

NFPA
502

**FIRE PROTECTION
FOR HIGHWAYS,
TUNNELS AND
BRIDGES
1981**



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Recommended Practice on Fire Protection for Limited Access Highways, Tunnels, Bridges, Elevated Roadways, and Air Right Structures

NFPA 502-1981

1981 Edition of NFPA 502

This edition of NFPA 502, *Recommended Practice on Fire Protection for Limited Access Highways, Tunnels, Bridges, Elevated Roadways, and Air Right Structures*, was prepared by the Technical Committee on Motor Vehicles and Highway Fire Protection and acted on by the National Fire Protection Association, Inc. on May 20, 1981 at its Annual Meeting in Dallas, Texas. It was issued by the Standards Council with an effective date of June 29, 1981.

Origin and Development of NFPA 502

A tentative standard, NFPA 502T, *Standard for Limited Access Highways, Tunnels, Bridges and Elevated Structures*, was prepared by the Technical Committee on Motor Vehicle Fire Protection and was adopted by the National Fire Protection Association on May 16, 1972 at its Annual Meeting in Philadelphia, PA. It was withdrawn in November 1975. In 1980, the Committee rewrote the document as a Recommended Practice and included a chapter on Air Right Structures. It was adopted at the 1981 Annual Meeting.

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Recommended Practice on Fire Protection for Limited Access Highways, Tunnels, Bridges, Elevated Roadways, and Air Right Structures

NFPA 502-1981

Chapter 1 General Information

1-1 Scope. This recommended practice is intended primarily for the guidance of those individuals responsible for the construction, operation, maintenance and fire protection of limited access highways, tunnels, bridges, elevated roadways and air right structures. It also applies, to a lesser extent, to buildings and structures that are exposed to the hazards of the operational zones.

1-2 Application. In cases where the facilities do not present serious fire problems because of low traffic volume, small size or other considerations, the authority having jurisdiction, responsible for fire protection, may adjust the recommendations of this recommended practice to provide for the fire protection needs of the facility.

1-3 Limited Access Highways.

1-3.1 Limited access highways present two fire protection problems. One is the protection to life and property transported by vehicles traveling on the facility, and the other is the protection of permanent installations located on, over, below or adjacent to the facility. Protection to life must in all cases merit primary consideration, while protection to the facility becomes of major importance by reason of its vital need to the community.

1-3.2 Protection of related facilities such as service areas, rest areas, toll booths, and buildings used for administration, law enforcement and maintenance presents problems which are not basically different from the fire protection problems of all such buildings. However, special consideration should be given to the fact that on, or adjacent to, limited access highways, such buildings may be in isolated locations.

1-3.3 Protection for people and property transported by vehicles is somewhat more complicated in that the location of emergencies cannot be predetermined; they may occur at any point or simultaneously at several points along the course of any facility. Fire emergencies may range from incipient fires in passenger vehicles to major accidents involving loaded buses, and trucks carrying hazardous materials. Heavy traffic and adverse weather conditions and night usage aggravate the problem.

1-3.4 Studies of fire protection for limited access highways indicate that there are 3 interdependent considerations. The first is rapid transmission of alarms to the proper authorities and a simultaneous warning to approaching vehicle operators. The second is the response of appropriate apparatus and manpower with a minimum of delay. The third is the matter of rescue operations followed by fire extinguishment or control. When life is endangered by fire, the possibility of effective rescue operations decreases rapidly with any delay.

1-3.5 Unless effective means of communication is provided, the reporting of fire and other emergencies by occupants of passing vehicles loses much of its value. Distance to interchanges, service areas and toll booths, and indecision due to unfamiliarity with emergencies will often consume the limited time of possible effective action. The development of Citizens Band radio offers a most effective communication device, especially for non-urban highways.

1-3.6 Control of traffic is a continuous problem from the time of occurrence of any emergency to the time of removal of the occupants and vehicle from the facility. Experience has indicated that the slowing of traffic is essential to minimize the hazard of multiple collisions.

1-4 Tunnels.

1-4.1 The fire protection problem created by a fire in a vehicular tunnel is similar to that of a fire occurring on a highway in that the emergency is complicated by existing traffic conditions, the number of passengers carried by vehicles involved, and the wide diversity of cargo transported by trucks. The problem is further complicated by sloping roadways and the possibilities of inadequate ventilation and illumination. Other problems connected with a fire emergency in a tunnel include limitations on fire fighting equipment and personnel, control of traffic, and evacuation of the public.

