use of plastic and other inflammable material on the walls and partitions and a temporary structure erected on the roof led to quick spread of smoke and fire to quickly spread. https://en.wikipedia.org/wiki/Delhi_hotel_fire
5. Data compiled by the Delhi Fire Services (DFS) states that roughly 250 hotels in the national capital continue to operate despite falling short on fire safety. According to a report by The Indian Express, a majority of these hotels are situated in crowded areas such as Karol Bagh and Pahad Ganj. Many of these hotels have restaurants or eateries operational on the terrace for which they have no non-objection certificate (NOC) as was the case with hotel Arpit Palace. Not just hotels, but nursing homes in Delhi are also at the risk of heightened casualties in the case of a fire owing to their non-adherence to fire-safety norms. In fact, a report by the national daily asserted that a majority of these nursing homes do not even comply with basic guidelines such as the provision of an exit path at least 2 metre wide. https://www.timesnownews.com/mirror-now/civic-issues/article/new-delhi-karol-bagh-hotel-arpit-palace-fire-dfs-report-hotels-nursing-homes-fire-safety-norms/365435

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2) https://www.ndtv.com/delhi-news/karol-bagh-hotel-fire-owners-of-arpit-palace-hotel-karol-bagh-delhi-violated-norms-police-1995553
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5) https://en.wikipedia.org/wiki/Delhi_hotel_fire

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Delhi Case study 6- Mundka commercial building

Fire incident	Mundka, Delhi,
Date and time	13th May 2023 at 4.40 pm.
City and State where incident occurred	Delhi, India.
Names of respondents and designation	• Fire Services official, Delhi. • 5 local respondents (eyewitnesses)
Description of the building and nearby premises	• It a four-storey building located near pillar number 544 of the Mundka metro station, out of which 3 storeys were commercial and 1 storey was residential. The building also had a ground floor and basement. The approximate area of the building was 400 square feet. • Investigations revealed that the two brothers took the first floor of the building on rent in 2018 to run their company's office. Between 2019 and 2021, they took two more floors to assemble and package items and store raw material. Nearly 250 employees, a majority of them women, worked on the three floors, according to locals (Hindustan Tinmes report). • The front portion of the building has three shops. • One shop was used by the building owner for running his real estate business, while the adjacent shop was empty and locked at the time of the fire. The third shop was under renovation. • The first floor of the building was used for running the company's office and for a visitor's lounge, while the second floor had a conference room, apart from a space to assemble and package items, the police said. • There was CCTV Camera Company and its materials were kept on 2nd and 3rd floor. • The third floor also had a storage, packaging and assembly unit of Wi-Fi routers. Most of the employees worked on the second and third floors, locals as well as police officials said. • The 4th floor was the residence of the owner. • The building had only one staircase.
Description of fire incident (time, call to control room, response of fire brigade)	• Fire broke out at Mundka building during motivational programme. - According to the FIR registered in connection with the case, "On Friday, around 4 pm, a motivational programme was organised for all employees and they had gathered on the 2nd floor for this event". • The FIR said police received information at 4.45 pm regarding the fire and people were trapped inside. - Police reached the spot and found that a fire broke out in premises number 193, main Rohtak road, opposite pillar number 544, Mundka village and some people escaped from the second floor of the building after breaking the glasses, the FIR stated. • The Delhi Fire Service Control Room got call at 4.40 pm - Immediate action was taken.

	- However, there was a considerable delay in giving fire call to the fire control room. - There was slow vehicle movement and massive traffic jam which caused further delay in reaching the location. • An ambulance also reached the site of the fire to provide immediate medical assistance to the victims. • A team of NDRF official was seen at the rescue site on 15th May, 2023 - Saturday morning. • The fire was at 1st, 2nd, 3rd, and 4th floors of the building. • There was fire and smoke which caused the deaths in the building. • Here is a timeline of how the tragedy unfolded: - 1 pm: Work was going on as usual. The building has several offices and factories. One of the tenant companies on the first floor was holding a special meeting. - 4.30 pm: Smoke was seen coming out of the first floor of the building, there was screaming everywhere. A rescue call was made to the police and fire brigade. People in the building scrambled to escape. - 4.40-45 pm: Some were already trapped by the swiftly spreading flames. Police and fire service reached the spot and began rescue and firefighting operations. - 4.50 pm: To escape, people broke the windows and started jumping off the first and second floors of the building with the help of ropes. Many were rescued by the police with the help of local people. - 5 pm: More and more fire tenders were rushed to the spot. People gathered to search for their friends and relatives. - 6.20 pm: The body of a woman, about 45-years-old, was found. The task of extinguishing the blaze continued. Ambulances went back and forth rushing the injured to the local hospital. - 10.50 pm: Fire was brought under control and cooling operations started. - Around this time, the fire brigade confirmed a total of 16 dead. Gradually the toll increased, after which the DCP said a total of 27 people died. - 11.40 pm: Flames appeared on the first floor again and were put out. - Midnight: Search operation and cooling work went on in tandem. - 2 am: Cooling work finally finished.
Cause of fire (according to respondents)	• According to the Delhi fire services dept., the cause of the fire was not established as yet and would require the future investigation from the Delhi police. • According to the respondents, short circuit was the cause of a huge fire that ripped through the building. • The fire started from the first floor. • There was meeting on 2nd floor and several people who were attending the gathering got trapped on the floor. • The electronic material for CCTV company on 2nd and 3rd floor also caught fire. Most of the employees worked on these two floors and got trapped due to flaming electronic debris. • There were large number of deaths due to delay in rescue operations.
Status of fire-fighting system inside premises	• Structural and design flaws: Glass panels covered the building on all sides making the exit of the people trapped inside extremely difficult. - Due to the glass building, it was not possible to get out and rescue operations became difficult. As a result, people died due to suffocation.

	- There were no windows in the hall on the • There was no fire exit for the building. • There was no fire safety management. • The building had only one staircase. • The building was neither properly ventilated nor compartmented and also had no fire safety arrangements where too many people were working.
Immediate efforts to douse fire and rescue people	• The Delhi Fire Service Control Room got call at 4.40 pm, immediate action was taken. - Immediately, 1 water tender, water bouser, and 1 bronto skylift were sent by the station officer and the fire rescue operation was commenced. - In addition, 8 water tenders, 6 water bouser, 1 BFT, 1 CCLV, 1 rescue responder 1 hose tender 1 MP and 1 FCC were sent to the location. • Police immediately reached the incident to help in the rescue operation. • An ambulance also reached the site of the fire to provide immediate medical assistance to the victims. • Following a six-hour long firefighting operation, the blaze was brought under control. Police, fire department and NDRF teams were involved in the rescue work. • When the fire broke out, the local citizens broke the glass of the building and rescued the citizens trapped inside.
Loss of life and injuries (no names, only age and gender)	• Majority of the deaths were at the 2nd floor. From the dead people 70% were female victims. • According to the official reports and statement of the Mr. Atul Garg | Directorate General Fire Services, Delhi, there were 12 injured people and 27 deaths (it's mentioned in the official report that it may go up further after the combing operation) from the incidence. According to the officials, an estimated 29 people are unaccounted for, at the time of the incident. • According to the FIR, about 100 people were in the building at the time of the incident. Witnesses, however, said the number could be as high as 200. The eye witnesses/ local respondents also mentioned that the deaths were highly underreported and actual number of deaths were a lot more than the number reported. • People died because of the smoke and fire. Many people fainted inside because of the smoke and burned to death in the fire. • Death of Mr. Kailash Jyani and his son Amit: Motivational speaker Kailash Jyani (62) was invited to deliver a lecture to the staff of the commercial unit in Mundka. His son, Amit Jyani (37), had accompanied him for the event. Later that evening, the father and son were killed in a fire at the building. • Amarnath Goel, father of owners of CCTV company, was taking part in a motivational session at the factory located on the first floor of the building when the fire broke out. Trapped by the flames and unable to escape, he was charred to death. • Fire station officer of Kirti Nagar, Ashok Kumar Sharma, who was leading the firefighting operation on Friday night, said "When they went inside to douse the flames some charred bodies were lying near the lift's access point on the second floor, suggesting that people may have tried to use it to get out of the building. The lift may have malfunctioned due to the fire or a short-circuit. Most of the charred bodies were on the second floor. A few of them were lying close to each other, suggesting that the victims may have attempted together to save their lives. The scene inside the building was horrific."

<table>
<tr><td>Damage to property, equipment, etc.</td><td>

The entire four story building was gutted in the fire.
All the materials of the CCTV camera manufacturing company caught fire.
The materials like petrol, oil, plastic, thinner, wires in the building was flammable which resulted in making the fire more severe.
The cars parked under the building also caught fire.

<table>
<tr><th>Items</th><th>High (Complete damage)</th><th>Medium</th><th>Low</th></tr>
<tr><td>Grounds and fence</td><td>✓</td><td></td><td></td></tr>
<tr><td>Foundation and support</td><td>✓</td><td></td><td></td></tr>
<tr><td>Flooring</td><td>✓</td><td></td><td></td></tr>
<tr><td>Walls (interior and exterior)</td><td>✓</td><td></td><td></td></tr>
<tr><td>Doors and windows</td><td>✓</td><td></td><td></td></tr>
<tr><td>Air conditioning system</td><td>✓</td><td></td><td></td></tr>
<tr><td>Electrical and lighting systems</td><td>✓</td><td></td><td></td></tr>
<tr><td>Communication systems</td><td>✓</td><td></td><td></td></tr>
<tr><td>Electrical appliances (TV, Geyser, Refrigerators, etc.)</td><td>✓</td><td></td><td></td></tr>
<tr><td>Hotel allied material</td><td>✓</td><td></td><td></td></tr>
<tr><td>Elevator shaft/elevator</td><td>✓</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Approximate damage estimates</td><td>

Approximately there was loss of Rs. 100-150 Cr.

</td></tr>
<tr><td>Rebuilding efforts (costs, time taken, alternate arrangements)</td><td>

There is an opportunity cost of business being shut totally and loss of employment for the staff.

</td></tr>
<tr><td>Investigations and legal action</td><td>

The building did not have clearance from the fire department and was not equipped with fire extinguishers.
The building did not have clearances from the Municipal Corporation of Delhi for industrial use.

The said manufacturing unit which produced high tech electronic and surveillance equipment including CCTV sets operated without any inspection or scrutiny by authorities.

The Delhi police registered the fire as culpable homicide and a criminal conspiracy.
They arrested two brothers, Harish Goyal and Varun Goyal, who owned Cofe Impex Pvt Ltd, a company that manufactures CCTV cameras, in whose office the fire is believed to have started.
The owner of the building, Mr. Manish Lakra who lived on the top floor of the building (but was absconding) was also arrested after the fire incident.

</td></tr>
<tr><td>Insurance and other compensation</td><td>

Govt. compensation: The govt. gave the compensation to the families of the victims.

Delhi government declared an ex-gratia of Rs 10 lakh to the families of all the deceased.

</td></tr>
</table>

	- At the same time, the injured were to be provided with Rs. 50,000 as ex-gratia by the Delhi government as per news reports.
Preventive measures (suggested by respondents)	• According to the respondents, before permitting any building, there should be checking of the fire extinguishing systems. • Every building should have exit door. • The people should get training of fire safety and extinguishing and rescue during fire accidents. • NOC should be given only when all the systems are checked and they are working properly. • Annual fire audit should take place without fail. • In all offices and commercial buildings there must be an alternative means of escape, the egress (emergency exit), for the occupants of such buildings. • While enough emphasis has been given to regulations and codes, it is important it is necessary to embrace fire safety measures as 'Good Practices'. • Natural ventilation is essential to ensure that the smoke venting exists otherwise corridors and staircases would get clogged with toxic smoke, thus suffocating the occupants to death.
Any other observations	• The soot blackened walls of the building and the piles of rubble told their own story of the intensity of a fire, the largest since a blaze at a factory in the Anaj Mandi area in December 2019 that killed 44 people and the second largest since the Uphaar Cinema tragedy in 1997 in which 59 people lost their lives. • Families, some in tears and others too stunned to react, thronged the hospital for some news, any news. Many waited for identification of the charred bodies, hoping desperately that their loved ones were not among them. • There have been 5 to 6 fire incidents in this location- Mundka. - A small fire was reported on 14th December 2022. - Another fire broke out on 15th January 2023 in the same building. As per the officer, the fire started on the second floor. - The officer believes it to be a matter of investigation as to how another fire can break in the same building at the same spot.

Additional Notes

1. According to the news reports, the number of people died in this incident is 27.

- However, during our data collection, the respondents (Eye witnesses) said there were 200-250 deaths

2. **Mundka fire:** Building had one escape route, toll may rise with more remains found and 29 people missing

   https://economictimes.indiatimes.com/news/india/mundka-fire-long-wait-for-families-of-missing-persons/articleshow/91564106.cms

3. **Mundka fire tragedy: Panic grips as several go missing after Delhi blaze**

   https://www.hindustantimes.com/cities/delhi-news/mundka-fire-tragedy-panic-grips-as-several-go-missing-after-delhi-blaze-101652484400630.html

4. The building which caught fire was running a factory, storehouse and an office on different floors. Hence, it falls under various labour laws.
5. There is a blatant lack of follow-up. The Mundka fire took place on May 13, 2022 but it has already been consigned to the grey space of media amnesia.

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Annexure 2: Cases of mental trauma faced by families

Mundka Fire – **The Tragedy, the Trauma, the apathy and the struggles . . .**

Case 1:

On 13 May, Mira Devi lost her 20-year-old daughter, Nisha, she was charred to death in a deadly fire which engulfed an illegal four-storey building—her office—in Mundka. Since her death, there is food in Mira's house only when the relatives or neighbours lend them some money or give them some grains.

Surrounded by piles of rotting garbage and clogged drains, Mira Devi lives with her family of seven in a shanty. Until recently, this large family had only one earning member. Today, it has none. Her young daughter died in Delhi's Mundka industrial area fire with 26 others in May. She used to assemble and pack CCTV cameras and routers to earn a meagre monthly income of Rs 7,500 to support her parents and siblings. But now, Mira is battling grief, loss and the labyrinth 'proof raj'—Indian compensation bureaucracy's unending demand for documents and proof. Inside the small structure of unpainted brick walls and a single light bulb, one of Mira's disabled daughters is staring blankly into space, next to her drunk father, unperturbed by the wailing of his infant daughter. Mira's other children are out on the streets, escaping their poverty-stricken home.

"Sometimes I want to take all my children and run away to start life afresh, leaving him (referring to her husband) here alone. He brings no money home. My daughter was the only one earning and she has left us forever," says Mira, her eyes welling up with tears.

https://theprint.in/features/who-gets-compensation-in-mundka-fire-who-doesnt-victims-families-battle-proof-raj/1074737/

Case 2:

On the night of the fire, Yashodha could not be saved.

With her husband working in mines in Alwar, Rajasthan and a loan of Rs 1.25 lakh on him, 35-year-old Yashodha worked relentlessly for four years in the company to augment the household income. With her monthly salary of Rs 10,000, which is below the minimum wage of Delhi at Rs 16,506 for unskilled workers, she would take care of the household expenses and her children's education. A part of it was kept aside to repay the loan.

When her husband, Vishawajeet, and the family members of other victims tried to get the compensation which the CM had announced, they got a first-hand experience of the system they are fighting against. "We tried to meet the CM four times, but could not meet him even once. We were told he is not in the office, or that he doesn't have time. Each time, we filed an application and left," says Vishawajeet. He faced similar humiliation in other departments as well, where he was made to wait all day by bureaucrats only to be told that his application did not have the DNA report or a copy of the FIR or the Aadhaar card, and so on.

https://theprint.in/features/who-gets-compensation-in-mundka-fire-who-doesnt-victims-families-battle-proof-raj/1074737/

Case 3:

On 6 July, 2022 the families of the deceased in Mundka Fire received Rs 1 lakh in their bank accounts from the Delhi government. But the hardships which they have been going through in the last three months could not be covered with this small amount, families say.

"When my son's body was brought home, we did not have money to even perform his last rites. Our relatives and neighbours contributed and from that one lakh, I repaid them. I still owe money to people," says Mithilesh, who lost his 24-year-old son, Vishal, who had been working in the company since 2015 for a meagre income of Rs 9,000.

https://theprint.in/features/who-gets-compensation-in-mundka-fire-who-doesnt-victims-families-battle-proof-raj/1074737/

Case 4:

Ms. Kajal, a survivor of the fire, said that she and other survivors are yet to get any support from the government, and not a single penny has been given as compensation, forget about psychological and other rehabilitation support. In his address at the public release of the reports, Mr. Sultan Ahmed of the International Labour Organisation (ILO) shared that the ILO has recently added a **'safe and healthy working environment'** as a fundamental principle and rights at work. He said that all member states of ILO should commit to the fundamental right to a safe and healthy working environment. This incident was entirely avoidable by proper enforcement of laws.

Public Release: Mundka Fire: Fact Finding Report & Access to Minimum Wages

https://workingpeoplescharter.in/media_statements/public-release-mundka-fire-fact-finding-report-access-to-minimum-wages/

Case 5:

The workers were not allowed to take mobile phones inside the factory. One of the workers, Aanchal, who has been working in this factory for a year and has survived the tragedy fortunately, told that the workers' phones were taken away and kept separately. When the fire started, one of her co-workers Preeti was carrying her phone by chance. Through this, Aanchal informed her brother about the incident and he immediately reached the factory with a rope to evacuate those trapped. According to the workers, "the employer, showing utter disregard for the lives of the workers, fled the scheme after incurring minor injuries".

https://thewire.in/labour/mundka-factory-fire-caused-by-negligence-many-havent-received-compensation-fact-finding-report

Case 6:

The police said that a victim's body was handed over to another family "by mistake". According to the police, the body of one Sweety was mistakenly identified as Ranju Devi by her husband, as both had similar characteristics. "On May 14, 2022 (the next day of the incident), eight bodies were identified by their family members and they were handed over. The FSL reports of seven were correctly matched with the samples of the family members. However, that of Ranju Devi did not match.

Santosh (Ranju Devi's Husband) said that he received a call on Wednesday, 18th May 2022 around 7 pm from police, following which he went to the Mundka police station. "When I reached there, Sweety's (another lady who also lost her life in the fire accident) family members were also present. The police told us that the body was mistakenly identified and no one was at fault. I was told that Ranju's body was identified by forensic examination and it was still at the hospital. "After the fire, I was emotional and identified that body as my wife. When I reached Sanjay Gandhi hospital on Thursday, Sweety's family members alleged that I had earlier identified the body as that of my wife to get the compensation of Rs 10 lakh," Santosh said. He claimed that he had to borrow money to cremate his wife. "I am a mason and since the incident has happened, I could not go to work. I received the body of my wife today around 1 pm and cremated it after borrowing money. "I was also assaulted by the family members of Sweety in the hospital and they slapped me at least four to five times. Her family members were asking me to bring back her body," he said.

https://timesofindia.indiatimes.com/city/delhi/mundka-fire-tragedy-victims-body-handed-over-to-another-family-by-mistake/articleshow/92418760.cms

Hotel Arpit Palace Fire – Tragedy before pilgrimage as fire sweeps through Delhi hotel

"It was a nightmare without end,"

Three of the victims of the hotel fire in Delhi belonged to a 13-member family that rose early and were getting ready to leave for Haridwar when disaster struck. "It was a nightmare without end," said Somshekhar, who had come to Delhi from Kerala with his family to attend a wedding in Ghaziabad and was staying in the hotel. They were residents of Ernakulam district in Kerala and were getting ready to go to Haridwar when the fire started. "Ten of us were rescued by police and fire teams. We had booked four rooms in the hotel. We were all ready early morning to go to Haridwar when suddenly there was a power cut. They switched on the generator and there was heavy smoke and smell," he said.

"My sister Jayashree P.C. spotted the smoke, informed us and rushed to check. The entire pathway was full of pungent smoke. My mother and brother (P. Naliniamma, and P.C. Vidhyasagar) were with her at that time. I immediately opened the room for fresh air and we managed to escape with help from police and firemen," Somashekhar added.

Jayashree, 53, Naliniamma, 84, and Vidhyasagar, 59, were killed in the fire.

https://timesofindia.indiatimes.com/city/delhi/delhis-karol-bagh-hotel-fire-it-was-a-nightmare-without-end/articleshow/67958166.cms

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Surat Coaching Class Fire

United in grief: Parents of Surat fire victims refuse to immerse ashes

More than one-and-a-half-months after the tragedy at Taxshilla Arcade at Varachha, the parents are yet to immerse their children's ashes. The mortal remains have become part of their home near Varachha, a migrants' hub in Surat. Cloth merchant Jayshukhbhai Gajera is not alone in his quest for justice for his 22-year-old Grisma, who was charred to death in May this year. The grieving parents of the other 21 students, who were killed in the fire at a rooftop coaching centre inside a commercial complex in Gujarat's Surat on May 24, are also standing firm and united behind Gajera. *"Immersion (of the mortal remains) is out of question until the real culprits are booked. My whole family agrees with me. That will be the real tribute to my daughter,"* says Jayshukhbhai. *"Only some junior staff have been booked and made the scapegoat,"* he adds.

"A couple of days after the cremation at Ashwini Ghat on May 25, we all gathered to discuss how to take the legal battle forward. It was then that the decision (to keep the mortal remains) was taken in unison," Chatur Vasoya, who lost his 17-year-old daughter Jhanvi, said.

"We have kept the mortal remains to send across a message to other parents – ensure that the places where your children go on regular basis are safe," says Kantibhai Kakadiya, Isha's father.

"We all know the importance of immersion. But through a legal fight we want to convey to our children that though they have left, their parents did everything to get them justice," adds Vasoya. As per Hindu customs, the immersion of ashes into a river releases the person's spirit from physical body so that the soul can be reborn.

The parents also regret that they could not sense the impending dangers as they were not aware about the required safety measures at Taxshilla Arcade. They also want to other parents to check all the security and safety parameters in commercial complexes before sending their children to these buildings.

https://www.hindustantimes.com/india-news/united-in-grief-parents-of-surat-fire-victims-refuse-to-immerse-ashes/story-FppHjBroXbTKUuX5lQstlL.html

"True Hero": Surat Man Enters Burning Building to Save Trapped Students

During the fire in Surat's coaching centre, a man risked his life to save lives of the students who were trapped inside Takshashila Arcade. Using a ladder in the backside of the complex, Ketan Jorawadia was able to rescue at least 10 students.

"There was smoke. I could not figure out what to do. A girl fell to the ground in front of me while trying to escape the blaze," he news agency ANI.

This accident pained him and he decided to do something.

"I took the ladder and first helped the children to get out of the place. I managed to save 8-10 students from the back side of the building. Later I managed to rescue two more students. I rescued as many students as I could have," he said.

https://www.ndtv.com/india-news/surat-man-who-saved-lives-of-10-students-in-fire-2043008

Sunrise Hospital Fire, Mumbai: For families of victims, shock, disbelief and helplessness

Harish Sachdev's relatives are still in shock. They can't believe they will never be able to meet him again. The 60 year old had tested positive only yesterday and was admitted to the Sunrise Hospital in Bhandup, close to their home. When the relatives heard of the fire, they rushed to the hospital in the middle of the night, but everything after that has seemed like an unending nightmare. Fire brigade personnel told them that patients were shifted out to four- five different hospitals as the fire-fighting continued. It took Sachdev's relatives to Fortis hospital in Mulund, the Jumbo Covid Centre and Agrawal hospital but his name wasn't on the list of transferred patients. A little post noon, they heard that some bodies had been brought to Agrawal hospital for identification. It confirmed their worst fears.

"The Fire Brigade personnel informed us that his body was found in the terrace of the hospital," wife Pooja Sachdev said.

