TRANSPORTATION

1. Introduction

The transportation of chemicals and related products is unusual in that substantial quantities are moved in packages as well as in bulk. Other materials, eg, coal, grain, and ore, are transported in bulk, but seldom in packaged form. Moreover, most other bulk commodities, including petroleum and its products, are limited in the diversity of their chemical and physical characteristics and, therefore, do not require as wide a variety of packaging and bulk conveyances as is necessary for the movement of chemicals. Virtually all railroad tank cars are supplied by chemical producers rather than railroad companies, which furnish at least a portion of most other types of equipment used in rail transportation. The multiplicity of chemical and physical characteristics, as well as resulting variations in product value, density, volume of movement, and other factors, including the type and supply of packaging and conveyances, tend to complicate transport pricing and relations between chemicals shippers and the many transportation carriers they employ.

Since the late nineteenth century, the U.S. federal government and almost all states have regulated both the supply and pricing of transportation service, and such regulation has had a profound effect on the chemical industry. Although economic regulation was substantially relaxed by legislation enacted in the 1970s, 1980s, and early 1990s, such relaxation was accompanied by more intense regulation of hazardous materials transportation. Because most of the volume that the chemicals industry produces annually is classified as hazardous, transportation safety has become increasingly important to shippers and carriers of chemicals seeking to comply with a growing body of federal, state, and even local regulations in an effort to avoid civil and criminal penalties. In an era of increasing litigation and sustained public interest in environmental safety, an additional incentive to such shippers and carriers is the avoidance of civil liability and more burdensome regulation.

Some of the more significant operational aspects of chemicals transportation in the context of the changing climate of both economic and safety regulation are discussed herein. The technical nature of safety regulations, especially in connection with hazardous materials and wastes, has necessitated frequent consultation between distribution and technical personnel in the chemical industry. The industry is one of the largest users of both commercial transportation services provided by rail, motor, water, air, and pipeline carriers, and of proprietary transportation by these same modes. Shipments of chemicals are made in a wide variety of containers, such as tank cars and tank trucks, barges, self-propelled vessels, drums, barrels, cylinders, bags, and even small bottles for samples and laboratory specimens.

The cost of transportation has an important effect on the marketability of chemicals. For that reason, transportation, along with numerous other factors, is often a significant consideration in determining the location of chemical production facilities. In addition, convenient and economical access to water and rail transportation and the interstate highway system, as well as proximity to raw materials and markets, may influence the choice of warehouse and terminal sites for storage and redistribution of chemical products (see PLANT LOCATION).

Since the 1970s, the concept of transportation management in the chemicals industry has been broadened to include such functions as packaging, order processing, sales service, warehousing, and scheduling of inbound raw materials. The expanded concept, commonly referred to as logistics or distribution (or physical distribution, as distinguished from market distribution), is in part a consequence of information technology, which has made it possible to relate total distribution costs to individual products, customers, and movements. Transportation, however, continues to be a central concern of most distribution managers in the chemical industry. Table 1 indicates the relative shares of U.S. tonnage, including chemicals, carried by various modes of transportation, as well as projected future shares by mode.

2. Transportation Modes

2.1. Railroads. Until the 1980s, railroads were almost exclusively common carriers that offered their services to the public as transporters of virtually all commodities between all points on their lines. As a result of deregulation, however, railroads now provide a significant volume of transportation services under privately negotiated contracts with individual shippers, although such contracts were prohibited prior to enactment of the Staggers Rail Act of 1980 (2).

Rail service may be single- or joint line. The former refers to movements that originate and terminate on a single railroad, without intermediate transportation by another rail carrier. Joint-line service occurs when more than one railroad participates in transportation from origin to destination, generally under agreements among the railroads involved for interchange at specified locations. Even where a single railroad serves both the origin and destination cities, joint-line service may be necessary or desirable in some situations, as, eg, where one carrier serves the shipper and another the consignee. In most cases where joint-line service is offered and appropriate routing restrictions are observed by the shipper, joint- and single-line movements of the same goods between the same points are charged identically, and the carriers who participate in the joint-line service share in divisions of the total revenue. In recent years, mergers of large railroads serving broad geographical areas has resulted in fewer joint-line movements.

Railroads generally do not supply tank cars and other special-purpose rail cars, such as covered hopper cars, for the movement of bulk plastic materials. Rather, shippers or receivers must furnish such equipment, usually through a purchase or lease arrangement with car manufacturers or lessors. Car manufacturers and intermediaries offer various forms of rail-car leases, ranging from short-term, full-maintenance rentals to long-term leases requiring outside financing (3). Many chemical shippers have substantial investments or lease commitments in tank cars and similar rail equipment, including cars constructed of or lined with special materials for particular products. Other cars may be thermally insulated to prevent excessive heat buildup in transit or for protection against fire.

At many chemical plants, as well as other manufacturing or receiving facilities dependent on rail transportation, railroad tracks are constructed within the

plant to permit the shipment or receipt of rail cars. Such tracks, usually called industry or private tracks or sidetracks, connect directly with the tracks of the railroad(s) serving the plant. Because the sidetrack must be compatible with the railroad track to permit railroad switch engines and crews to enter the plant, the industry and railroad enter into a written sidetrack agreement (4), which defines their respective rights and obligations with regard to track construction, maintenance, and operation. Included in such agreements are provisions pertaining to required lateral and overhead track clearances and maintenance of hoppers, pits, or other loading or unloading devices.

