DOCUMENT RESUME

ED 076 829 VT 020 214

TITLE	Expressway and Freeway Emergencies. California Fire Service Training Program.
INSTITUTION	California State Dept. of Education, Sacramento. Bureau of Industrial Education.
PUB DATE	70
NOTE	38p.
AVAILABLE FROM	California State Department of Education, Business Service Section, Textbook and Publication Sales, 721 Capitol Mall, Sacramento, CA 95814 ($1.00)
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Accident Prevention; *Accidents; *Emergency Squad Personnel; Fire Science Education; Industrial Education; *Manuals; Safety Education; *Traffic Safety; *Trainees

ABSTRACT

This manual has been prepared to assist in training fire department personnel for extending emergency service on expressways and freeways. Information provided in the manual is designed to answer questions dealing with these topics: (1) Expressway and Freeway Incidents and Operations, (2) Special Expressway and Freeway Problems, (3) Sizing Up Expressway and Freeway Incidents, (4) Use of Standard Fire Apparatus and Equipment, (5) Special Equipment Available from other Agencies, (6) Emergency Response Considerations, (7) Personnel Safety, (8) Liaison with Law-Enforcement Agencies, (9) Handling and Disposal of Hazardous Materials, and (10) Special Materials for Controlling Spills and Fires. A bibliography is included, and regulations pertaining to the placarding of vehicles transporting hazardous materials is appended. (SB)

PREFACE

Expressways and freeways are arterial routes designed to carry heavy traffic at relatively high speeds. The design of these routes incorporates provisions for controlling or eliminating cross traffic and for minimizing congestion by vehicles entering or leaving the routes. Both expressways and freeways are limited-access routes, but they differ in means of access. Expressways are open to access by intersecting or crossing streets and roads, although entries and exits are usually controlled by traffic signals. On the other hand, freeways are accessible only by means of on-ramps and off-ramps. Streets and roads that would otherwise cross or intersect freeways are diverted over or under them.

The California Division of Highways has reported that more than 4,000 miles of expressways and freeways were in use at the beginning of 1970 and that more than 800 additional miles are scheduled for completion by 1971. The legislature has recently approved more than 12,000 miles of expressway and freeway construction. Upon completion, the entire system will serve both metropolitan areas and county seats as well. During 1969, expressways and freeways in Los Angeles, Orange, and Ventura counties alone carried more than 21 billion miles of traffic. Many freeways in these areas each carried more than 200,000 vehicles per day within that year.

In the event of emergency, users of expressways and freeways are forced to depend on the resources of the communities through which or by which they pass. Therefore, a majority of California fire departments are having to extend protection to the limited-access routes in their vicinity. In the near future, fire departments that do not provide emergency service to some portion of such a highway will be exceptional. This manual has been prepared to assist in training personnel for extending such emergency service.

Through the information presented in this manual, an attempt has been made to analyze expressway and freeway emergencies that are likely to fall within the jurisdiction of the fire services. Although general in nature and therefore limited in depth of detail, this manual can at the least serve as a framework for planning against such emergencies.

The publications cited in the text of this manual and some selected documents are listed in the Bibliography. Because their subject matter is relevant to the subject of this manual, their acquisition by fire-service organizations is highly recommended.

Initial work on this manual, *Expressway and Freeway Emergencies*, was accomplished at the Fire Training Officer's workshop, Conference on Expressway and Freeway Emergencies, Fresno, May 8-12, 1967. Materials developed at that conference were subsequently reviewed and amplified by Ralph B. Hamilton, Battalion Chief, Downey Fire Department. The California Fire Service Training Program staff expanded certain sections and organized the material into manual form for publication.

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CONTENTS

	Page
Foreword	iii
Preface	v
TOPIC 1 – EXPRESSWAY AND FREEWAY INCIDENTS AND OPERATIONS	1
TOPIC 2 – SPECIAL EXPRESSWAY AND FREEWAY PROBLEMS	3
TOPIC 3 – SIZING UP EXPRESSWAY AND FREEWAY INCIDENTS	5
TOPIC 4 – USE OF STANDARD FIRE APPARATUS AND EQUIPMENT	7
TOPIC 5 – SPECIAL EQUIPMENT AVAILABLE FROM OTHER AGENCIES	9
TOPIC 6 – EMERGENCY RESPONSE CONSIDERATIONS	11
TOPIC 7 – PERSONNEL SAFETY	13
TOPIC 8 – LIAISON WITH LAW-ENFORCEMENT AGENCIES	15
TOPIC 9 – HANDLING AND DISPOSITION OF HAZARDOUS MATERIALS	17
TOPIC 10 – SPECIAL MATERIALS FOR CONTROLLING SPILLS AND FIRES	23
BIBLIOGRAPHY	25
APPENDIX – HAZARDOUS MATERIALS PLACARDING	27

Topic 1 — EXPRESSWAY AND FREEWAY INCIDENTS AND OPERATIONS

This topic, "Expressway and Freeway Incidents and Operations," is planned to provide answers to the following questions:

- In what ways do incidents that occur on expressways and freeways differ from incidents that occur on other thoroughfares?
- What are typical expressway and freeway incidents?
- Why do freeway collisions create severe rescue problems?
- What kinds of fires can be expected on expressways and freeways?
- What are typical fire department operations during expressway and freeway incidents?
- What are the basic premises for dealing with incidents involving hazardous materials?

Emergencies that occur on expressways and freeways and those that take place on other thoroughfares all have one thing in common: they are usually results of human error. Vehicle failures are a secondary cause. The circumstances of expressway and freeway incidents are, however, compounded by several conditions:

1. More vehicles carrying more people and more materials
2. Higher rates of speed
3. Serious effects of natural occurrences, such as rain, snow, sleet, fog, flood, and slides
4. Fewer means of access to incidents by fire departments and other emergency units
5. Fewer water sources available for fire-department operations

These factors make it necessary for fire departments to develop special procedures for handling expressway and freeway incidents. Such incidents often involve rescuing passengers from damaged or burning vehicles, providing emergency care for accident victims, combating fires, and dealing with various types of hazardous-materials problems.

Typical Incidents

Typical incidents that take place on expressways and freeways include collisions, fires, explosions, and cargo leaks and spills.

Collisions

Collisions on expressways and freeways commonly result in injuries and vehicular damage more extensive than those on other thoroughfares. Cars and trucks traveling at high speeds can instantaneously involve large numbers of vehicles in freeway collisions. Cases are on record of 100 or more vehicles of various descriptions having collided in a single incident.

Fires

Vehicle or cargo fires can occur as a result of collision, or they can be caused by a number of other factors. Vehicle fires can develop in engine or passenger compartments; fuel, electrical, and braking systems; and tires. Cargo fires, usually more extensive than vehicle fires, can involve a wide range of combustible, flammable, explosive, and toxic materials.

Explosions

Although rapid burning, often with explosive force, is sometimes associated with ruptured fuel tanks, explosions within automotive systems or components are very rare. When cargo vehicles are involved, however, the danger of explosion can be extreme. Trucks carry flammable liquids and gases, combustible and explosive materials, and strong oxidizing agents over freeways in large quantities. These materials are subject to explosion from shock of impact, exposure to heat, or mixing with other incompatible materials in the event of collision.

Cargo Leaks or Spills

Leaks or spills can result from collisions or from container failure for various causes. Such incidents may or may not require fire-department response. Noncombustible and nontoxic materials may only create traffic problems, and the extent of fire-department involvement is governed by local policy. This means that fire departments could be called upon to flush liquids from freeways or to assist in moving solid materials. Where flammable or toxic materials are involved, operating procedures are usually such that command is delegated to the fire department, and law-enforcement agencies and other agencies are required to assist as necessary.

Typical Fire-Department Operations

Typical fire-department operations during freeway and expressway emergencies include rescue and aid to victims, extinguishing fires, and disposing of hazardous materials.

Rescue

Freeway rescue operations can be intricate; and the victims, vehicles, and circumstances involved can be numerous and varied. Persons may be so entrapped within and under vehicles that rescue work might entail extensive cutting, prying, spreading, and shoring of the vehicles involved. Rescue activities during freeway incidents can be expected to include the following operations:

1. Locating actual and potential victims
2. Protecting entrapped or immobilized persons from further injury by fire, from the efforts of enthusiastic but untrained bystanders, and other hazards
3. Providing emergency care for persons who are injured or entrapped
4. Removing entrapped persons from vehicles
5. Providing emergency care for victims who are awaiting transportation to hospitals
6. Providing transportation to hospitals in certain instances

Local policy usually establishes responsibility for transportation. In some areas, fire departments either provide transportation or are responsible for summoning ambulances. In other areas, police agencies are completely responsible for transportation.

Information regarding rescue and first-aid techniques may be found in the manual, *Emergency Care of the Sick and Injured,* Sacramento: California State Department of Education, 1969.

Fires

Many freeway fires are relatively simple to control with only portable extinguishers or water from portable supplies. Others are highly complex and require unusual commitments of equipment and manpower. Fire-control operations on freeways, while generally similar to those conducted on other thoroughfares, are usually influenced by certain unique factors, four of which are outstanding: (1) limited or obstructed access; (2) inadequate water supplies; (3) unusual personnel hazards; and (4) hazardous materials in transport.

Suggestions for dealing with these and other factors characteristic of freeway incidents will be provided further on in this manual.

Incidents Involving Hazardous Materials

The quantity and variety of hazardous materials transported over freeways is enormous, and cargoes include materials that may be combustible, flammable, explosive, and toxic. Hazardous materials can create problems from collison, fire, container failure, and for a multitude of other reasons. Fire-control operations during incidents involving hazardous materials are necessarily based upon three premises: (1) determining the type of material; (2) deciding the proper action; and (3) deploying the necessary manpower, apparatus, equipment, and extinguishing agents.

Since hazardous materials create severe fire-control and personnel-protection problems, methods of dealing with incidents involving the several categories of hazardous materials are discussed extensively in subsequent topics.

Topic 2 — SPECIAL EXPRESSWAY AND FREEWAY PROBLEMS

This topic, "Special Expressway and Freeway Problems," is planned to provide answers to the following questions:

- How can an adequate water supply be maintained throughout the expressway or freeway emergency?
- What are some reliable sources of water for highway use?
- What are some environmental exposure problems that could be encountered at the scene?
- What are the dangers of fires occurring on bridges or elevated freeways?

The vast network of restricted-access roadways, together with limited water available for fire fighting, create unusual problems on the freeway and expressway systems throughout California. By the very nature of the expressway and particularly the freeway, access to the scene is undoubtedly the first problem of fire-service units. Because of its paramount importance, access is covered extensively in Topics 3 and 6.