Shyam Bhaktani tested positive for Covid-19 on Monday and was admitted to the Mulund Jumbo Centre. The 77-year-old had a cardiac issue and doctors at the jumbo centre recommended that the family move him to a private hospital that had the facilities to take in a cardiac patient. Given that he was Covid positive, finding a hospital bed was a challenge. After a day's stressful hunt for a hospital bed, the family had returned home after admitting him to Sunrise hospital at 10.30pm. In just a few hours, they woke up to phone calls and news that there was a fire in the hospital. They tried calling the hospital and the doctors but got no response. Even when they got to the hospital there was no information, only chaos. Bhaktani's son-in-law told TOI Online that after searching in different hospitals, they finally came to Agrawal Hospital where they identified his body

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Ahmednagar hospital fire: The family members bid farewell to their dead relatives with a heavy heart after the bodies were handed over to them by the hospital administration

The hospital administration handed over the bodies to their relatives who performed the last rites at crematoriums in Ahmednagar city and neighbouring Nevasa tehsil in the district.

Bhagwan Pawar, who lost his father Bhivaji Pawar (80) in the hospital blaze, said they had to perform his last rites in Ahmednagar instead of their native village in Parner tehsil. The other relatives could not attend the funeral, he rued. "My father had a tragic death. Due to COVID-19, the cremation was conducted in Ahmednagar only. Only a few of us were present in the crematorium," he said.

Vivek Khatik, whose father Kadu Bal Gangadhar Khatik (65) also died in the tragedy, said they performed his funeral at their village in Nevasa tehsil. "We received the body late Saturday evening for the last rites. My mother was also in the same ICU. We could save her, but not my father," Khatik said.

Adinath Wagh, who lost his uncle Ramkishan Harpude (70) in the hospital blaze, performed his cremation at their native place in Nevasa on Saturday night. "It was only two days back that he was admitted and we were expecting a speedy recovery. But he died in the fire tragedy," he said. Wagh said many of the close family members were distraught and inconsolable as they could not see Harpude's face one last time due to the COVID-19 protocols. "After receiving the body, it was taken to our native place and we performed the last rites in the presence of close family members," he added.

https://economictimes.indiatimes.com/news/india/maharashtra-hospital-fire-kin-of-deceased-in-shock-as-hope-of-recovery-from-covid-19-turns-into-permanent-loss/articleshow/87566393.cms?from=mdr

KNOWLEDGE PAPER

Identifying Gaps and Needs to Enhance Fire Safety in India

CUTS International

CONTENTS

List of Tables, Figures and Boxes

ABBREVIATIONS

Acronym	Expansion
ADSI	Accidental Deaths and Suicides in India
ASTM	American Society for Testing and Materials
ARFF	Airport Rescue and Fire Fighting services
BDA	Bangalore Development Authority's
BIS	Bureau of Indian Standards
CISF	Central Industrial Security Force
CED	Civil Engineering Division
CPSC	Consumer Product Safety Commission
CTIF	Comité Technique International de prevention et d'extinction de Feu
DISH	Department of Industrial Safety and Health
DLB	Directorate of Local Bodies
ESIC	Employees' State Insurance Corporation
FDA	Food and Drug Administration
GDCR	General Development Control Regulations
GDP	Gross Domestic Product
ICU	Intensive Care Unit
IIT	Indian Institute of Technology
ISI	Indian Standards Institution
ISO	International Organisation for Standardisation
IOT	Internet of Things
KSFES	Karnataka State Fire and Emergency Services
MFB	Mumbai Fire brigade
NFS	Nagpur Fire Service
NDMA	National Disaster Management Authority
NDRF	National Disaster Response Fund
NEC	National Electrical Code
NFPA	National Fire Protection Association
NFSC	National Fire Service College
NFSA	National Fire Sprinkler Association
NGT	National Green Tribunal
NHM	National Health Mission
NOC	No-objection certificate

NRC	Nutrition Rehabilitation Centre
PESO	Petroleum and Explosives Safety Organisation
RERA	Real Estate Regulatory Authority
RMSI	Risk Management Solutions Inc.
SDRF	State Disaster Response Forces
SME	Small and Medium Enterprises
SPA	Special Planning Authority
SFAC	Standing Fire Advisory Committee
SNCU	Sick Newborn Care Unit
UK	United Kingdom
ULB	Urban Local Bodies
US	United States
WHO	World Health Organisation

EXECUTIVE SUMMARY

Fire is always one of the major disasters that threaten life, structure, property, and environment. In India where most of the urban areas are densely packed and heavily populated, fire poses a significant challenge and greater risk to buildings and lives. Fire incidents have become a regular occurrence in the country, which has led to massive financial damage and fatalities. The analysis of fire safety in the country through this study brings to light those policies and systems related to fire services in India need further strengthening.

Fire Related Deaths and Injuries

As per the recent Accidental Deaths and Suicides in India (ADSI) 2021 report, maintained by the National Crime Records Bureau, a total of 8,491 cases of fire accidents were reported in the country in 2021, which rendered 8,348 deaths and injuries to 485 persons.

As per available data, the primary cause of fire accidents across the country is attributed mainly to electric short circuits, cooking gas and stove bursts. Such accidents are perceived to be of recurring nature across the country and have led to stakeholders raising questions about public safety. Fire accident data over the past few years show a steep increase in fire accident-related deaths despite percentages showing a declining trend. The number of deaths outweighs the injuries showing a grim view of the negligence of preventable factors of such accidents.

The data reveals that most of the fire accidents in the country occurs in residential buildings. Almost 50.8 percent of total deaths during 2021 and 57.6 percent of total deaths during 2020 were reported in such buildings.
A study of the types of buildings where fire accidents previously occurred reveals that there are more fire hazards in high-rise buildings due to electrical fitting defects and defective infrastructure. This is due to the fact that planning and execution of electrical works in a high-rise building is different from the smaller two storey building. Further there is a disturbing shift in fire accidents from commercial buildings, manufacturing units and factories to urban dwellings and households, require the attention of municipal, local, and central authorities to work together with organizations and prevent such disasters.

Fire: A State Subject

Fire service is considered as a State subject as per the constitution of the country. Therefore, fire prevention and firefighting services are managed and organized by concerned State Government, Union Territory, or the Urban Local Bodies (ULB) and associated rules are laid in

the form of state regulations or municipal bylaws.

Today the majority of the States have enacted legislation or rules to ensure fire prevention and safety. Most of these complement the Model Fire Service Bill and the National Building Code issued by the central government. Many of the National Building Code provisions and other standards prescribed by the Bureau of Indian Standards (BIS) have been incorporated by various State Governments and Local Bodies in their building regulations.

Today the country has numerous legislations spread across every state that deals with fire prevention and safety. However, despite the many legislations, enforcement of fire safety standards needs to be further strengthened and this would require governments to address several systemic and functional challenges related to coordination and allocation of role and responsibilities of government and non-government stakeholders.

Significance of the Study

The status of fire accidents in India based on the available data and the analysis of recent fire incidents, therefore, justifies the need for in-depth study of the whole issue related to fire prevention and safety in the country

Hence, this knowledge paper developed by CUTS International with the support of APCO Worldwide India Private Limited attempts to identify the gaps and highlight the challenges from a national perspective. It points out best practices within the country and across the globe that our policy makers can rely upon.

The paper focused extensively on secondary data relevant to fire accidents in India and around the world largely relying upon government data, official documents, internet articles, newspapers, investigation papers, other reports and round-table discussions with experts and professionals.

Hence, this paper would hopefully be helpful to policymakers within the government and other related stakeholders and help them strengthen the existing fire prevention policies and enforcement.

Key recommendations based on findings of the study

India's fire services are still in a nascent stage, with limited progress in modernizing due to lack of push from officials. It is recommended that ‘fire prevention’ should be considered to be included in the Concurrent list of the Constitution of India. This would facilitate shared responsibility between the Centre and the States, enabling uniform legislation across the country with better stringent enforcement.

Mandatory standardization of processes: Mandatory standards for products that impact the health and safety of the consumers, such as electrical fittings and appliances, industrial safety and fire safety equipment are of utmost importance. Annual compulsory upgradation of fire safety infrastructures in industries is important. Regulatory authorities should aim for stringent checks/inspections and introduce stricter penalties for any legal violation.

Mandatory fire prevention and precautions: There should be periodic inspection of electrical installation by Chartered Electrical safety engineers. Along with electrical installation inspections electrical safety audits by independent agencies should be made mandatory in all states.

Improved data management: The fire accident database needs to be strengthened to accurately assess fire safety. Police should be vigilant while collecting data and providing resources for all accidental fire incidents. New technologies can improve data collection and management. Therefore, should be introduced at every level. Stringent rules should be enforced in terms of data collection and analysis, and market surveillance should be improved.

Investment in R&D: Setting up Fire Forensic Institute/s in the country is necessary. Further, National Fire Service college should be financially supported. This would encourage research and experiments related to fire prevention and safety. Advanced encouraging innovations and funding for technologies for firefighting, first aid, and rescue are vital.

Digitalization: Digitalizing the process of fire safety will enable more robust and effective methods of communication across public safety disciplines and government.

Optimum utilization of resource: Every state needs a transparent command structure and effective utilization of resources in Fire services. Modern firefighting equipment is importance to ensure maximum protection against fire. The state government should make adequate provisions to facilitate basic firefighting equipment to the brigades.

Investment opportunities: Fire and safety equipment has a strong growth potential in India. Private equity firms and venture capital should be encouraged to invest in fire and safety businesses.

Targeted interventions: Inspection of the type of building would prove crucial in addressing fire safety concerns. Also, targeted interventions would ensure fire safety for people with special needs so that causalities and injuries of vulnerable population is reduced.

Introduction of rural fire service network: Since the number of fire accidents is equal to that in urban areas, a rural fire service network is necessary.

Fire safety awareness: Fire safety awareness should be an integral part of daily learnings in schools, universities, hospitals, theatres. Moreover, focused training and awareness programs in collaboration with local fire department/municipalities are equally important. Felicitation of vigilant citizens who highlights fire safety risks can encourage more citizens to do so. Therefore, it is also crucial to educate citizens about fire prevention, adherence to rules etc. along with safety measures.

INTRODUCTION

The discovery and control of fire is still recognised as a significant stage in human evolution. Since then, handling and using of fire and fire-causing chemicals and tools/equipment has led to several accidents in civilisations, societies, homes, offices, schools, and other public places with severe repercussions across the globe. Often such accidents result in significant injury or loss of human lives and livelihood, economic and social impact, property damage, or loss, business and community disruption and environmental crisis.

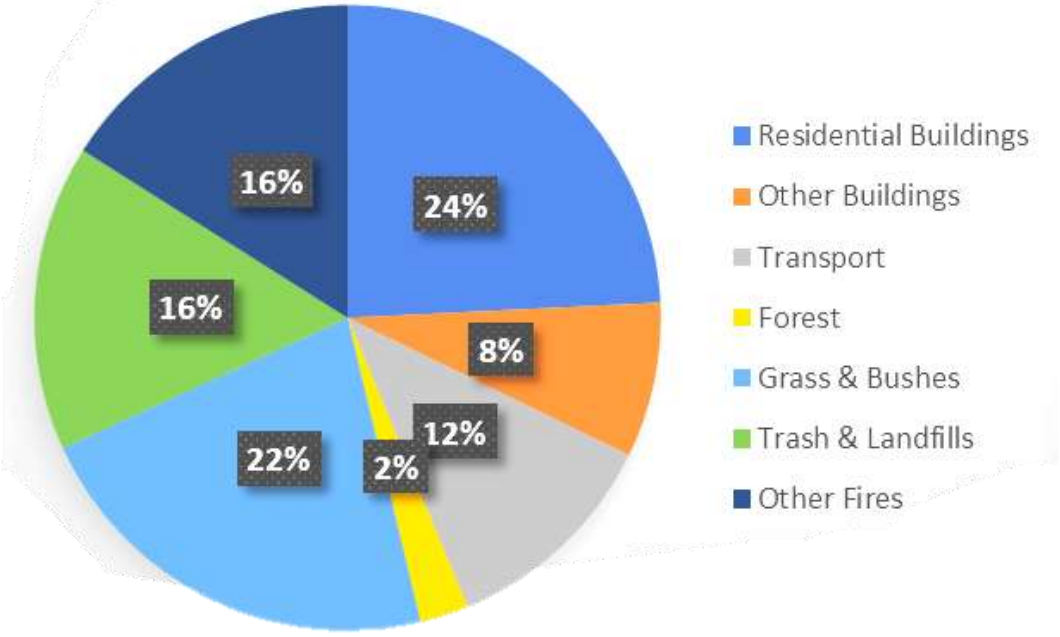
Recognising this seriousness, man-made hazards, including fire accidents, are part of the United Nations' Sendai Framework for Disaster Risk Reduction 2015–2030, the first major agreement of the post-2015 development agenda that provides the Member States with concrete actions to protect development gains from the risk of disaster.[1]

It recognises that the State has the primary role in reducing disaster risk, but that responsibility should be shared with other stakeholders, including local government and the private sector. Even the United Nations Global Assessment Report 2019[2] has recognised fire as one of the major hazards. According to Eastern Kentucky University, fires are often the result of unintentional negligence such as not using the proper electrical infrastructure, irresponsible consumer or technician behaviour, or product or technology defects. India's National Disaster Management Authority (NDMA) also recognises fire as a human-induced disaster.

According to the 2022 Centre of Fire Statistics released by the International Association of Fire and Rescue Services, Comité Technique International de prevention et d 'extinction de Feu (CTIF), approximately 0.6 deaths and 2.1 injuries per 100,000 persons due to fire hazards have been reported globally in the year of 2020, while the total number of incidents reported in the same year is around 3.9 million. More precisely, in 2020, in 48 countries surveyed, 20,600 people died due to fire accidents and 69,500 people were injured

[1] Sendai Framework for Disaster Risk Reduction 2015–2030. Accessed at <www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030>
[2] 2019 Global Assessment Report on Disaster Risk Reduction (GAR). Accessed at <https://gar.undrr.org/report-2019.html>

Fig 1: Global Fire - Place of Occurance



The report also reveals that approximately 33.6 percent of all fires occur in buildings (refer Figure 1)[3] and such wide damage to property, injuries, and loss of lives have great impact on the economy and society. According to UL's Fire Safety Research Institute, it is projected that every year the world incurs a financial loss of around two percent of global Gross Domestic Product (GDP).

[3] World Fire Statistics, Report no. 27, Centre for Fire Statistics, International Association of Fire and Rescue Services, 2022. Accessed at < https://ctif.org/sites/default/files/2022-08/CTIF_Report27_ESG_0.pdf>

1. FIRE ACCIDENTS IN INDIA: WHAT THE DATA SAYS

In India, fire accidents have become a regular occurrence, with thousands of lives and millions of rupees lost yearly. There is a fire outbreak almost every week across the country. As per the recent Accidental Deaths and Suicides in India (ADSI) 2021 report,[4] maintained by the National Crime Records Bureau, a total of 8,491 cases of fire accidents were reported in the country in 2021, which rendered 8,348 deaths and injuries to 485 persons. As per available data (refer Table 2), the primary cause of fire accidents across the country is attributed mainly to electrical short circuits, cooking gas and stove bursts. While the total number of accidents may have reduced, the 2021 data still amount to around 23 deaths in a day. Given the size of the country, underreporting, and missed reporting should also be factored in while taking into account the scale of the problem. Fires in the villages, and remote towns may inadvertently be missed or not reported.

Table 1: Fire Accidents, Death & Injuries in India 2015-2021

Year	Fire Accidents	Death	Injuries
2021	8,491	8,348	485
2020	9,329	9,110	468
2019	11,037	10,915	441
2018	13,099	12,748	777
2017	13,397	13,159	348
2016	16,695	16,900	998
2015	18,450	17,700	1193

Source: Compiled from ADSI Reports, National Crime Records Bureau.

There is a disproportionate skew towards number of deaths as compared to injuries in accidents, depicting the fatal nature of the accident. And given that most of the fires are preventable, it is important that the subject be considered with utmost serious concern and be addressed by authorities. Besides, the decline in the number of fire accidents can also be either due to a lack of effective compilation of data and incidents or a modest rise in awareness among the public regarding precautions to be taken while dealing with fire.
Death Rate has increased from 95.9% in 2015 to 98.3% in 2021. The approximate increase in the number of deaths resulting from the increase in the death rate from 2015 to 2021 would be approximately 203.7

[4] Accidental Deaths and Suicides in India (ADSI) 2021. Accessed at <https://ncrb.gov.in/sites/default/files/ADSI-2021/ADSI_2021_FULL_REPORT.pdf>

Table 2: Cause of Fire Accidents in India 2015-2021

Cause	2021	2020	2019	2018	2017	2016	2015
Electrical Short circuit	1808	1943	2183	1970	1886	2500	2485
Riot/Agitation	3	36	6	16	17	2	3
Fireworks	129	77	102	238	218	253	110
Cooking Gas Cylinders/Stove Burst	1606	2056	2137	2672	3260	3927	3390
Accidental Fire (Other Causes)	4945	5217	6609	8203	8016	10013	12462

Source: Compiled from ADSI Reports, National Crime Records Bureau.

Also, when it comes to where the fire accidents happen (refer Table 3), data reveals that most of the fire accidents in the country happen in residential buildings and there are inter-state variances. There were high number of fire accident cases reported in Odisha (1,248), accounting for 14.7 percent of such cases in 2021 (refer Table 3.1). However, in 2020, the table was topped by Madhya Pradesh (1,430 out of 9,329), accounting for 15.3 percent of total such cases. The State/UT wise analysis of place of fire accidents revealed that 22 States & UTs had reported 50.0 percent or more deaths due to 'Fire in residential or dwelling building' during 2021. These include Mizoram (100.0 percent), Assam (95.7 percent), Himachal Pradesh (88.2 percent), Karnataka (86.9 percent) and Tripura (86.4 percent).

Table 3: Place of Occurrence-wise Number of Fire Accidents in India during 2021-2015

Place	2021	2020	2019	2018	2017	2016	2015
School Buildings	5	7	23	7	6	21	10
Commercial Buildings	274	208	328	367	446	463	716
Residential/Dwelling Buildings	4,348	5,391	6,364	7,241	7,660	8,359	7,493
Government Buildings	24	53	60	24	13	48	35
Fire in Factory Manufacturing Combustible Materials	64	9	27	51	76	253	410
Fire in other Factories	67	109	181	184	235	151	212

Source: Compiled from ADSI Reports, National Crime Records Bureau.

Fast growing urban population coupled with shrinking availability of land has compelled humans to depend on vertical development of realty projects. While skyscrapers have

become a necessity in metros and Tier 1 cities in India, Tier 2 cities are now gradually following the trend with growing population and changing lifestyles. This put an unprecedented amount of strain on our electric al grid systems which were not designed to take on this load leading to failures, short circuits and even fires.

Latest ANAROCK research reveals that as Indian cities are under increasing pressure to grow vertically, the share of high-rises (G+20 floors or more) scaled unprecedented heights in 2019. Their data indicates that of a total 1,816 residential projects launched across the top 7 cities in 2019, over 52 percent were high-rises. Unsurprisingly, land-scarce Mumbai Metropolitan Region tops the list with over 75 percent of the total 734 projects launched in 2019 in the high-rise category. With G+20 floors the new normal in the region, Mumbai is closing in on other megacities like New York, Hong Kong, and Tokyo where buildings as tall as G+50 floors are the norm.

National Capital Region came next with nearly 70 percent of its total launched projects in the high-rise category. Bangalore clocked in with 45 percent of the total projects launched in 2019 towering above G+20 floors, followed by Pune with 41 percent share. In Hyderabad, Kolkata and Chennai, the share of G+20 floors or above option is scantier, with their high-rise share at 23, 21 and 16 percent, respectively. Notably, Chennai and Hyderabad - two cities which had stuck to more conventional low-rise formats for long – are gradually warming up to high-rise housing developments.

With the growth of such high-rise buildings and apartments there has been a surge in demand for large electric power delivery systems up to the buildings and subsequently inside the premises Fire safety therefore becomes an important aspect requiring special attention while designing and constructing such buildings. The requirements of the planning and execution of electrical works of an ordinary building having ground plus one or two floors housing are quite different from those of a multi-storeyed or high-rise building. Table 2 and 3 depict that **fire hazards take place in high rise buildings because of electricity and defective infrastructure**.

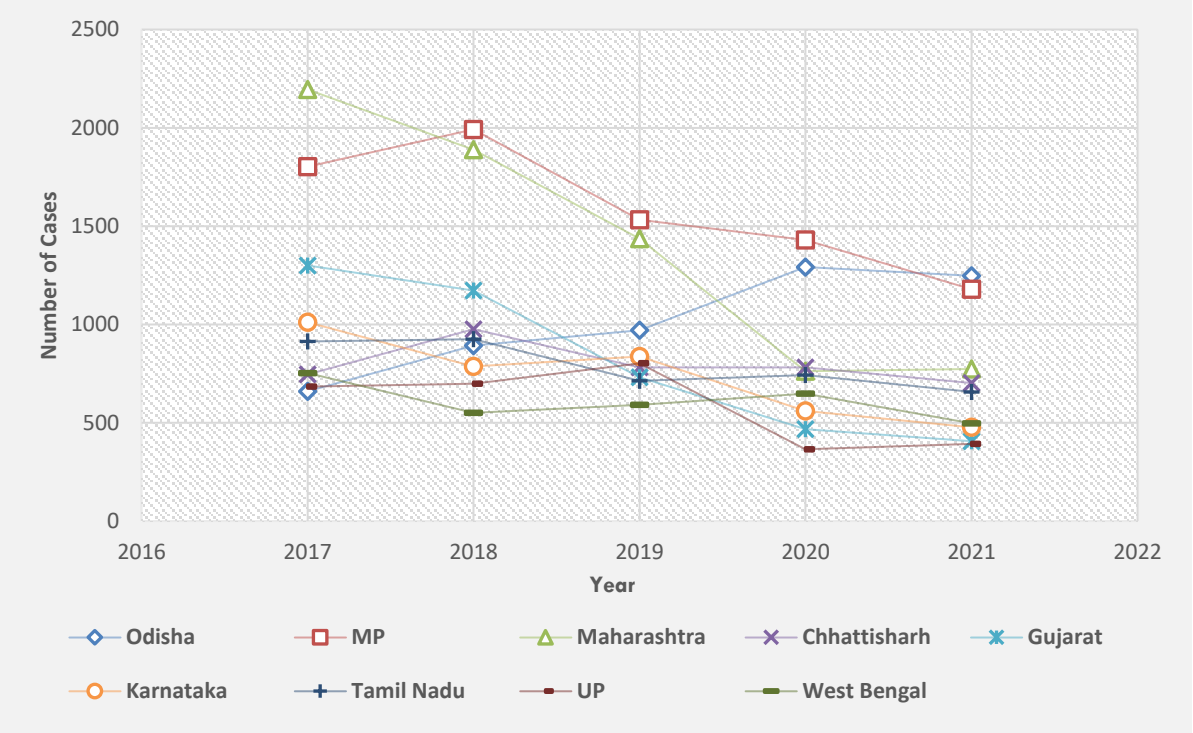
Table 3.1: Top 12 States and 2 UTs with High No. of Fire Accidents, Person Injured and Died during 2021

No.	State	No. of Cases	Injured	Died
1.	Odisha	1248	0	1248
2.	Madhya Pradesh	1179	9	1178
3.	Maharashtra	774	0	790
4.	Chhattisgarh	702	0	702
5.	Tamil Nadu	657	61	694
6.	West Bengal	497	66	480
7.	Karnataka	477	2	495
8.	Gujarat	406	0	409
9.	Uttar Pradesh	393	134	416
10.	Bihar	369	83	327

11.	Jharkhand	299	11	285
12.	Rajasthan	271	1	277
Union Territory				
1.	Jammu & Kashmir	88	0	14
2.	Delhi	80	31	68

Source: ADSI Report, National Crime Records Bureau.

Figure 2: Top Five States with Highest Number of Fire Accidents Cases during 2017-2020



Source: Compiled from ADSI Reports, National Crime Records Bureau.

Figure 4 shows that Madhya Pradesh, which is one of the fastest growing economies in the country, started witnessing a steady growth in highest number of accidental fires during the last five years. With 7,936 incidents in the last five years, Madhya Pradesh has topped the list, followed by Maharashtra (7,055). However, the number of such accidents are seen to be steadily declining in Maharashtra — 2,195 in 2017 to 774 in 2021, while in case of Madhya Pradesh it remains almost stagnant with 1,803 in 2017 to 1,179 in 2021. On the other hand, Odisha is witnessing an exponential rise from just 660 in 2017 to 1248 in 2021 and other states like Tamil Nadu, Chhattisgarh and West Bengal have seen fluctuating trends but an overall decrease in the number of fires.