1-4.2 Protection to life is the primary concern. The secondary consideration is protection to the tunnel structure itself. Damage to the ventilation, lighting or drainage systems would endanger the lives of persons not involved in the original emergency.

1-4.3 As with highways, the primary need is a means for prompt and rapid notification to the authorities of the existence and location of an emergency and the development of effective means of traffic control.

1-5 Elevated Roadways and Bridges.

1-5.1 A fire occurring on an elevated roadway or bridge has the same characteristics as a fire occurring on a highway, but is usually less accessible.

1-5.2 Protection to life is the primary concern. However, protection to the elevated roadway or bridge may be more important than protection to vehicles and cargo. Damage to a critical structural member from collision or exposure to high temperatures could result in dangerous weakening or complete collapse of the elevated roadway or bridge.

1-5.3 Approaches to elevated structures and bridges frequently pass directly over congested residential or high value industrial areas. Certain hazardous material fires on the structures could result in serious exposure fires in the occupancies beneath and in close proximity to the structures. Conversely, these occupancies, particularly those dealing with hazardous materials, may seriously expose the structures.

1-6 Air Right Structures.

1-6.1 Air right structures also present two fire protection problems. One relates to the persons and property in the air right structure. The other relates to the persons and property using the roadway that passes under or adjacent to the air right structure.

1-6.2 Fire protection for the air right structures presents problems that are similar to those involving like buildings found in other locations. These problems can be aggravated, however, by limited access, traffic congestion and the fire situation in the roadway under or adjacent to the structure.

1-6.3 Fire protection for a roadway under an air right structure is similar to that needed for a tunnel. Occupancy and use of the space above the ceiling of the roadway is a significant difference.

1-6.4 While protection of life is the primary consideration, there are other important concerns. The structural members that support the air right building could be subjected to very high temperatures, particularly in a flammable liquids fire or explosion. Damage to these members could have a serious effect on the building. In addition, openings from the roadway such as ventilation shafts, drainage systems and walkways could permit passage of flammable liquids or vapors to the air right structure with subsequent damage from fire or explosion.

1-6.5 Consideration must be given to the fact that flammable liquids or vapors can flow from the roadway scene by gravity or via the drainage system and thus extend the fire well beyond the area of the original emergency.

1-6.6 Major structural elements that support an air right structure may be subject to physical damage from motor vehicle accidents.

1-7 Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). One unit (liter), outside of but recognized by SI, is commonly used in international fire protection. See ASTM E380, *Standard for Metric Practice*.

1-7.1 If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated is to be regarded as the requirement. A given equivalent value may be approximate.

1-7.2 The conversion procedure for the SI units has been to multiply the quantity by the conversion factor and round the result to the appropriate number of significant digits.

1-8 Official NFPA Definitions.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an in-

surance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Should. Indicates a recommendation or that which is advised but not required.

Chapter 2 Limited Access Highways

2-1 Alarm Transmission.

2-1.1 Means should be provided whereby emergency alarms may be transmitted to an appropriate authority by the general public from locations along the routes of highways. Citizens Band (CB) radio has proven to be an excellent and efficient device for such transmissions, especially for highways in other than urban areas. Signs should be erected at all access points on the highway indicating that the police monitor Channel 9 (the emergency CB channel). All police, maintenance and emergency vehicles should be equipped with CB radios, as well as conventional shortwave radios. In addition, alarm transmission may be provided by the installation of outdoor-type telephone boxes, coded alarm telegraph stations, radio transmitters, sensing equipment, or other suitable devices. They should be made conspicuous by indicating lights or other suitable markers, and should be located so as to permit their use without vehicles having to stop on the roadway.

Mile markers should be installed along the highway to permit motorists to give reasonably accurate locations for accident or emergency areas.

2-2 Fire Control.

2-2.1 Arrangements for the response of nearby fire companies and emergency squads should be made. Means of access, permitting the entrance of outside aid companies to the facility, should be provided and procedures for utilizing them should be included in the emergency plan. Appropriate precautions should be taken at these points of entry so as to alert and control traffic to permit safe entrance by emergency equipment. It is important that apparatus responding to fires on limited access roads be equipped with booster tanks [500 gal (1900 L) minimum] and foam production equipment or an equivalent amount of dry chemical.