Water Supplies

The problem of a severely limited or perhaps nonexistent water supply is the most important consideration after access itself. Few freeways are equipped with water main and hydrant systems. In most cases, water for fire control must either be obtained from hydrants on nearby streets or transported to the scene by tank vehicles. Long hose deployments through adjoining properties, over fences, up or down embankments, and so forth, are time consuming. Transporting water by tank vehicle may be almost impossible because of traffic and congestion, and the adequacy of such a water source for extensive operations is questionable. Extensive prefire planning for getting water to any portion of a freeway is therefore of prime importance. Such plans should pinpoint all nearby water sources and prescribe primary and alternate means of getting water to the scene of an emergency.

Appropriate questions can serve as guidelines to planning. Some questions that recognize foreseeable problems might be: Will extra manpower be necessary to hand-lay hose? Will relay pumping be required, Is the only available source so far away that tankers will be necessary? Are unusual hose deployments required, as up or down from overpasses or underpasses via ladders? These and many other anticipatory questions must be answered before an incident occurs.

Plans, including maps of water sources, may be carried on apparatus or maintained in dispatching centers. Water sources may include reservoirs, portable pumps, drops from aircraft, and the like. If water has to be transported, plans should include the use of outside-agency equipment, such as transit concrete-mixer trucks, water or milk tankers, and so forth. Freeway sprinkler systems normally used for irrigation purposes may be considered as possible sources, although the available flow is usually barely adequate for fire-fighting purposes.

Environmental Problems

Immediately following an accident or emergency incident on freeways and expressways, environmental problems usually occur in profusion. Hazards attending the original incident are rapidly compounded by an accumulation of vehicles near the scene. To make matters worse, droves of curious spectators appear, seemingly from nowhere. These developments seriously impede the efforts of fire personnel and the movement of apparatus. Curious onlookers add to operational problems, and they expose themselves to unnecessary danger. Besides these hindrances are a number of other environmental considerations (exposures), which include:

1. Roadside structures, trees, grass, brush, or timber, that may become ignited by exposure to flames, by runaway vehicles, or by ignition of flammable vapors
2. The flowing into storm drains of flammable liquids and vapors that become subject to ignition or explosion
3. Large amounts of water that, used in emergencies, could flood lower areas of freeways

Fires or emergencies in unusual location, such as on elevated or depressed roadways, bridges, and major interchanges, may be difficult to reach because of traffic congestion. Plans for such conditions might include the use of aerial ladders or elevating platforms.

Topic 3 — SIZING UP EXPRESSWAY AND FREEWAY INCIDENTS

This topic, "Sizing Up Expressway and Freeway Incidents," is planned to provide answers to the following questions:

- What information must be obtained when receiving notification of a freeway emergency?
- What apparatus and how many units should be dispatched to the scene?
- What factors determine accessibility to the scene?
- What are some of the strategic factors to be considered in prefire planning for freeway emergencies?

Notification of freeway emergencies can come to fire-fighting agencies from several sources and with varying degrees of authenticity and completeness. The person receiving the notification is responsible for obtaining as much information as necessary regarding the "what" and "where" of the incident.

Receiving the Report

Alarm operators should make every attempt to get adequate information from persons reporting freeway incidents. Basically, this consists of the type and location of the incident and the types and numbers of injuries. Information as to the type of emergency would include such facts as: vehicle or right-of-way fire, cargo spill or leak, or type and number of vehicles involved. The specific location of the emergency should be included, such as:

1. Name or number of freeway or expressway
2. Distance from on-ramp or off-ramp, overpass or underpass, landmark, town, district, or other reference point
3. Informant's location, including number of telephone he is calling from
4. Lane or lanes in which emergency exists (inbound, outbound, westbound, and so forth)

Individual lanes are designated by number and are numbered from the center divider outward. The lane nearest the divider (the "fast" lane) is number one; the next lane is number two, and so forth. Injured persons should be reported, and this information should include the number of injured and the types of injuries if possible.

Getting Accurate Information

If the general area of the emergency were thoroughly familiar to the person reporting, as it would be to a highway patrolman or highway maintenance employee, the location of the accident usually would be well described. Also, when an emergency highway telephone is used, the operator receiving the call could easily determine the location of the telephone being used. Commonly, however, the informant is unfamiliar with the area and possibly has traveled some distance before finding a telephone or person to whom the emergency can be reported. Occasionally, an emergency will be reported by persons not traveling the freeway. Persons in structures near the freeway or in vehicles traveling off-freeway streets, pilots or passengers in aircraft, or a member of a train crew may be the source of communicating necessary information. In those events alarm operators must take extra care to obtain as much information as possible. This will entail questioning reporting individuals to get any and all information that will help to pinpoint the incident. Prefire planning should include an interrogation checklist to be used by alarm operators. Familiarity with the list and ever-ready access to it will help significantly in obtaining all necessary information from the person reporting an incident.

Certain kinds of additional information will assist in determining location. That information might include recognition of landmarks, highway signs and markers, direction of vehicular travel, bridges, overpasses and underpasses, and exits and entrances. Such information should also include pertinent facts regarding the nature of the incident.

Radio-equipped units that can respond to freeway emergencies can also be of great service in guiding other responding units and alerting them about traffic conditions, vehicles involved, injuries, and common-carrier contents. All fire-department personnel involved in freeway emergencies should be aware of the importance of keeping all units informed of current conditions and of providing other relevant information.

Sizing Up the Incident

As in the case with all incidents, the techniques and procedures used on freeways will be based on the estimate made by the officer in charge. Sizing up incidents on

freeways or elsewhere is based largely on prefire planning, which is basically a process of gathering and studying various types of information that must take local conditions into account. Irrespective of local conditions, however, prefire planning should include four important considerations: (1) access to freeway locations; (2) peak traffic periods; (3) environment around the incident; and (4) available resources. These factors are subject to further consideration.

Access

Access to freeway locations would logically include locations of on-ramps and off-ramps, interchanges, underpasses, overpasses, and portions of freeway that are at grade, above grade, and below grade. Also included with this information might be location and types of side fencing, center dividers, and methods of crossing barriers. Access could be greatly facilitated by such information as location of freeway portions that are abutted by frontage roads or railroad rights-of-way; also, vacant or unimproved property adjacent to freeways through which access with apparatus is possible. Peak traffic periods represent information that is highly relevant to access, since they might determine direction of approach, types of equipment, and so forth.

Water Supply

The matter of water supply is dependent on such factors as location of hydrants along surface streets that are adjacent to freeways and static water sources (ponds, lakes, tanks, and the like) near the freeway. Availability and adaptability of various types of mobile water-carrying equipment also constitute important information about water supply.

Environment

Environmental factors include structures adjacent to freeways, as well as natural or constructed drainage through which flammable and toxic materials could flow and thereby become a threat to life or property.

Resources

Available resources refers to manpower, apparatus, and equipment available. These factors are affected by the category of alarm or the seriousness of the incident, whether mutual aid is available in the immediate vicinity, and other resources that may be available by special call. Cooperative responses by other departments in borderline areas or areas of dual responsibility could also add to the available resources.

Topic 4 — USE OF STANDARD FIRE APPARATUS AND EQUIPMENT

This topic, "Use of Standard Fire Apparatus and Equipment," is planned to provide answers to the following questions:

- What are the various types of fire apparatus available to respond to freeway incidents?
- What is the minimum manpower required to handle these incidents?
- What types of equipment will assist in solving the water-supply problem?
- What are some probabilities and eventualities that must be considered during large-scale operations?

The equipment and manpower necessary to deal with incidents effectively on freeways and expressways can be extensive. Large-scale and unusual operations might seem to necessitate the use of equipment from agencies other than fire service. However, the time involved in requesting and obtaining such equipment through proper channels, getting it to the scene, and making it effectively operational could result in serious and costly delays. Fire-department apparatus and trained personnel can respond immediately and get into operation quickly. The plans and procedures that are developed should therefore include the adaptation of standard apparatus to the fullest extent for various uses during freeway incidents.

Fire Companies and Special Apparatus

The various fire-department contingents and the special apparatus required for freeway and expressway emergencies include engine companies, truck companies, rescue companies, mobile water supplies, foam fire-fighting units, and lighting units. These are discussed individually as follows:

Engine Companies

An adequately manned engine company (an absolute minimum of three men) under the direction of a company officer and carrying the recommended complement of equipment is perhaps the most generally suitable unit to deal with freeway incidents. The engine company, carrying forcible-entry tools, hose water, ladders, and other equipment, is usually well prepared to serve as the basic unit for any type of freeway operation.

Truck Companies

Truck companies may be useful during freeway and expressway incidents that are beyond the capabilities of engine companies. Extensive ladder operations, more specialized rescue equipment, and heavy-duty rescue equipment are typical of truck-company capabilities. Truck companies can also provide additional manpower for large-scale rescue or fire-control operations.

Rescue Companies

Rescue or squad companies, manned by personnel well-trained in the use of specialized equipment, are invaluable at freeway and expressway incidents. The manning of such companies will vary in accordance with local conditions. These companies usually carry a wide array of special rescue tools, depending upon the type or size of vehicle. A partial list may include the following:

1. Hydraulic rescue tools and jacks of various ratings
2. Cutting torches
3. Hoisting and pulling equipment, including ropes, chain hoists, and other mechanical devices
4. Portable generators for supplying electric tools and lighting equipment
5. Extensive emergency care equipment and supplies including resuscitators, litter, splinting equipment, blankets, first-aid kits, and the like
6. Various types of electrical or gasoline-powered saws
7. Fire extinguishers of various types and sizes
8. Miscellaneous tools including cargo or hay hooks, pitchforks, shovels, hammers of various sizes, redwood plugs, and so forth
9. Other types of tools, including bolt or wire cutters, lock-breakers, mechanical axes, crash and fire axes, and miscellaneous mechanic's tools
10. Self-contained breathing apparatus

Mobile Water Supply Apparatus

During extensive fire-fighting operations on freeways or expressways, water is a critical factor, and fire-department tankers can be extremely useful for these situations.

Large-capacity (1,000 to 2,000 gallon) tankers are desirable. Shuttling of tankers to supply pumpers may be required when hydrants or other sources are either unavailable or inadequate.

Foam Fire-Fighting Units

When foam units are not included in an initial response, consideration must be given to the time lapse involved in obtaining them. It is likely that this type of equipment will be necessary to cope with large flammable-liquid fires. Consideration must also be given to the availability of foam units and supplies of foam material from other departments.

Lighting Units

Large-scale nighttime operations will tax lighting equipment ordinarily carried by small or even average-size departments. Therefore, it may be necessary to make arrangements with large fire departments to furnish heavy-duty units.