It is reported that 'Fire' has climbed from 10th in 2019 to the fourth position in India Risk Survey 2021.[5] Due to the rising environmental concerns and the coronavirus pandemic,

[5] FICCI-Pinkerton India Risk Survey 2021, Released on 4th March 2022. Accessed at <https://pinkerton.com/media/our-insights/briefings/sources/india-risk-survey-2021.pdf>

'Natural Hazards' has been voted the top risk by industries. Fire has been voted the third biggest concern among manufacturing sector individuals.
Although it is very difficult to completely prevent fire outbreaks, government together with individuals and organisations can take proportionate steps to minimise the risk associated with such accidents. Developing Better infrastructure policies, ensuring sufficient funds are funnelled into the development of fire safety in an urban setting and policies that back the same are necessary steps to be taken. Table 4 highlights the amount of funds allocated in the respective state budget for fire safety and prevention in selected states for the past four years.

Table 4: State Budget Allocated Year Wise (2022-2019) in the Selected States for Fire Safety & Prevention

State	2022	2021	2020	2019
Delhi	313.23	240.55	213.22	226.39
Maharashtra	365	115.63	104.45	201.43
Gujarat	157	59	--	--
Madhya Pradesh	-	-	-	-
Odisha	295.57	253.09	246.60	230.25
Mizoram	14.19	14.94	15.20	14.58
Karnataka	353.37	338.06	299.57	292.29
Kerala	77	69	70	75

Source: Compiled from various sources *Values in ₹crore - Data Not Available

Analysing Table 4 and 3.2 together it shows that while fund allocation for Maharashtra seems to have substantially increased and fire incidents decreased, with only a minor increase in allocation of funds for Odisha, incidents keep rising. Also, Delhi has significantly high fund allocation while its record has been quite decent. So not just adequate fund but ensuring effective utilisation of funds remain crucial.

Short comings of reporting, record keeping and data warehousing in India is known to be marred by legacy issues and hence a nuanced understanding of the variables of fire accident and safety need to be understood to appreciate the gravity of the issue.

2. SOME RECENT FIRE INCIDENTS IN INDIA

Fire accidents have become a regular occurrence, with thousands of lives and millions of rupees lost yearly. In fact, such accidents impact the poor and vulnerable the most and this connection between poverty, vulnerability and elevated fire risk has been documented in multiple studies across the globe. Low levels of infrastructure, cheap materials used in construction of their dwellings, low family stability, overcrowding, old and many time dilapidated housing, lack of preparedness to protect themselves during an incident etc., all contributes to impact of fire accident. The data shared above highlights that there is a decline in the number of fire accidents in commercial buildings and factories that manufacture combustible materials, and this could be attributed to the relatively stringency in enforcement of safety standards in factories and commercial buildings. However, the number of fire accidents in residential and government buildings fluctuate and in fact increase, a clear indication of the need for sustained and increased focus on enforcement of fire safety standards in such buildings. a

Table 5 highlights a few selected significant fire accidents occurred in the country recently that had caused extensive damage to life and property. The table highlights the causes of such fire accidents to create some kind of pathway while coming up with solutions and recommendations in the later sections.

Table 5: Major Fire Accidents in Recent Times

Accident Location/Date	Fatality	Injured	Property Damage	Cause of Fire	Findings
Anaj Mandi Factory Fire, Delhi December 08, 2019	45	16	Entire factory gutted	Electrical short circuit on the 2nd floor	✓ No fire clearances ✓ No fire safety equipment is installed on the premises
Fire at Coaching Centre, Surat May 24, 2019	22	30	3-floors perished	Electrical short circuit	✓ Highly inflammable material and tyres, used as chairs in the class, caused the fire to spread rapidly. ✓ Civic officials had turned a blind eye to illegal construction on the complex's top floor to create space for the coaching institute.

Explosion at Sattur fireworks factory, Tamil Nadu January 05, 2022	20	35	Factory gutted.	Blast triggered due to friction while workers were handling chemicals in a working shed.	✓ Investigations revealed that excess workforce and illegal sub-leasing of the premises contributed to the disaster.
Sick Newborn Care Unit (SNCU), Bhandara District General Hospital, Maharashtra January 20,2021	10	7	Entire SNCU on 1st Floor Perished	Fire in SNCU spread from a radiant warmer and electrical wiring system connected to it.	✓ The inquiry committee found a lapse in electrical maintenance. Functioning since 1981 without a no-objection certificate (NoC) from the fire department. ✓ Hospital extension in 2015 to open the SNCU, medical store and a Nutrition Rehabilitation Centre (NRC), also without a NOC from the Fire Department. ✓ No fire audit was carried out.
Fire at Corona treatment facility in Dream Mall, Mumbai. March 26, 2021	11	-	3 floors perished	Defective electric circuit	✓ Illegal construction by several shopkeepers within the mall. ✓ During Dreams Mall's fire safety investigation, a couple of months before the accident, the Mumbai Fire Brigade Department found that the mall's fixed firefighting system was not working. ✓ Most equipment used to fight the fire was either missing or not functioning. ✓ Through the notice, the mall administrator was instructed to remove these flaws within the stipulated time, which never happened.
Fire at Intensive Care Unit (ICU) of Vijay Vallabh Hospital, Virar, Maharashtra April 23, 2021	15	3	2nd floor of ICU perished	Blast in the air-conditioner	✓ Delay of over 30 min in reporting the fire to the Vasai Virar Municipal Corporation fire brigade. ✓ Vijay Vallabh hospital did not adhere to the guidelines laid down by the Maharashtra Fire Prevention and Life Safety Measures Act. ✓ No NoC was obtained for the year 2021-2022.
Fire at 19th floor of Sachinam Heights, locally called Kamala	9	21	The entire building was engulfed in smoke,	Unknown.	✓ At the time of the fire, installed firefighting systems, such as risers, fire alarms etc., were not in working condition. ✓ Encroachments in the common

Building, Mumbai January 22, 2022			though fire gutted only one flat and common passageway of the floor.		passage area. ✓ Terrace door locked, encroached.
Fire at a four storeyed Hotel, Secunderabad, Telengana. Sep 12, 2022,	8	11	All 4 floors perished.	Electric vehicle batteries of the bike showroom stashed in the cellar blew up, triggering the blaze.	✓ Illegal construction of extra floors ✓ Did not have emergency exit. ✓ No fire safety setup was in place in the building. ✓ Flouted multiple fire safety norms.
Bhadohi Fire, Uttar Pradesh. Oct 02, 2022	17	75	Entire pandal perished.	Halogen lights overheated, generating an electric wire to catch fire.	✓ Organisers negligent in taking the required fire safety measures while organising the event.

3. PROBLEM STATEMENT & RATIONALE

Developments in technology along with efforts made by local and state governments have improved the state and occurrence of fires, however, given the substantial human and economic loss associated with fire accidents, the situation urges policy makers to do more. With India perhaps being on the cusp of its economic development and undergoing rapid urbanization, it is critical that policy makers give the required attention to prevention of fire accidents and safety of human lives affected by these accidents.
The study of fire accidents in India is based on the available data which is limited in nature. A thorough understanding therefore, needs a more in-depth study of the subject. While there are sporadic studies carried out at the State level covering some aspects of fire safety, there is a need to need to understand the subject of fire prevention and safety from a national level and with a policy-regulatory perspective. Hence this knowledge paper attempts to identify the gaps and needs, highlight the challenges from a national perspective and point out best practices, if any, within the country and across the globe that our policy makers could rely upon. More importantly, the paper provides specific set of recommendations to improve the fire safety scenario in the country.

The paper focused extensively on secondary data relevant to fire accidents in India and around the world largely relying upon government data, official documents, internet articles, newspapers, investigation papers, and other reports. There have been several major fire accidents happening across the country in recent times. As a result, nine major fire accidents that had a great number of injuries and casualties were identified to highlight the graveness of the subject. To complement and validate the extensive secondary research 6 key stakeholders, from an array of experts from fields related to fire prevention and safety in the country- were interviewed. Also, a round table discussion and 3 focused discussions were carried out with professionals and experts.

The paper would therefore be helpful to policymakers, governments, and all other related stakeholders to move towards an appropriate direction to strengthen the existing fire disaster policies.

4. FIRE SAFETY IN DEVELOPED WORLD: A PEEK THROUGH

4.1 United States of America

In the United States (US), fire safety regulations are primarily adopted from codes developed and published by the National Fire Protection Association (NFPA). They constantly update these codes that form the basis for national, state, and local legislation. The NFPA Fire & Life Safety analysis shows that implementing fire safety technologies through mandated codes and standards has greatly helped reduce fire accidents.[6]

Implementation of fire safety technologies through mandated codes and standards has hugely helped in reducing fire accidents in US.

Buildings such as hospitals, nursing homes, schools, and hotels have seen stricter requirements for fire safety in the last four decades, and, as a result, catastrophic fires in these types of buildings are rare. For residential homes, it is reported that there is a decline in the number of deaths per 1,000 reported fires in apartment buildings, while there has been an increase in the deaths in less regulated smaller family homes.

The NFPA Fire & Life Safety Ecosystem identifies eight components that must work together to minimise risk and help prevent loss, injuries, and death from fire, electrical, and other hazards (Refer Box 1). Recent studies show that at least three elements of the ecosystem - government responsibility, development and use of current codes, and an informed public- have positively impacted the US fire experience.[7]

[6] Mart Ahrens, Birgitte Messerschmidt, Fire Safety in the United States since 1980: Through the Lens of the NFPA Fire & Life Safety Ecosystem, NFPA 2021. Accessed at <www.nfpa.org/~/media/Files/News%20and%20Research/Fire%20statistics%20and%20reports/US%20Fire%20Problem/osNFPAEcosystemFireSafetyReport2021.ashx?utm_source=emil&utm_medium=email_medium&utm_campaign=emil0358&utm_content=mbrs&order_src=e827>

[7] Key Findings of the 2021 NFPA Report on Fire Safety in the US, National Fire Protection Association, 2021 Accessed at <www.nfpa.org/~/media/Files/Code%20or%20topic%20fact%20sheets/FireSafetyInTheUSFactSheet.pdf>

BOX 1: NFPA FIRE & LIFE SAFETY ECOSYSTEM

A framework that identifies the components that must work together to minimise risk and help prevent loss, injuries, and death from fire, electrical, and other hazards. Eight key components are interdependent. When they work together, the Ecosystem protects everyone. If any component is missing or broken, the Ecosystem can collapse, often resulting in tragedy.

Government Responsibility - must create a policy and regulatory environment where laws, policies, and spending priorities are dictated by public safety needs and not by special interests.

Development and Use of Current Codes - Using the latest codes and standards developed by experts from around the world establishes minimum levels of safety to protect people and property. Codes and standards are updated (typically on a three- to five-year cycle) to reflect our changing world.

Referenced Standards - Referenced standards are a fundamental part of the primary fire, life safety, building and electrical codes and standards. Developed through the consensus process, these standards include references to installation and product standards that are developed by a wide range of organisations.

Investment in Safety - Investing in safety should be everyone's priority. We all must take a vested interest in the public's safety and work together to allocate resources to reduce losses from fire and related hazards.

Skilled Workforce - It takes a skilled workforce to ensure the most current codes are applied correctly to reduce the risk of injuries, loss, and death for workers and the public. We all must support ongoing training and professional development in our workforces and encourage others to work in the fire and life safety fields.

Code Compliance - Supporting effective code enforcement. Whether a house or a new office building, the places people live, and work are only as safe as the construction and code compliance in place.

Preparedness And Emergency Response - When they put their lives on the line, first responders should feel they are prepared to protect their communities, and their communities are working to help prevent and prepare for emergency situations. Prioritising and investing money in effective preparedness and response capabilities and resources before, during, and after an emergency helps first responders meet the varied needs of their communities.

Informed Public - When given education and resources to help address hazards, the public can make better, more informed decisions and take action to protect their home and personal safety. People do take extra safety measures when they understand the risks and the consequences associated with fire and related hazards and are given viable solutions.

Source: NFPA Fire & Life Safety Ecosystem. Accessed at <www.nfpa.org/-/media/Files/About-NFPA/Ecosystem/NFPAOneInfographic.pdf>

NFPA 70, *National Electrical Code* (NEC), sets the foundation for electrical safety in residential, commercial, and industrial occupancies. NFPA 70E, *Standard for Electrical Safety in the Workplace* actually requires that an electrical safety program get audited and reviewed on a regular basis (not to exceed three years) to ensure that the program is still in alignment with applicable safety requirements. Next, field work audits are also required to be performed to verify that the procedures within the electrical safety program are being followed in practices in the field. Field audits are something that must be performed on a yearly basis.

Apart from this, entities like the National Institute of Standards and Technology (NIST), American Society for Testing and Materials (ASTM), Underwriters Laboratories, Factory Mutual and National Fire Sprinkler Association (NFSA) all contribute to the development of fire safety legislation, either through documents, standard setting/certification, inspection or by serving as approval bodies for materials, like using copper for the sprinkler systems which is useful due to their high heat resistance, and equipment like copper wiring that is known to reduce electrical fires, systems, and so forth. The NIST, the federal technology agency that develops and promotes standards, measurements, and technology, developed standards and codes for residential smoke alarms during the 1960s and 1970s.
Similarly, smoking was identified as one of the leading causes of home fire deaths until 2018. Upholstered furniture or mattresses and bedding were often the first to get ignited by smoking materials. After trying several approaches to address this issue, US Consumer Product Safety Commission (CPSC) issued mandatory flammability standards for mattresses and supported voluntary upholstered furniture standards, such as the Upholstered Furniture Action Council's Construction Criteria. Such move played a significant role in reducing the fire accidents at home. So was the introduction of standards to develop child-resistant cigarette lighters and candles, which led to a decrease in the overall number of fires.[8] Thus, the voluntary and mandatory product standards also played an essential role in fire safety in the US.

Last year, New York introduced a numerous pieces of legislation designed to improve fire safety and hold property owners more accountable in response to the tragic residential building fire at the 19-story apartment building in the Bronx on January 9 that claimed the lives of 17 New Yorkers, including eight children.[9] Investigation had concluded that the fire was caused by a defective space heater that caught fire in the bedroom of a third-floor apartment. New laws empower the U.S. Fire Administration to investigate major fires; space heaters sold in New York to have thermostats and an automatic shut-off feature and meet certification standards; and more importantly landlords will no longer be able to certify any door repairs without approval from a city inspector, and the city would be required to reinspect buildings cited for a violation within 20 days.

[8] *Supra n.9*
[9] One year after Twin Parks fire, a raft of legislative fixes, Spectrum News NY1, 09 January 2023. Accessed at <www.ny1.com/nyc/all-boroughs/politics/2023/01/10/one-year-after-twin-parks-fire--a-raft-of-legislative-fixes>

BOX 2: INCENTIVISING SMALL AND MEDIUM ENTERPRISES (SMES) TO ADOPT SAFETY

The US federal tax reform legislation in 2018 - the Tax Cuts and Jobs Act includes incentives that make it more affordable for small business owners to install fire sprinklers. Fire sprinkler systems are the only tool that can reduce the spread of fire, heat and smoke in a building and contain the fire until the fire department arrives. This provides valuable time for employees and customers to escape a fire.

The incentive makes it possible for restaurants, retail outlets, night clubs and other small businesses to install, retrofit or upgrade their current fire suppression systems. Also, small businesses can deduct the interest from any loan they receive for this type of renovation.

Source: www.usfa.fema.gov/blog/ci-061218.html

Looking into the infrastructure and human resources in fire service department, it is reported that there were 29,537 fire departments in the US in 2019. Of these, 18 percent were all career departments and protected 69 percent of the US population. Also, out of an estimated 1,080,800 total firefighters in the United States in 2019, almost 358,000 (33 percent) were career firefighters (full-time uniformed firefighters) and 722,800 (67 percent) volunteer firefighters (active part-time).[10]

It is also reported that fire protection costs have risen 140 percent since 1986, while the number of career firefighters has increased 51 percent.

Today, the number of fires and fire deaths in the US has reduced dramatically through effective and stringent enforcement of standards and codes, including a proper focus on electrical fire safety, increased public awareness and adequate investment. Still, it is reported that this progress has now unfortunately led to fire safety taking a back seat to other social concerns that seem more pressing.[11] Also, the fire problem in the US remains serious, it still has one of the highest fire death rates in the industrialised world.

Ensures effective and stringent enforcement of standards and codes, increased public awareness and adequate investment for Fire Safety.

Summary:

- Electrical fire safety is an important component of overall fire safety regulations in the US.
- NFPA 70, the National Electrical Code (NEC), provides the foundation for electrical safety in residential, commercial, and industrial occupancies.
- NFPA 70E, the Standard for Electrical Safety in the Workplace, requires regular audits and reviews of electrical safety programs to ensure they align with applicable safety requirements.
- Field work audits are also required on a yearly basis to verify that procedures within

[10] US Fire Department Profile 2019, National Fire Protection Association, December 2021. Accessed at <www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/Emergency-responders/osfdprofile.pdf>

[11] *Supra n.8*

the electrical safety program are being followed in practice.

- Using materials like copper for sprinkler systems and wiring can reduce the risk of electrical fires.
- The development of standards and codes for residential smoke alarms in the 1960s and 1970s led to widespread adoption of smoke alarms and a consequent decline in US fire deaths by 50% between 1975 and 1998.
- Electrical fires are a significant cause of home fires and deaths in the US, and addressing this issue is crucial for improving overall fire safety.

LESSONS FOR INDIA:

- Mandatory codes and standards greatly help reduce fire accidents.
- Prioritising government responsibilities (policies & fund allocation), regularly updating existing codes, and constantly educating the public positively impact fire safety scenario.
- Identifying and targeting risk factors to ensure fire prevention and focusing to work on those factors helps considerably.
- Encouraging small businesses to adopt fire prevention tools like sprinklers by providing tax incentives helps not only these businesses to adopt fire safe practices but also help them to quickly recover the upfront cost of installing such basic but vital firefighting equipment's.

4.2 United Kingdom

The principal fire safety legislation is The Regulatory Reform (Fire Safety) Order 2005, while other fire safety legislations cover specific situations. This legal document rationalised and simplified the fire legislation in the UK and provides a minimum fire safety standard in non-domestic premises such as places where people work, shared areas, workplace facilities, and the means of access to that workplace. A part of this legislation also sets out the statutory obligations on those responsible for carrying out a suitable and sufficient fire risk assessment of the workplace and keeping it up to date, providing information, instruction, and training to employees about the fire precautions in the workplace etc.

The recent Fire Safety (England) Regulations 2022 introduce new duties for building owners or managers (responsible persons) under the Fire Safety Order. The regulation implements most of the recommendations the Grenfell Tower Inquiry report put forward.[12] However, no fire safety legislation covers existing individual homes, but the 2005 Order controls the common areas of flats. In addition, the British Standards, Codes of Practice, and other documents offer

Implemented majority of the recommendations put forth by Grenfell Tower Inquiry Report.

[12] In 2017, the Grenfell Tower fire broke out in the 24-storey Grenfell Tower block of flats in North Kensington, West London. It caused 72 deaths and injury to 70 people. It was the deadliest structural fire in the United Kingdom since the 1988 Piper Alpha disaster and the worst UK residential fire since the Second World War.

guidance.

Regular testing of a building's wiring structure and maintenance is mandatory by law under The Electricity at Work Regulations 1989 and IET Wiring Regulations BS 7671:2018. The 5-year electrical testing rule applies to commercial, office, retail, and educational properties. Likewise, the Electrical Safety Standards in the Private Rented Sector (England) Regulations 2020 mandated that the private landlords must ensure every electrical installation in their residential premises is inspected and tested at intervals of no more than 5 years by a qualified and competent person. To ensure its strict enforcement the law also mandates that the landlord should supply a copy of that report to each existing tenant within 28 days of the inspection and test; and also submit a copy to the local housing authority within 7 days of receiving a request in writing for it from that authority.

More specific information on period of testing of electrical systems and installations that are followed in UK are given in Table 6.

Table 6: Guidance on frequency of periodic, fixed wire testing and routine checks of electrical systems and installations (IET Wiring Regs, BS7671, 2018):

TYPE OF INSTALLATION	ROUTINE CHECK	MAXIMUM INTERVAL BETWEEN TESTING
General Installation		
Domestic accommodation – general Domestic accommodation – rented houses and flats	– 1 year	Change of occupancy/10 years Change of occupancy/5 years
Residential accommodation (Houses of Multiple Occupation) – halls of residence, nurses' accommodation, etc.	1 year	Change of occupancy/5 years
Educational establishments	6 months	5 years
Industrial	1 year	3 years
Commercial	1 year	Change of occupancy/5 years
Offices	1 year	5 years
Shops	1 year	5 years
Laboratories	1 year	5 years
Hospitals and Clinics		
Hospitals and medical clinics – general areas	1 year	5 years
Hospitals and medical clinics – medical locations	6 months	1 year
Buildings open to the public		
Cinemas	1 year	1-3 years
Church installations	1 year	5 years

Leisure complexes (excluding swimming pools)	1 year	3 years
Places of public entertainment	1 year	3 years
Restaurants and hotels	1 year	5 years
Theatres	1 year	3 years
Public houses	1 year	5 years
Village halls/Community centres	1 year	5 years

Source: https://emelec.co.uk/5-year-electrical-testing-fixed-wire-test/

The recent advances in fire safety coupled with effective regulations have decreased the total number of fires in the UK from 473,000 in 2003-04 to 162,000 in 2016-17 and now further down to 149,779 in 2020-21.[13]

The Fire and Rescue Services undertake prevention activities that provide information and advice and encourage fire safety behaviours. They regularly educate people about steps to be taken to prevent the occurrence of a fire and increase survivability when involved in a fire. Also, the survey on working smoke alarm ownership shows that in the financial year 2020 to 2021, 94 percent of households owned a working smoke alarm.[14] Besides, Home Fire Safety Checks and Safe and Well visits are conducted, mainly where older citizens and disabled people reside. However, data shows that such visits have declined over the last decades due to budgetary restrictions.[15] Home fire safety checks for the elderly and disabled have been rising due to focused attention on those at the most significant fire risk.