When private tracks have insufficient capacity for the number of freight cars required to be stored, shippers or receivers of freight may lease additional trackage from a railroad in the vicinity of the plant (5). Because leased tracks are considered private during the term of the lease, demurrage is not payable on private cars held on such tracks, although a reasonable rental for the track lease must be paid. Frequently, tracks located at strategic places remote from a plant facility may be leased for storage of loaded cars in order to have them available for prompt delivery to customers or distributors in the vicinity of the track.

When a railroad provides transportation services under a continuing contract, many of these matters are addressed in the contract. Demurrage charges, in particular, are inapplicable, except to the extent the railroad and shipper agree on the terms of such charges, and the parties may negotiate all other terms and conditions in the same manner as any other contract would be negotiated. Transportation service provided pursuant to a contract is not subject to further regulation under the ICC Termination Act of 1995 (6).

2.2. Motor Carriage. Since the 1930s, motor carriage has been an essential part of the U.S. transportation system. Initially confined to movements of small shipments or over short distances, motor carriers took advantage of improved public highways, including the interstate system, to develop a network of transportation competitive with railroads in both rates and service. Less capital-intensive and, therefore, more numerous than railroads, and unconfined by the rigidity of tracks, motor carriers demonstrated a flexibility that broke historic patterns of industrial concentration in transportation centers, thereby contributing to the dispersion of manufacturing and other commercial enterprises to suburban and rural areas.

For both economic and legal reasons, individual motor carriers traditionally have specialized in the type of services offered, either in terms of commodities carried, areas or locations served, or type of equipment provided. Some truckers restrict services to particular categories of materials, such as “Chemicals, in bulk”, “Acids, in packages”, or single commodities, eg, “Acetylene, in cylinders”, as well as to specified cities, towns, counties, or states. As federal regulations were relaxed in the 1980s and early 1990s, most legal obstacles disappeared. Today, if a motor carrier restricts its service to particular commodities or geographic areas, it is usually an economic choice rather than a limitation imposed under a governmental franchise.

Motor carriage may fall within one of three different categories. Until the 1980s, most motor carriers offered services to the public as common carriers. All rates, terms, and conditions of common carriers were required to be published in tariffs filed with the Interstate Commerce Commission (ICC), and carriers could

not deviate from these provisions. In 1994, U.S. Congress eliminated most tariff filing requirements for common carriers, allowing shippers and common carriers to negotiate individually determined rates, terms, and conditions. Tariffs are required for chemicals traffic only if the shipment moves in noncontiguous domestic trade, eg, transportation from or to Alaska, Hawaii, or a territory or possession of the United States (7). Some limited volume of traffic also may be subject to certain rates, terms, and conditions collectively established by a group of carriers pursuant to an agreement between such carriers, if approved and exempted from the antitrust laws by the Surface Transportation Board (STB) (8). Whenever any rate arranged between a shipper and carrier incorporates provisions of such an agreement, a shipper should request confirmation from the carrier that the carrier is a party to the agreement.

In addition to common carriers, motor contract carriers have been widely used in the chemical industry, in part because relaxation of federal regulations governing contract carriage resulted in a proliferation of such service. Over time, the distinction between common and contract motor carriers has been largely obscured. This has been particularly true since 1994 when tariff filing requirements were virtually eliminated for common carriers, leaving little to distinguish an agreement with a common carrier from a contract with a contract carrier. In the ICC Termination Act of 1995, Congress eliminated the legal distinction between common and contract carriers altogether, so that all laws previously applicable to common carriage are applicable to contract carriage (9). However, Congress preserved the essence of contract carriage by permitting a carrier and shipper to waive application of any provision of the ICC Termination Act of 1995 by contract between them, except for provisions governing carrier registration, insurance, and safety fitness (10).

A third type of motor carriage of considerable importance to many industries, including the chemicals industry, is proprietary or private carriage. Such transportation is conducted in furtherance of a primary business other than transportation (11). Thus, manufacturers transporting goods that they have manufactured or processed or that they will use in such manufacturing or processing, or for purposes of bona fide sale or purchase, are engaged in private carriage. It is generally not required that a company use only vehicles that it owns rather than leases, or that it directly employ the drivers of such vehicles, provided that such company actually controls the transport operation and bears its characteristic burdens and financial risks (12).

Corporate members of a single group of corporations may lawfully perform such transportation for a parent or subsidiary, or for a sister subsidiary, provided that the one corporation wholly owns the other or that both are wholly owned by a common parent (13). Such transportation does not require a franchise and is not subject to other regulatory requirements. As a result, it is possible for many corporations to combine in a single vehicle their freight with that of other members of the same group of corporations, thereby improving equipment and labor utilization in consolidated private trucking operations.