Miscellaneous Fire Department Equipment

Fire officers in charge of freeway incidents should not overlook other equipment that may be useful. Hose bridges may be necessary to protect hose while enabling traffic to proceed. Thought should be given to the use of public-address systems for crowd control and command purposes. Other miscellaneous equipment may include the following items:

1. Portable pumps
2. Gasoline trucks or trailers for fueling fire units
3. Portable water reservoirs
4. Command centers
5. Salvage units
6. Brush units

Topic 5 — SPECIAL EQUIPMENT AVAILABLE FROM OTHER AGENCIES

This topic, "Special Equipment Available from Other Agencies," is planned to provide answers to the following questions:

- In addition to the emergency vehicles normally dispatched to a freeway accident, what equipment might be needed in unusual situations?
- Where can such special equipment be obtained?
- How can flammable petroleum products be removed from damaged tankers?

Operations involving fire prevention and control and rescue on freeways sometimes require the use of specialized equipment. Long-range prefire planning for an extraordinary emergency includes knowing all types of equipment available. Therefore, preplanning for freeway incidents includes listing applicable equipment operated by other public agencies, contractors, towing and wrecking firms, military installations, public utility companies, equipment rental companies, and so forth. An up-to-date listing of such equipment, the agency in possession of it, and the means of getting it should be maintained in the dispatching center. Such an inventory will be of little value unless it is constantly updated and unless it includes 24-hour telephone numbers for obtaining necessary equipment.

Types of Useful Equipment

Following is a partial summary of special equipment that could be useful during freeway incidents:

Ambulances

Ambulances are usually procured through law-enforcement agencies. If the responsibility for obtaining ambulances rests with the fire department, certain agreements must be made beforehand. That is, such matters as priority and sequence of calling various ambulance companies and provision for payment (to determine who pays if the persons transported cannot) must be prearranged.

Tow Trucks

Tow trucks are often needed in numbers as a result of freeway incidents. Since some accidents will involve heavy vehicles, the size and capacity of tow trucks is an important factor. Responsibility for paying for tow-truck operations must be planned in advance, usually by the law-enforcement agency responsible for the freeways.

Dump Trucks

Dump and rubbish trucks may be needed to haul away debris resulting from accidents. Dump trucks may also be used to bring sand to the scene of the accident for covering an oil slick or for constructing dikes to retain liquids released from tank vehicles. Dump trucks are usually available from state or county departments of highways or from city public works departments.

Earth-Moving Equipment

Skip loaders and bulldozers may be necessary to construct dikes, to dig retaining pits for fuel or water, or to move heavy articles that have fallen from vehicles.

Cranes and Hoists

Motor cranes might be needed to lift and move vehicles too heavy for a tow truck to handle, or to remove heavy articles (as steel beams or sections of preformed concrete) that have fallen from vehicles.

Liquid-Transfer Equipment

Vacuum, transfer, and defueling trucks are useful for removing liquid from wrecked vehicles or diked areas when it is not safe or practical to allow the liquid to be drained away naturally. Trucks and pumps for this purpose may be obtained from such sources as oil companies, military or civil airfields, and septic-tank service companies.

Communications Equipment

Communication units may be required on the scene of highway emergencies. Most vehicles used for emergency public service work are radio equipped, although all may not be on the same frequency. If it becomes necessary to secure additional communications equipment or to set up a multifrequency command post, prefire planning should include the source of this equipment and the means of obtaining it. The most probable sources of command-type communications equipment are public agencies, such as civil defense, county communications, or large police and fire organizations.

Helicopters

Helicopters can be useful for removing injured persons when surface vehicles cannot reach them and for surveying a section of the freeway that is congested with disabled or stalled vehicles. Helicopters may also be used for command-post duties. Prefire planning should include the sources of these craft, whether police, military, or private.

Tank Vehicles

Water from portable sources may be required quickly and in large quantities. Tank vehicles are sometimes available from city street maintenance departments, county and state highway departments, military agencies, contractors, and so forth. Plans should include this equipment.

The foregoing list is not complete. Other types of necessary equipment may be specified in accordance with the area served or determined by knowledge based on a specific incident. Types of equipment that may be available are widely diversified. Equipment that may be readily available in one area may be difficult to obtain in other areas. When disaster strikes, the fire department is expected to respond and take positive corrective action. No fire department can fulfill its responsibility without having made comprehensive plans that include knowing about all possible special equipment, where it is located, how to get it, and how to use it.

Topic 6 — EMERGENCY-RESPONSE CONSIDERATIONS

This topic, "Emergency-Response Considerations," is planned to provide answers to the following questions:

- From what directions should fire apparatus approach to gain access to freeway emergencies?
- When should red lights and sirens be used?
- How should apparatus be deployed upon arrival at the scene?
- What precautions must be considered when using flares, fusees, and reflectors?

Fire apparatus responding to freeway or expressway emergencies should consider approaching the incident from opposite directions, whenever practicable. A converging approach will tend to offset the effects of heavy traffic congestion, since rush-hour traffic tends to crowd one lane or the other at a given period. The practice of approaching from both directions will also help solve problems presented by center dividers or fences that might delay or prevent access to the scene of the emergency.

A difficult decision often faced by fire personnel responding to freeway emergencies is whether or not to actuate red lights or sirens, or both. Discretion in this matter is usually left to company officers, guided by local police regulations and fire-department policy. Under extremely heavy traffic conditions, however, the use of such warning devices is not recommended. Motorists often reveal a tendency to apply brakes when they see red lights or hear a siren, which would add to traffic congestion and increase the possibility of other accidents.

The wrong-way use of off-ramps by fire fighting units to gain access to freeways or expressways is not recommended. Travel against traffic flow should be attempted only when fire or police units already at the scene verify that it is safe to do so.

Fire apparatus should be parked at a location safely away from traffic lanes, on the shoulder or near the center divider when practicable. Also, placing apparatus between oncoming traffic and trapped victims can afford protection for them as well as for the firemen working at the scene.

Hazardous situations created by toxic, explosive, or flammable materials may require that apparatus be placed upwind, upgrade, and a safe distance from the scene of the incident. Those situations may also determine or restrict the types of flares, fusees, or reflectors to be used. When it is concluded that those devices may be used safely, they should be placed at least 50 feet from hazards created by toxic materials and 200 feet away from hazards created by explosive materials or flammable liquids and gases.

Topic 7 — PERSONNEL SAFETY

This topic, "Personnel Safety," is planned to provide answers to the following questions:

- What safety precautions must fire personnel observe at the scene of freeway and expressway incidents?
- What are some of the hazards that will be introduced or aggravated by the presence of onlookers?
- Why should immediate liaison be established with law-enforcement agencies and personnel?

Precautions for Preventing Injuries

Serious freeway incidents usually result in a complete stoppage of traffic. On the other hand, seemingly insignificant incidents can be extremely hazardous because traffic may not even slow, much less stop. Under the latter condition, special precautions must be taken to prevent injury to fire personnel. Men who are not needed for operational purposes should remain on the apparatus, and those who are needed should alight only on the side away from traffic. It is of course essential that personnel stay out of the traffic flow, if possible, and not wander around the area.

Safety in Use of Tools

Extreme caution is necessary while using tools such as pike poles, ladders, hose, and nozzles, because they may cause serious injury to fire personnel if struck by passing vehicles. Complete protective clothing should be worn when responding to freeway emergencies. Reflector tape on helmets is recommended for working on highway accidents at night. Fire apparatus can serve as a shield when it is positioned between the traffic and operating area, providing protection to fire personnel, accident victims, and others at the scene.

Safety with Flammable and Toxic Materials

Whenever possible, personnel and apparatus should be positioned upgrade and upwind when flammable or toxic materials are involved. Neither personnel working at the scene nor bystanders should be permitted to smoke under those circumstances. Fire personnel should remain on guard against indiscriminate use of flares or fusees, whether by police or bystanders.

In the event that police protection is inadequate, fire personnel should be assigned to observe and direct traffic and to give warning of potential hazards. As mentioned previously, immediate liaison should be established with police officers, which is sufficiently important to merit further discussion in Topic 8.

Topic 8 — LIAISON WITH LAW-ENFORCEMENT AGENCIES

This topic, "Liaison with Law-Enforcement Agencies," is planned to provide answers to the following questions:

- What are the primary functions and responsibilities of the fire department?
- What are the primary functions and responsibilities of law-enforcement agencies during freeway incidents?
- What is the primary purpose of a command post at freeway incidents?

Responsibilities of Law-Enforcement Officers

The primary responsibility of law-enforcement officers at a freeway incident usually is to direct and control traffic. Proper control is required to provide access and operating space for fire department apparatus and to maintain safety for fire personnel.

Other responsibilities of law-enforcement officers include crowd control and evacuation of areas whenever public health or safety is threatened. They are also usually responsible for summoning ambulances and for safeguarding the bodies of dead victims.

Responsibilities of Fire-Department Personnel

Specific functions for which fire-department personnel are primarily responsible include:

1. Rescue
2. Fire control
3. Dealing with problems involving hazardous materials
4. Specification and identification of areas to be evacuated

Liaison Between Law-Enforcement and Fire Agencies

Successful handling of a major freeway incident will largely depend on how quickly and how well liaison is established between law-enforcement and fire agencies. Communications must be well established and maintained throughout the emergency, and a law-enforcement officer will usually be in charge. As the size of an incident increases, manpower and equipment requirements, crowd-control problems, and personnel hazards are likely to increase proportionately. To ensure necessary liaison with law-enforcement and other agencies, a command post should be established as soon as possible. A mobile or portable radio of each frequency and agency located at the command post can be used to receive and relay necessary information to the associated fire and police units.

The California Highway Patrol is the responsible law enforcement agency during most expressway and freeway incidents. The local patrol office should be consulted as part of the fire department's planning to deal with highway emergencies. A mutual understanding should be developed between the responsible fire agency and the Highway Patrol. To facilitate effective cooperation and coordination between the two agencies, their respective published procedures should be mutually maintained and understood. Each agency ought to be thoroughly familiar with the other's authority, responsibilities, and methods for effective coordination.

Topic 9 — HANDLING AND DISPOSITION OF HAZARDOUS MATERIALS

This topic, "Handling and Disposition of Hazardous Materials," is planned to provide answers to the following questions:

- What is meant by hazardous materials?
- What are the basic premises for handling a hazardous-materials incident?
- What are some of the ways in which the objectives of these premises can be achieved?
- What are some typical procedures for dealing with various types of hazardous materials?