The budget restrictions over the past decade have also negatively affected the infrastructure and human resources of the fire and rescue service department. There is a dramatic decline of 8,000 fewer full-time firefighters in the UK in 2021 compared with 2010, with London alone having 1,112 fewer firefighters, 10 fewer fire stations and 57 fewer fire engines.[16]

Figure 3: Total Number of Firefighters in England, 2010-2021

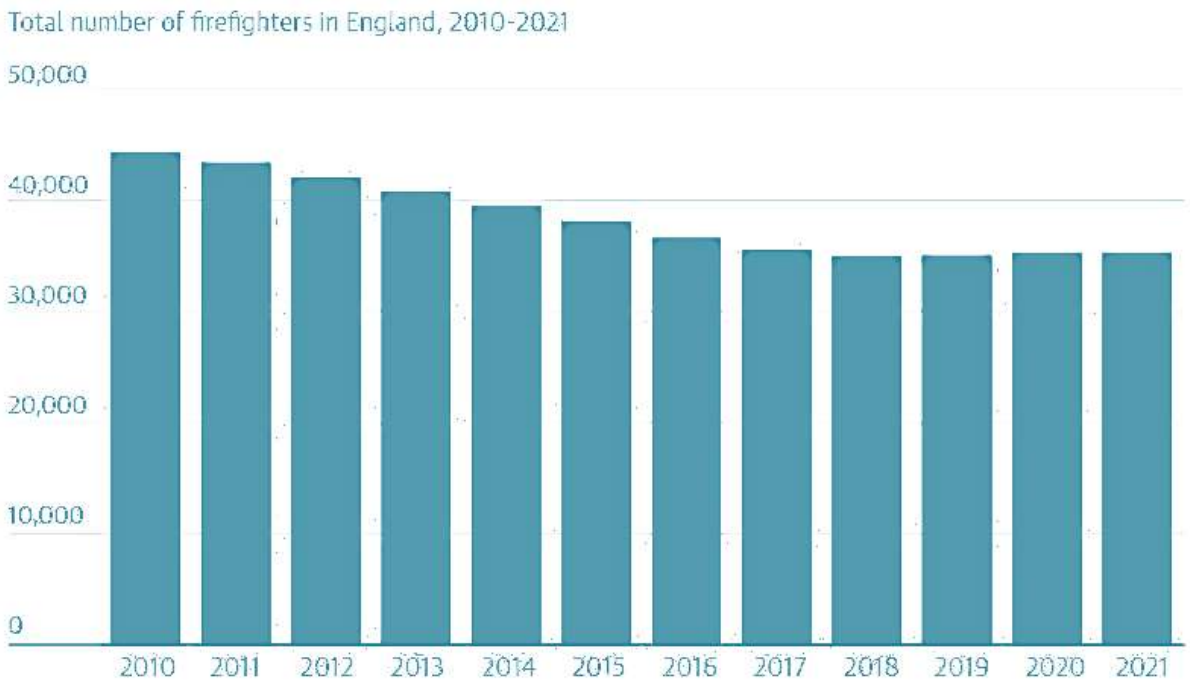
[13] Fire and Rescue Incident Statistics: England, Year ending June 2021, 11 Nov 2021.Accessed at <www.gov.uk/government/statistics/fire-and-rescue-incident-statistics-england-year-ending-june-2021/fire-and-rescue-incident-statistics-england-year-ending-june-2021>

[14] FIRE0701: Percentage of households owning a smoke alarm or working smoke alarm, England and Wales or England. Accessed at < https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1100306/fire-statistics-data-tables-fire0701-010922.xlsx>

[15] Taylor, M., Oakford, G., Appleton, D. et al. Fire Prevention Targeting by Merseyside Fire and Rescue Service in UK. Fire Technol 58, 1827–1837 (2022). https://doi.org/10.1007/s10694-022-01249-8

[16] London firefighter numbers fall by more than 1,100 in a decade, Evening Standard, 05 October 2021. Accessed at <www.standard.co.uk/news/london/london-firefighter-numbers-fall-fire-brigades-union-priti-patel-b958805.html>

The number of firefighters in England decreased 20.4% between 2010 and 2021



Source: Home Office, fire and rescue authorities. Note: Figures are for 31 March of each year

Relied on technology to connect with people.

In spite of limited budgets, the officials keep looking for innovative strategies to communicate with the public and rely on social media to engage individuals and gather insight into their preferences and needs. Such frequent engagements provide evidence and intelligence needed to re-design fire prevention services that are more targeted, effective, and efficient. Initially, such platforms were used only for text-based fire prevention messages. Still, gradually the content has become more varied through the use of short videos and images, which appears to have increased reach and engagement levels.

Summary:

- Compliance with the Electricity at Work Regulations 1989 and IET Wiring Regulations BS 7671:2018 is mandatory by law for all commercial, office, retail, and educational properties.
- The recent Electrical Safety Standards in the Private Rented Sector (England) Regulations 2020 mandate that private landlords ensure every electrical installation in their residential premises is inspected and tested at intervals of no more than 5 years by a qualified and competent person.
- Failure to comply with the regulations can result in severe consequences, including fines, imprisonment, or even loss of life in case of an electrical fire.
- The frequency of periodic fixed-wire testing and routine checks of electrical systems and installations varies according to the type of installation, ranging from 1 year to 5 years.

- The 2005 Regulatory Reform (Fire Safety) Order provides a minimum fire safety standard in non-domestic premises and sets out statutory obligations on those responsible for carrying out a suitable and sufficient fire risk assessment of the workplace.
- The recent Fire Safety (England) Regulations 2022 introduce new duties for building owners or managers (responsible persons) under the Fire Safety Order, implementing most of the recommendations from the Grenfell Tower Inquiry report.
- Regular maintenance and testing of a building's wiring structure are essential to prevent electrical fires and ensure the safety of occupants.
- Despite recent advances in fire safety regulations, the decline in budgets has negatively affected the infrastructure and human resources of the fire and rescue service department, necessitating more targeted, effective, and efficient fire prevention strategies.

LESSONS FOR INDIA:

- Due importance should be given to implement recommendations put forth by various committees on fire prevention and safety.
- Laying down proper guidance on frequency of mandatory testing and routine check of electrical systems and installations covering all types of building is vital. Not just guidance, law should clearly fix responsibilities and ensure timely and effective enforcement of such law.
- Regular interventions to educate people about steps to be taken to prevent the occurrence of a fire and increase survivability when involved in a fire is vital. Relying on technology like social media platforms, and partnering with civil society organisations, can help authorities to reach out to a wider population.
- Identifying and targeting risk factors to ensure fire prevention and focusing to work on those factors helps considerably.
- The recent Fire Safety (England) Regulations 2022 introduce new duties for building owners or managers (responsible persons) under the Fire Safety Order, implementing most of the recommendations from the Grenfell Tower Inquiry report.
- Setting mandatory standards for fire protection products like fire extinguishers, fire detectors, fire alarm devices, fire escape & Fire Survival Cable is crucial.
- Developing five-year plan on fire protection to help reform, modernise and develop fire protection infrastructure and capabilities. This would provide the fire department and the policy makers a tool that is capable of being evaluated, reviewed, and refined on an annual basis depending on the ability to meet the objectives listed in the plan.
- Applying updated smart firefighting technologies can help better prepare firefighters during fire accidents in crowded urban cities.
- Improving equipment's used in fighting fires would increase the efficiency of firefighting and ensure the safety of firefighters within fires.

5. FIRE SERVICE: LEGAL & REGULATORY FRAMEWORK IN INDIA

Various scriptures from ancient times in India talks about urban planning, fire prevention and safety. For instance, the *Kautilya's Arthashastra* talks in detail about the responsibilities of the municipal administration and the citizens for preventing the fire outbreaks in more crowded cities and the verses even mention subsequent punishments in cases of failing to follow the respective responsibilities.[17]

Regular fire services in India were established about 220 years back from now. The service was first established in Bombay in 1803, followed by Calcutta in 1822, Delhi in 1867, Madras in 1908 and Hyderabad and Bangalore in 1942. Before the Independence, the Imperial Police Service (established by the India Act of 1861), the firefighting task was majorly done. Thus, the development of fire services has been co-existent with the police service.

Post-independence, fire service came under state subject. Therefore, the fire prevention and firefighting services are managed and organised by the concerned State Government, Union Territory, or the Urban Local Bodies (ULB) and the associated rules are laid in the form of state regulations or municipal bylaws. Fire services come under the 12th schedule of the Constitution of India through the 74th Constitutional Amendments Act of 1992, this schedule contains the powers, authority, and responsibilities of Municipalities. The schedule has 18 items and item no. 7 covers "Fire Service". [18]

The key role of fire services is to save lives and property from fire, conduct rescue operations, and educate and create public awareness for fire prevention. Municipal bodies and State Governments allocate resources to strengthen Fire Services with modern gadgets and technologies and to take various steps required for the safety of life and property of the citizens in the area of their jurisdiction.

Today, 22 out of 28 states have state-run fire services. The remaining six states, namely Maharashtra, Gujarat, Madhya Pradesh, Rajasthan, Punjab, and Haryana, have fire services maintained by ULB, i.e., Municipal Corporations, Councils and Special Planning Authorities like the Maharashtra Industrial Development Corporation or the City and Industrial Development Corporations.
The Ministry of Home Affairs, Government of India, under its advisory role in matters related to Fire Service, had prepared a Model Bill titled "Maintenance of a Fire Force for the State" in 1958 to facilitate the enactment of Fire Service Acts/Rules in the States. Further, to address all issues related to Fire Service, including their role in Disaster Management as Multi-Hazard

[17] Sameer M Deshkar, *Kautilya Arthashastra and Its Relevance to Urban Planning Studies*, Institute of Town Planners, India Journal 7-1, Jan – March 2010. Accessed at <www.itpi.org.in/uploads/journalfiles/jan8_10.pdf>
[18] Constitution of India, Legislative Department, Ministry of Law and Justice, Govt of India, Pg. 239. Accessed at <https://legislative.gov.in/sites/default/files/COI.pdf>

Response Unit and provisions of the National Building Code of India, a revised model bill was approved by the Ministry titled 'Model Bill to Provide for the Maintenance of Fire and Emergency Service for the State' in the year 2019 which was circulated later to all states and UTs for suitable revision in their respective Fire Service Rules / Regulations on the basis of revised Model Bill.

5.1 National Building Code

The National Building Code[19] of India covers detailed guidelines for the structures' construction, maintenance, and fire safety. BIS publishes the Code, and the states could consider incorporating and implementing the recommendations put forth in the Code into their local building bylaws. However, these codes are not mandatory but mere recommendatory. Part – IV of the Code titled 'Fire and Life Safety' covers the requirements for fire prevention, life safety about fire and fire protection of buildings.

The main objective of this part is to specify measures that will provide a degree of safety from fire, which is practical and can be reasonably achieved. It also insists upon compliance with minimum fire safety standards necessary for building occupants and users and even recommends the usage of equipment and installation duly certified under the BIS Certification Marks Scheme. The Code also lays down a Fire and Life Safety Audit provision, which shall be carried out for all buildings with a height of more than 15 meters.

Part – VIII Section 2 of the Code titled 'Building Services - electrical and allied installations' covers the essential requirements for electrical installations in buildings to ensure efficient use of electricity including safety from fire and shock. This Section also includes general requirements relating to earthing and lightning protection of buildings, as well as on the right selection and sizing of electrical equipment's including cables as per NBC for safer environment

5.2 State Regulations

With the Model fire Safety Bill and National Building code as overarching constructs, majority of the States, except a few[20], have enacted legislation or rules to ensure fire prevention and safety. Most of these complement the Model Fire Service Bill and the National Building Code issued by the Centre. Several of the National Building Code provisions and other standards prescribed by BIS have been incorporated by various State Governments and Local Bodies in their building regulations.

For example, the Acts and Rules enacted by states/UT like Andhra Pradesh,[21] Odisha,[22]

[19] National Building Code of India 2016. Accessed at <www.bis.gov.in/index.php/standards/technical-department/national-building-code/>
[20] Fire & Emergency Services Act is in force in 24 states. There is no such law in States like Madhya Pradesh, Rajasthan, Jharkhand, Nagaland.
[21] Andhra Pradesh Fire Service Act, 1999 & Andhra Pradesh Fire and Emergency Operations and Levy of Fee Rules, 2006
[22] Odisha Fires Service Act, 1993 & Odisha Fire Prevention & Fire Safety Rule, 2017

Manipur[23] and Delhi[24] are aimed to improve the overall status of fire safety measures in their respective states by meeting minimum standards for fire prevention and fire safety that are under those published by BIS and National Building Code of India.

Table 7: No. of Fire Accidents Reported Past Three Years in States that have No Dedicated Legislation on Fire Service

State	2021		2020		2019	
	No. of Accidents	No. of Death	No. of Accidents	No. of Death	No. of Accidents	No. of Death
Madhya Pradesh	1179	1178	1430	1390	1532	1467
Rajasthan	271	277	352	351	524	535
Jharkhand	299	285	305	303	332	345
Nagaland	6	6	0	0	4	5

Source: Compiled from ADSI Reports, National Crime Records Bureau.

Table 7 shows that Madhya Pradesh is one state that requires some kind of immediate policy intervention to protect its people's life and property from fire incidents. The compliance audit report[25] of ULBs in Madhya Pradesh by the Comptroller and Audit General in 2017 has also expressed concern over the lack of initiative on the part of the state government to enact the Fire Service Act. It is reported[26] that the state government has been long working on a fire safety bill and tenancy bill and intends to introduce it in near future. Currently, the fire services are organised under Municipal Corporations Act 1956 and Municipalities Act 1961.

However, the respective municipal acts have not been designed keeping in mind compliance with the Model Fire Bill. This includes penalties and punishments for violation of the duty of fire service personnel, failure of a person in communicating information on an outbreak of fire, false report of the outbreak of a fire; and liability of property owner whose property catches fire due to deliberate or negligent action, to pay compensation to any other person suffering damage to his property.

Similar is the case with respect to Building By-Laws. In 2016, the urban development ministry has circulated a Model Building By-Laws which specifies the regulatory mechanism and engineering parameters such as equipment and material standards that one needs to be aware of to prevent fire and electricity accidents before starting any construction project in India. However, building regulations being a state subject the states the states are not mandated to take into account alignment with model bye laws. Due to this each State has a different approach and plan to prevent fire accidents in the building and while this

[23] Manipur Fire Service Act 1992 & Manipur Fire Service Rules, 1997
[24] Delhi Fire Service Act 2007 & Delhi Fire Service Rules 2010
[25] CAG Compliance Audit Report No. 4, Local Bodies, Government of Madhya Pradesh, 2017. Accessed at <https://cag.gov.in/uploads/download_audit_report/2017/Chapter_5_Compliance_Audit_of_Report_No.4_of_2017_Local_Bodies_Government_of_Madhya_Pradesh.pdf>
[26] Bhopal: Govt working on fire safety, tenancy bill, Free Press Journal, 02 January 02, 2023. Accessed at <www.freepressjournal.in/bhopal/bhopal-govt-working-on-fire-safety-tenancy-bill>

customization does help in catering to local needs, a more standardised approach taking into account the need to synchronize central and state laws would help create a more robust structure and plan to mitigate fire accidents in the country.

5.3 Miscellaneous Other Laws

Other than such specific State Acts and Rules, numerous other legal documents related to fire prevention and safety. For instance, the Factories Act 1948 specifies the precautions and effective measures for fire safety in factories. The Cinematograph Film Rules, 1948, specifies precautions to be taken to prevent an accident by fire or explosion where the film is stored or handled. The Shops and Establishments Acts enacted by various state governments have a separate Chapter on Occupational Health and Safety providing for cleanliness, ventilation, lighting, and precautions against fire and first aid. Likewise, the Indian Electricity Act of 2003, Gas Cylinders Rules 2004, Coal Mines Regulations 1957, Mines Rescue Rules 1985, Petroleum Rules 2002 etc., all have fire prevention and safety provisions.

The Guidelines on scaling, type of equipment and training of fire services issued in the year 2012 by the National Disaster Management Authority (NDMA) under Section 6 of the Disaster Management Act 2005 provide for standardisation and revamping of the fire services in the country and effective, efficient, and comprehensive management of fire incidents. To operationalise the process systematically, the NDMA issued these guidelines about scaling, type of equipment, manpower and training, along with a strategy for funding the requirements.

In addition, as per guidelines provided by the International Civil Aviation Organisation and the Directorate General of Civil Aviation, the Airport Rescue and Fire Fighting (ARFF) services are provided at all airports in the country.[27] Also, the Central Industrial Security Force (CISF) Rules, 2001 establishes a Fire Wing to offer protection against fire hazards at industrial undertakings and installations.[28] The Fire Wing is an integral part of CISF and is the largest, well-trained, equipped fire fighting force in the government sector.

5.4 Standards for Fire Safety

BIS has formulated hundreds of fire safety standards with the help of various sectional committees. Through Fire Fighting Sectional Committee, Civil Engineering Division (CED) 22 has formulated standards on fire safety in buildings and firefighting equipment, extinguishers & systems etc. These include standards for Fire Alarm & Detection systems, First Aid Fire Extinguisher, Fixed CO2 Fire Extinguishers, Hose Pipes, Hose Reels, Hydraulic Fluids, Fire Safety Symbol & Signs, Firefighter – PPE, Fire tender & equipment etc. Likewise, the Fire Safety Sectional Committee, CED 36, has formulated a series of Indian Standards about General requirements and specific to various buildings & industries.[29]

[27] Airport Authority of India. Accessed at <www.aai.aero/en/services/fire-service>
[28] MD Sharma, MC Sharma, Paramilitary Forces of India, Gyan Publishing House, 2008.
[29] N Rani, Fire Safety Legislations and National Building Code of India, 2005: Ground Reality and Desired Improvements, International Journal of 360 Management Review, Vol 7, Special Issue, May 2019. Accessed at < https://www.ij360mr.com/docs/vol7/spcl/28.pdf>

5.5 ISO Standards

Since the International Organisation for Standardisation (ISO), the then Indian Standards Institution (ISI) and now BIS, has been an active member and has been contributing to the policy as well as in technical matters related to international standardisation. BIS has also been, to the extent possible, harmonising its standards with ISO standards while adapting and adopting them as Indian standards.

Fire safety issues appear in reports of several technical committees of ISO, but there only one committee solely dedicated to the fire safety named ISO/TC 92. They have so far published 33 ISO standards under the direct responsibility of ISO/TC 92/SC4, and 6 ISO standards are under development.[30] The main goal of the committee is to produce standards in the field of fire safety engineering, at the same time support the enforcement of standards. The sub-committees address topics like SC1 - Fire initiation and growth; SC2 - Fire containment; SC3 - Fire threat to people and environment; and SC4 - Fire safety engineering. The fire safety standards addressing combustible materials are mainly produced in SC1, while guidance related to toxicity and the environment is dealt with in SC3.[31]

[30] Accessed at <https://www.iso.org/committee/50552.html>
[31] International Organisation for Standardization ISO and Fire related activities. Accessed at <www.flameretardants-online.com/news/archive?showid=17928>

6. EXPLORING THE CHALLENGES & BARRIERS IN FIRE PREVENTION & SAFETY

If every Indian standard was taken seriously, and every single regulation was upheld and effectively implemented by state authorities then there would have been fewer fire accidents and victims across the country. Enquires reveal that, almost every fire accident in the country could have been prevented or damages could have been reduced if fire safety regulation and standards enforcement was strengthened and the authorities acted in a more synchronised manner. Besides the property owners/ responsible person need to ensure compliance with the existing fire safety guidelines and standards. To prevent fire accidents proper coordinated and integrated effort is required at all levels, from centre to state, wherein the stakeholder have clarity of their role and are given the authority and accountability to prevent fire from all causes.

6.1 Fire Prevention

Fire prevention strategies begin from the designing and planning stage of a building and hence are largely influenced by decisions made by the builder and homeowner prior to the commencement of a construction. The Part IV of the National Building Code of India on 'Fire & Life Safety' includes the requirements for fire prevention and life safety in relation to fire and fire protection of buildings. It includes comprehensive recommendations on minimum standards of fire protection and specifies the demarcation of fire zones, restrictions on construction of buildings in each fire zone, classification of buildings based on occupancy, types of building construction according to fire resistance of the structural and non-structural components and other restrictions and requirements necessary to minimise danger to life from fire, smoke, fumes, or panic before the building can be evacuated. To be more specific, some of the key features in the Building Code that focuses to prevent fire includes:[32]

- Demarcation of fire zones and restrictions on construction of buildings in these fire zones
- The use of non-combustible and non-flammable materials like copper
- Design and planning of electrical wiring installation including but not limited to using copper wiring in all buildings.
- Design details to prevent the passage of smoke and flames up through the building

However, unlike in most other countries, National Building Code of India serves only as a Model Code and not a mandatory Code for adoption by all organisations and agencies involved in building construction works. The State lacks the capacity to carry out efficient

[32] Part 4: Fire and Life Safety, National Building Code of India. Accessed at <https://mptownplan.nic.in/act%20&%20Rules/NationalBuilding%20Code%20Part-IV%20(Fire%20Safety).pdf>

enforcement and penalize, sanction cancellations or approve demolitions in cases where buildings do not comply with building codes or violate the National Building Code. Despite best intentions by the policy makers, these codes and safety standards are rarely taken seriously by builders and other responsible authorities in practice. Even the few states that have adopted the standards as rigorous as the National Building Code the enforcement levels were far from stringent.[33]

In advanced economies like the United States, buildings that do not comply with building codes or violate the National Building Code have to face stringent penalties, sanction cancellations, or demolition. In United Kingdom, if a developer fails to comply with building regulations, s/he will be served with an enforcement notice and face legal action. There are high penalties for violating building regulations.

6.2 Electric Short Circuit a Recurring Cause

Electrics short-circuit is a recurring cause of fire accidents. Data from Table 2 and the recent incidents cited in Table 5 confirms this. As per available data, there were approximately 1808 electrical short circuit fires accidents alone in the year 2021, while it was 1943 in 2020 across the country. Further region-wise analysis of cause of fire reveals that 70 percent of the fires reported in Mumbai in the last four years were caused by defective electric circuits i.e., 12,117 fire accidents from the reported 17,527 fires were from 2019 to 2022 were of electric-origin.[34] and most of these were preventable. The fact that this is state of play in the financial capital of the country which would have more resources than other cities of the country, shows that there is a lot that can be done in terms of further strengthening the fire safety prevention system and its enforcement – when it comes the electric causes.

Electricity sparked fires would have several triggers and their causes vary. it could be due to non-adherence to existing Indian standards i.e. poor electrical design, defective insulation, lack or improper earthing, unauthorised work, poor wiring, undersized wires and cables, moisture in switch board Overloaded electrical circuits due to addition of extra electrical load in existing buildings with insufficient electrical infrastructure, unlike structural audits absence of electrical audits are some of the major causes of residential fires mainly in over-crowded urban space where fire retardant material is still not a norm.

The enforcement agencies within the country need to focus more on the importance of the electrical audits. They have been constrained due to lack of mandatory legal provisions to conduct such audits in buildings, lack of trained staffs, financial shortage or sometimes even lack of awareness and seriousness towards the job of on field personnel. There is an urgent need for strong statutory backing to carry out thorough electrical audit by a competent engineer, checking the current capacity v/s the connected load, insulation etc. mainly of apartments, high multistorey residential buildings, commercial buildings, and buildings where more public gather for a purpose.

[33] Hon'ble Supreme Court of India in its judgement in Avinash Mehrotra Vs Union of India [(2009)6SCC398] while dealing with case of Fire safety in School's observed this.
[34] Mumbai: 70 percent of all fires reported in city in last four years caused by defective electric circuits, Free Press Journal, 24 Oct 2022. Accessed at < www.freepressjournal.in/mumbai/mumbai-70-percent-of-all-fires-reported-in-city-in-last-four-years-caused-by-defective-electric-circuits>

Often it is witnessed that during the time of construction, the builder provides electric equipment and fittings to carry a definite fixed electrical load, taking into consideration the basic needs of electrical equipment in a household. However, as years pass the property owners keep increasing the electrical installation without bothering to check whether existing electrical wiring and provided load is sufficient to meet the requirement.

Central electricity authority, under the provision of Safety regulation 2010, mandates electrical inspection of Low Voltage electrical installations (includes residential buildings) every 5 years. The high use of electrical equipment and machinery in urban areas leads to higher chances of faulty electric connections and gadget failures amplifies the risks further.

6.3 Lacunae in Legal Framework

As in most developing economies, regulatory standards and their enforcement in India needs further system strengthening There is need to have proper coordination between several government departments for optimal enforcement. Further given that most of the standards are non-mandatory, compliance is function of the responsible behaviour of the property owner, and to Currently, BIS has more than 21,901 quality standards for different products and services, but only around 361 products are under mandatory certification.[35] . Stringent enforcement needs the authorities to be equipped with appropriate powers to penalise or reward with minimal confusion in roles and responsibilities.