2-2.2 All patrol cars, maintenance vehicles and similar official vehicles should be equipped with portable multi-purpose fire extinguishers of nominal 20-lb (9-kg) capacity.

2-2.3 Service areas, maintenance areas, and other permanent installations should be protected by public water supply systems with accessible hydrants where such supplies are available. Where such

facilities are not served from municipal or other water systems, storage of at least 50,000 gal (190 000 L) at a minimum pressure of 20 psi (138 kPa) should be provided for major installations. Consideration should be given to providing automatic sprinkler protection.

2-2.4 Fire extinguishers should be provided at highway installations and buildings in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*. Protection of special hazard areas should be provided in accordance with appropriate NFPA standards. For example, for the protection of restaurant cooking facilities, refer to NFPA 96, *Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment*; for gasoline service stations, refer to NFPA 30, *Flammable and Combustible Liquids Code*; and for repair garages, refer to NFPA 88B, *Standard for Repair Garages*.

2-2.5 It is important that a designated authority carry out a complete and coordinated program of fire protection which should include written preplanned response and standard operating procedures.

2-2.6 Emergency traffic control procedures should be established to regulate traffic.

NOTE: Such procedures have the dual purpose of preventing the involvement of additional vehicles in the original accident and of slowing traffic during inclement weather conditions.

2-2.7 In order to derive the maximum benefit from the fire protection program, comprehensive training programs are necessary for all personnel and agencies expected to participate in fire fighting operations and hazardous material emergencies. Such a program should involve a competent supervisory staff experienced in fire fighting techniques and hazardous material emergencies.

2-2.8 Contacts should be made with roadside businesses and with responsible persons living along limited access highways to elicit their cooperation in the reporting of fires and other emergencies. The objective of such contacts should be to establish a positive system for the reporting of emergencies. Those who agree to participate in the system must be provided with specific information as to the procedures for reporting and with a means for determining and reporting the location of the emergency as precisely as possible.

Chapter 3 Tunnels

3-1 Alarm Transmission.

3-1.1 Means should be provided whereby emergency alarms may be transmitted by the general public, by members of the foot patrol when stationed in the tunnel or by personnel observing a tunnel operation by means of closed circuit TV. Coded alarms or outdoor-type telephone boxes should be installed at intervals of not more than 300 ft (90 m) and should be made conspicuous by indicating lights or other suitable markers. In addition, tunnels with high volume traffic should be equipped with a traffic monitoring system which would automatically transmit alarms to a central control at any time normal traffic flow is interrupted. Such a system is most effective when it is integrated with a closed-circuit television system.

3-1.2 A traffic control system should be provided. It may be interlocked with the fire alarm system to turn all signals red between the point of alarm transmission and the tunnel entrance, and amber between that point and the tunnel exit. It may be controlled by personnel on duty either in the tunnel or at a central control observing a closed-circuit television system.

3-2 Fire Apparatus, Equipment.

3-2.1 Suitable apparatus should be available at the tunnel exit. Apparatus should be designed for double-end lifting operation and equipped with "dollies" for towing disabled vehicles from the tunnel. The apparatus should carry a potassium bicarbonate base dry chemical/AFFF, or a similar self-contained fire fighting system and/or means to obtain water from a standpipe system. It should also carry portable extinguishers, complete self-contained breathing apparatus, cutting torches, forcible entry tools, hose, chains, coffin hoists, tarpaulins, and other appropriate hand tools. The apparatus should be radio-equipped.

3-3 Water Supplies.

3-3.1 A water supply system capable of supplying not less than 1,000 gal per min (3800 L/min) at adequate pressures [minimum 20 psi (140 kPa) residual] should be installed and connected at each end to storage tanks or to an adequate municipal water supply system. It is recommended that the water supply be available for 30 minutes. Mains should be placed with suitable interconnection and valving

facilities to allow isolation and repair of any section without impairing the supply. Hose connections should be installed and conspicuously marked at a maximum of 300-ft (90-m) intervals. Where freezing conditions are likely to be encountered, piping should be protected.

NOTE: It may be desirable to provide a small pump to circulate water through the system during the freezing periods.

3-4 Portable Extinguishers.

3-4.1 Portable fire extinguishers, each with at least a nominal 20-lb (9-kg) capacity multipurpose agent, should be placed on both sides of the roadway in well-marked, flush-wall cabinets at intervals of not more than 300 ft (90 m).

3-5 Emergency Ventilation.