Problems with Hazardous Materials

Hazardous materials are highly active chemicals in liquid, gaseous, or solid state that, by virtue of their high-energy potential, represent latent sources of danger to life and property. Their effects may be corrosive, toxic, flammable, explosive or any combination thereof. Their extensive use and hence their widespread transportation is increasing rapidly. Expressway and freeway construction in California is also on the increase. Together, these expanding conditions provide a basis for predicting that more hazardous materials will be transported over more expressways and freeways in the future. This trend correspondingly increases the potential of hazardous-materials incidents in nearly every fire department's area of responsibility.

Regulations for Hazardous Materials

The storage, handling, and use of hazardous materials is governed by federal, state, and local regulations. Their transportation is regulated chiefly by the U.S. Department of Transportation, although state and local regulations also apply in some instances. These regulations, reflecting safe practices recommended by various trade associations, have served to bring about a high degree of transportation safety. Despite all routine precautions, however, collisions, fires, and container failures do occur. Every fire department should be prepared to deal with all such occurrences within its jurisdiction, not the least of which are those involving the transporting of hazardous materials.

Basic Considerations in Hazardous Materials Handling

Successful handling of hazardous-materials incidents must be based on three basic considerations: (1) determining the type of material; (2) determining the correct action; and (3) obtaining and utilizing the necessary manpower, apparatus, equipment, and extinguishing agents.

Determining the Type of Material

Information about the type of materials involved may be available from a number of sources: (1) drivers of the transporting vehicles; (2) shipping orders or manifests; (3) placards or labels on vehicles; or (4) labels on containers.

Truck drivers may or may not have the necessary information. Drivers of vehicles carrying special cargo such as flammable liquids and gases, cryogenics, explosives, or nuclear weapons may have a great deal of information about their cargo and the emergency procedures it requires. Drivers of vehicles carrying mixed freight, on the other hand, may have little or no information.

Shipping orders, manifests, and labels can be important sources of information, which may be in the form of chemical or trade names or in the form of Department of Transportation labels and labels of the agency formerly responsible — the Interstate Commerce Commission. In certain instances, labels or placards simply state DANGEROUS, FLAMMABLE, EXPLOSIVES, CORROSIVE, TOXIC, or some similar word or phase. Methods of interpreting information contained in shipping orders or manifests or listed on labels or placards are beyond the scope of this manual. Sources of such information are various publications carried by many fire departments on apparatus, in chiefs' cars, or maintained in dispatching centers. Access to those publications, either at the scene of an incident or through radio contact with a dispatching center, is an important key to determining types of materials to be dealt with during freeway incidents. Examples of applicable publications also cited in the Bibliography include:

1. *Fire Protection Guide on Hazardous Materials*
   a. *Flashpoint Index of Trade Name Liquids*, National Fire Protection Association (NFPA) No. 325A
   b. *Fire Hazard Properties of Flammable Liquids and Gases*, NFPA No. 325M
   c. *Hazardous Chemicals Data*, NFPA No. 49
   d. *Manual of Hazardous Chemical Reactions*, NFPA No. 491M

e. *Recommended System for the Identification of the Fire Hazards of Materials*, NFPA No. 704M
2. *Fire Protection Handbook*
3. *Chemcard Manual*
4. *Highway Emergencies Involving Hazardous Materials*

Determining Correct Action

The importance of correct action in dealing with a hazardous-materials incident cannot be overemphasized; the results of incorrect efforts can be disastrous. General procedures for dealing with selected typical hazardous materials are discussed in this manual. Those procedures can be augmented with additional specialized details available in the publications listed in the preceding paragraph. All relevant publications should be carried in designated fire department vehicles or maintained in dispatch centers. Many departments maintain in their dispatch center a list of agencies to contact for information and assistance. Numerous agencies, both public and private, can be called upon to assist with incidents involving radioactive substances, cryogenics, explosives, ammunition, and other dangerous materials. In an extreme situation, a telephone call to manufacturers or distributors of hazardous materials may be necessary. Requisite to correct action is getting the correct information quickly.

General Procedures

As in all cases of actual or potential fire, the order of priority is: (1) the rescue of victims; (2) the safety of persons in the immediate area; and (3) the protection of exposures. The hazards are compounded by the presence of flammable liquids and gases, corrosive and toxic materials, explosives, and other reactive materials. Normal procedures of fire suppression are sometimes further complicated by limited water supply and restricted vehicular movement. Nonetheless, as a result of proper prefire planning, rescue, safety, protection of exposures, confinement of fire, and eventual extinguishment should proceed routinely in accordance with on-the-scene conditions.

When vehicle accidents involve fire or the threat of it, rescue problems are often complicated by the predicament of entrapped victims. In such cases, initial action consists of the attempt to protect both victim and rescuers with hose streams. Limited water supply makes this a precarious operation. Hose streams must be kept in operation continually but judiciously so as not to exhaust the water before an additional supply arrives.

When a flammable but unburning substance is released from the carrier by accident, all precautions against ignition must be taken by all persons in the area. This means strictly prohibiting smoking, carefully placing flares, and severely restricting vehicular traffic, since an automobile ignition spark can cause ignition of flammable substances. If vapors from the product could find their way to pilot lights or burners in nearby structures, these devices must be located and extinguished and the structures evacuated.

Emergency-services personnel must always be alert to the necessity of evacuating all spectators from an area where there is possibility of a flash fire involving vapors, rupture of a flammable-products container, escape of toxic vapors, or an explosion. Vapors can travel far under certain conditions, and a considerable effort might be expended in removing people a safe distance from the hazard.

Highly important to all fire-service personnel is familiarization with the correct ways of approaching and cooling containers involved in or exposed by fire. Such training is recommended for all firemen who might be called upon to respond quickly to freeway incidents. Further information on this subject is found in *Fire Control — Flammable Liquids and Gases*, Sacramento: Fire Service Training Program, California State Department of Education, 1964.

Where multiple hose lines can be laid to hydrants within reach of the freeway, water sufficient to control or dissipate major conditions can be obtained. Therefore, long-range planning should include laying large lines through adjoining properties and over fences to the freeway. This requires preliminary mapping of areas bordering the freeway. Maps should indicate hydrant locations and distances in relation to established highway markers. Copies of these water-supply maps should be carried on apparatus responding to freeway incidents and maintained at the dispatching center.

Fires that cannot be extinguished because of insufficient water supply or condition of the fuel or the container are usually allowed to burn out. Most of the fuel must be consumed before the fire can be extinguished. Under those conditions, use of available water supplies must be restricted to protecting exposures and cooling containers. The necessity for the latter is vital to prevent container collapse, with a consequent sudden release of contents, which could instantaneously cover a wide area with burning fuel.

Specific Procedures

In addition to the general procedures already discussed, specific steps should be followed in accordance with the nature of the emergency. The foremost of these specific procedures are the following:

Flammable and Combustible Liquids

Flammable liquids, as distinguished from combustible liquids, include many materials that have flash points at or below 140°F. Some of these are gasoline, acetone, naphtha, jet fuels, alcohols, thinners, and various solvents. Flammable liquids vaporize readily and are therefore in the proper state (vapor) to burn at normal temperatures.

Combustible liquids have flash points above 140°F., and they do not vaporize at normal temperatures. Under fire conditions, however, these materials have characteristics similar to those of flammable liquids. Some examples of combustible liquids are "safety solvents", heavy fuel oils, transformer oils, and lubricating oils.

Vast quantities of flammable and combustible liquids are transported over expressways and freeways in tank vehicles. Limited quantities are transported in drums and other small containers.

When dealing with burning flammable or combustible liquids, firemen should perform the following operations (not necessarily in the order given):

1. Rescue, if necessary.
2. Evacuate bystanders and occupants of nearby vehicles and structures.
3. Protect exposures.
4. Contain flowing liquids with dikes or hose streams, or both.
5. Cool burning or exposed tanks with hose streams.
6. Use water judiciously, if supply is limited.
7. Extinguish fire, if possible.
8. Consider allowing fuel to burn out under controlled conditions.

When dealing with spilled, but unburning, flammable or combustible liquids, firemen should perform the following operations (not necessarily in the order given):

1. Spot apparatus upgrade and upwind from the spill, if possible.
2. Rescue, if necessary.
3. Evacuate area, as necessary.
4. Use combustible-gas indicator to determine location of vapors.
5. Prevent ignition.
6. Stop leaks in container, if possible, under protection of hose streams.
7. Contain flowing fuel with hose streams or dikes, or both.
8. Consider flushing fuel into storm drains.
9. Consider calling for vacuum trucks to recover fuel from diked areas or damaged containers.

Liquified Petroleum Gases

Liquified petroleum gases (LPG), such as butane and propane, remain in the gaseous state at normal temperatures and pressures and become liquids at low temperatures and high pressures. Used primarily as fuels, refrigerants, and aerosol spray expellants, LPG products are stored and transported at normal temperatures under moderate pressures (40 to 200 psi). One cubic foot of liquid LPG is the equivalent of about 250 cubic feet of gaseous LPG. Hence for obvious economic reasons LPG is kept in liquid state for storage and handling.

Butane and propane are odorless in their natural state, but they are odorized to aid leak detection if they are to be used as fuels. They are not odorized if they are to be used for certain other purposes, as aerosol expellants, for example.

Fire-control problems with LPG, whether in storage or transport, are similar to those encountered with flammable liquids. When dealing with an incident involving escaping LPG, fire-service personnel must be aware of the following conditions:

1. The liquid-to-gas ratio (1 to 250) can create a situation wherein extreme volumes of flammable gas will be released in the event of tank failure or exposure to fire.
2. During a leak with no fire, the gas will not readily dissipate because it is much heavier than air (one and one-half to two times).
3. During a leak with no fire, the gas is invisible, being colorless and possibly odorless (depending upon its intended use).

When dealing with leaking and burning LPG, firemen should perform the following operations (not necessarily in the order given):

1. Rescue, if necessary.
2. Evacuate area, as necessary.
3. Cool exposed tanks with hose streams.
4. Protect other exposures.
5. Attempt to extinguish fire, but only by stopping fuel flow or leak under protection of hose streams.

When dealing with leaking but unburning LPG, firemen should perform the following operations (not necessarily in the order given):

1. Locate apparatus uphill and upwind, if possible.
2. Prevent ignition.
3. Rescue, if necessary.
4. Evacuate downhill and downwind area, as necessary.
5. Use combustible-gas indicator to determine location of vapors.
6. Dissipate leaking vapors with fog streams.
7. Control leak, if possible, under protection of hose streams.
8. Call for tank vehicle to transfer fuel from damaged tanks.