Therefore, the non-regulatory BIS standards related to fire safety can be enforced as a dynamic guideline only if the authorities or the industry are enabled to makes such provisions and then exercise their authorities. Until this happens, these compliance with the standards would be considered voluntary by stakeholders. With respect to National Building Code also, enforcement and compliance is a challenge, as states have yet to entirely adopted. Audit reports have revealed that even in progressive states like Kerala, where provisions regarding the fire protection activities mentioned in the Code were adopted, yet the Kerala Municipal Building Rules did not include detailed specifications regarding prevention and fire safety.[36]

Likewise, there still exists high degree of confusion among builders across various states regarding compliance with NBC or the respective state legislation regarding the term 'high-rise buildings', a key term that requires more clarity to decide whether fire safety compliance is required for a building or not. For instance, in 2007, while the Bangalore Development Authority's (BDA) Master Plan says 24-metre-high buildings are high-rises, the Bruhat Bengaluru Mahanagara Palike, the administrative body responsible for civic amenities, and the Karnataka State Fire and Emergency Services (KSFES) follow the National Building Code that specifies 15 metres and above as high-rises.[37] This created confusion among the builders

[35] BIS Annual Report 2020-21 Review Statement. Accessible at <www.bis.gov.in/wp-content/uploads/2022/02/Review-Statement-BIS-AR-2020-21.pdf>
[36] CAG Compliance Audit Report No.5, Kerala, 2017. Accessed at <https://cag.gov.in/uploads/download_audit_report/2017/Kerala_Chapter_5_Compliance_Audit_Report_No._5_Of_2017_On_GSS.pdf>
[37] High Confusion on High-Rise building norms, Citizen Matters, 27 April 2010. Accessed at <https://bengaluru.citizenmatters.in/1969-high-rise-buildings-norms-unclear-1969>

to decide whether a 'No Objection Certificate' is required or not until 2015, when the BDA finally amended its provisions to match it up with National Building Code. [38]

Similar is the situation in other states, where plethora of rules and regulations are used selectively and irrationally. There is a need to standardise legislation across the country to enable the stakeholder in tackling fire incidents. In a state like Gujarat, while municipal corporations have their own set of rules under the Gujarat Provincial Municipal Corporations (Amendment) Act, 2017, the state also has the Gujarat Fire Prevention and Life Safety Measures Act, 2013 and the General Development Control Regulations (GDCR) for 2021 which are mostly not in sync.[39] The statutory provisions, which are mandatory, serve as a minimum standard to ensure fire safety. Still, its amendment process in case of mismatch or omission is so lengthy and time-consuming that it is often challenging to keep it matching with needs and requirements in this area. The Gujarat Fire Prevention and Life Safety Measures Regulations, 2021, drafted to eliminate certain discrepancies in the provisions of the NBC and the GDCR is yet to see the light.

Also, it remains unanswered how old buildings that were designed and constructed even before the enactments of the present fire safety legislation were brought under its purview to make them fire safe.[40] Many housing societies and busy commercial spaces, even in major cities like Delhi, Mumbai, and Kolkata, were built in 1970's - 60's or even much earlier are not safe even for habitation now. Due to the present deplorable condition and comparatively lower rent, such places are often crowded with people who ignore fire safety rules. They often do not have adequate time and resources to prioritise fire safety nor have realised the larger risks involved due to poor knowledge and awareness related to fire safety.

Looking into the gravity of accidents whenever fire incidents happen, coupled with confusion and irregularity in fire service legislation across the country, it would be prudent to **revisit the seventh schedule of the Constitution, which specifies the allocation of powers between the Centre and the States, and shift fire safety to concurrent list.** Given the negative impact of fire accidents on economic, social, and environmental surroundings, fire service certainly has the potential to become a subject that deserves the attention of the Centre equally, and greater coordination among different tiers of governance. Besides, it should be recognised that Municipalities that are struggling to self-sustain cannot establish, nor maintain and develop fire service as a service delivery organisation. Also, it turns out that almost 70 percent of the population who live in rural India do not have fire protection services. Therefore, the country would do much better if the fire service were brought under the concurrent list.

6.4 Fire Inspection, Enforcement & Infrastructure

[39] Fire Safety: Maze of Rules Providing Loopholes? Times of India, 04 Jan 2018. Accessed at <https://timesofindia.indiatimes.com/city/ahmedabad/fire-safety-maze-of-rules-providing-loopholes/articleshow/62358454.cms>

[40] Retrofitting rules a problem, put old buildings at risk, Times of India, 22 January 2019. Accessed at <https://timesofindia.indiatimes.com/city/kolkata/retrofitting-rules-a-problem-put-old-buildings-at-risk/articleshow/67633472.cms>

Other than the absence of uniform legislation throughout the country, the country has numerous legislations spread across every state that deal with fire prevention and safety. But like in other sectors, despite these many legislations and fire safety standards due to weak enforcement, poor inspection and inadequate financial support, vast majority of the country still faces the threat of raging accidental fires. For instance, an assessment of 484 government hospitals in Maharashtra, undertaken a day after the Bhandara fire incident, found that at least 90 percent of hospitals do not possess a NOC from the fire department. Another 81.8 per cent never conducted a fire-safety audit in their hospitals and only 218 hospitals (45 per cent) had conducted a mock fire drill in the past.[41]

Similar is the situation in Karnataka, where the State Health Commissioner issued an order on May 07, 2022, directing 16 district and 150 taluk hospitals to conduct the audits and receive an NoC from the State Fire and Emergency Services Department by May 21. The Department even approved ₹82 lakh for the fire audits of 166 hospitals (at ₹50,000 each) under the National Health Mission (NHM). Later, it was reported that only 44 of the 166 hospitals (27 percent) got the fire audit done within the stipulated time. Implementation was zero in 14 districts, including Bengaluru Urban.[42]

According to Mumbai Fire Brigade data, of the 324 fires reported in the city's high-rise fires between January 2020 and October 2021, 127 buildings (39.2 percent) did not have an operational firefighting system.[43] Likewise, a recent inspection after an incident of fire in a hotel in Lucknow revealed that there is no proper arrangement for extinguishing the fire in 150 hotels and 154 hospitals in the city, including the district hospital, where thousands of patients visit daily. There are 900 such large buildings for which NOC has not been obtained from the fire department. This negligence has also come to the fore in 102 societies and 300 industrial units.[44]

In Kolkata, a recent audit by the Fire Services Department has revealed that over 500 business establishments, including factories, godowns and storehouses across Kolkata, have the potential to become hotspots of the devastating fire.[45]

According to CUTS report titled State of Consumer Safety in India 2016, there is no clear provision in any of the safety legislations in India regarding the scope, objectives, methodology and periodicity of a fire safety audit, which is a good tool to assess fire safety

[41] Bhandara hospital fire: Probe votes for engineers over PWD for hospitals' upkeep, The Indian Express, 21 January 2021. Accessed at <https://indianexpress.com/article/cities/mumbai/bhandara-hospital-fire-probe-votes-for-engineers-over-pwd-for-hospitals-upkeep-7155130/>

[42] Only 27% of 166 government hospitals in Karnataka complete fire safety audits despite prodding by PM, The Hindu, 25 May 2022. Accessed at <www.thehindu.com/news/national/karnataka/only-27-of-166-govt-hospitals-in-state-complete-fire-safety-audits/article65461107.ece>

[43] In 39% of high-rise fires, firefighting system did not work: Mumbai Fire Brigade, Hindustan Times, 18 Nov 2021. Accessed at <www.hindustantimes.com/cities/mumbai-news/in-39-of-high-rise-fires-firefighting-system-did-not-work-mumbai-fire-brigade-101637258646728.html>

[44] Complete arrangements to extinguish fire were not found in 150 hotels and 154 hospitals, News7, 14 September 2022. Accessible at <https://news7noida.com/complete-arrangements-to-extinguish-fire-were-not-found-in-150-hotels-and-154-hospitals/>

[45] Safety Audit reveals fire hazards in 568 trade establishments in Kolkata, Telegraph India, 25 June 2022. Accessed at <www.telegraphindia.com/my-kolkata/news/safety-audit-reveals-fire-hazards-in-568-trade-establishments-in-kolkata/cid/1871686>

standards. The National Building Code recommends periodic fire safety inspections by the key personnel among the occupants of the building. In industrial buildings, the statutory authorities insist on fire safety audits by external agencies depending on the type of activity and the nature of the materials handled in the building. Maharashtra Fire Prevention and Life Safety Measures Rules, 2009 made it mandatory for building owners and residents to conduct half-yearly fire safety audits and submit the report to the fire department. While this is a positive development, however, making the licensed agencies responsible for conducting the fire safety audit creates confusion because the same agency has also been entrusted with installing and maintaining the firefighting systems. This dilutes the scope and methodology of the audit.[46]

Similar is the case across the length and breadth of the country. One of the main reasons highlighted in the FICCI report[47] for the rise in fire accidents is rapid urbanisation and the lack of fire safety norms and safety protocol. Fire safety audits, violations of regulations, and lack of awareness are all common causes of fires. Most states and ULBs struggle to keep up with the legal requirements or turn a blind eye. Often the concerned authorities wake intermittently after a major accident to temporarily appease the higher reporting authorities, committees, judiciary, and the media. Then after things get settled, everything returns to the normal routine state of the affair until the next untoward incident.

A fragmented and weak institutional framework has failed to assign well-defined roles and responsibilities. This is often evident when enforcing fire safety norms in buildings. The authorities, including the city corporation, the Department of Fire and Rescue services and the district administration, often pass the responsibility to each other. In Kerala, for instance, the corporation, which grants building permits, claims enforcement does not come under its purview. At the same time, fire and rescue services authorities say it is not their responsibility either. Interestingly, both departments claim it is the district administration that should be enforcing the rules. In contrast, the district administration reverts to saying they have not heard anything from the fire department.[48]

Many times, the judiciary is forced to fix the responsibility while dealing with cases related to fire mishaps. On the issue of accountability, the Gujarat High Court recently, while dealing with a Public Interest Litigation[49] on frequent fire incidents within the state, had held clearly that certain officers should be fixed with accountability in case of mishaps and proposed to fix the accountability as under:

Accountability		
S.No.	**Particular**	**Person Responsible**
1.	Occupation without Building	Owner/Builder/Developer

[46] State of Consumer Safety in India 2016, CUTS International, 2017. Accessed at <https://cuts-cart.org/pdf/Report-State_of_Consumer_Safety_in_India_2016.pdf>
[47] *Supra n. 7*
[48] Who'll enforce fire safety norms? Deccan Chronicle, 09 Aug 2019. Accessed at <www.deccanchronicle.com/nation/current-affairs/090819/wholl-enforce-fire-safety-norms.html>
[49] Amit Manilal Panchal Vs. State of Gujarat, C/WPPIL/118/2020, Order Dated 30/06/2022. Accessed at <http://gujarathc-casestatus.nic.in/gujarathc/#>

	Use Permission	
2.	Expired NOC/ No NOC	Occupant/Owner/Chief Fire Officer
3.	Accountability for illegal action or inaction by the Authority	i. Municipal Commissioner ii. Deputy Municipal Commissioner (Estate Department) iii. Deputy Municipal Commissioner in charge of the concerned Department. iv. Chief Fire Officer

Fire services being identified as technical first responders, it is essential that at each level in the organisational structure, starting from the chief fire officer to the right up to the corporation level, the role/responsibility of fire service are clearly defined. A clear and transparent chain of command should be established at each level and answerable to the next higher authority. Entrusted with a great social responsibility, there is a need for a transparent command structure and effective utilisation of resources. But often, it is witnessed that in the absence of any organised mechanism for intervention in non-fire emergencies like rescuing trapped persons from collapsed buildings and drowning cases, fire services are quite often pressed to tackle non-specific emergencies. Today, they are forced to act as multi-hazard response services without adequate training, equipment, and the legal basis.

Proper organisational structure, well-defined system of incentives and disincentives, access to adequate resources, training and career progression of its personnel are also lacking in most fire departments. For instance, the 2021 Comptroller and Auditor General of India Report on Rajasthan highlights the improper management and utilisation of technical staff recruited as firemen by the Directorate of Local Bodies (DLB). In 2016, DLB recruited 610 firefighters and posted them in various ULBs. Still, the DLB issued orders for deploying these firemen, who are technical staff, for other administrative works and hired firefighters on a contract basis.[50] Thus, on the one hand, while ULBs are facing an acute shortage of manpower, on the other, trained firemen are being deputed for routine official work.

The Directorate General (Fire Service, Civil Defence and Home Guards), Ministry of Home Affairs had engaged Risk Management Solutions Inc. (RMSI), a consultative firm, to carry out Fire & Risk Hazard Analysis in the year 2011. It highlighted the actual requirement of the country as of 2012 for Fire Station, Manpower, and Firefighting Appliances/Vehicles. Later, the Directorate General in 2018 collected data from the States on the availability of fire stations, rescue vehicles and fire extinguishing personnel. The gap between the 2018 data and the RMSI report 2012 is highlighted in Table 8.

Table 8: Availability and Gap of Fire Stations, Rescue Vehicles and Fire Extinguishing personnel in the Selected States

[50] Performance Audit on Efficacy of implementation of 74th Constitutional Amendment Act, Report of the CAG, Gov of Rajasthan, Report No.5, 2021. Accessed at <https://cag.gov.in/webroot/uploads/download_audit_report/2021/Full%20Report-English-74th%20CAA-0622b24e8505c47.07308141.pdf>

State	Fire Station			Manpower			Firefighting Appliances/ Vehicles		
	2018	Requirement	Gap	2018	Requirement	Gap	2018	Requirement	Gap
Delhi	53	108	55	1632	6052	4420	179	304	125
Maharashtra	157	1074	917	5240	48078	42838	435	3075	2640
Gujarat	183	394	211	1447	34240	32793	770	1467	697
Madhya Pradesh	292	513	221	964	40327	39363	480	1994	1514
Odisha	340	331	0	2606	21170	18564	279	1289	1010
Mizoram	12	49	37	209	1997	1788	30	148	118
Karnataka	195	377	182	4329	29736	25407	469	1583	1114
Kerala	100	228	128	2427	15292	12865	364	781	417
Rajasthan	126	874	748	1158	29937	28779	262	1580	1318

Source: Rajya Sabha Unstarred Question No.516 Answered on 26th June 2019 by Minister of State in the Ministry of Home Affairs, Govt of India.

The Ministry of Home Affairs 2019 informed Parliament that the country had just 3377 fire stations against the requirement of 8,559, a shortfall of almost 61 percent. India needs 5191 fire stations, 5,03,365 trained fire personnel, and 25,460 firefighting equipment and vehicles.[51]

This lack of adequate infrastructure and manpower significantly hinders fire protection services and the effective enforcement of available legislation. Experts have repeatedly recommended strengthening the enforcement machinery, but no major developments have happened anywhere in the country. A recent PIL filed before the Rajasthan High Court[52] points to this gory fact: fire service personnel across the state often fight fire without having basic firefighting equipment, clothes, and shoes to wear. Lack of such basic infrastructure seriously impacts fulfilling their duties, resulting in more casualties, death, and loss to the economy.

For instance, this PIL was filed after firemen could not control the fire in time resulting in the death of five people in a house in 2018. Most municipal corporations across the state do not have adequate resources and trained personnel to extinguish the fire in multi-storey buildings. With almost 13 industrial areas in Jaipur city alone, the Department needs to be well equipped with both manpower and equipment, including updated data regarding the kind of chemicals or potentially dangerous material used in these areas.

[51] Rajya Sabha Unstarred Question No.516 Answered on 26th June 2019 by Minister of State in the Ministry of Home Affairs, Govt of India. Accessed at <www.mha.gov.in/MHA1/Par2017/pdfs/par2019-pdfs/rs-26062019/516.pdf>

[52] Kunal Rawat Vs State of Rajasthan and Others, D.B. Civil Writ Petition No. 1481/2018, High Court of Rajasthan.

The situation in other states is quite similar, the Jammu and Kashmir Fire & Emergency Services Department had submitted to its government 92 potential sites for new fire stations. Still, no new fire station has been established for the last five years due to administrative reasons.[53]

Likewise, per the norms laid down by the Central Standard Fire Advisory Committee (SFAC), as of 2021, Pune city requires 74 fire stations and 1,620 firefighters, but as per reports, the Fire Department is operating with only 14 fire stations and 380 firefighters. This means the Department operates at a fifth of the number of fire stations required and has only one-fourth of the strength needed.[54] Worst is the situation in states like Jharkhand, where firefighters' salary might not be paid in the coming months due to the absence of drawing and disbursing officers in the Department.[55]

As per reports, 250 posts of firefighters and 44 posts of fire officers across the state are lying vacant. The vacancy has reduced the strength of the Department to 418 firefighters and 38 officers to take care of fire safety in the entire state with the help of 41 fire stations. This is despite requisition being sent to the home department couple of times to provide the required strength.

Even institutional structures do not have proper fire safety mechanisms in place, putting several people associated with these institutions at significant risk of losing livelihood, limb, or life.

The 2022 Report of the Comptroller and Auditor General of India on the Efficacy of Implementation of the Seventy-fourth Constitutional Amendment Act in Maharashtra highlights that adequacy of trained manpower is essential for speedy response and rescue operations in disaster situations. In the 44 test checked ULB audits, observed the following:[56]

- In 43 ULBs, as against the sanctioned requirement of 6,688 fire personnel, 3313 posts (50 percent) were vacant.
- Out of the eight test-checked Municipal Corporations, it was seen that in seven Municipal Corporations, viz., Greater Mumbai, Amaravati, Latur, Nagpur, Nashik, Thane and Vasai-Virar Municipal Corporations, the post of Chief Fire Officer was either vacant or held by lower rank officials.
- The post of Fire Officer was vacant in 34 (97 percent) out of the 35 test-checked Municipal Councils/ Nagar Panchayats. No officials were posted against 17 posts of Municipal Fire Service Grade A and 90 posts of Municipal Fire Service Grade B. Further, as against 360-sanctioned Municipal Fire Service Grade C posts, 319 posts (89 percent)

[53] Understanding the rise in fire incidents in Jammu and Kashmir, JK Policy Institute, 26 May 2022. Accessed at <www.jkpi.org/understanding-the-rise-in-fire-incidents-in-jammu-and-kashmir/>

[54] Pune fire brigade operating with 20% fire stations, 25% of firefighter strength, Indian Express, 19 April 2022. Accessible at <https://indianexpress.com/article/cities/pune/pune-fire-brigade-operating-with-20-pc-fire-stations-25-pc-of-firefighter-strength-7875672/>

[55] Hit by manpower crisis, Jharkhand's fire brigade staff may not get salary from next month, Lagatar News, 16 Oct 2021. Accessed at <https://lagatar24.com/hit-by-manpower-crisis-jharkhands-fire-brigade-staff-may-not-get-salary-from-next-month/66767/>

[56] Report of the Comptroller and Auditor General of India on the Efficacy of Implementation of Seventy-fourth Constitutional Amendment Act in Maharashtra, Government of Maharashtra Report No. 3 of the year 2022. Accessed at <https://cag.gov.in/en/audit-report/details/117101>

were vacant.

Further, in 17 out of the 34 test checked ULBs[57], the fire stations were available as per the norms, while in 17 ULBs, there was a shortage of 73 fire stations (61 percent) as against the requirement of 120 fire stations.

6.5 Fire Incidents & Prevention Research in India

Over millions of people in our country live and work in informal and unsafe settlements, and this number is ever increasing alongside growing urbanisation. These crowded settlements are some of the most vulnerable areas to large-scale fires that cause significant harm to life and livelihood. Therefore, adequate, and constant research after considering the peculiar situations of our country should be the constant aim to make life in such settlements safer, including the life of the firefighters who protect them in case of an incident.

While countries including the US, UK and even smaller countries like Thailand have well-organised firefighting setup divided into many wings, which look after – planning and supervision, research and development, training, campaign, and public awareness etc., comparatively, India still lags when it comes to research advancement in this field. Many modern, useful, and effective firefighting technologies are imported, making the equipment prohibitively costly and difficult to procure. Data's reveal that between 2019 and 2020, the second fastest growing importer of Fire extinguishers was India ($13.6M).[58] This dependency on other countries for equipment's can be largely attributed to the fact that fire safety and fire science, including fire engineering, is the least developed due to the lack of adequate fire programmes in Indian universities and research institutes. Including fire safety equipment in 'Make in India' and similar incentive programmes would help change this scenario.

Another basic problem with fire research and development is the lack of reliable statistics about the number of incidences, damage, area burnt, etc. This type of information is rarely available, and if available, its reliability is question marked. Reliable data on the cause of fires, area burned, and damage are usually available in a limited number of countries. In most other countries, including India, maximum data are collected from various scattered sources and most of these usually cover only major reported fire incidents. Also, insufficient research and development funds contribute to this neglected scenario.

The Ministry of Home Affairs, while responding to a question in Parliament in 2016, categorically stated that there is no scheme in this Ministry for funding research projects related to fire safety through educational institutions in the country.[59] Sufficient fund provision is to be made for research and development and suitable projects should be sanctioned to state-level research institutions to establish a strong database.

Recently the Indian Institute of Technology (IIT), Gandhinagar, with the financial support of a

[57] Alibaug, Khultabad, Lakhani, Motala, Nandurbar, Osmanabad, Shirala, Shirur-Anantpal, Sindkhed and Trimbak ULBs did not furnish the information.
[58] OEC. Accessed at <https://oec.world/en/profile/hs/fire-extinguishers-whether-or-not-charged>
[59] Unstarred question no.1053, Lok Sabha, Ministry of Home Affairs, 22 Nov 2016. Accessed at <www.mha.gov.in/MHA1/Par2017/pdfs/par2016-pdfs/ls-221116/1053.pdf>

private firm, announced its plan to augment its efforts in Fire Safety Engineering by setting up a new fire testing lab and undertaking multiple scholarly activities to boost research and development in the area of fire safety in the country.60 The same was inaugurated as Shah Bhogilal Jethalal Laboratory for Passive Fire System Testing in December 2022.[61] The new lab will help enhance fire safety in high-rise buildings, airports, metro rail, and other infrastructure projects by critically testing building elements. Likewise, in 2021 the Underwriters Laboratories Inc. and National Fire Service College (NFSC), Nagpur, signed a memorandum of understanding designed to promote greater collaboration and help advance lithium-ion battery fire safety and standardisation in India.[62]

[60] IIT Gandhinagar to augment 'Fire Safety Engineering' with a new fire testing lab and scholarly activities, India Today, 05 July 2022. Accessed at <www.indiatoday.in/education-today/news/story/iit-gandhinagar-to-augment-fire-safety-engineering-with-a-new-fire-testing-lab-and-scholarly-activities-1970415-2022-07-05>

[61] IIT Gandhinagar Inaugurates World-Class Laboratory For Passive Fire System Testing – Aims To Augment 'Make In India' Efforts In The Fire Safety Industry, IITGN News, 03 December 2022. Accessed at <https://news.iitgn.ac.in/2022/12/12/iit-gandhinagar-inaugurates-world-class-laboratory-for-passive-fire-system-testing-aims-to-augment-make-in-india-efforts-in-the-fire-safety-industry/#:~:text=With%20an%20aim%20to%20augment,standards%20on%20December%2003%2C%202022.>

[62] Underwriters Laboratories Inc. and National Fire Service College of India Agree to Collaborate and Advance Understanding of Battery Fire Safety in India, UL Press Release, 18 Aug 2021. Accessed at <https://ul.org/news/underwriters-laboratories-national-fire-service-college-india-mou>

7. FIRE SAFETY INTERVENTIONS: VOICES THAT WENT UNHEARD

7.1 13th Finance Commission 2010-2015

The 13th Finance Commission[63] recommended that to ensure fire safety across the country, all municipal corporations with a population of more than 1 million (2001 census) must put in place a fire hazard response and mitigation plan for their respective jurisdictions and publish them in the respective State gazettes to demonstrate compliance. Also accepting the need to restructure fire and emergency services across the urban and rural areas of the country, the commission recommended that a portion of the grants provided to the ULBs be spent on revamping the fire services within their respective jurisdictions.