3-5.1 Emergency ventilation procedures should be developed to permit maximum utilization of the ventilation system for the removal of smoke during fires. The ventilation equipment should be resistant to the heat of a fire so that it is capable of operating even under sustained fire exposure temperatures. The design of the ventilation system should provide for excess ventilation to accomplish this purpose. The ventilation procedures should be designed to afford maximum protection for motorists trapped between the fire and the tunnel entrance. In addition, the procedure should afford help for fire crews consistent with the primary aspect of protection for the motorists.

3-6 Drainage System.

3-6.1 A complete drainage system should be provided, with a sump and pump at every low point in the tunnel.

3-7 Control of Hazardous Materials.

3-7.1 The authority having jurisdiction of tunnels, especially those in excess of 200 ft (60 m) long, should adopt rules and regulations found in Title 49, *Transportation, Code of Federal Regulations*, Parts 170-178, applicable to the transportation of hazardous materials. A program should be maintained for enforcing these regulations.

3-8 Responsibility for Fire Protection.

3-8.1 It is important that a designated authority carry out a complete and coordinated program of fire protection which should include preplanned response and Standard Operating Procedures (S.O.P.).

3-8.2 In order to derive the maximum benefit from the fire protection program, comprehensive training programs are necessary for all personnel and agencies expected to participate in fire fighting operations and hazardous material emergencies. Such a program should involve a competent supervisory staff experienced in fire fighting techniques and hazardous material emergencies.

Chapter 4 Bridges and Elevated Roadways

4-1 Alarm Transmission.

4-1.1 Means should be provided whereby the general public may transmit emergency alarms. This may be accomplished by the installation of outdoor-type telephone or coded alarm boxes or other suitable devices at intervals of approximately 500 ft (150 m) on bridges and elevated roadways. They should be made conspicuous by indicating lights or other suitable markers. In remote areas, use should be made of Citizens Band radio transmission. Adequate signs should be provided to indicate that the responsible authority monitors Channel 9. Signs should also provide definite location information for motorists or other people transmitting alarms.

4-1.2 A traffic control procedure should be established so that vehicles will either stop or proceed with caution. It is essential that traffic does not block or otherwise interfere with the response of emergency and fire equipment.

4-2 Fire Apparatus, Water Supplies, Equipment.

4-2.1 Suitable apparatus should be available within 1 mile (1.6 km) of all points on elevated roadways and bridges in urban areas; use of ladders by municipal fire fighters is satisfactory where elevated structures and bridges are accessible from beneath. Design of apparatus intended for use only on bridges or elevated structures should be based upon the conditions encountered. The apparatus should have braking equipment adequate under all conditions, both to maintain a position on any existing slope and to restrain disabled vehicles being towed. Apparatus responding to fires on bridges and elevated roadways should be equipped with potassium bicarbonate base/AFFF or similar self-contained fire fighting equipment. In addition, the vehicle should have booster tanks [500 gal (1900 L) minimum], and should be radio-equipped.

4-2.2 Standpipe systems capable of supplying not less than 1,000 gal per min (3,800 L/min) at adequate pressures [minimum 20 psi (140 kPa) residual] should be installed in urban areas. It is recommended that the water supply be available for 30 minutes. An alternate would be to supply a standpipe system from pumpers in the street below and, if available, from fire boats. It is desirable that duplicate systems be installed on each side of the roadway and the systems be cross-connected. Where freezing conditions prevail, systems should be dry-type. Signs should indicate the location of street level hydrants.

4-2.3 Sand should be provided for use during icy weather conditions. Suitable absorbent materials should be provided for controlling the spills of hazardous materials. On bridges and elevated roadways, consideration should be given to drainage systems to channel spilled hazardous materials to areas that will not cause additional hazards. For example, expansion joints should be designed as to prevent spillage to the area below.

4-3 Control of Explosives and Radioactive Materials.

4-3.1 The authority having jurisdiction of a bridge facility or an elevated roadway, especially those in excess of 200 ft (60 m) long should adopt rules and regulations, found in Title 49, *Transportation, Code of Federal Regulations*, Parts 170-178, applicable to the transportation of hazardous materials. A program should be maintained for enforcing these regulations. In developing such regulations, consideration should be given to the following factors:

- (a) The fire and accident experience of other similar facilities.
- (b) Past fire and accident experience on the facility and adjacent roads, or, in the case of a new facility, the past fire and accident experience on roads in the area.
- (c) Anticipated traffic volumes in peak and off-peak periods.
- (d) The need for inspection of vehicles and cargo and the availability of a safe place to conduct inspections with a minimum of interference with other traffic.
- (e) The need and desirability of escort service with due consideration of the extent to which it may disrupt the orderly flow of traffic and create additional hazards.
- (f) The extent to which diverting such vehicles from the facility may result in a greater degree of hazard by requiring them to use less safe routes.