Cryogenic Materials

Cryogenics is the branch of physics that deals with materials at or near absolute zero. The term is also used to describe certain gases that can be liquified at extremely low temperatures, most commonly hydrogen, nitrogen, and oxygen. Fluorine is treated as a cryogenic, but it is also a halogen and is discussed in this manual under that name. Other gases, argon and helium, for example, are also cryogenics.

A recent development in the field is liquified natural gas (LNG), or methane. As with LPG, the purpose of storing and transporting certain gases as cryogenic liquids is economy. Literally hundreds of times the quantity of gas can be placed in a container of comparable size when the gas is in liquid form. For example:

One cubic foot of liquid hydrogen will vaporize into 850 cubic feet of gas.

One cubic foot of liquid nitrogen will vaporize into 696 cubic feet of gas.

One cubic foot of liquid oxygen will vaporize into 861 cubic feet of gas.

One cubic foot of liquid methane will vaporize into 636 cubic feet of gas.

Cryogenic materials are transported in vacuum-rated tank vehicles designed to maintain the required low temperatures. Incidents involving these materials may create fire, toxicity, causticity, or other hazards. In the open air, hydrogen and methane are combustible, oxygen increases combustibility of organic materials, and nitrogen is inert. All are maintained as liquids at temperatures of -250°F. and below. Cryogenic temperatures are so extreme as to be capable of killing any living tissue that comes in contact with materials in the cryogenic state.

When dealing with an incident involving leaking cryogenic materials, firemen should perform the following operations (not necessarily in the order given):

1. Determine the type of material involved.
2. Rescue, if necessary.
3. Use complete personnel-protection gear.
4. Call for technical assistance, as necessary.
5. Prevent ignition, if hydrogen or methane are involved.
6. Flush oxygen spills on asphalt pavement with water to vaporize the oxygen. (Oxygen-impregnated asphalt can explode if subjected to mild shock or pressure.)
7. Attempt to control leaks, under protection of hose streams.

Compressed Gases

Gases that are compressed by high pressures but not liquified are transported in pressure cylinders that may be portable or integral with the vehicle. Such gases can be flammable or nonflammable, toxic or nontoxic. However, all gases present a common hazard when exposed to fire – rapid expansion. Therefore, they must be kept cool to reduce the hazard of cylinder failure.

When dealing with an incident involving cylinders of compressed gases, firemen should perform the following operations (not necessarily in the order given):

1. Determine the type of gas involved.
2. Use breathing apparatus, if necessary.
3. Rescue, if necessary.
4. Cool exposed cylinders with hose streams.
5. Dissipate leaking gas with hose streams.
6. Protect exposures.
7. Call for technical assistance, if necessary.

Halogens

The halogens are a family of highly active elements that deserve special attention because they can create severe health and fire-control problems. The halogens are fluorine, chlorine, bromine, iodine, and astatine. All are more or less toxic and corrosive. Fluorine and chlorine are particular fire hazards, and astatine is radioactive.

Fluorine is a greenish-yellow gas, which can be transported as a pressurized gas in cylinders or as a cryogenic liquid. It is the most active chemical known and will react violently with organic substances (including the human body), metallic powders, and water.

Chlorine is a heavy, greenish-yellow gas. It is transported under pressure in cylinders. Although chlorine is nonflammable by itself, it can cause fires when it comes into contact with certain other materials, such as acetylene, ammonia, turpentine, or finely powdered metals.

When dealing with an incident involving leaking halogens, especially fluorine and chlorine, firemen should perform the following operations (not necessarily in the order given):

1. Determine the type of material involved.
2. Use complete personnel protective gear.
3. Rescue, if necessary.
4. Evacuate area, as necessary.
5. Call for technical assistance.
6. Dissipate leaking chlorine vapors with water.
7. *Warning:* Do not use water near fluorine.

Explosives and Blasting Agents

Explosives are materials that detonate or deflagrate upon initiation by shock, heat, pressure, or electrical or microwave stimulus. Explosives range in degree of hazard from the hypersensitive materials (such as liquid nitroglycerin, lead azide, and fulminate of mercury) to relatively insensitive products (such as firecrackers, paper caps, and small-arms ammunition).

According to United States Department of Transportation regulations, only certain materials are designated as "Acceptable Explosives" for transportation by common carrier:

1. Class A Explosives – those presenting a detonating or maximum hazard. These include dynamite, nitroglycerin, picric acid, lead azide, fulminate of mercury, black powder, blasting caps, and detonating primers.
2. Class B Explosives – those presenting a flammable hazard, such as propellant explosives (including smokeless powder), photographic flash powders, and certain pyrotechnics and fireworks.
3. Class C Explosives – those types of manufactured articles that contain Class A or Class B explosives, or both, as components, but in restricted quantities.

Blasting agents are mixtures of ammonium nitrate and fuel oil used as a substitute for commercial explosives. (The Department of Transportation term for blasting agents is nitro-carbo-nitrate.)

According to California law, trucks carrying explosives must bear placards that read EXPLOSIVES and must travel on designated routes, mostly freeways. Fire departments should maintain a record of designated routes within their jurisdiction for transportation of explosives.

When dealing with an incident involving explosives or blasting agents, firemen should perform the following operations (not necessarily in the order given):

1. Determine the types and quantities of explosives involved.
2. Evacuate the area, as necessary, depending upon type and quantity of explosive.
3. Prepare to protect exposures.
4. If fire fighting is attempted, use large streams operated from protected locations.

Radioactive Materials

Radioactive materials are being transported by common and private carriers in quantities ranging from minute to vast. Shipments are regulated by the Department of Transportation, and the materials are classified and labeled as follows:

1. Class D Poison, Group III (white label with blue printing). This consists of materials that emit corpuscular rays only (alpha and beta rays of low penetration). They are not harmful unless the container is broken and the materials are actually ingested.
2. Class D Poison, Group I or II (white label with red printing). Those materials that present an external health hazard.

Trucks transporting "Red Label" (Groups I and II) cargoes are required to bear placards that read, DANGEROUS RADIOACTIVE MATERIALS.

Fires involving radioactive materials can be controlled with water. The prime concern when dealing with such fires is their contamination hazard. This can be minimized through the use of monitoring devices, complete protective clothing, and contamination-control procedures.

Technical assistance for incidents involving radioactive materials is available from a number of agencies. The Atomic Energy Commission (AEC) publishes an *Emergency Radiological Assistance Plan* (See Bibliography), which contains the names of these agencies and their telephone numbers, as well as suggested procedures for dealing with incidents involving radioactive materials. Every fire department should maintain a copy of this plan at its dispatching center.

When dealing with an incident involving radioactive materials, firemen should perform the following operations (not necessarily in the order given):

1. Locate fire apparatus upwind of scene.
2. Determine the type of material involved.
3. Notify the Atomic Energy Commission.
4. Use complete personnel protective gear.
5. Rescue, if necessary.
6. Evacuate the area.
7. Utilize monitoring devices to measure radiation.
8. Combat fire, as necessary.
9. Segregate persons, materials, and equipment that may be contaminated.

Nuclear Weapons

Nuclear weapons that may be transported over freeways and expressways are designed to prevent nuclear yield in the event of accidental detonation. However, they contain plutonium, a Class D, Group I Poison and high explosive. If exposed by a fire, the high explosives can detonate if their temperatures exceed 300°F. If they burn inside the weapon, they can detonate or emit jets of white flame.

The Department of Defense (DOD) and AEC provide assistance to local agencies in the event of an incident involving nuclear weapons. The AEC's Emergency Radiological Assistance Plan contains information regarding whom to call and what to do pending arrival of representatives.

When dealing with an incident involving cargo that includes nuclear weapons, firemen should perform the following operations (not necessarily in the order given):

1. Call the nearest military base or the AEC.
2. Rescue, if necessary and if possible.
3. Evacuate all casual persons to a distance of at least 1,500 feet.
4. If weapons are exposed *but not involved by fire*, attempt to cool such weapons with 2-½-inch hose streams and to extinguish the fire.
5. If weapons are involved by fire, clear the entire area of all persons for a distance of at least 1,500 feet.

Water-Reactive and Air-Reactive Materials

These materials include alkalis, aluminum trialkyls, anhydrides, carbides, hydrides, metallic and nonmetallic oxides, phosphorous, and sodium hydrosulfite. As their classifications indicate, they react violently with water or air: some burn, some explode, some are strong oxidizers, and some produce toxic vapors. When dealing with such cargoes, the importance of ascertaining the type of material cannot be overstressed.

When dealing with air- and water-sensitive reagents, such as those described, firemen should perform the following operations (not necessarily in the order given):

1. Determine the type of material involved.

2. Rescue, if necessary.
3. Evacuate area, if necessary.
4. Call for technical assistance.
5. Determine the correct procedures, based upon type of material involved.
6. Use complete personnel protective gear.
7. Protect exposures, as necessary.

Oxidizing Materials

Oxidizing materials are a group of chemicals that liberate oxygen under various conditions. They include nitrates, nitrites, peroxides, chlorates and perchlorates, chlorites and hyperchlorites, permanganates, and persulfates. The oxygen they are capable of liberating will tend to increase the intensity of a fire burning in and around them. Additionally, some are combustible in themselves (cellulose nitrate, for example); some emit toxic vapors; and some react with sufficient heat to ignite nearby combustible materials.

When dealing with an incident involving oxidizing materials, firemen should perform the following operations (not necessarily in the order given):

1. Determine the type of material involved.
2. Rescue, if necessary.
3. Evacuate, if necessary.
4. Determine the correct control procedures based upon the type of material involved.
5. Use complete personnel protective gear.
6. Protect exposures, as necessary.

Acids

Hazardous acids have a destructive effect on living tissues, are usually strong oxidizers, and frequently produce toxic vapors. They are noncombustible but may react spontaneously with other materials. The hazardous acids include sulfuric, nitric, hydrochloric, hydrofluoric, and perchloric.

When dealing with an incident involving hazardous acids, firemen should perform the following operations (not necessarily in the order given):

1. Use complete personnel protective gear.
2. Rescue, if necessary (flush acids from victims with water).
3. Evacuate, if necessary.
4. Protect exposures.
5. Extinguish fires with water, as necessary.
6. Flush (with water) leaking acids away from organic materials.
7. Dilute leaking acids with large volumes of water.

Topic 10 — SPECIAL MATERIALS FOR CONTROLLING SPILLS AND FIRES

This topic, "Special Materials for Controlling Spills and Fires," is planned to provide answers to the following questions:

- How can hazardous-liquid spills be absorbed and removed from road surfaces?
- What material will absorb some of the common acids?
- What extinguishing agents can be used on combustible metals?