7.2 15th Finance Commission 2021-2026

The 15th Finance Commission has recommended fund allocation of INR 5,000 crore under National Disaster Response Fund (NDRF) for the period from 2021-22 to 2025-26 for strengthening fire services at the State level. These resources could be allocated through the Preparedness and Capacity-building component of the NDRF. States need to apply for these funds, for which they should contribute 10 percent of the amount sought. These resources could ideally provide a top-up to the existing programs. The States can also make use of this fund for procurement of modern firefighting equipment to deal with fire disasters.[64]

7.3 Selected Judicial Interventions

Supreme Court took *suo motu* cognisance of various fire incidents in Covid Hospitals, including the one that happened in Rajkot, Gujarat, on November 26, 2020, resulting in the death of Covid patients, and issued the following directions[65]:

- All States/Union Territories should appoint one nodal officer for each covid hospital, if not already appointed, who shall be made responsible for ensuring the compliance of all fire safety measures.
- In each district, State Government should constitute a committee to carry fire audit of each Covid hospital at least once a month, inform the hospital's deficiency management, and report to the government for follow-up action.
- The Covid hospital who have not obtained NOC from the Fire Department of the State

[63] Accessed at <https://fincomindia.nic.in/TFC/13fcreng.pdf>
[64] Accessed at <https://fincomindia.nic.in/writereaddata/html_en_files/fincom15/Reports/XVFC%20VOL%20I%20Main%20Report.pdf>
[65] Suo motu writ petition (civil) no.7 of 2020, Civil Original Jurisdiction, Supreme Court of India. Accessed at <https://main.sci.gov.in/supremecourt/2020/12672/12672_2020_37_1_25112_Judgement_18-Dec-2020.pdf>

should be asked to apply for NOC immediately. After carrying necessary inspection, the decision shall be taken. Those Covid hospitals who have not renewed their NOC should immediately take steps for renewal on which appropriate inspection be taken and a decision be taken. COVID Hospital was found not to have NOC or not have obtained renewal, and the State took appropriate action.

National Green Tribunal (NGT) took *suo motu* cognisance of the 2021 major fire accident on the site of M/s. SVS Aqua Technologies is situated in the village of Urawade, Tal. Mulshi, Dist. Pune. The Tribunal constituted a five-member joint committee to ascertain the cause and allied issues and the steps required to prevent such occurrences. Some of the key set of recommendations that apply to all other factories engaged in a similar operation and/or structure includes:[66]

- An appropriate degree of coordination between the various concerned government agencies must be ensured so that all necessary compliances to be achieved by the industry in question are tracked and verified. The authorities need to be approached in the following order: District Administration, District Industries Centre, State Electricity Board, State Pollution Control Boards and Department of Industrial Safety and Health (DISH). On receiving any application from a prospective industry, all agencies need to become informed simultaneously. An online portal may be developed to enable this information sharing.
- Any manufacturer in a factory dealing with hazardous materials shall not be permitted unless respective authorities issue a final "No Objection" certificate under Maharashtra Fire Prevention and Life Safety Measures Act, 2006.
- Approvals for the establishment of an industrial unit shall be granted in the following sequence to ensure all necessary compliances: Consent to Establishment/Provisional Fire NOC/Plan Approval from DISH/Approval of Layout Drawing by local Planning Authority (such as Industrial Development Corporation and Regional Development Authority) / Plan approval by Food and Drug Administration (FDA) (In case of Pharmaceutical and Food processing units). Drawing approval by Petroleum and Explosives Safety Organisation (PESO) (If applicable) can occur in parallel. For allowing production to commence, Consent to Operate followed by final Fire NOC, PESO approvals, FDA approval if applicable and finally, license by DISH must be secured. Also, intimation needs to be given to Employees' State Insurance Corporation (ESIC) and provident fund authorities to enrol workers for social security facilities.
- The Government of Maharashtra takes the necessary steps to recruit the necessary number of officers at DISH and ensures their empowerment to ensure regulatory enforcement.
- Areas where industrial development took place other than notified industrial area needs basic infrastructure such as road, health care centres/ ambulance services, hospitals and fire stations should be ensured.

[66] M/s SVS Aqua Technologies - Report of the Committee in the matter of original application no. 130/2021, National Green Tribunal, Jan 2022. Accessed at <https://cpcb.nic.in/NGT/Report_SVS_Aqua_Tech.pdf>

April 2022: Supreme Court fixes vicarious liability for negligence on organisers of event leading to horrific fire tragedy in 2006 and allowed compensation to the victims. The unfortunate incident claimed the lives of 65 persons and left over 161 more with burn injuries.

June 2022: Gujarat High Court instructed the Ahmedabad Municipal Corporation to take strict action and seal the buildings that do not have a fire safety system, and also against residential buildings that have not renewed their fire safety NOCs.

Aug 2022: Mumbai High Court sought report with recommendations for implementation of draft regulations for fire safety in buildings vulnerable to man-made disasters from a four-member panel constituted by the government.

Sep 2022: Rajasthan High Court sought a compliance report from the state government regarding the fire safety system in malls, coaching centres, multiplexes, and multi-storey buildings in the state within four weeks, while hearing a PIL filed by Kunal Rawat.

Jan 2023: Mumbai High Court observed that negligence in compliance of fire safety requirements and failure to undertake fire audit is nothing short of playing with fire.

Box 3: 13 Years and Still Counting: No Regulation in sight

On February 27, 2009, the Government of Maharashtra issued a draft of special regulations for building vulnerable to manmade disasters through notice of the urban development department. Numerous objections and suggestions were submitted in the same year that was processed by the Deputy Director, Town Planning, and a summary was sent to the state government to notify a final special regulation for building vulnerable to manmade disasters. With no progress for years, on January 15, 2018, complainant Singh wrote to the government to issue the final notification. Seeing no action forthcoming, the complainant approached the Mumbai High Court through a PIL seeking the enforcement of the draft regulation. The High Court in July 2022 directed the government to set up a four-member committee that has been given two months' time to submit its recommendations about the enforcement of the fire safety norms.

8. ROLE OF OTHER AUTHORITIES IN FIRE PREVENTION

8.1 Insurance Sector

Well-designed insurance policies work as a market-based instrument to discourage risky behaviour and promote risk awareness and mainstream adversity proofing in economic and financial decisions. In some developed countries, the insurance industry has played an important role in encouraging and enhancing safety, loss prevention and supporting loss control research through such a well-planned approach. In India, too, insurers promote urban fire safety. Still, these are restricted to commercial buildings as fire insurance is neither mandatory in India nor the public is aware of its need and importance.

In actuality, the insurance sector can encourage development of fire brigades and enhance compliance with building codes, and they have the potential to be on the front lines of the resilience movement. Losses directly affect insurers' bottom line; and the more done to promote preparation, effective building codes, smart construction, and positive community support, the better insurers can protect their customers and maintain profitability.[67]

International studies point out that more accurate risk assessment will allow insurers to harness their potential in helping to reduce fire risk and build more resilient communities, particularly through:[68]

- Providing information to property owners about the risk and how to mitigate the risk.
- Providing insurance coverage that is appropriate for the risk and sends the right signals (setting price, limits, deductibles, and other terms and conditions to provide incentives that encourage better risk management by property owners).
- Managing claims *ex post* in a way that helps to reduce the risk in the future (i.e., rebuilding in a more fire resilient manner).
- Working with other stakeholders, particularly the government, to ensure a consistent and effective approach to risk management.

CHANGE TO BE MADE	ACTION TO TAKE
Increase awareness about the importance of fire insurance	Promote fire insurance as a necessary safety measure and make it mandatory in certain situations

[67] M Mourad, Resilience and Preparation: Learning the Lessons from a Month of Natural Disasters, National Building Code Assessment Report 2019, Insurance Service Office Inc. Accessed at <www.verisk.com/siteassets/media/downloads/underwriting/location/2019-bcegs-schedule.pdf>

[68] Kelly M, Kleffner M, Halek M, Nickerson D, "The Role of Insurance in Reducing the Frequency and Severity of Fire Losses", University of the Fraser Valley, Dec 2017. Accessed at <https://cjr.ufv.ca/wp-content/uploads/2018/04/WLU-The-Role-of-Insurance-in-Reducing-the-Frequency-and-Severity-of-Fire-Losses.pdf>

Encourage development of fire brigades	Collaborate with local authorities to establish and support fire brigades
Enhance compliance with building codes	Encourage compliance with building codes and provide incentives for property owners to adhere to safety regulations
Provide information to property owners about fire risk mitigation	Develop educational materials and resources to help property owners identify and mitigate fire risk
Offer insurance coverage that reflects risk	Set appropriate prices, limits, deductibles, and other terms and conditions to provide incentives for better risk management
Manage claims to reduce future risk	Encourage rebuilding in a more fire-resilient manner
Work with government and other stakeholders	Collaborate with government and other stakeholders to ensure consistent and effective risk management approaches

Note: These actions are not mutually exclusive and can be taken in conjunction with each other to promote fire safety and resilience.

Box 4: National Insurance Co. Ltd. vs. M/S. Nitin Industries & Anr.

National Consumer Disputes Redressal Commission in May 2022 imposed costs on the insurance company for concealing material facts regarding the cause of the fire and at the same time recognising the fact that the complainant did not take any fire safety measures, such as installing a running water fire extinguisher, etc., found contributory negligence on their part. The case was related to a fire accident caused in a firm engaged in the business of plastic reprocessing in the year 2004. The firm had taken a Standard Fire & Special Perils Insurance Policy for Rs.29 lakhs but the Insurance Company repudiated the claim of the Complainant on the ground that it was a fraudulent claim.

Source: Concealment of material facts by an insurance company, NCDRC imposes costs, 5 June 2022. Accessed at <www.livelaw.in/news-updates/ncdrc-consumer-protection-act-insurance-company-contributory-negligence-200910>

8.2 Electrical Inspectorate

Stringent electrical safety regulations are vital to prevent fire incidents. While the regulatory and statutory framework in the Electricity Act, Electricity rules and the Central Electricity Authority Regulations have been framed, its implementation remains challenging. For instance, in Kerala, as per the law, approval from the electrical inspector (EI) is necessary for the following electrical installations: high tension and extra high-tension industries, multi-storeyed buildings (those taller than 15 metres), installations involving standby generators, those having neon sign boards, X-ray units, lifts and escalators, and temporary connections where more than 100 persons are likely to assemble.

But it is reported[69] that the shortage of manpower is affecting safety right in the construction phase. It has now become a norm for owners to state in writing that they have complied with the guidelines to secure a safety certificate once an EI finds defects in the installation of his building or industrial concern and asks the owner to make the changes to produce a compliance report. In very few instances, they conduct random checks, but that does not cover even 20 percent of the buildings where compliance verification must be carried out. The official at the Inspectorate who concedes this blames the high-rise apartments officials (office-bearers of a flat), who often fear additional expense to meet the required standards, knowingly abstain from such vital inspections. That is why electrical accidents are often less in industrial units than in high-rises.[70]

CHANGE TO BE MADE	ACTION TO TAKE
Increase manpower for electrical inspection	Hire more qualified electrical inspectors to ensure proper implementation of regulations
Conduct regular inspections	Conduct regular inspections and compliance verification of electrical installations in high-rise buildings and industrial units
Enforce strict penalties	Enforce strict penalties for non-compliance with electrical safety regulations to ensure accountability and deter risky behavior
Raise awareness	Educate building owners and occupants on the importance of complying with electrical safety regulations to prevent fire incidents and promote safety culture.

BOX 5: NO ADEQUATE CHARTERED ELECTRICAL SAFETY ENGINEERS

Section 4 and 5A of the Central Electricity Authority (CEA) Regulations amended in 2015 introduced the concept of Chartered Electrical Safety Engineer (CESE) to inspect all electrical installations for safety. Unfortunately, it is often witnessed across different states that the post remains vacant or an insufficient number of them are appointed as CESE for various reasons. For instance, it was only after experts' continuous demand and media pressure very recently the State of Maharashtra managed to appoint one person to this post, after a long period of almost 7 years since its introduction. In Haryana, despite a written test conducted in 2019 for authorisation of CESE, no single candidate qualified for the written test, thus compelling the state to facilitate the owner of the electrical installation for self-certification. Self-certification is done after getting it tested through his own eligible engineer who meets the qualification and experience of the CEA Regulations.

8.3 Real Estate Regulatory Authority

[69] Kerala: Lack of adequate staff hits power safety, Deccan Chronicle, 3 Jan 2018. Accessed at <www.deccanchronicle.com/nation/current-affairs/030118/kerala-lack-of-adequate-staff-hits-power-safety.html>
[70] *Ibid*

Real Estate Regulatory Authority (RERA) has the legal power to cancel a registration issued by it to a promoter based on a complaint received or "*suo motu*" by the Authority itself in case the promoter fails to meet the requirements specified in the plan of development works which includes firefighting facilities etc., while applying for the registration. A vital tool in the hands of the Authority is to ensure that basic minimum firefighting facilities are provided in every building. But one must wonder how effectively this tool has been utilised by any state authority when developers fail to keep up with their assured requirements.

Reports are there, for instance, that most of the housing projects registered under the Telangana State RERA are not equipped with adequate fire safety measures and have not obtained fire NOCs from the concerned departments.[71] Had the Authorities across the states done their role effectively, it could have largely boosted the fire safety scenario in the country, particularly in high-rises.

Likewise, there have been some genuine calls from experts to hold developers liable for any defective electrical and allied equipment used in their buildings for 10 years instead of the current five-year provision.[72] Such an updated provision could greatly encourage builders to opt for better quality electrical equipment, thereby reducing the probability of electrical fire incidents.

CHANGE TO BE MADE	ACTION TO TAKE
Effective utilization of RERA's power to cancel registration	State authorities to ensure that basic minimum firefighting facilities are provided in every building; Authorities to cancel registration of promoters who fail to meet firefighting facility requirements
Hold developers liable for any defective electrical and allied equipment used in their buildings for 10 years	Update current provision to hold developers liable for any defective electrical and allied equipment used in their buildings for 10 years instead of the current five-year provision; Encourage builders to opt for better quality electrical equipment, thereby reducing the probability of electrical fire incidents

[71] Hyderabad: RERA nod granted, but no fire safety measures in place, The Indian Express, 10 May 2019. Accessed at <www.newindianexpress.com/cities/hyderabad/2019/may/10/hyderabad-rera-nod-granted-but-no-fire-safety-measures-in-place-1975016.html>

[72] Stringent Fire Safety Regulations are Need of the Hour, Industrial Health & Safety Review, 01 Aug 2018. Accessed at <www.isrmag.com/stringent-fire-safety-regulations-are-the-need-of-the-hour/>

9. CONSUMER RIGHTS & **RESPONSIBILITIES**

Like other consumer rights, the right to safety is an important area of consumer protection which needs timely inspection and evaluation. The UN Guidelines for Consumer Protection mention the right to safety as one of the inalienable rights of the consumer. The Constitution of India also has provisions regarding the right to safety. Apart from the Constitutional provisions, numerous legislations, international conventions, and various regulations issued by different regulatory agencies on the safety issue. But in India, to realise the right to safety, it is not enough to just have safety acts and policies in place.

It is equally important that acts and policies are implemented well, monitored, and popularised among the masses so that the people can also play a constructive and participatory role in ensuring their safety. By empowering consumers, visibility, accountability and functioning of agencies mandated to ensure consumers' right to safety in India would be enhanced.[73]

Likewise, one cannot enjoy the benefits by claiming the rights alone; consumers have certain responsibilities to enjoy such rights. For instance, residents of a society should be aware of the basic rules related to fire safety in their building and check if they are being followed. They should ensure that the building in their society is being maintained properly.

[73] State of Consumer Safety in India - 2016, CUTS International, 2017. Accessed at <https://cuts-cart.org/pdf/Report-State_of_Consumer_Safety_in_India_2016.pdf>

10. FIRE PREVENTION & SAFETY: POOR PUBLIC AWARENESS & EDUCATION

The 'State of Indian Consumer Report 2012' prepared by CUTS (with support from the Department of Consumer Affairs, Government of India) found a serious lack of consumer awareness about safety standards/certification. Only 22 percent of consumers reported that they always assessed products or services in terms of their potential to cause threats/hazards. 32 percent of consumers never considered the safety aspect of a product before making a purchase. Now after almost a decade, nothing much has ever changed. In 2017 among the world's top four consumer markets, including the US, China, and Germany, it is in India consumers have suffered the highest number of product safety incidents in the last five years.[74]

This holds even now as a recent study conducted across the country to gauge consumer response towards receiving defective high-value products found that nearly one in two Indian consumers reported being stuck with one or more high-value faulty products.[75]

The present Indian scenario can be thus explained as follows:[76]

- Lack of awareness of consumers about their safety-related rights (what they can expect and should demand).
- Lack of information on products/services quality and related hazards.
- Lack of interest on the part of manufacturers/producers/service providers/ traders/regulators to implement the basic safety norms; and
- Lack of motivation/interest and capacity on the part of regulatory authorities to implement safety norms in a proactive and reactive manner.

The problem is deep-rooted. Even the implementation of guidelines will not take unless it is made mandatory and increase awareness. This is particularly true in the case of fire safety, as already discussed above. The consumers often do not show sufficient interest in the follow-up action or extend necessary co-operation to the authorities concerned to implement these guidelines. Recently it was revealed through a survey carried out across seven key cities by Godrej Security Solutions that majority of consumers (58 percent) in India are not even confident about fire safety protocol in their homes.[77] Therefore, creating awareness among

[74] Product safety lowest in India among world's top 4 markets, yet brand rules, The Time of India, May 10 2017. Accessible at <https://timesofindia.indiatimes.com/business/india-business/product-safety-lowest-in-india-among-worlds-top-4-markets-yet-brand-rules/articleshow/58585945.cms>
[75] One in two Indian consumers stuck with high value defective products: Survey, Livemint, 31 March 2022. Accessible at <www.livemint.com/industry/retail/one-in-two-indian-consumers-stuck-with-high-value-defective-products-survey-11648706907758.html>
[76] *Ibid*
[77] 58% Indian home-owners not confident about fire safe compliance in their homes, Construction Week Online,

citizens about fire safety standards and sensitising them about its importance is therefore very much vital. A well-sensitised consumer will ensure that they insist on providing fire safety norms before purchasing a flat.

Another major concern is the poor knowledge about fire safety and engineering even among practicing engineers, architects, and builders. The National Building Code outlined by BIS remains more of an academic exercise as most practicing engineers are not even aware of it. Similar is the case with respect to various other minor but pertinent issues. For instance, despite having high endurance and lifesaving properties, FS (Fire Survival Cables) cables are still not a standard practice in the industry. This is mainly due to high initial cost and lack of awareness among the contractors and builders' community over the quality of wires and cables that are to be used during construction. In most cases, standard PVC cables are still used in electrical installations that, during a fire, emit hazardous chemicals through the smoke that can be deadly for the ones inhaling it. Therefore, emphasis on the usage of FS cables needs to find its place in the National Building Code.[78]

There is a need to provide suitable training and generate awareness among engineers, architects, electricians, masons and the public about building regulations and their usefulness.

26 May 2022. Accessed at <www.constructionweekonline.in/people/58-indian-home-owners-not-confident-about-fire-safe-compliance-in-their-homes>

[78] A Need for an overhaul of fire safety guidelines on electrical installations in India, Industrial Health & Safety Review, 04 March 2022. Accessed at <www.isrmag.com/a-need-for-an-overhaul-of-fire-safety-guidelines-on-electrical-installations-in-india/>

11. STAKEHOLDER VALIDATION: KEY POINTS

To understand the gaps in current fire safety scenario in India, thereby to recommend solution and intervention to improve the situation, the project team met and discussed with key selected stakeholders to know the ground realities and challenges while ensuring fire prevention and safety. Key points that emanated during these discussions with expert stakeholders are summarized below to give the readers a brief overview of the current situation:

- Central lawmakers may get involved in fire prevention and make certain prevention methods relating to electrical fires and other major causes to be mandatory.
- Primary responsibility for enforcement of fire safety norms mainly in the state of Maharashtra is with the Special Planning Authority (SPA), Urban Local Bodies, and Municipalities.
- As per ADSI 2021 Report, out of total 774 fire accidents in Maharashtra the number of deaths is 790 while the number of injured is 0. The main reason for nil injury and more deaths in the lack of a centralized data collection system, only 40 - 50 percent of fire accident data is recorded and investigated by police that too only when there is any harm to life. Besides, there are no fire services available in rural areas so fire reporting in such areas is completely missed.
- Faulty electrical engineering in wire and cable leads to fire accidents. Uphaar Cinema fire 1997, Vigyan Bhawan fire accident 2016, Delhi's Gandhi Nagar textile market fire accident 2022, Mundka Factory Fire 2022, Karol Bagh Fire 2022, are few of the examples of faulty electrical engineering and negligence of the people.
- As per the National Electrical Code, annual electrical audits are not mandatory though some discussions are going on.
- Around 60 - 70 percent of fire accidents in Maharashtra are because of electric issues. The causes are not just restricted to electric short circuits but also because of poor Electrical infrastructure, poor quality of electric products and appliances, low and high voltage issues, and increased loads.
- There is a need for skilled workmanship within the electrical departments across the country. Besides, there is a need for mandatory ISI certification for all electrical accessories. Markets flooded with fake ISI electrical products and consumers have poor awareness.
- After it was discovered that 70% of the fire accidents in Mumbai was caused by electrical fires a new Municipal committee was formed to battle the ongoing fight against fire accidents. Firefighters are underfunded and under-equipped. Often there are shortage of breathing apparatuses, fire hoses and fire extinguishers, fire-resistant protective clothing, fire-resistant gloves, respirators, and even basic communication equipment's.

- The practice of digitalization of NOCs in Mumbai and Delhi is a welcome move, and the rest of the states could follow this.
- Emergency Fire Call Response System is a good practice that is reducing the response time of fire brigades and fire services. The digital control rooms of fire call centers are helping a lot in this regard.
- The approval process of licenses in Maharashtra by the 14 SPAs and Municipalities is a best practice that other states could imbibe. All the approvals and maintenance of related data are through online. However, some proviso related to fire safety could also be added in the online GIS mapping of city property tax which includes all the houses, commercial and other house structures.
- The recent efforts by BIS and International Copper Association to jointly produce two handbooks 'Safety in Electrical Installations – A way forward to Safety by National Electrical Code of India' and Guide for Using National Building Code of India 2016, along with three pamphlets for awareness of the general public about their rights and duties while constructing their own home or buying one from a builder are worth appreciative.[79] Efforts should be taken to ensure that the general public is aware of these documents so that it can guide them when the need arise.
- Maharashtra has developed a list of mandatory fire-retardant material that buildings should adhere to, but implementation is a big issue.
- Nagpur Fire Service (NFS) College trains government professionals and does not impart training to private sector professionals and common consumers. It trains officials from National Disaster Response Force, State Disaster Response Forces (SDRF), and selected fire safety officers and related staff from various state departments.
- NFS College is only of its kind training center in India having 10 regional offices in various states. However, the college does not carry out any research as the research lab is just newly established and not fully operational yet.
- Research on fire is advancing slowly and a number of IITs including IIT Bombay, Delhi and others are conducting research on fire safety. These institutes collaborate with NFS College and take a collaborative approach to advance research further.
- In the year 2022, NFS College provided training to 510 officials approximately. The regional training centers of this college provided training to 240 officials, so a total of 650 officials were trained in the year 2021-22. There were online fire safety training courses too and under that a total of 600 officials received training on fire service and fire safety.
- NFS College strongly supports the need for bringing a national and unified law in fire safety so that the entire country can have uniform provisions and standards of fire safety law.
- Observing Fire Service Week (April 14-20) and National Safety Day (March 04) is helping to raise awareness among the public and the consumers. Civil societies and consumer organisations can play a huge role in this regard.
- Insurance sector needs to revive across all state's its earlier practices, like providing rebate in insurance premium if building is having all the licenses etc.

[79] Shri Goyal releases handbook on Safety in Electrical Installations and Guide for Using National Building Code of India 2016, PIB Delhi, 12 September 2022. Accessed at <https://pib.gov.in/PressReleasePage.aspx?PRID=1858722>

- Creating a fire safe rating system for commercial, residential, and public buildings by the fire department based on compliance would be a welcome move.
- Developing mandatory fire forensics for post fire investigation will be very difficult given the current ground realities and infrastructure facilities available. Currently ULBs and Municipalities do not have the required capability or capacity to conduct fire forensics and often lack the technical expertise. This process has to be independent.
- The Ease of Doing business policy of the state government in Maharashtra prohibits rigorous physical inspections. Physical inspections are done based on a given checklist and mandatorily within 48 hours the filled in checklist needs to be uploaded online and the NOC needs to be approved or rejected based on that.
- The ISI system is already there in the country to promote a standard driven culture but most of the standards are voluntary and not mandatory, so implementation is a big issue. For critical sectors like hospitals more and more mandatory standard driven culture is required.
- There is an imminent need for setting up a Fire Forensics Institute in the country. A fire forensics lab at district level would be of much benefit. With a central database across all districts.
- Given that the number of fire accidents in rural areas is equal to that in urban areas, it is ideal to have a dedicated Rural Fire Service Network at the state level, targeting the formation of groups of trained volunteers across every village. A practice that is common in most other countries. It could also have a mandate to include Electrical fire safety audits in rural areas.
- There has to be rigorous training of fire officials to use the fire appliances effectively. The Internet of Things (IoT) based technologies and strategies need to be introduced for both fire prevention and operations sections.