Motor carriers use a wide variety of highway vehicles, including trucks, tractors, trailers, tank vehicles, hopper vehicles, low boys, vans, and others. Unlike railroads, commercial motor carriers of bulk liquids or solids in tank or hopper trucks usually offer shippers both power equipment (tractor) and

freight-carrying trailers, although shippers frequently supply such trailers under special arrangements. Highway tractors used for long, continuous journeys are usually equipped with sleeper-cabs to allow one driver to rest while a second driver operates the tractor trailer.

The development of the interstate highway system and more permissive federal and state legislation have allowed the use of vehicular equipment of increased length and other dimensions, as well as higher weight-carrying capacity, thereby contributing to more economical motor transportation. Such legislation, however, has in turn given rise to disputes concerning highway tolls, fuel taxes, registration fees, and similar assessments, against both for-hire and proprietary truck operators, to permit adequate maintenance of highways. Because both passenger and freight-carrying vehicles use the highways, such disputes are not readily resolved.

2.3. Waterborne Transport. Despite natural limitations, the transportation of chemicals by water has enjoyed substantial growth, especially since the end of World War II. Assisted by governmental development of the inland waterways system, including locks and other navigational aids, water carriers transport large quantities of bulk chemicals in barges between inland ports or between such ports and coastal ports. In addition, bulk chemicals are transported by self-propelled tank vessels between U.S. coastal points, and between U.S. ports and overseas destinations.

Although water carriers are sometimes classified as common or contract carriers, such distinctions are frequently insignificant, because water carriage of bulk chemicals in the United States is essentially unregulated. In conformity with long-standing practice in the maritime field, such transportation is often provided under various forms of agreement, such as bareboat charters, time charters, or voyage charters. In a bareboat charter, the owner of a vessel charters (leases) the vessel without crew; in a time or voyage charter, the vessel is leased with crew for a specified period or for a particular voyage. On U.S. inland waterways, chemical shippers sometimes engage towboat operators to tow barges that such shippers either own or charter (lease) from others. In the United States, little remains of a once flourishing liner trade in the transportation of packaged freight, although such liners are still engaged in such transportation to and from foreign ports.

Barges, like other transportation vehicles, are available in a variety of types, sizes, and capacities. On the inland waterways, barges are usually crewless and without power independent of towboats, which push several barges in a group. In deepwater, or ocean, transportation, barges sometimes carry a crew and are capable of self-propulsion. Deepwater barges, whether self-propelled or pulled by a hawser (cable) between the barge and towboat, are generally larger than river barges. Deepwater tows rarely consist of more than one or two barges.

As in the case of highways, considerable contention results from public maintenance of the inland waterways for recreation, flood control, and other purposes, as well as for the transportation of barges and other freight-carrying vessels. Because barge transportation of chemicals is considered essential to economical distribution, governmental tolls assessed for such maintenance are of critical interest to the chemicals industry.

Most oceangoing vessels, particularly those used between North America and other continents, are self-propelled. For the movement of packaged freight in international commerce, ocean transportation in recent years has been dominated by container ships designed to load and carry large, trailer-sized containers. Because such ships can be loaded and unloaded more quickly than traditional freight-carrying vessels, the amount of time these ships are docked at port has been greatly reduced, thereby increasing the number of voyages possible in a given period and reducing operating costs. Other types of ocean vessels include tankers and dry-bulk ships for the transportation of a wide variety of liquid hydrocarbons, chemicals, and materials, such as coal, coke, and ores in large quantities. Chemical parcel tankers tend to be smaller in size than petroleum tankers and usually have several compartments, each designed to carry one or more products.

2.4. Pipelines. The feasibility of pipeline transportation depends on the availability of very large quantities of compatible materials between locations with sufficient storage facilities. Thus, pipeline transportation is predominantly, but not exclusively, limited to the movement of hydrocarbons, many of which are raw materials in the production of petrochemicals. Although proprietary pipelines, generally of short distances, are not unusual, commercial petroleum pipelines are considered to be common carriers available to serve all customers who can tender sufficient quantities of acceptable liquids for transportation between terminals.

2.5. Air Transport. Relatively small quantities of chemicals are transported by air, although availability of such service for the movement of samples, emergency shipments, and radioactive chemicals with a short half-life is important. Both economic and safety considerations impede the development of air carriage as a significant means of transporting a substantial volume of chemicals.

2.6. Other Services. Domestic freight forwarders, although sometimes treated as common carriers, do not provide any physical transportation service. Instead, they arrange transportation services for their customers, usually the underlying shipper of goods, and perform related functions such as the booking of space with a carrier and preparing necessary documentation. One important function commonly performed by freight forwarders is the consolidation of multiple small shipments into carload or truckload lots, which are forwarded to a central location for subsequent distribution to individual destinations. In the export and import trade, where transportation is provided in whole or in part by a water carrier, similar services are provided by commercial operators known as nonvessel operating common carriers (NVOCC). Shipper cooperatives, more commonly known as shippers' associations, also provide consolidation and distribution services for the purpose of passing on the resulting savings in freight charges to their members. With the proliferation of contract carriage, particularly in the domestic transportation markets, many shippers' associations have undertaken the function of negotiating transportation agreements for the benefit of the members.