Many kinds of liquids being transported over the highways are generally classified as petroleum products and acids. The degree of hazard from the possible release of these liquids from their containers varies greatly. In many cases the presence of a source of ignition can cause an emergency of great proportions.Preplanning for freeway emergencies will therefore include procedures for draining, washing away, absorbing, and counteracting dangerous liquids, as well as fire-fighting techniques to be used when the occasion arises.

To control spills, the principal concern is to channel, dike, or absorb the unconfined liquid. The necessity for doing this will be determined by the flammability or corrosiveness of the liquid or by the hazard to traffic created by a foreign substance on the right-of-way.

Where applicable, a common easily obtained substance such as sand or earth is used for channeling, diking, or absorbing. Sometimes this means is available at or near the scene and can be used by men working with shovels. Of course, when not readily available, or if required in large quantities, sand or dirt must be trucked to the scene.

Whenever diking and channeling must be done, consideration must be given to the areas to which lighter-than-water liquids are to be diverted. If the liquid is flammable, its vapor must be regarded as a hazard. Therefore, when possible sources of ignition for flammable liquids are present along the route of travel, protection must be given and the liquids must be impounded in a safe location.

Besides sand and earth, sawdust is another common substance used for absorbing liquids. If the few bags of sawdust carried on fire apparatus are not sufficient for the job, sawdust can be trucked to the scene. Care should be taken when disposing of contaminated sawdust (soaked with oil or acid), because burning could be quite violent should ignition occur.

Acids, such as sulfuric, nitric, and muriatic, can be effectively neutralized with applications of soda ash (sodium carbonate).

Where combustible metals are burning, specific agents and methods must be used to control the fire. Acquiring information about correct agents according to the types of metals, where and how to get the agents, and how to use them is also a part of the prefire planning process.

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HAZARDOUS MATERIALS PLACARDING

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California Department of
Highway Patrol
April 8, 1970

HAZARDOUS MATERIALS PLACARDING

Commodities known to afford a hazard to health during transportation have been designated hazardous materials by the U.S. Department of Transportation. The placarding of vehicles transporting hazardous materials alerts carrier personnel to the dangers involved, and is of considerable informational value to public safety services at the scene of an accident or spillage.

In all, there are more than 1,400 hazardous materials -- many are listed in this guide. Generally, the shipping papers or the package markings provide sufficient information to identiiy a commodity as hazardous.

Complete listing of commodities requiring placarding are contained in the following references:

1. Dangerous Articles Tariff - American Trucking Association.

2. Guide to Transportation of Explosives and Other Dangerous Articles - Private Carriers Conference (ATA).

State of California
DEPARTMENT OF CALIFORNIA HIGHWAY PATROL

H. W. Sullivan, Commissioner

Nov.8, 1967

STATUTORY REQUIREMENTS

CALIFORNIA VEHICLE CODE

27903. Designation of Cargo. Notwithstanding other provisions of this code no person shall operate any vehicle transporting any explosive substance, flammable liquid, flammable solid, oxidizing material, corrosive liquid, compressed gas, poison gas, poison liquid, poison solid, radioactive material or other materials classified by the Interstate Commerce Commission as a dangerous article unless at the time of such transportation there is displayed on the vehicle signs conforming to the regulations of the Interstate Commerce Commission.

This section does not apply if the vehicles are transporting not more than 20 pounds of smokeless powder or not more than five pounds of black sporting powder or any combination thereof.

27904. Exceptions. Notwithstanding the provisions of Section 27903, a vehicle which is used for the transportation of flammable liquids defined in Section 324 of this code may display the required signs when empty or when transporting any liquid with a flashpoint below 200 degrees Fahrenheit.

NOTE:

The responsibility for regulating interstate hazardous materials transportation has been transferred from the Interstate Commerce Commission to the U.S. Department of Transportation. Effective April 1, 1967, the former ICC regulations were designated Department of Transportation Hazardous Materials Regulations (Title 49, Code of Federal Regulations, Parts 171-179).

DOT PLACARDING REQUIREMENTS

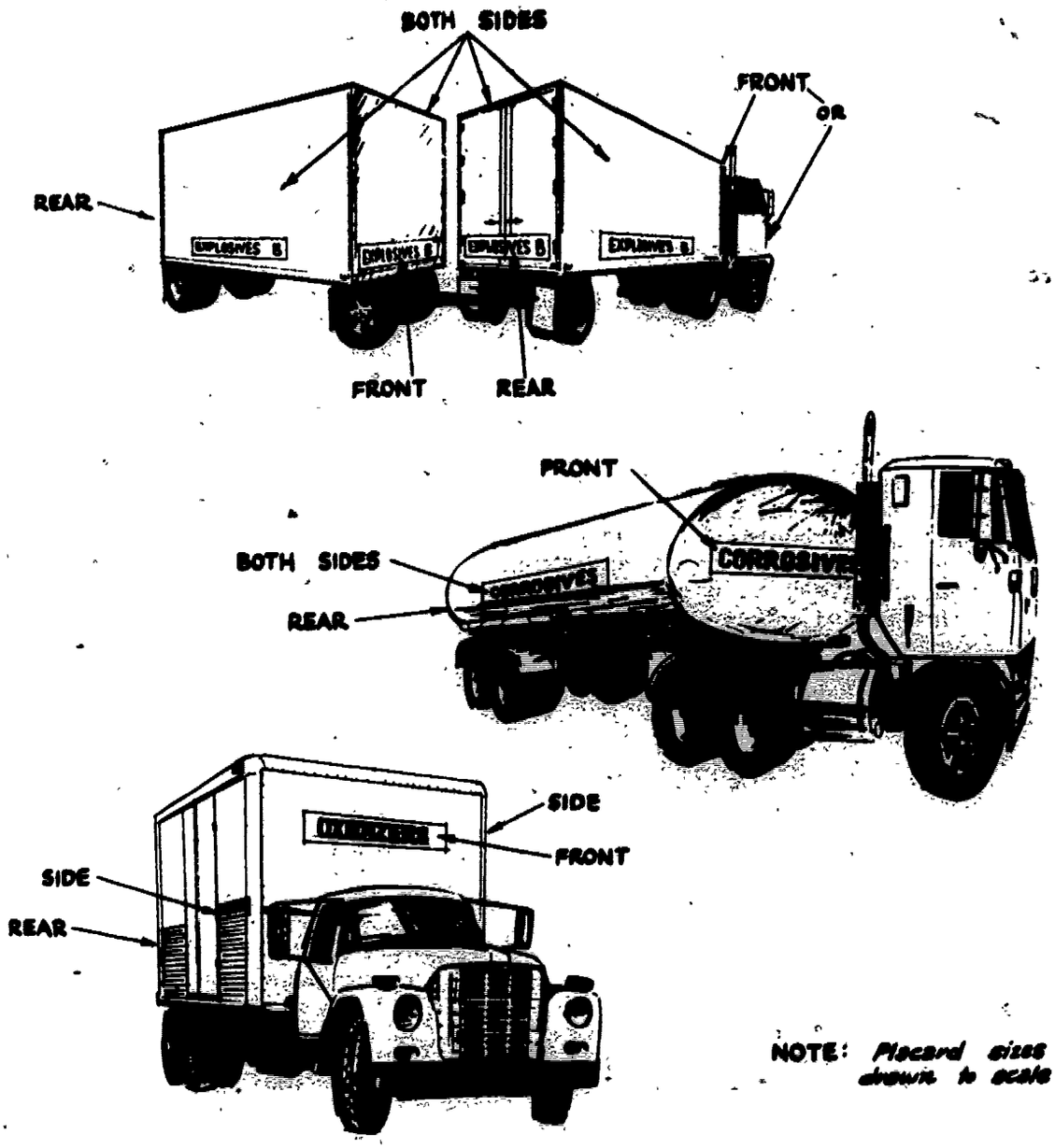
TITLE 49. CODE OF FEDERAL REGULATIONS

177.823 Required exterior marking on motor vehicles and combinations.

(a) Every carrier operating, hauling, or in any manner using a motor vehicle or trailer containing any explosive or other dangerous article as specified in subparagraph (a)(1) and paragraph (b) of this section shall cause every motor vehicle, trailer, or combination vehicle, at all times while containing such explosive or other dangerous article, or combination of such articles, to display markings or placards in accordance with the following requirements:

(a)(1) The marking or placards required to be displayed on each motor vehicle or trailer shall be as follows:

COMMODITY	TYPE OF MARKING OR PLACARD
Explosives, class A, any quantity or a combination of class A and class B explosives.	EXPLOSIVES A (Red letters on white background)
Explosives, class B, any quantity.	EXPLOSIVES B (Red letters on white background)
Poison, class A, any quantity; Poison, class B, 1000 pounds or more gross weight.	POISON (Blue letters on white background)
Flammable liquid, 1000 pounds or more gross weight: flammable solid, 1000 pounds or more gross weight.	FLAMMABLE (Red letters on white background)
Oxidizing material - 1000 pounds or more gross weight.	OXIDIZERS (Yellow letters on black background)



PLACARD PLACEMENT

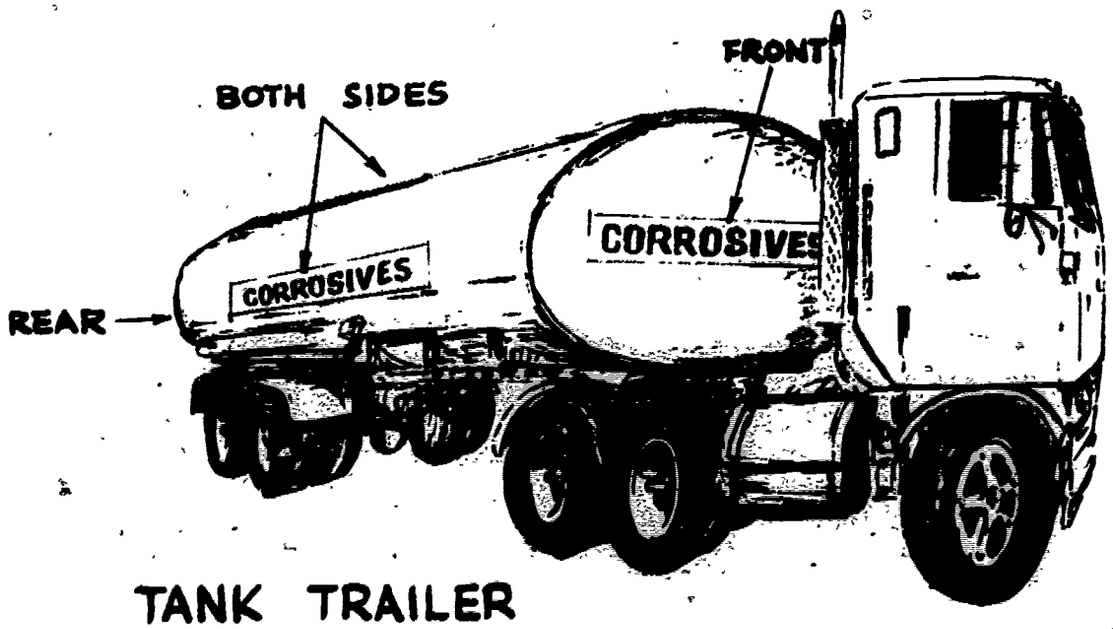
COMMODITY	TYPE OF MARKING OR PLACARD
Nonflammable compressed gas - 1000 pounds or more gross weight.	COMPRESSED GAS (Green letters on white background)
Corrosive liquid - 1000 pounds or more gross weight.	CORROSIVES (Blue letters on white background)
Flammable compressed gas - 1000 pounds or more gross weight.	FLAMMABLE GAS (Red letters on white background)
Radioactive material, any quantity, requiring red label as prescribed in 173.414 (a) and (c).	RADIOACTIVE (Black letters on yellow background)
Mixed ladings - See subparagraph (a)(4) of this section.	DANGEROUS (Red letters on white background)