PERSPECTIVE	STAKEHOLDER
National Perspective	National Fire Service College- Nagpur
State Perspective	State Fire Department- Maharashtra
Center Perspective	Central Public Works Department (CPWD), Government of India
Risk Management Perspective	Chola MS Risk Services, Chennai
Policy Perspective	Central Electricity Authority, Government of India
Regulatory Perspective	Bureau of Indian Standards (BIS), Government of India
Government Perspective	CEA, Ministry of Power
Industry and Trade Perspective	Energy Regulatory Affairs, International Copper Association India (ICA India)

12. KEY RECOMMENDATIONS

The above analysis of fire safety in the country proves that fire services in India is still at a nascent stage or to call it more appropriately in an ignored state with no much progress or developments happening to cope up with the growing responsibility of the Department as Multi Hazards Response Unit in the Disaster Management Response System. Such stagnant growth is largely due to the callous and insensitive attitude of the concerned officials coupled with a lack of adequate and timely resources, expertise, training facilities, equipment's etc. It has proved that state governments cannot independently handle the modernisation process.

Therefore, this study recommends the need to include 'fire service' in the Concurrent list of the Constitution of India. This would facilitate shared responsibility between the Centre and the States, facilitating uniform legislation across the country with better stringent enforcement and adequate financial assistance to improve the existing cadre by equipping them with advanced training, modem appliances and equipment. In fact, the Central and Finance Commission grants could then be linked to refurbish the fire service department.

Similarly, like the Swachh Survekshan ranking cities and states on cleanliness, every state, district, city, factory, and building should be ranked based on fire safety readiness. Such public naming and shaming by the relevant authorities can to a large extent ensure rapid compliance with fire safety regulations.

Besides, some of the priority elements that should be considered by the concerned ministries or by the respective Regulatory Bodies for strengthening the fire safety regulation are:

- Fire accident database should be strengthened for accurate assessment of the fire safety situation. In order to be useful, the data need to cover more than deaths and should include data on injured and the circumstances of the fire accident. This will help various departments that are responsible to contribute to safety improvement to devise and implement appropriate measures designed to combat specific problems. Local police who are often the first to reach, record and manage fire accident data also need to be motivated through appropriate incentives/awards and be convinced of the usefulness of devoting considerable effort to collect these data. They should be provided with adequate resources in terms of staffing, training, and computer systems. With the aid of technology better data collection and management should be ensured.

- Ensure better and more stringent rules enforcement and drastically improve market surveillance regularly. Technology can play a huge role for monitoring compliance. Causes and outcomes of fire accidents in the country always point to the fact that

accountability and enforcement of existing fire standards and building codes need to be improved.

- The importance of code enforcement in fire safety should not be underestimated. Frequent and regular update of existing codes and standards is very much vital to keep up with the latest findings and advances in technology. When government adopts such updated standards and codes, it encourages stakeholders to enforce, monitor and prioritise public health and safety most affordably. In addition, it helps to meet sustainability and climate adaptation.

- Bring in mandatory standards for products that impact the health and safety of the consumers, public and the environment, such as electrical fittings and appliances, industrial safety and fire safety equipment, and other allied materials related to fire safety. With increasing human-induced and natural catastrophes, it is high time India adopts a standard-driven culture.

- Need for setting up of a Fire Forensic institute in the country. Fire Forensics have been leading experts in fire investigation across the globe for decades. It involves the examination of all fire-related incidents once firefighters have extinguished the fire. The investigation includes meticulously surveying the damaged scene to establish the fire's origin and the real cause. In India, this field is yet to be developed and take shape. There is no standard programme or institution to investigate in the country when fire accidents happen.

- Enhancing technologies for firefighting, first aid, and rescue is vital. There is a lot of advanced research happening worldwide on fire technology, which our experts need to be involved with to imbibe it to suit our country's needs. Many new technologies keep evolving every other day, which our experts are unaware of. Technology advancements in the fire service have helped many countries improve responses and reduce needless firefighter deaths.

- All states should digitalize the process of issuing fire safety NOCs, this will enable more robust and effective methods of communication across public safety disciplines and throughout all levels of government thereby enhancing the delivery of data. Besides, it should be made mandatory for all establishments to display their NOC status prominently on their building and their websites.

- Strengthen the national fire service college and financially support them to take up more research and experiments related to fire prevention and safety. They should be encouraged to deliver common, consistent standards of safety-critical training and improve intra-operability across the Fire Service.

- Both Centre and the State should facilitate adequate and constant research in the field after considering the needs and situations of our country, including topography. Promotions of enhanced research and innovations could help the country to be less dependent on others for fire safety equipment’s, thereby promoting the idea of ‘Make in India’ by the Government of India.

- Every state should clearly define the role/responsibility of Fire Service professionals. A clear and transparent chain of command should be established at each level and answerable to the next higher authority. Entrusted with a great social responsibility, there is a need for a transparent command structure and effective utilisation of resources.

- Importance of modern firefighting equipment is an indispensable one to ensure maximum protection against fire. However, access to even basic types of equipment leave alone modern ones to firefighters is quite low across the country. The state governments should make adequate budgetary provisions to facilitate basic firefighting equipment are available to the brigades.

- Like in developed countries, private equity firms and venture capital should be encouraged to invest in fire and safety businesses as fire and safety equipment market in India has a strong growth potential. The sector is highly fragmented and dominated by large unorganised players with strong regional presence. Therefore, there are opportunities to consolidate companies into more cohesive and unified offerings

- A dedicated Rural Fire Service Network at the state level should be constituted, targeting the formation of groups of trained volunteers across every village. Such practices are common in most other countries. Given that the number of fire accidents is equal to that in urban areas, with zero planning or infrastructure, rural areas need some attention. As they face a unique fire risk, it calls for a separate focus and planning.

- Appoint an adequate number of Chartered Electrical Safety Engineers in every State and direct them to inspect every electrical installation for safety on periodic basis. Electrical short circuit is always blamed for fire accidents in India because nobody gets blamed later.

- Annual or biannual fire and electrical safety audits by independent agencies should be made mandatory all over India, at least for firms involved in risky businesses, public buildings including schools, hospitals, theatres, government offices, high-rises etc. This would greatly ensure effective implementation of the rules and regulations, codes and standards related to fire safety.

- Targeted interventions depending on the type of building would prove crucial in addressing fire safety concerns. There is a need to identify a few key risk areas within each category/type of building and build capabilities within those areas. Likewise, targeted interventions to ensure fire safety for special populations such as older adults, people with physical or mental disabilities, the deaf or hard of hearing, and the visually impaired is vital to ensure far less causalities and injuries of vulnerable population.

- Need to prescribe compulsory upgradation of fire safety infrastructures in industries every year by mandating that a part of companies' budget be allotted for fire safety

every year. However, to avoid burdening SMEs that are already weathering the impact of the Covid 19 crisis, some kind of tax incentives should be provided to those who meet the standard fire safety norm. The 2018 US federal tax reform legislation is a best practice that India could adhere to in this regard.

- Regulatory authorities, including RERA, should direct all its state authorities to facilitate the effective implementation of various provisions related to fire safety. Effective enforcement and surprise checks and inspection need to be carried out regularly to ensure developers comply with the requirements specified during registration.

- RERA should consider amending its existing legal provision wherein developers are held liable for any defective electrical and allied equipment used in their buildings for a period of five. Instead, a 10-year period should be provided as advocated by experts, to encourage builders to opt for better quality electrical equipment, thereby reducing the probability of electrical fire incidents.

- Fire safety awareness and escape skills should be reinforced in the whole learning process and daily life of school students to ensure future enlightened citizens. Research has pointed out that more than 80-90 percent of the fires are caused by weak awareness, lack of common sense and illegal operations. Even a lack of fire escape skills has often led to a rise in casualties.

- Likewise, consumer awareness is key in electric safety therefore awareness raising about new and updated standards, energy efficiency, basic electrical engineering concepts and electrical safety needs to be imparted to students in engineering colleges and at senior school level.

- Focused training and awareness generation targeting building occupants, like staff and security in hospitals, schools, theatres etc., are vital. The local fire department/municipalities should make it a regular mandatory affair to impart such trainings in hybrid mode with the help of experts. Such training and awareness generating activities should be recorded in a register with vital information like when and to whom trainings were given. Such targeted interventions are vital because the hidden danger of fire caused by fire code violations is more prominent if one scans through reports of fire incidents across the country. The occupation of fire truck passageways, the locking of emergency exits, the blocking of evacuation passageways, the nonstandard use of fire exit doors and the damage to fire hydrants are all glaring examples.

- Greater public awareness, understanding of various legal tools and building codes and stakeholders' efforts to protect the public from fire accidents can make a big difference. It can encourage individuals to reach out to their decision makers to implement changes in their area that help make their community safer, stronger, and more fire resilient. Vigilant citizens could be felicitated for highlighting fire safety risks.

- The consumer organisations and civil societies should periodically review compliance,

responsiveness of the government and act as whistle-blowers to pressurize the authorities to implement the law. Such organisations can contribute significantly to raise public awareness on the whole issue and therefore can be supported through penalties collected by government for non-compliant entities.

- The world has developed into a single market; it has become imperative for every country to learn from each other and arrive at a common understanding. Working towards a sub-regional, regional, and global coalition for improved fire prevention technologies must be considered with much vigour. G 20 could be a good platform to encourage co-operation on fire safety. AI algorithms, Reg Tech, Sup Tech, and end-to-end fire management systems are all powerful tools for fighting fires, but to fully tap its potential global collaborations with educational institutions are vital for developing and lesser developed countries.

- The government should encourage fire prevention and support loss control research in the insurance sector. The sector actively plays a huge role in most other countries in preventing and appropriately responding to fire accidents. However, in India, it plays a very limited role; whatever little they do is just limited to commercial establishments. The sector can contribute much to preventing and responding to fire accidents through designing customized products and by offering better premium when the building owner adopts codes and standards and ensures better fire prevention practices like using fire sprinklers, fire alarms, less using of easily combustible materials for construction, approach to building location etc. Such offers in premium would encourage the public to adopt fire safety equipment's in their buildings. But to reap such benefits, people should be simultaneously educated and encouraged to insure their properties. Property insurance is not as popular as health or motor insurance. Also, in case of an untoward fire accident the sector should ensure that the victims get a timely processing of claims.

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ANNEX 24A

INPUTS OF SHRI T.R.A. KRISHNAN on THE REVISED VERSION OF CLAUSE 5

5 FIRE PROTECTION

5.1 Fire Extinguishers/Fixed Firefighting Installations

5.1.1 All buildings depending upon the occupancy use and height shall be protected by fire extinguishers, hose reels, wet riser, down-comer, yard hydrants, automatic sprinkler installation, deluge system, high/medium velocity water spray, foam, water mist systems, gaseous or dry powder system, manual/automatic fire alarm system etc, in accordance with the provisions of various clauses given below, as applicable.

a) Firefighting appliances shall be provided and installed in accordance with good practice [4(18)]. The firefighting equipment and accessories to be installed in buildings for use in firefighting shall also be in accordance with the accepted standard [4(17)] and shall be maintained periodically so as to ensure their perfect serviceability at all times.

b) The requirements of fire extinguishers/yard hydrant systems/wet riser/down-comer installation and capacity of water storage tanks and fire pumps etc, shall be as per Table 7 wherever specified. The requirements regarding size of mains/risers shall be as given in Table 8. The typical details of Pumping arrangements for single or multiple pumping sets, down-comer and wet riser installations etc. are shown in Fig. 13, 14 and 15. The wet riser shall be designed for zonal distribution ensuring that unduly high pressures are not developed in risers and hose-pipes. *Installation of the system otherwise shall comply with various requirements stipulated in relevant IS standards.*

c) The extinguishers shall be mounted at a convenient height to enable its quick access and efficient use by all in the event of a fire incidence.

d) First-aid hose reels shall be installed in buildings (where required under Table 7) on all the floors, in accordance with accepted standard [4(19)]. The first-aid hose reel shall be connected directly to the riser/down-comer main and diameter of the hose reel shall not be less than 19 mm.

e) Hydrants for firefighting and hose reels shall be located in the lobby in firefighting shaft. Those hydrants planned to be provided near fire exit staircase on the floor shall be within 2M to 5M from exit door in exit access. Such hydrant cabinet may finish with doors to meet interior finishes with requirement of glass panel to provide visibility to the installations inside and inscribed with the word: ‘FIRE HOSE CABINET’ of letter size 75 mm in height and 12 mm in width. Such door of the fire hose cabinet need not be fire resistant rated. The location of such cabinets shall be shown on floor plan and duly displayed in the landing of the respective fire exit staircase.

f) All valves in fixed firefighting installations shall have supervisory switch with its signalling to fire alarm panel or to have chain(s), pad lock(s), label and tamper-proof security tag(s) with serial number to prevent tampering/unauthorized operation of valves. These valves shall be kept in their intended ‘open’ position.

g) Pressure at the hydraulically remote hydrant and at the highest hydrant shall not be

less than 3.5 bars. The pressure at any of the hydrants, however, shall not exceed 7.0 bars considering the safety of operators involved and avoid unduly high pressures within the network. Landing valves at lower levels are likely to experience high pressures and it is necessary to introduce approved pressure reducing arrangements at lower levels to ensure that pressures anywhere in the network are controlled between 3.5 bars and 7 bars. (see note 13 under Table 7)

h) Wet risers shall be interconnected at terrace level to form a ring and cut-off valves shall be provided for each connection to enable repair/maintenance without affecting rest of the system.

Table 8 Size of Mains

[*Clause* 5.1.1(a)]

Sl No.	Size of the Mains mm		Type of Building	Remarks m
(1)	(2)		(3)	(4)
i)	100 mm with single outlet landing valves	a)	Residential building (A)	
			1) Dormitories	–
			2) Apartments	–
			3) Hotels	Up to 45 m
		b)	Educational buildings (B)	–
		c)	Institutional buildings (C)	Up to 30 m
		d)	Assembly buildings (D)	–
		e)	Business buildings (E)	Up to 45 m
		f)	Mercantile buildings (F)	–
		g)	Industrial buildings (G)	Up to 15 m
ii)	150 mm with single outlet landing valves	a)	Hotels	Above 45 m
		b)	Starred Hotels	–
		c)	Institutional buildings (C)	Above 30 m
		d)	Business buildings (E)	Above 45 m
		e)	Industrial buildings (G)	Above 15 m
		f)	Storage buildings (H)	Up to 15 m
		g)	Hazardous buildings (J)	Up to 15 m

5.1.2 *Static Water Storage Tanks and Pump House*

Construction of water storage tanks, fire water pump house and the installation of hydrant system shall comply with various requirements stipulated in IS 13039 in all respects. However, certain major requirements are shown as under:

5.1.2.1 *Static water storage tanks*

a) A satisfactory supply of water for the purpose of firefighting shall always be available in the form of underground/terrace level static storage tank with capacity specified for each building with arrangements or replenishment by means of reliable alternative

source of supply. When this is not practicable, authorities may suggest on increasing the water capacity beyond what is stated in Table 7.

b) Water for the hydrant services shall be stored in an easily accessible surface/underground lined reservoir or above ground tanks of steel, concrete or masonry. The effective capacity of the reservoir above the top of the pump casing (flooded suction) for various types of occupancies shall be as per wherever specified in Table 7.

c) Water storage for firefighting shall be stored in two or more interconnected compartments of equal size to facilitate cleaning and maintaining the tanks without interrupting the water availability for firefighting.

d) To prevent stagnation of water in the static water storage tank, the suction tank of the domestic water supply shall be fed only through an overflow arrangement from the fire water storage tanks to maintain the level therein at the minimum specified capacity.

e) Alternatively, domestic and fire water can be stored in two interconnected compartments as mentioned above. The suction inlet(s) for the domestic water pumps shall be so located at an elevation that minimum water requirements for firefighting as stated in Table 7 will be always available for fire pumps.

f) The static storage water supply required for the above mentioned purpose shall entirely be accessible to the fire engines of the local fire service. Provision of suitable number of manholes shall be made available for inspection, repairs, insertion of suction hose, etc.

g) The underground fire water storage tank(s) shall not be more than 7M in depth from the level having fire brigade draw-out connection, while the draw-out connection shall not be more than 5M away from the tank wall.

h) The covering slab shall be able to withstand the total vehicular load of 45T (or as applicable) equally divided as a four-point load when the slab forms a part of pathway/driveway.

i) The static water storage tank shall be provided with a fire brigade collecting head with 4 number 63 mm diameter (2 number 63 mm diameter for pump with capacity 1 400 litre/min) instantaneous male inlets arranged in a valve box at a suitable point at street level. The same shall be connected to the static tank by a suitable fixed galvanized iron pipe not less than 150 mm in diameter to discharge water into the tank when required at the rate of 2 250 litre/min, if tank is in the basement or not approachable for the fire engines.

j) Each of the static water storage tanks shall also be provided with a fire brigade draw out collecting head with 63 mm diameter instantaneous male draw out arranged in a valve box at a suitable point at street level. This draw out shall be connected to galvanized iron pipe of 100 mm diameter with foot valve arrangement in the tank.

5.1.2.2 *Firefighting pump house*

a) It is preferable to install the pump house at ground level either at a detached location or separated all around by 2 hours rated fire walls/doors when attached to or situated

within any building. Pump house shall be situated so as to be directly accessible from the surrounding ground level.

b) Pump house shall be installed not lower than the first basement. When installed in the basement, following shall be borne in mind:

1) Direct accessibility staircase/ramp shall be available, leading directly to the pump house from the ground level.
2) Access to the pump room shall not require negotiating through other occupancies within the basement.
3) Pump house, in no case, shall come under the roads even if the road is designed for the load carrying capacity.
4) Pump room shall be fire separated all around by 2 hours rated fire walls and doors of similar rating shall be fitted in fire walls.
5) Forced mechanical ventilation is recommended for the pump room within the basement.

a) Pump house shall be well ventilated and due care shall be taken to avoid water stagnation.

b) No other utility equipment shall be installed inside fire pump room and also no Utility piping(s)s or duct(s) shall be routed through the pump room.

c) Installation of negative suction arrangement and submersible pumps shall not be allowed.

d) Battery of diesel engine operated fire pump shall have separate charger from emergency power supply circuit.

e) Exhaust pipe of diesel engine shall be insulated as per best engineering practice and taken to a safe location at ground level, considering the back pressure.

f) Where multiple buildings within a large complex are protected by common pumping, pump hose shall be situated only at ground level in a strategic location to meet pressure requirements between 3.5 bars to 7 bars. (see clause 5.1.1(g) above and also notes 10,11,12 and 14 under Table 7)

g) Various requirements stipulated in IS-13039 for installation of water tanks and the pump house shall be complied with in all respects.

5.1.3. Hydrant system

Design, installation and maintenance of Hydrant system (both external and internal) shall comply with various requirements stipulated in IS-13039.

5.1.3 *Automatic Sprinkler Installation*

Design, installation and maintenance of Sprinkler system shall comply with various requirements stipulated in IS-15105 in all respects. Following requirements shall need attention in particular:

a) Automatic sprinklers shall be installed wherever required in terms of Table 7 throughout the building in accordance with good practice [4(20)]. Selective

provision of sprinklers shall not be allowed.

b) Pressures anywhere in the sprinkler system shall not exceed 7 bars unless any special application calls for pressures higher than 7 bars. Minimum pressure required at any sprinkler or in the system shall be governed by various provisions stipulated in IS-15105.

c) The sprinkler flow switches provided for each compartment shall be monitored by fire alarm panel.

d) High rise buildings shall be sprinklered with provisions stipulated in Annexure __ of IS-15105 in all respects.

e) Usage of Flexible piping and cPVC piping shall be strictly governed by various provisions stipulated in IS-15105 in all respects.

f) Use of (sprinklered) false ceiling voids for storage or as return air plenums shall be strictly prohibited.

g) Pipes having diameter less than 50mm shall not be welded and only screwed fittings (forged) shall be used.

h) For areas having very high ceiling height and other special function areas where sprinklers cannot be provided or where the installation is not validated, alternate protection shall be provided in consultation with authorities.

i) Sprinkler Installation control valves with alarm gongs shall be installed at the respective entrances of each building at visible and readily accessible locations at ground levels.

j) Supervision of sprinkler system shall comply various with provisions stipulated in Annexure of IS-15105 in all respects.

5.1.4 *Automatic High Velocity and Medium Velocity Water Spray Systems*

Automatic high velocity water spray or emulsifying system shall be provided for protection of outdoor and/or indoor oil-cooled transformers as applicable in accordance with good practice [4(21)] where applicable (*see* Annex E). Also medium velocity water spray system shall be provided for tankage (where applicable), conveyors, cable galleries and other occupancies listed in good practice [4(21)] and in accordance with IS 15325 in all respects.

5.1.5 *Fixed Foam Installation*

Fixed foam generating system shall be provided for protection of oil storage area for boilers with its ancillary storage of furnace oils in basement. Fixed foam installations can be low, medium or high expansion types, which can be provided based on the type of fire hazards identified in the facility. High expansion foams are used for cable tunnels and other confined areas. Design and installation of foam systems shall be governed by good practice [4(22)] and in accordance with IS 12385 in all respects.

5.1.6 *Gas Based Suppression System*

Gas based (clean agent) fire extinguishing installation shall be provided in accordance

with good practice on premises where water or foam cannot be used for fire extinguishing because of the special nature of the contents of the buildings/areas to be protected where either the building(s) have very limited manpower or unmanned. The protection design for fixed carbon dioxide fire extinguishing system shall conform to good practice [4(23)] in all respects. For some special fire risk/essential applications, carbon dioxide may not be suitable and alternate provisions shall be made as per relevant standards (*see* **5.1.9**).

5.1.7 Firefighting equipment shall be suitably located and clearly marked by luminous signs.

5.1.8 *Automatic Water Mist Systems*

These systems involve the use of fine water sprays for the efficient extinguishment of fires. These systems may be provided to protect areas in buildings for the uses as specified in good practice [4(24)] and in accordance with IS-15519.

5.1.9 *Extinguishing Systems with Clean Agents*

Alternative systems for halon gas protection systems shall be provided where necessary as prescribed in this Part. These shall be in accordance with the accepted standards [4(25)] and in accordance with relevant IS standards.

5.2 Fire Detection and Alarm System

System shall be designed and maintained as per IS 2189 and 15908 in all respects and also attention is drawn to various requirements stipulated in clause 4.9 of this code

5.3 The fixed firefighting installations and systems shall be maintained in accordance with good practice [4(26)] and the Part 12 ‘Asset and Facility Management’ of the Code.