The diversity and flexibility of a highly developed transportation structure is demonstrated by intermodal transportation, ie, the combination of two or more transportation modes. Traditional combinations, such as rail and water or truck and water, are essentially end-to-end arrangements. However, since the late

1980s there has been substantial growth in combinations of the various transportation modes, such as the piggyback transportation of trucks or trailers on railroad flat cars, and similar loadings of trucks or containers on ships or barges. These methods of transportation are largely deregulated and have led to substantial economies for both carriers and shippers (14).

2.7. Warehouses and Terminals. Warehousing constitutes an integral part of the distribution system in the United States. Although employed primarily to store inventory, warehouses are also used to assure timely deliveries to customers remote from a production facility. Additionally, warehousing may facilitate the aggregation of large shipments, thus reducing transportation costs. Warehouses may be owned and operated by individual companies for their own purposes or they may be available to the public for storage of goods. The chemicals industry makes extensive use of bulk terminals for storage of liquid- and dry-bulk materials in a wide variety of sizes and types of tanks, silos, bins, and other facilities.

Warehouse and terminal operators, who offer their facilities and services for compensation, are liable for goods in their custody if they are negligent. Many operators limit the amount of their liability by provisions in the warehouse receipt, the customary document issued as evidence of goods held in storage. Warehouse charges are generally determined by the amount of space occupied by the stored goods and the period of storage, as well as the ease of handling, hazardous characteristics, and similar considerations.

3. Shipping

3.1. Shipping Terms. Although frequently referred to as shipping terms, the acronyms FOB, FAS, and CIF are actually terms of sale because they pertain to the relationship between vendor and vendee, rather than between shipper and carrier. The term FOB, eg, means free on board and usually indicates that delivery of the goods to the vendee will occur when the goods, packaged in accordance with the terms of the sales agreement, are delivered aboard a vehicle of the type agreed upon at the fob point named. The risk of loss in transit is usually transferred at the point of delivery. "FOBorigin" means that the vendee or consignee assumes such risk, whereas "FOB destination" means that the vendor or consignor assumes it. In the absence of a contrary agreement between vendor and vendee, freight charges are payable by and are for the account of the party who bears the risk of transit loss.

The selection of shipping terms has a material effect on the sales contract. The party with the risk of loss must decide whether or not to insure against such risk and must prepare and file a claim against the transportation carrier when goods are lost or damaged in transit. Unless otherwise agreed, that party must also pay transportation charges and file any claims for freight overcharges. In export or import transactions, shipping terms, eg, fas (free alongside ship) or cif (cost, insurance, freight), may also determine the party responsible for preparing required documents, obtaining customs clearances, and similar matters (15).

3.2. Shipping Documents. The document most commonly used in both domestic and international transportation is the bill of lading. Historically, the

bill of lading has served as both a receipt for goods delivered to a carrier and as a contract of carriage. Bills of lading may be negotiable documents and as such constitute evidence of title or the right to possession of the goods described in the document. Most domestic transportation, however, occurs on nonnegotiable bills of lading. The face of the bill of lading identifies the shipper, origin, consignee, destination, vehicle or car number, routing, commodity, containers, quantity shipped, and other information required for the carrier to properly transport and invoice the freight. The contract terms, usually on the reverse side of the bill of lading, specify rights and obligations of the shipper, consignee, and carrier, including most importantly, limitations on carrier liability, methods and time limits for submitting damage claims, payment of freight charges, and disposition of the goods in case of nondelivery. The short-form bill of lading does not reproduce all contract terms on the reverse side, but refers to such terms as published elsewhere.

In international trade, the ocean bill of lading serves essentially the same purposes, although it may differ in form and content and is frequently negotiated in such a manner that payment by the foreign consignee is required before delivery of goods by the carrier. Where a shipper's freight occupies the whole or a substantial portion of a particular vessel, the document used may be a voyage charter, which provides for use of the vessel for a single voyage. For shipments of bulk chemicals by tanker, a shipper may use a specified tank on a particular vessel under an arrangement referred to as a parcel charter. Another document commonly used in ocean shipping is a dock receipt, which is evidence that the goods have been delivered to a dock pending arrival of the vessel on which they will be loaded for transportation overseas.

A freight bill is an invoice issued by a carrier requesting payment for transportation services. Generally, the freight bill contains the information shown on the face of the bill of lading, together with the freight rate and charges and the carrier's invoice (pro) number. Carriers usually require submission of the original paid freight bill as part of a shipper's claim for freight loss, damage or delay, or for overcharge. A paid freight bill may also be required to prove that the vendor or vendee has paid freight charges, especially in cases where freight is added to or deducted from the merchandise invoice or is equalized with freight charges from competing shipping points.

A delivery receipt is a document, frequently a copy of the freight bill, which has been signed by the consignee as evidence of delivery of goods by the carrier. Where no exceptions have been noted on the delivery receipt, it constitutes prima facie proof of delivery in full, and in apparent good order and condition.

The above shipping documents can also serve as the hazardous materials shipping paper. This document is an important device for communicating hazards of the materials shipped. For a complete description of the hazardous materials shipping paper requirements, see the section HAZARD COMMUNICATIONS.