(a)(2) Each marking or placard shall consist of letters not less than four inches high, in the color specified, using approximately a 5/8 inch stroke. The placard must be larger than the lettering required thereon by at least one inch at the top and bottom sides. Such marking or placard described in subparagraph (a)(1) shall be contained in an area on the vehicle which has no other marking, lettering, or graphic display, for at least three inches in each direction, except as specified in subparagraph (a)(4) and paragraph (c) of this section.

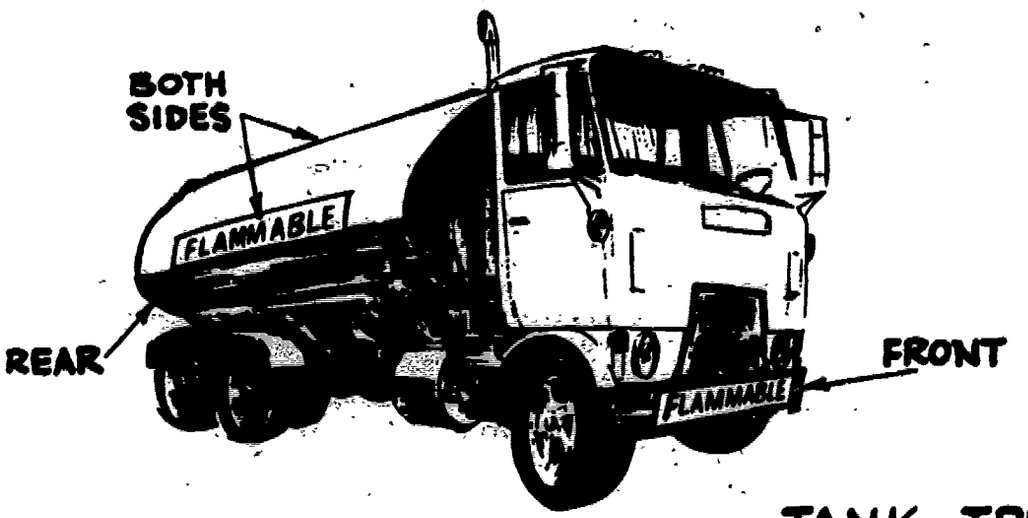
(a)(3) Such markings or placards shall be displayed at the front, rear, and on each side of the motor vehicle or trailer, or other cargo carrying body while it contains explosives or other dangerous articles of such type and in such quantity as specified in subparagraph (a)(1) and paragraphs (b) and (c) of this section. The front marking or placard may be displayed on the front of either the truck, truck body, truck tractor or the trailer.

(a)(4) Any motor vehicle, trailer or other cargo carrying body containing more than one kind of explosives or other dangerous article requiring different placards under the provisions of subparagraph (a)(1) of this section, the aggregate gross weight of which totals 1,000 pounds or more, shall be marked or placarded "DANGEROUS" instead of being marked or placarded as required by that subparagraph. Any such vehicle which contains any quantity of explosives class A, explosives class B, poison class A, or radioactive materials requiring red label as prescribed in 173.414 (a) and (c), shall display the marking or placard "EXPLOSIVES A," "EXPLOSIVES B," "POISON" or "RADIOACTIVE," as appropriate, in addition to the marking or placard "DANGEROUS." If explosives class A and explosives class B are loaded on the same vehicle, the "EXPLOSIVES B" marking need not be displayed.

PLACARD PLACEMENT



TANK TRAILER



TANK TRUCK

Topic 4 — USE OF STANDARD FIRE APPARATUS AND EQUIPMENT

This topic, "Use of Standard Fire Apparatus and Equipment," is planned to provide answers to the following questions:

- What are the various types of fire apparatus available to respond to freeway incidents?
- What is the minimum manpower required to handle these incidents?
- What types of equipment will assist in solving the water-supply problem?
- What are some probabilities and eventualities that must be considered during large-scale operations?

The equipment and manpower necessary to deal with incidents effectively on freeways and expressways can be extensive. Large-scale and unusual operations might seem to necessitate the use of equipment from agencies other than fire service. However, the time involved in requesting and obtaining such equipment through proper channels, getting it to the scene, and making it effectively operational could result in serious and costly delays. Fire-department apparatus and trained personnel can respond immediately and get into operation quickly. The plans and procedures that are developed should therefore include the adaptation of standard apparatus to the fullest extent for various uses during freeway incidents.

Fire Companies and Special Apparatus

The various fire-department contingents and the special apparatus required for freeway and expressway emergencies include engine companies, truck companies, rescue companies, mobile water supplies, foam fire-fighting units, and lighting units. These are discussed individually as follows:

Engine Companies

An adequately manned engine company (an absolute minimum of three men) under the direction of a company officer and carrying the recommended complement of equipment is perhaps the most generally suitable unit to deal with freeway incidents. The engine company, carrying forcible-entry tools, hose water, ladders, and other equipment, is usually well prepared to serve as the basic unit for any type of freeway operation.

Truck Companies

Truck companies may be useful during freeway and expressway incidents that are beyond the capabilities of engine companies. Extensive ladder operations, more specialized rescue equipment, and heavy-duty rescue equipment are typical of truck-company capabilities. Truck companies can also provide additional manpower for large-scale rescue or fire-control operations.

Rescue Companies

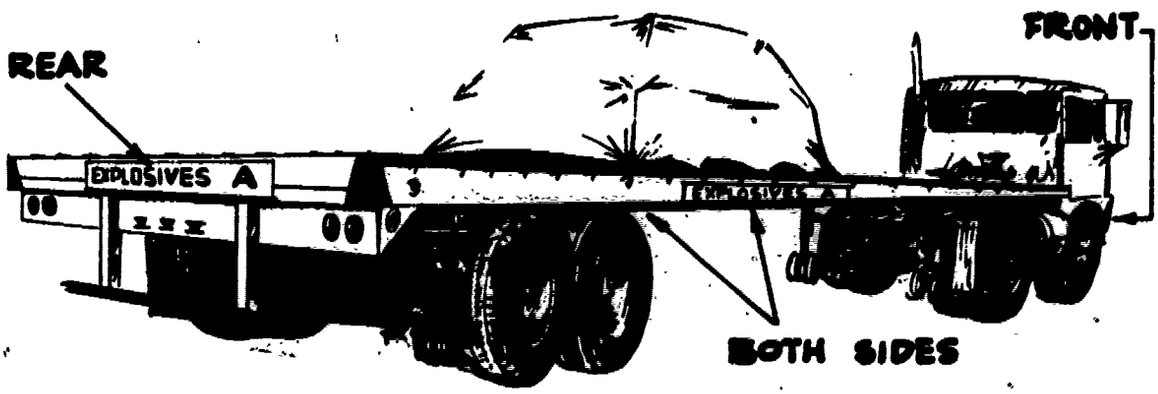
Rescue or squad companies, manned by personnel well-trained in the use of specialized equipment, are invaluable at freeway and expressway incidents. The manning of such companies will vary in accordance with local conditions. These companies usually carry a wide array of special rescue tools, depending upon the type or size of vehicle. A partial list may include the following:

1. Hydraulic rescue tools and jacks of various ratings
2. Cutting torches
3. Hoisting and pulling equipment, including ropes, chain hoists, and other mechanical devices
4. Portable generators for supplying electric tools and lighting equipment
5. Extensive emergency care equipment and supplies including resuscitators, litter, splinting equipment, blankets, first-aid kits, and the like
6. Various types of electrical or gasoline-powered saws
7. Fire extinguishers of various types and sizes
8. Miscellaneous tools including cargo or hay hooks, pitchforks, shovels, hammers of various sizes, redwood plugs, and so forth
9. Other types of tools, including bolt or wire cutters, lock-breakers, mechanical axes, crash and fire axes, and miscellaneous mechanic's tools
10. Self-contained breathing apparatus

Mobile Water Supply Apparatus

During extensive fire-fighting operations on freeways or expressways, water is a critical factor, and fire-department tankers can be extremely useful for these situations.

PLACARD PLACEMENT
(FLAT BED)



PLACARDS MUST BE SECURED TO EQUIPMENT TRANSPORTING THE EXPLOSIVES OR TO PLACARD BOARDS. SEE DOT SEC. 177.835

(c)(1) and (c)(2) Cancelled.

(d) The marking or placarding required by this section shall be removed from or covered on any motor vehicle to which it is attached when such vehicle does not contain the article for which the marking is required, except in the case of tank motor vehicles used exclusively for transportation of the article for which such marking is required.

(d)(1), (d)(2) and (d)(3) Cancelled.

(e), (e)(1) and (e)(2) Cancelled.

(f) Cancelled.

(g) Cancelled.

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177.835 Explosives

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(b)(1) Whenever tarpaulins are used for covering explosives, they shall be secured by means of rope or wire tie downs. Explosives placards or markings required by Sec. 177.823 shall be secured, in the appropriate locations, directly to the equipment transporting the explosives. If the vehicle is provided with placard boards, the placards must be applied to these boards.