4-4 Responsibility for Fire Protection.

4-4.1 It is important that a designated authority carry out a complete and coordinated program of fire protection which should include preplanned response procedures.

4-4.2 In order to derive the maximum benefit from the fire protection program, comprehensive training programs are necessary for all personnel and agencies expected to participate in fire fighting operations and hazardous material emergencies. Such a program should involve a competent supervisory staff experienced in fire fighting techniques and hazardous material emergencies.

Chapter 5 Air Right Structures

5-1 Alarm Transmission.

5-1.1 Means should be provided whereby emergency alarms may be transmitted by the general public. Coded alarm or outdoor-type telephone boxes should be installed at intervals of not more than 200 ft (60 m) and should be made conspicuous by indicating lights or other suitable markers. Air right structure roadways with heavy traffic volumes should be equipped with a traffic monitoring system which would automatically transmit alarms to a central control at any time normal traffic is interrupted. Such a system is most effective when it is intergrated with a closed-circuit television system.

5-1.2 A traffic control system should be provided. It may be interlocked with the fire alarm system. The system should be capable of operation from a remote control source or from either end of the roadway passing under the air right structure. The traffic control system should be designed for use by authorized personnel only.

5-2 Fire Apparatus — Equipment.

5-2.1 Fire apparatus assigned to companies responsible for air right structure roadways must be equipped to effectively deal with flammable liquid and hazardous material fires and incidents. They should be equipped to carry foam, potassium based dry chemical/AFFF or similar systems for this purpose and suitable to the unique characteristics of the structure.

5-3 Water Supplies.

5-3.1 A water supply system capable of supplying not less than 1,000 gal per min (3,800 L) at adequate pressure [minimum 20 psi (140 kPa)] should be available. It is recommended that the water supply be available for 30 minutes. It should be connected to storage tanks or to a suitable municipal water source. Hose connections should be installed and conspicuously marked at a maximum of 200-ft (60-m) intervals.

5-3.2 Air right structure roadways in excess of 200 ft (60 m) long should be equipped with a manual deluge sprinkler system to be fed and controlled by the designated authority.

5-4 Portable Extinguishers.

5-4.1 Portable multipurpose fire extinguishers, each with a nominal 20-lb (9-kg) capacity, should be placed on both sides of the roadway in well-marked flush-wall cabinets, at intervals of not more than 200 ft (60 m). Consideration should be given to incorporating removal of an extinguisher into the fire alarm system.

5-5 Emergency Ventilation.

5-5.1 Air right structure roadways in excess of 200 ft (60 m) long should be designed with a positive ventilation system. The ventilation equipment should be resistant to the heat of a fire so that it is capable of operating even under fire conditions. Emergency ventilation procedures should be developed to permit maximum utilization of the system for removal of smoke from the roadway area during fires. The design of the system should provide excess ventilation capabilities for this purpose. The design should also prevent or minimize adverse effects on the air right structures and their occupants from the fire products such as heat, smoke and toxic gases.

5-6 Drainage System.

5-6.1 A complete drainage system should be provided for the air right structure roadways. Sumps with automatic pumps should be provided where necessary. The design of the drainage system should provide protected collection areas so that spills of hazardous materials, such as flammable liquids, cannot create a fire or health hazard in another area.

5-7 Control of Hazardous Materials.

5-7.1 The authority having jurisdiction over an air right structure roadway, especially those in excess of 200 ft (60 m) long, should adopt rules and regulations found in Title 49, *Transportation, Code of Federal Regulations*, Parts 170-178, applicable to the transportation of hazardous materials. A program should be maintained for enforcing these regulations.

5-8 Structural Factors.

5-8.1 All structural elements that support buildings over roadways and/or provide separation between the buildings and roadways should have a 4-hour fire resistance rating in accordance with ASTM E119. This recommendation does not apply to the buildings above the 4-hour rated separation.

5-8.2 Structural members should be protected from physical damage from vehicle accidents. An inspection and repair program should be kept in force to maintain the protection.