ANNEX 24B

INPUTS OF SHRI T.R.A. KRISHNAN on THE REVISED VERSION OF

Table 7 Minimum Requirements for Fire Fighting Installations

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (in l)		Pump Capacity (in l/min)	
		Fire Exting-usher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems **(Note 1)**	Automatic Detection and Alarm System **(Note 2)**	Under-ground Static Water Storage Tank Capacity for one set of pumps	Terrace Tank **(Note 9)**	Fire Pump Near Underground Static Water Storage Tank	Pump at the Terrace Tank Level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
RESIDENTIAL BUILDINGS (A)													
a)	**Lodging and Rooming Houses (A-1)** (*Note* 3a)												
1)	Less than 15 m in height												
	i) Up to 15 rooms	R	NR	NR	NR	NR	R (*Note* 4)	NR	NR	NR	5 000 (*Note* 5)	NR	NR
	ii) More than 15 and up to 30 rooms	R	R	NR	NR	NR	R (*Note* 4)	NR	NR	NR	5 000 (5 000) (*Note* 6)	NR	450 (450) (*Note* 6)
	iii) More than 30 rooms	R	R	NR	NR	NR	R (*Note* 4)	R (*Note* 7)	NR	NR	10 000 (5 000) (*Note* 6)	NR	450 (450) (*Note* 6)
b)	**One or two Family Private Dwellings (A-2)** (*Note* 3a)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (in l)		Pump Capacity (in l/min)	
		Fire Exting-usher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems **(Note 1)**	Automatic Detection and Alarm System **(Note 2)**	Under-ground Static Water Storage Tank Capacity for one set of pumps	Terrace Tank **(Note 9)**	Fire Pump Near Underground Static Water Storage Tank	Pump at the Terrace Tank Level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
c)	**Dormitories (A-3) Apartment Houses (A-4)** (Notes 8 and 22)												
1)	Less than 15 m in height	R	R	NR	NR	NR	R (*Note* 4)	NR	NR	NR	5 000 (5 000) (*Note* 6)	NR	450 (450) (*Note* 6)
2)	15 m and above but not exceeding 35 m in height	R	R	NR	R	NR	R (*Note* 4)	R	NR	NR	25 000	NR	900
3)	Above 35 m but not exceeding 45 m in height	R	R	R	NR	NR	R (*Note* 4, Note 15a)	R	NR	75 000	5 000	(*Note* 10)	NR
4)	Above 45 m in height but not exceeding 60 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	NR	150 000	10 000	(*Note* 11)	NR
5)	Above 60 m in height	R	R	R	NR	R	R (Note 15b)	R	R	200 000	10 000	(*Notes 12 and 13)*	NR
d)	**Hotels (A-5)** (Notes 8 and 22)												
1)	Less than 15 m in height												
	i) Floor area not exceeding 500 m^2 on any of the floor	R	R	NR	NR	NR	R (*Note* 4)	R	NR	NR	5 000 (5000) (*Note* 6)	NR	450 (450) (*Note* 6)

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (in l)		Pump Capacity (in l/min)	
		Fire Exting-usher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems **(Note 1)**	Automatic Detection and Alarm System **(Note 2)**	Under-ground Static Water Storage Tank Capacity for one set of pumps	Terrace Tank **(Note 9)**	Fire Pump Near Underground Static Water Storage Tank	Pump at the Terrace Tank Level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	ii) Floor area exceeding 500 m^2 but not more 1 000 m^2 on any of the floor	R	R	NR	R	NR	R (*Note* 4)	R	R	NR	20 000 (5000) (*Notes* 6 and 7)	NR	450 (450) (Note 6)
	iii) Floor area exceeding 1 000 m^2 on any of the floor	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	100000	10 000 (*Note* 4)	Note 10	NR
2)	15 m and above but not exceeding 30 m	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	150 000	20 000	Note 10	NR
3)	Above 30 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	200 000	20 000	Notes 11 and 13	NR
e)	**Hotels (A-6)**	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	250 000	20 000	Notes 12 and 13	NR
EDUCATIONAL BUILDINGS (B) (*Note* 3b)													
1)	Less than 15 m in height	R	R	NR	R	NR	R (Note 4)	NR	NR	NR	10 000 (5 000) (Notes 6 and 7)	NR	450 (450) (Note 6)
2)	15 m and above but not exceeding 24 m in height	R	R	NR	R	NR	R (Note 4)	R	NR	NR	25 000	NR	900

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (in l)		Pump Capacity (in l/min)	
		Fire Exting-usher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems **(Note 1)**	Automatic Detection and Alarm System **(Note 2)**	Under-ground Static Water Storage Tank Capacity for one set of pumps	Terrace Tank **(Note 9)**	Fire Pump Near Underground Static Water Storage Tank	Pump at the Terrace Tank Level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
3)	Above 24 m but not exceeding 30 m in height	R	R	R	NR	NR	R (Note 4)	R	NR	50 000	(5 000) (Note 6)	Note 14	NR
INSTITUTIONAL BUILDINGS (C) (*Notes* 3b,8 and 22), Clause 6.3.2 g-4)													
a)	**Hospitals, Sanatoria and Nursing Homes (C-1)**												
1)	Less than 15 m in height with plot area up to 1 000 m^2												
	i) Up to ground plus one storey, with no beds	R	R	NR	NR	NR	R (Note 4)	R	NR	NR	2500 (2500) (Note 6)	NR	(450) (*Note* 6)
	ii) Up to ground plus one storey with beds	R	R	NR	NR	NR	R (Note 4)	R	NR	NR	5 000 (5 000) (Note 6)	NR	450 (450) (*Note* 6)
	iii) Ground plus two or more storeys, with no beds	R	R	NR	R	NR	R (Note 4)	R	R	NR	10 000 (5 000) (Notes 6)	NR	900 (450) (*Note* 6)

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (in l)		Pump Capacity (in l/min)	
		Fire Exting-usher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems **(Note 1)**	Automatic Detection and Alarm System **(Note 2)**	Under-ground Static Water Storage Tank Capacity for one set of pumps	Terrace Tank **(Note 9)**	Fire Pump Near Underground Static Water Storage Tank	Pump at the Terrace Tank Level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	iv) Ground plus two or more storeys, with beds	R	R	R	NR	NR	R (Notes 15a and 15b)	R	R	50,000	10 000	Note 10	NR
2)	Less than 15 m in height with plot area more than 1 000 m^2	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	1 00 000	10 000	(*Note* 10)	NR
3)	15 m and above but not exceeding 30 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	150 000	20 000	(Note 10)	NR
4)	Above 30 m and not exceeding 45 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	200 000	20 000	(Note 11)	NR
b)	**Custodial (C-2), and Penal and Mental (C-3)**												
1)	Less than 10 m in height												
	i) Up to 300 persons	R	R	NR	NR	NR	R (*Note* 4)	R	NR	NR	10 000 (5 000) (Note 6)	NR	450 (450) (*Note* 6)
	ii) More than 300 persons	R	R	NR	R	NR	R (*Note* 4)	R	NR	NR	15 000 (5 000) (Note 6)	NR	900 (450) (*Note* 6)

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (in l)		Pump Capacity (in l/min)	
		Fire Exting-usher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems **(Note 1)**	Automatic Detection and Alarm System **(Note 2)**	Under-ground Static Water Storage Tank Capacity for one set of pumps	Terrace Tank **(Note 9)**	Fire Pump Near Underground Static Water Storage Tank	Pump at the Terrace Tank Level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
2)	10 m and above but not exceeding 15 m in height	R	R	R	NR	R	R (Note 4)	R	R	100 000	5 000 (5 000) (Note 6)	(Note 10)	NR
3)	15 m and above but not exceeding 24 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	150 000	10 000	(Note 10)	NR
4)	24 m and above but not exceeding 30 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	200 000	20 000	(Note 11)	NR
ASSEMBLY BUILDINGS (D) (*(Notes 3b,8 and 22)*													
a)	**Buildings (D-1 TO D-5**)												
1)	Less than 10 m in height												
	I) Up to 300 persons	R	R	NR	R	NR	R (*Note* 4)	R	NR	NR	20 000 (5 000) (Note 6)	NR	450 (450) (*Note* 6)
	ii) More than 300 persons	R	R	NR	R	NR	R (*Note* 4)	R	NR	NR	25 000 (5 000) (Note 6)	NR	900
2)	Above 10 m but not exceeding 15 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	100 000	5 000 (5 000) (Note 6)	Note 10	NR

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (in l)		Pump Capacity (in l/min)	
		Fire Exting-usher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems **(Note 1)**	Automatic Detection and Alarm System **(Note 2)**	Under-ground Static Water Storage Tank Capacity for one set of pumps	Terrace Tank **(Note 9)**	Fire Pump Near Underground Static Water Storage Tank	Pump at the Terrace Tank Level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
3)	Above 15 m but not exceeding 24 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	150 000	10 000	(Note 10)	NR
4)	Above 24 m but not exceeding 30 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	200 000	20 000	(Note 11)	NR
b)	**Buildings D-6**	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	200 000	20 000	(Note 12)	NR
c)	**Buildings D-7**	For details *see* **clause 6.4.4**											
BUSINESS BUILDINGS (E) (Notes 8 and 22)													
1)	Less than 10 m in height	R	R	NR	R	NR	R (*Note* 4)	R	NR	NR	10 000 (5 000) (Note 6)	NR	450 (450) (*Note* 6)
2)	Above 10 m but not exceeding 15 m in height	R	R	R	NR	NR	R (*Note* 4)	R	R	50 000	5 000 (5 000) (Note 6)	(*see* Note 14)	NR
3)	Above 15 m and up to 24 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	100 000	10 000	(*Note* 10)	NR
4)	Above 24 m and up to 30 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	150 000	20 000	(*Note* 11)	NR

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (in l)		Pump Capacity (in l/min)	
		Fire Exting-usher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems **(Note 1)**	Automatic Detection and Alarm System **(Note 2)**	Under-ground Static Water Storage Tank Capacity for one set of pumps	Terrace Tank **(Note 9)**	Fire Pump Near Underground Static Water Storage Tank	Pump at the Terrace Tank Level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
5)	Above 30 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	200 000	20 000	(*Notes* 12 and 13)	NR
MERCANTILE BUILDINGS (F) (Notes 3b,8 and 22)													
a)	**F-1 & F-2**												
1)	Less than 15 m in height												
	i) Ground plus one storey, with total of all floor area not exceeding 500 m^2	R	R	NR	NR	NR	R (Note 4)	NR	NR	NR	5 000 (5 000) (Note 6)	NR	450
	ii) Ground plus one storey and total of all floor area exceeding 500 m^2	R	R	NR	R	NR	R (Note 4)	R	NR	NR	20 000 (5 000) (*Note* 6)	NR	900
	iii) More than ground plus one storey	R	R	NR	R	NR	R (*Note* 4)	R	NR	NR	25 000 (5 000) (*Note* 6)	NR	900
2)	Above 15 m but not exceeding 24 m in height	R	R	R	NR	NR	R (Notes 15a and 15b)	R	R	100 000	10 000	(*Note* 10)	NR
3)	Above 24 m but not exceeding 30 m in height	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	200 000	20 000	(*Note* 11)	NR

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (in l)		Pump Capacity (in l/min)	
		Fire Exting-usher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems **(Note 1)**	Automatic Detection and Alarm System **(Note 2)**	Under-ground Static Water Storage Tank Capacity for one set of pumps	Terrace Tank **(Note 9)**	Fire Pump Near Underground Static Water Storage Tank	Pump at the Terrace Tank Level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
b)	**Underground shopping complex (F-3)**	R	R	R	NR	R	R (Notes 15a and 15b)	R	R	150 000	10 000	(*Note* 11)	NR
INDUSTRIAL BUILDINGS (G) (Notes 8 and 22)													
a)	**Low Hazard (G-1)** (Notes 3c, 16a and 16b)												
	i) Aggregate floor area of the largest building within the plot upto 500M2	R	R	NR	NR	R	NR	NR	NR	25000		(Note 17)	NR
	ii) Aggregate floor area of the largest building within the plot exceeding 500M2 but within 2000M2	R	R	R	NR	R	NR	R	NR	50000		(Note 17)	NR
	iii) Aggregate floor area of the largest building within the plot exceeds 2000M2	R	R	**(Notes 18, 19, 21a and 21b)**									
b)	**Moderate Hazard (G-2)** (Notes 3c, 16a and 16b)												

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (in l)		Pump Capacity (in l/min)	
		Fire Exting-usher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems **(Note 1)**	Automatic Detection and Alarm System **(Note 2)**	Under-ground Static Water Storage Tank Capacity for one set of pumps	Terrace Tank **(Note 9)**	Fire Pump Near Underground Static Water Storage Tank	Pump at the Terrace Tank Level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	i) Aggregate floor area of the largest building within the plot upto 500M2	R	R	NR	NR	R	NR	NR	NR	50000		(Note 14)	NR
	ii) Aggregate floor area of the largest building within the plot exceeding 500M2 but within 2000M2	R	R	R	NR	R	NR	R	NR	75000		(Note 14)	NR
	iii) Aggregate floor area of the largest building within the plot exceeding 2000M2	R	R	**(Notes 18, 19, 21a and 21b)**									
c)	**High Hazard (G-3)** (Notes 3a and 16c)	R	R	**(Notes 18, 19, 21a and 21b)**									
STORAGE BUILDINGS (H) (*Note* 3a)													
1)	Below 15 meter in height and covered area less than 1000 m^2	R	R	R	NR	NR	R (Note 4)	NR	NR	50000	NR	(Note 14)	NR
2)	Below 15 meter in height and covered area more than 1000 m^2												
	I. Ground floor only	R	R										

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (in l)		Pump Capacity (in l/min)	
		Fire Exting-usher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems **(Note 1)**	Automatic Detection and Alarm System **(Note 2)**	Under-ground Static Water Storage Tank Capacity for one set of pumps	Terrace Tank **(Note 9)**	Fire Pump Near Underground Static Water Storage Tank	Pump at the Terrace Tank Level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	II. Ground plus one floor	R	R	**(Notes 18, 19, 21a and 21b)**									
	III. More than ground plus one floor	R	R										
3)	Multi-Level Car Parking (MLCP) Note 3d)	R	R	R	NR	R	R (Notes 15a and 15b)	R	NR	150 000	NR	(Note 11)	NR
HAZARDOUS BUILDINGS (J) (*Note* 3a)													
1)	Up to 15 m in height	R	R	**(Notes 18, 19, 20, 21a and 21b)**									

R – Required NR – Not Required

Notes	Requirements
1,	MOEFA System shall also include talk-back system and public address system in all buildings 15 m and above in height, except for A-3 and A-4 occupancies where these shall be provided for buildings of height 24 m and above. These shall also be provided in car parking areas more than 300 m^2 and in multi-level car parking irrespective of their areas.
2.	Automatic detection and alarm system is not required to be provided in car parking area. Such detection system shall however be required in other areas of car parking such as electrical rooms, cabins and other storage areas.
3(a)	Buildings above 15 m in height are not to be permitted for occupancies Group A-1 and A-2, Group G, Group H (1 and 2) and Group J
3(b)	Buildings above 30 m in height not to be permitted for Group B, Group C, Group D and Group F occupancies.
3(c)	Buildings above 18 m in height not to be permitted for G-1 and G-2 occupancies.
3(d)	Buildings above 45 m in height are not to be permitted for occupancies Group H-3
4.	Required to be installed in basement, if area thereof exceeds 200 m^2.
5.	Required to be provided if basement area exceeds 200 m^2.
6.	Additional value given in parenthesis shall be added if basement area exceeds 200 m^2.

7.	Required to be provided for buildings with more than two storeys (Ground + one)
8.	In case, the complex consists of building(s) with occupancies having different classifications, fire protection systems shall be governed by the most restrictive provisions of the code among those applicable for individual occupancies.
9.	Overhead tank of specified capacity (along with Terrace pump if applicable) as indicated under respective items in the table shall be provided for each building/tower. Whether the building(s)/tower(s) are situated attached or detached. Further the Tanks shall be connected to sprinkler systems, down comers and hose reels either directly or through terrace pumps as applicable in the table.
10.	One set of pumps shall be provided for each 100 hydrants or part thereof, with a maximum of two sets. See clause 5.1.2.2(l) for more details. In this case, one set consisting of one electrically driven pump, one diesel driven standby pump (having a capacity of 2280 LPM) and one electrical driven Jockey pump (having a capacity of 180 LPM) shall be provided). See Figure 11. Irrespective of the number of hydrants beyond 100, two sets of pumps with water tank capacities as mentioned in the Table shall be sufficient subject to compliance of clause 5.1.1(g).
11.	One set of pumps shall be provided for each 100 hydrants or part thereof, with a maximum of two sets. See clause 5.1.2.2(l) for more details. In this case, one set consisting of two electrically driven pumps (one each for Hydrant and sprinkler systems), having a capacity of 2280 LPM), one diesel driven common standby pump (having a capacity of 2280 LPM) and two electrically driven Jockey pump (having a capacity of 180 LPM, one each for Hydrant and sprinkler systems) shall be provided). See Figure 12. Irrespective of the number of hydrants beyond 100, two sets of pumps with water tank capacities as mentioned in the Table shall be sufficient subject to compliance of clause 5.1.1(g).
12.	One set of pumps shall be provided for each 100 hydrants or part thereof, with a maximum of two sets. See clause 5.1.2.2(l) for more details. In this case, one set consisting of two electrically driven pumps (one each for Hydrant and sprinkler systems), having a capacity of 2850 LPM), one diesel driven common standby pump (having a capacity of 2850 LPM) and two electrically driven Jockey pump (having a capacity of 180 LPM, one each for Hydrant and sprinkler systems) shall be provided). See Figure 12. Irrespective of the number of hydrants beyond 100, two sets of pumps with water tank capacities as mentioned in the Table shall be sufficient subject to compliance of clause 5.1.1(g).
13.	Lower levels in high rise buildings 60 m or above in height are likely to experience high pressure and therefore, it is necessary to consider multi-stage, multi-outlet pumps (creating pressure zones) or installation of pumps at one or more levels or variable frequency drive pumps or any other equivalent arrangement.
14.	One set of pumps shall be provided for each 100 hydrants or part thereof, with a maximum of two sets. See clause 5.1.2.2(l) for more details. In this case, one set consisting of one electrically driven pump, one diesel driven standby pump (having a capacity of 1620 LPM) and one electrical driven Jockey pump (having a capacity of 180 LPM) shall be provided). See Figure 11. Irrespective of the number of hydrants beyond 100, two sets of pumps with water tank capacities as mentioned in the Table shall be sufficient subject to compliance of clause 5.1.1(g).
15(a)	Sprinklers shall be fed water from both underground static water storage tank and terrace tank when both are prescribed in the Table.
15(b)	Entire building(s) i.e. Common areas as well as Livable areas within shall be protected as per Indian standards.
16(a).	Those industries which were defined or licensed as “Artisans workshops, Village and Cottage Industries, Tiny sector industries” by the Government of India shall need to provide only Extinguishers and Buckets, their quantity and distribution shall comply with relevant Indian standards.
16(b)	Multiple occupancy Industrial estates (all in one building) shall be protected according to the requirements for “Moderate” hazard industries. No high hazard occupancies shall be allowed in such buildings.
16(c)	In case of high hazard industries like Petrochemical industries, Refineries and the like, in addition to compliance of requirements of Table 7, compliance to statutory requirements like Oil Industries Safety Directorate, Fire insurance regulations and the like are mandatory,
17	Entire occupancy shall be protected by one electric driven main pump of at least 900 LPM discharge capacity, one standby pump of similar capacity (with reliable back-up supply) and one jockey pump of capacity of at least 180 LPM.
18	Entire occupancy shall be protected by hydrant, sprinkler, water spray, water mist, clean agent, foam, fire alarm systems etc. as applicable in accordance with relevant IS codes in all respects that include design and installation of pumps, pipelines etc.. See note 19 and 21 below.
19	Certain occupancies may also be protected by Automatic water mist systems with appropriate (pressure) applications if such systems are evaluated/certified by recognised National/International agencies for such occupancies. Installation and design of such systems, besides complying with various provisions of IS – 15519, shall be as per manufacturers specifications, complying with test conditions and the same shall have acceptance of the authorities concerned. Extrapolation of test results shall not be allowed to provide protection to larger areas unless specifically permitted by the reputed testing agencies”
20	Pump capacity for hydrant system shall be based on the covered area of the buildings i.e for area upto 500M2 pumping should be @ 2.0 LPM/M2, for areas greater than 500M2 but upto 1000M2, pumping should be @ 2.5 LPM/M2. Areas more than 1000M2 are not acceptable unless there are fire separations equivalent to two hours. Entire hydrant and sprinkler systems shall be designed as per the relevant IS standards. See notes 18, 19 and 21(a) and 21(b).
21(a)	For all occupancies under classifications A to J, pumping capacities and water requirements shall need to be provided wherever indicated in respective columns and notes in the above Table. However, where pumping capacities and whatever requirements are not indicated in the respective columns, reference shall be made to the concerned IS codes of practices for Hydrant/Sprinkler/Water spray etc for details. In either case, Design and installation of systems like hydrant, sprinkler, spray systems etc. shall strictly be carried out as per provisions in respective Code of practices like IS-13039, IS-15105, IS-15325 etc.

21(b)	Where application of water as extinguishing medium is not appropriate due to the presence of water reactive materials or other valid acceptable reasons, a suitable alternative extinguishing system and method shall be provided in consultation with the appropriate authorities. Protection methods suggested shall be in compliance with relevant BIS standards in all respects. Other types of systems for fire alarms, clean agent etc. shall also be designed and installed as per relevant Indian standards in all respects.
22	As per the requirement of local authority dry riser may be used in hilly areas, industrial areas or as required.

ANNEX 24C

INPUTS OF SHRI T.R.A. KRISHNAN on THE REVISED VERSION OF Clause E-6 of Annexure E (Additional requirements for High rise buildings)

The above clause is not well understood and there are several queries from those who use NBC for their activities:

The queries are as below:

1) There are only two paragraphs and contents in the first para provides for sprinkler installation arrangement for residential occupancies with heights more than 120M and for other occupancies above 60M height. Apart from Residentials, only Business occupancy has no height restriction.
2) What is the basis for 120M height? Not well understood..
3) The second para is continuous with multiple sentences with casual mention of heights (again upto residentials only) and it is very complicated reading and not well understood at all. In fact, this clause requires re-phrasing in a realistic way as below:
4) Note 13 under Table 7 has very clearly provided various methods to be followed for pumping when height exceeds 60M and this is applicable to hydrant as well as sprinkler installation. Hence mentioning heights of 120M, 150M, 175M etc. under this clause seem to be inconsistent anyway.

Revision of wording for clause E-6 of Annexure E

E-6.1 Fire protection arrangements for Residential and business occupancies where the NBC has not capped the heights of the buildings shall be as following. In all the other types of occupancies, the maximum height specified is 30M to 45M only. Hence the following requirements shall apply to Residential and Business occupancies only.

E-6.2 Yard hydrant system, installation of pumps and pump houses, water tank arrangement, provision of staircase etc. shall follow various guidelines stipulated in IS-13039 (particularly clause 20) in all respects. Some important provisions are as below:

E.6.2.1 When the height of the building exceeds 60M, pumping and water supply arrangements shall be arranged in any one of the following methods:

E.6.2.1 Pumps can be provided with two (or more) wet risers –one directly feeding the upper levels and the other(s) feeding the lower levels through pressure reducing arrangement(s)

E.6.2.2 Pump with multi-stage, multi-outlet and risers tapped from different outlets of the pump according to the pressure required at various heights

E.6.2.3 Creating pressure zones like multiple wet risers zoning system and installation of pumps and water tanks at 60M level and at every 60M height thereafter subject to following conditions:

a) Water storage at upper zones shall be equivalent to at least 30 minutes run of the installed pumping capacity at that level.

b) Arrangements shall be made to fill the tanks at upper zone(s) from ground level by dedicated pumps and there shall be a standby pump of similar type and capacity driven by diesel engine or electrical motor if emergency supply is available for such pumps. Also, two risers at different locations shall be used for filling the tanks at upper zones.

c) Fire pumps at ground level may also be used for filling the tanks at upper levels as an alternate arrangement.

d) Separate pumping arrangements and water tank with pump house shall be provided for each building and no common facilities are acceptable.

e) Drainage/bye pass pipes from the installation shall terminate into the respective tanks in zones concerned

E-6.3 Pump house

E-6.3.1 In case of pump houses at upper zones (E-6.2.3 above), they can be installed with other utility equipment such as general water pumps, STP, water treatment plants etc. No other operations or storage shall be carried out at this level.

E-6.3.2 50% of the area occupied by all services at upper zones shall be left vacant which may also be used for refuge of people during emergency.

E-6.3.3 Fire water tank at upper zones shall also be connected to the sprinkler installation in the lower zone as an alternate supply to the latter in case of emergency requirements.

E-6.3.4 Talk back connectivity shall be available between the pump rooms at various zones as well as at ground level and fire Command center.