4. Interstate and Intrastate Commerce

The applicability of various federal and state transportation laws and regulations depends on whether transportation constitutes interstate or intrastate

commerce. The transportation laws and regulations that may apply are both economic (ie, rates and routes) and safety related. Beginning in January 1996, however, Congress preempted all remaining state economic regulation of intrastate motor and rail carriage, but did not substitute federal regulation for the preempted state regulations (16). As a result, although limited economic regulation of interstate commerce by motor carrier remains, there is no economic regulation of intrastate commerce by motor carrier. Similarly, there is no state economic regulation of intrastate commerce by rail carriers, although limited federal economic regulation of intrastate commerce by rail carrier remains.

Except in rare instances, it can be assumed that transportation requiring physical movement across state boundaries is interstate commerce. On the other hand, transportation that takes place wholly within the confines of a single state is not necessarily intrastate commerce, because such transportation may be a portion of a continuous movement in interstate commerce. As a general rule, where there is a "fixed and persisting intent" that transportation be provided from a point in one state to a point in another state or in another country without coming to rest at an intermediate location, all portions of such transportation are considered interstate, even though one or more portions may be performed wholly within a single state (17). It is immaterial that different carriers or even different modes of for-hire transportation may be employed for each portion, or that new bills of lading are issued or separate freight bills rendered.

Thus, eg, where freight is transported by motor carrier from Springfield, Illinois, to a railroad piggyback ramp in Chicago for movement in railroad service to a place in New York, the truck service is in interstate commerce although neither the vehicle nor its driver physically leave the state of Illinois in the course of such transportation. Consequently, the motor carrier would be subject to federal franchise requirements. Similarly, a shipment from Albany, New York, to a New York City pier for export to Europe is considered interstate (or foreign) transportation and, therefore, subject to federal regulation, despite the issuance of a new, export bill of lading at the pier.

However, certain forms of interstate commerce also are not subject to federal regulation. For example, a shipment transported by motor carrier within New York City to a New York City pier for export, although likewise in interstate commerce, would generally not be subject to such regulation because a provision of the ICC Termination Act of 1995 exempts interstate motor carriage within a single municipality or commercial zone (18). An additional variation of the general rule occurs when freight is transported by a private carrier from one state to a second state, where it is given to a for-hire carrier for final delivery within the second state. In such cases, the ICC and the courts have concluded (19) that the for-hire portion of such movement is not subject to federal regulation even though the freight actually crossed a state line in the course of the through transportation. Neither, however, is the movement subject to state regulation because the movement is considered to be in interstate commerce (20).

5. Economic Regulation

In the United States, transportation has long been subjected to regulation by both federal and state governments. Generally, such regulation has been directed at operational safety or toward economic concerns, eg, discrimination in rates and services or excessive competition. In addition, regulatory statutes have provided for control of entry into the transportation business, regulation of freight rates and charges, and various finance, accounting, and insurance requirements, although there are numerous exceptions. Among the exceptions of particular importance to the chemical industry is that afforded to water carriage of liquid and dry-bulk commodities.

At the federal level, the STB, the Federal Maritime Commission (FMC) the Department of Transportation (DOT), and the Federal Energy Regulatory Commission (FERC) are all concerned with economic regulation of various modes of transportation. The STB regulates interstate railroads, motor and water carriers, and pipelines (other than water, gas, and oil). The DOT regulates motor carriers, through the Federal Motor Carrier Safety Administration (FMCSA), and international airlines, through the Office of the Secretary, DOT. The FMC regulates water transportation of containers in foreign commerce. The FERC regulates pipeline transportation of oil, natural gas, water, and other energy resources.

There has been a significant trend toward relaxation of many economic regulatory controls since the 1970s that has resulted in substantial change in the transportation industry. Thus, entry into the motor-carrier business has been greatly liberalized resulting in more available carriers and, consequently, increased competition and reduction in freight rates. In addition, motor carriers are no longer required to publish rates and terms of transportation in public tariffs for most transportation. Similarly, railroads are no longer required to file tariffs for most transportation and are permitted to enter into contracts with individual shippers, providing for guaranteed volumes of movement at reduced rates, improved services or car supply, discounts for routing via specified railroads, and other flexible arrangements previously considered unlawful. Antitrust immunity, which most carriers formerly enjoyed in the collective establishment of rates, has been removed to a substantial extent and, in general, more reliance has been placed on market competition to achieve the objectives of economic regulation.

Regulation, however, has not been entirely abandoned and in many respects at least the form of railroad regulation remains essentially intact. Thus, eg, railroads must obtain STB authority to extend their lines or to abandon existing service, although such abandonments are more freely allowed. Similarly, but to a much lesser extent, motor carrier regulation also remains intact. For example, motor carriers must be qualified to provide service by the FMCSA, which issues motor carrier registrations. Registration, however, is based only on safety and financial fitness and is granted more freely than the operating franchises that were previously issued by the ICC. Railroad consolidations or mergers also require STB approval.