PLACARDING EXEMPTIONS

REQUIRED PLACARD	CLASSIFICATION/DEFINITION	EXEMPTIONS/REMARKS
EXPLOSIVES A	Classification: Explosives, Class A Definition: Any chemical compound, mixture, or device the primary or common purpose of which is to function by detonation. Examples: Dynamite-high explosives-high explosives, liquid-black powder-ammunition for cannon with explosive projectiles-blasting caps (more than 1,000)-detonating primers-explosive mines-hand grenades-certain igniters and jet thrust units (jato)-fulminate of mercury, wet-rocket ammunition with explosive, illuminating, incendiary, or gas projectiles.	1) Placards required when transporting, any quantity. 2) No exemptions.
EXPLOSIVES B	Classification: Explosives, Class B Definition: A chemical compound, mixture, or device, the primary purpose of which is to function by rapid combustion rather than detonation. Examples: Ammunition for cannon with nonexplosive projectiles-special fireworks-certain igniters and jet thrust units (jato)-explosive power devices-propellant explosives, solid (includes smokeless powder for small arms)-propellant explosives, liquid-rocket ammunition with nonexplosive projectiles.	1) Placards required when transporting any quantity. 2) No exemptions. 3) Smokeless powder for small arms, in quantities of less than 100 pounds per vehicle, is classified as a flammable solid when packaged in Bureau of Explosives-approved containers.
	Classification: Explosives, Class C Definition: Manufactured articles which contain class A, or class B explosives, or both, as components but in restricted quantities. Examples: Blasting caps (1,000 or less)-small arms ammunition of less than .75 caliber-blank cartridges-explosive cable cutters-cordeau detonant fuse-electric squibs-toy paper caps-explosive rivets-common fireworks-railway or highway fusees.	No placards required or authorized.
FLAMMABLE	Classification: Flammable Liquids Definition: Any liquid which gives off flammable vapors at or below a temperature of 80 degrees Farenheit. Examples: Gasoline-ether-certain alcoholm-certain paints and varnishes-pentaborane-certain inks-certain liquid cements-certain polishes-ethyl methyl ketone-ethyl nitrate-ethyl nitrite-ethyl mercaptan-ethylene oxide-ethyl chloride-acrolein, inhibited-carbon bisulfide (disulfide)-ethylene imine, inhibited-propylene imine, inhibited-dimethylhydrazine, unsymmetrical (UDMH).	1) Placards required when transporting 1,000 lbs. or more (gross weight, including containers). 2) Portion of load packaged in small containers exempted when determining if placards are required unless commodity is marked "No Exemptions" in References 1 or 2. 3) Commodities preceded by * in References 1 or 2 may or may not be classed as hazardous depending upon characteristics of the particular shipment. 4) VC 27904 permits, but does not require, the placarding of cargo tanks in a manner at variance with DOT 177.823(d).

REQUIRED PLACARD	CLASSIFICATION/DEFINITION	EXEMPTIONS REMARKS
FLAMMABLE	Classification: Flammable Solids Definition: Any solid material, other than explosives which are liable to cause fire through friction, through absorption of moisture, through spontaneous chemical changes, or as a result of heat retained from the manufacturing process. Examples: Aircraft rocket engines (commercial)-ammonium bichromate-metallic calcium-charcoal briquettes-wood charcoal-coal, ground bituminous, sea coal, coal facings, etc.-matches, strike/anywhere-phosphorous-cotton rags, oily-certain magnesium scrap-certain rubber scrap-metallic sodium-Xray film (nitrocellulose base)-zirconium scrap.	1) Placards required when transporting 1,000 lbs or more (gross weight, including containers) 2) Portion of load packaged in small containers exempted when determining if placards are required unless commodity is marked "No Exemptions" in References 1 or 2. 3) Commodities preceded by * in References 1 or 2 may or may not be classed as hazardous depending upon characteristics of the particular shipment
OXIDIZERS	Classification: Oxidizing Materials Definition: Materials which will decompose readily to yield oxygen when heated and may react violently with other chemicals or combustible materials. Examples: Nitro carbo nitrates-other nitrates-chlorates-certain peroxides-barium permanganate-calcium chlorite-peracetic acid-permanganate of potash or soda-potassium bromide-sodium nitrite-sodium bromate-tetranitromethane-zinc ammonium nitrite-zinc permanganate-zirconium picramate wet.	1) Placards required when transporting 1,000 lbs. or more (gross weight, including containers). 2) Loads and portions of loads consisting of certain nitrates, including nitro carbo nitrates, are exempted from placarding requirements when packaged as follows: a. In wooden or fiberboard boxes with glass, metal, or other strong inside containers. b. In metal or fiber drums. c. In kegs or barrels. d. In strong metal cans. 3) Portion of load packaged in small containers exempted when determining if placards are required unless commodity is marked "No Exemptions" in References 1 or 2. 4) Commodities preceded by * in References 1 or 2 may or may not be classed as hazardous depending upon characteristics of the particular shipment.
CORROSIVES	Classification: Corrosive Liquids Definition: Liquids which will cause severe damage to living tissue and to freight by chemical action. Examples: Acids (chlorosulphonic, nitric, hydrochloric, perchloric, sulphuric)-alkaline or acid battery fluids-antimony (pentachloride and pentafluoride)-batteries, electric storage, wet-benzyl bromide-benzyl chloroformate-boron trichloride-bromine-caustic potash or soda, liquid-chlorides (anisoyl, benzyl, chromyl, sulphur, sulfuryl, thionyl)-chlorine trifluoride-chromic acid solution-ethyl chloroformate-fire extinguisher charges-certain hydrogen solutions-iodine monochloride-certain hypochlorite solutions-oil of vitrol (sulphuric acid)-oleum-phosphorous (oxybromide, oxychloride, tribromide, trichloride)-propyl trichlorosilane-sodium aluminate, liquid-sulphur trioxide.	1) Placards required when transporting 1,000 lbs. or more (gross weight, including containers) 2) Portion of load packaged in small containers exempted when determining if placards are required unless commodity is marked "No Exemptions" in References 1 or 2. 3) Commodities preceded by * in References 1 or 2 may or may not be classed as hazardous depending upon characteristics of the particular shipment
COMPRESSED GAS	Classification: Nonflammable Compressed Gas Definition: Any material having in the container an absolute pressure exceeding 40 psi at 70° F., or an absolute pressure exceeding 104 psi at 130° F., or both. Examples: Air-anhydrous ammonia-argon-boron-trifluoride-carbon dioxide oxygen mixture-hydrogen bromide-hydrogen chloride-certain liquefied gases-neon-nitrogen-nitrous oxide-oxygen-sulphur dioxide-sulphur hexafluoride-certain materials in cylinders, tanks and "acrosol" cans when charged to pressures above 40 psi at 70° F. with nonhazardous gases listed above.	1) Placards required when transporting 1,000 lbs. or more (gross weight, including containers). 2) Portion of load packaged in small containers exempted when determining if placards are required unless commodity is marked "No Exemptions" in References 1 or 2. Exemptions for electronics tubes, cosmetics and foodstuffs in pressurized containers, and fire extinguisher components are many and varied. 3) Commodities preceded by * in References 1 or 2 may or may not be classed as hazardous depending upon characteristics of the particular shipment.

REQUIRED PLACARD	CLASSIFICATION/DEFINITION	EXEMPTIONS REMARKS
FLAMMABLE GAS	Classification: Flammable Compressed Gas Definition: Compressed gas which offers the hazards of fire or explosion. Examples: Acetylene-butadiene, inhibited-butane cyclopropane-difluorethane-difluoromonochloroethane-dimethylamine, anhydrous-dimethyl ether-engine starting fluid-ethane-ethylene-hydrocarbon gas, liquefied or gaseous-hydrogen, liquefied or gaseous-hydrogen sulfide-methane-liquefied hydrocarbon gas-methyl acetylene-methyl chloride-methyl chloride/methylene chloride mixture-methyl mercaptan-monomethylamine, anhydrous-nonliquefied hydrocarbon gas-propane tetrafluoroethylene, inhibited-trifluorochloroethylene-trimethylamine, anhydrous-vinyl chloride-vinyl fluoride, inhibited-vinyl methyl ether.	1) Placards required when transporting 1,000 lbs. or more (gross weight, including containers). 2) Portion of load packaged in small containers exempted when determining if placards are required unless commodity is marked "No Exemptions" in References 1 or 2. 3) Commodities preceded by * in References 1 or 2 may or may not be classed as hazardous depending upon characteristics of the particular shipment.
POISON	Classification: Poison, Class A Definition: Poisonous gases or liquids of such nature that a very small amount of the gas, or vapor of the liquid, mixed with air is dangerous to life. Examples: Mustard gas-lewisite-hydrocyanic acid-nitrogen tetroxide-nitric oxide mixtures-phosgene (diphosgene)-cyanogen.	1) Placards required when transporting any quantity. 2) No exemptions.
POISON	Classification: Poison, Class B Definition: Substances, liquids or solids (including pastes and semi-solids) which are known to be so toxic to man as to afford a hazard to health during transportation. In the absence of data on the effects on humans, tests on laboratory animals establish the relative toxicity (by ingestion, inhalation, or absorption through the skin). Examples: Aniline oil-arsenic acid-carbolic acid (phenol)-certain chemical ammunition (no explosive or ignition elements)-chlorpicrin-certain organic phosphate compounds-aldrin-arsenical compounds-cyanide mixtures-certain drugs, chemicals, medicines, and cosmetics-certain insecticides, pesticides, herbicides, and rodenticides.	1) Placards required when transporting 1,000 lbs. or more (gross weight, including containers). 2) Portions of load packaged in small containers exempted when determining if placards are required unless commodity is marked "No Exemptions" in References 1 or 2. 3) Commodities preceded by * in References 1 or 2 may or may not be classed as hazardous depending upon characteristics of the particular shipment.
	Classification: Poison, Class C Definition: Liquid or solid substances which upon contact with fire or when exposed to air give off dangerous or extremely irritating fumes. Examples: "Tear Gas" - Tear gas grenades, candles, other devices-monochloracetone, stabilized.	No placards required or authorized.
RADIOACTIVE	Classification: Poison, Class D Definition: Radioactive materials which emit radiation capable of penetrating and severely damaging living tissue and undeveloped film. Examples: Radium-uranium-235 - polonium-plutonium-strontium-90.	1) Placards required when transporting any quantity of radioactive materials bearing "red" label. 2) Exemptions are many and varied.

NOTES

1. FLAMMABLE placard is required when transporting 1,000 lbs. or more of flammable liquids and flammable solids in mixed lading.
2. DANGEROUS placard is required when transporting commodities requiring different placards in mixed lading (1,000 lbs. or more gross).
3. Mixed lading which includes Class A Explosives, Class B Explosives, Class A Poison, or Radioactive Materials (red label) requires the display of the appropriate placard for the commodity listed in addition to the DANGEROUS placard (double placarding).
4. See DOT 177.823(b)(2) for use of "GASOLINE" placard.