With respect to freight rates, historic rules requiring that rates be reasonable and prohibiting discrimination or preference as between particular shippers or geographic areas have been phased out to varying degrees among different modes of transportation. To the extent these historic rules remain at all, their impact has been largely dissipated by provisions placing increased reliance on competitive forces. In connection with railroad rates, eg, the STB has lost virtually all of its powers to prescribe maximum reasonable rates, except in cases where railroads exercise market dominance with regard to particular movements (21). In most cases, however, the STB has tended to make it extremely difficult to prove the existence of such market dominance, much to the consternation of transportation managers in the chemical industry who contend that a substantial volume of chemicals railroad traffic is captive to that form of transport. With regard to air freight rates, the DOT has exempted most carriers and forwarders from rate regulations (22). Laws governing the rates of most motor carriers have been repealed in their entirety.

A significant result of regulatory relaxation is an increase in the authority of the STB to grant administrative exemptions from railroad and motor-carrier regulation (23). Such authority has been exercised in a variety of ways, including the virtually complete deregulation of most piggyback transportation (24). Thus, railroads are not treated as regulated carriers when performing piggyback service.

Regulated railroads, when not operating under contracts with shippers, are required to provide a shipper, upon request, its rates and terms for transportation as a common carrier. A rail common carrier cannot increase a rate or change the terms of service for a shipper who has requested this information within the previous 12 months unless the carrier provides 20 days prior notice (25). This is a significant change from previous law that required rail carriers to publish and file with the ICC tariffs or schedules of their rates and charges. Rail carriers were required to strictly adhere to these tariffs regardless of errors, conflicting promises or agreements, contrary intent, or other circumstances.

Shippers must bring a lawsuit to recover any overcharges by a railroad and carriers must bring a lawsuit to recover any undercharges within 3 years after the claim accrues (26). Transportation performed pursuant to a contract between a shipper and rail carrier is deemed unregulated and the parties must resolve any contractual disputes among themselves or in the courts, without the aid of the STB. With regard to motor carriers, a claim by a shipper against a motor carrier or a claim by a motor carrier against a shipper for recovery of freight charges, must be initiated within 18 months of delivery of the shipments (27).

Among other aspects of regulation that have survived reform are requirements pertaining to time periods for the collection of freight charges by motor carriers pursuant to the extension of credit (28) and insurance requirements applicable to motor carriers (29). The credit regulations require motor carriers to bill and collect their freight charges within specified times. However, longer credit periods may be, and typically are, granted in compliance with minimum regulatory requirements. Motor carriers must also maintain certain minimal liability insurance coverage for the protection of the public, as well as insurance covering carrier liability for loss of or damage to freight. The latter type of

insurance is frequently beneficial to shippers who have difficulty in collecting damage claims because a carrier has become bankrupt.

In the past, many state governments regulated economic activity in intrastate transportation in a manner similar to federal regulation. However, beginning in 1995, the federal government preempted all state economic regulation of intrastate motor carriage (30), although the federal government did not supplant state regulation. Instead, the market for intrastate motor carriage was left open to competitive market forces. With respect to railroads, federal legislation has effectively compelled the states to abandon railroad regulation entirely (31).

5.1. Freight Rates and Allowances. The establishment of freight rates, ie, a transportation price structure, embraces virtually all articles of commerce in a multitude of packages and quantities, via numerous routes and between innumerable locations. A variety of intermediate services are also often included, eg, storage or reconsignment in transit and stop-offs to partially load or unload. The classification of freight into various categories or classes is the result of an effort to systemize the various factors considered in fixing a particular rate. Freight classifications are generally based on freight density, susceptibility to damage or theft, value of the goods, etc. Freight classification should not be confused with hazardous materials classification. Freight classification is an economic term, while hazardous materials classification is a means of identifying different hazards posed by various materials. For a complete description of hazardous materials classification, see the discussion in the section on SAFETY REQUIREMENTS.

Freight classification has established a more or less standard nomenclature to identify the numerous products shipped in commerce. This standardization facilitates preparation of shipping documents, determination of freight rates, and free interchange of freight between connecting or competing carriers. Chemical and freight nomenclatures, however, are frequently different. Thus, for example, many chemicals may be grouped under the single freight description "Chemicals, NOIBN", referring to chemicals that are not otherwise indexed (in the freight classification) by name. On the other hand, a particular product such as acetone may be specifically listed and, therefore, would not qualify for inclusion in the NOIBN category. Misdescription of freight resulting in misclassification is a frequent source of freight overcharges and undercharges.

The variety of possible transportation arrangements available today is virtually without limit, but it may be useful to generally describe the most common types of freight rates and charges. (*1*) Less-than-carload or less-than-truckload rates are applicable to quantities of particular commodities less than a specified volume considered to constitute a carload or truckload quantity of such commodities. In most cases, small shipments are also subject to a minimum charge per shipment. However, almost all railroads have abandoned the transportation of less-than-carload freight. (*2*) Carload or truckload rates are applicable to quantities of a commodity sufficient to constitute a specified minimum carload or truckload volume. Such rates, of course, are substantially lower than less-than-carload or less-than-truckload rates. Freight rates are usually stated in $/100 lb, although rates on some materials, eg, coal or gravel, may be stated per short ton or similar unit of weight. (*3*) Multiple car rates are applicable only when a specified number of carloads is tendered to a railroad for transportation

in a single shipment. For commodities such as coal, which move in large volumes, trainload rates may be provided. (*4*) Annual (or periodic) volume rates are applicable to individual shipments that are part of an aggregate tonnage of a particular commodity or commodities that a shipper has agreed to ship between specified points in a specified period. (*5*) Accessorial charges are for services that are ancillary to line-haul transportation, such as switching, demurrage, storage or stopping in transit, reconsignment, and similar services.

For those regulated carriers required to publish tariffs, ie, motor carriage of household goods and domestic offshore water carriers, any payment by the carrier to the shipper could be construed as a reduction of tariff charges and, therefore, an illegal rebate. To avoid such rebates, carriers may publish allowances in their tariffs which they are willing to pay to the shipper, or deduct from the freight bill, for services performed by the shipper in lieu of the carrier. For example, a carrier who includes loading as part of transportation service may publish an allowance to shippers that perform such loading. Similarly, motor carriers may publish allowances for shippers who deliver freight to the carrier's terminal rather than requesting pick-up by the carrier.

The mileage (distance) allowances established by railroads for use of tank cars, hopper cars, and other railroad equipment furnished by shippers for transportation of products are of great importance to the chemical industry. Empty return movements are usually made without charge, provided that aggregate loaded and empty distances on each railroad are maintained in equilibrium. Such allowances, paid for loaded miles of car movement, historically represented large revenues for the industry and were an important consideration in calculating the actual (net) cost of transporting a given shipment. The amount of the per mile allowance varies with the fair market value and age of a car. For administrative convenience, many, if not most, chemical shippers and railroads have shifted to a "zero allowance" program, which eliminated mileage allowances payments by the railroads in exchange for a lower freight rate. This eliminates the administrative burden of tracking the loaded mileage traveled by a rail car and making regular monthly payments.

5.2. Freight Loss and Damage. Under the common law of the United States, common carriers by land were liable for loss of or damage to goods in their custody, except loss or damage resulting from an act of God, the act of a public enemy (revolution or hostility between governments), an act of governmental authority (eg, quarantine), inherent vice or defect of the goods, or the fault or negligence of the shipper. In the early 1900s, such liability was codified in the Interstate Commerce Act for railroads, motor carriers, and freight forwarders and provided that such carriers were liable for the full, actual loss of or damage to the goods. This codification is commonly referred to as the Carmack Amendment.

In general, common carriers could not limit their liability for loss or damage except for consideration in the form of a reduced freight rate if the shipper retains the right to select either full or limited liability. Historically, liability limitations generally required the approval of the ICC, which was sparingly given. However, because of the enactment of regulatory reform legislation in the early 1980s, approval is no longer required and shippers and carriers may agree on liability limitations. Freight rates applicable to shipments subject to limited carrier liability are known as released rates.

Amendments to the Carmack Amendment, however, arguably have allowed rail and motor carriers to unilaterally limit their liability by the establishment of released value rates, without the shipper's knowledge (32). The Act also provides that claims for loss or damage of goods transported via joint through routes may be filed against either the originating or destination carrier or against an intermediate carrier on whose line(s) the goods are known to have been damaged (33). Additionally, the Act provides a minimum time limit for filing a claim (9 months) and commencing suit (2 years) (34). Despite the 9-month minimum for filing claims, shippers are well advised, in the case of damage that is not apparent at the time of delivery, to promptly notify the delivering carrier and afford an opportunity for inspection of the damaged goods. Many carriers more recently have taken the position that, if they offer released value rates, they also can modify other provisions of the Carmack Amendment, such as the time for filing claims and commencing suits. Thus, under the current law, shippers are well advised to request from the rail or motor carrier a copy of the applicable rates, terms, and conditions, including liability limitations, that apply to the transportation service to be provided.

Carriers generally are liable only for full actual loss. Thus, eg, a vendor who has prepaid freight charges that are not separately invoiced to the vendee may not recover both the invoice value of the goods and the freight paid, because such recovery would put the vendor in a more advantageous position than if the goods had been delivered undamaged and the vendee had paid the invoice as rendered.

When goods consigned to a shipper's warehouse or terminal are damaged, disputes frequently arise as to their value. Usually, the carrier contends that shippers should not earn profit on sales not made, and the shipper contends that it should not be required to produce goods merely to recover its costs. Such disputes are sometimes resolved by payment of the sales price less costs not incurred, such as the cost of delivery from the warehouse to the consignee.

Contract carriers generally are not held to the same standard of liability as common carriers because they are considered ordinary for-hire bailees and, therefore, are liable only for their failure to exercise a reasonable degree of care for goods in their custody or possession, although such liability may be varied by the contract. However, motor carriers providing service under contract are held to the same liability standard applicable to common carriers unless the statutory provisions imposing the standard are waived in the contract.

The liability of water carriers is established under principles of traditional admiralty law, which generally reflect the fundamental concept of liability for negligence, modified to accommodate risks peculiar to the long and dangerous voyages in ancient times. Thus, eg, ship owners may limit their liability to the value of the vessel and cargo after an accident, and cargo jettisoned at sea to save the venture may be compensated by general average charges against owners of the remaining cargo. Many other variations of water-carrier liability for cargo damage can be found upon examination of the multiplicity of charters, bills of lading, tariffs, and contracts employed in connection with such transportation.

The liability of common carriers by land for loss of or damage to freight is sometimes referred to as that of an insurer. This characterization is technically incorrect, however, because carriers are not liable for the fault or negligence of the shipper as, eg, in using faulty or defective packaging or in improper loading.

Nevertheless, most transit loss or damage is recoverable from the carrier and, as a result, many shippers find it unnecessary to insure freight transported by land carriers, unless carrier liability has been limited in accordance with the legal principles discussed above. On the other hand, it is common practice for shippers or receivers to insure cargo transported by water, unless the carrier has contractually agreed to purchase such insurance. In some cases, as in transportation by air or in highway carriage of household goods, shippers may be afforded an opportunity to purchase insurance directly from the carrier.

6. Safety Regulation

The DOT administers safety regulations for the transportation of goods in the United States. In general, DOT safety regulations fall into two categories. The first category pertains to the vehicle and the driver, including driver qualifications and hours of service and the safety of transport operations and equipment. The second category, of special concern to the chemical industry, pertains to the transportation of hazardous materials and related commodities.

Various agencies within the DOT are responsible for transportation safety. The Federal Motor Carrier Safety Administration (FMCSA) prescribes extensive regulations regarding drivers' qualifications, the maintenance of drivers' logs, required vehicle equipment and inspections, and accident records and reports (35). Such regulations are applicable to all interstate carriers by highway, and violations are subject to criminal and civil penalties. The National Highway Traffic Safety Administration (NHTSA) issues motor vehicle safety standards including, among others, standards for tires, brakes and brake fluids, bumper protection, and passenger restraint systems (36).

The DOTs Federal Railroad Administration prescribes similar regulations for railroads, including requirements pertaining to the quality of tracks, train speeds, and freight-car construction. The FAA and Coast Guard continue to regulate safety by air and water, respectively, including aircraft and ship construction, maintenance, and operation. A separate, independent federal agency, the National Transportation Safety Board, is responsible for investigating serious accidents by all modes of transportation, including pipeline and passenger transportation. This agency makes recommendations to U.S. Congress and the regulatory agencies with respect to safe transportation practices and regulatory requirements.

Since the end of World War II there has been a substantial increase in the volume of hazardous materials transported domestically and internationally by all modes of carriage. According to the Association of American Railroads, $\sim$1.7 million carloads of hazardous materials are transported by U.S. railroads each year (37). Prompted in part by such tragic occurrences as those at Bhopal and Chernobyl and heightened concerns over hazardous material as potential terrorist targets, there is a renewed and widespread interest in the safe transportation of explosives, toxic and radioactive materials, and other products with dangerous potential. Responsive to such concerns, the American Chemistry Council adopted a broad series of initiatives collectively known as Responsible Care®, which includes a requirement that participants obtain independent third-party verifi-

cation of management systems that address emergency response, security and distribution of hazardous chemicals.

Federal legislation pertaining to the movement of hazardous materials, however, precedes such concerns. As early as 1866, Congress restricted the transportation of such products as nitroglycerin and blasting oil. In 1908 and 1909, the ICC was authorized to issue regulations governing railroad transportation of explosives, and in 1921 such authority was extended to the regulation of flammable liquids and solids, oxidizing materials, corrosive liquids, compressed gases, and poisonous substances (38). Subsequent amendments to the 1921 legislation further extended ICC jurisdiction to transportation by contract and private carriers by motor vehicle and certain liquid pipelines, and added etiologic agents and radioactive substances to the categories of hazardous materials subject to such jurisdiction.

Following the initial transfer of safety functions from the ICC, FAA, and Coast Guard to DOT, it became evident that more comprehensive legislation and better coordinated regulation of all modes was required. Accordingly, in 1974, Congress enacted the Hazardous Materials Transportation Act (HMTA), and in 1990 amended HMTA with the Hazardous Materials Transportation Uniform Safety Act (HMTUSA) (39). This statute consolidated the authority of DOT with respect to safety regulation of the various modes, extended its jurisdiction to include manufacturers of containers used for transportation of hazardous materials, greatly increased penalties for violation and provided other enforcement mechanisms, and authorized the regulation of any substance or material that could create an unreasonable risk to health, safety, or property. Under HMTA, as amended by HMTUSA, authority has been assigned to DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA), except for bulk water movements, which remain subject to the authority of the Coast Guard.

Generally, the purposes of hazardous materials regulation are "to protect the Nation adequately against the risks to life and property that are inherent in the transportation of hazardous materials in commerce (40)". To assure the safe handling of hazardous materials in transit and to communicate the hazards of a material to carrier personnel, cargo handlers, police, fire, other emergency personnel, and bystanders. Thus, DOT hazardous materials regulations, published at 49 CFR Parts 171–180, prescribe in considerable detail safe handling and communication requirements.

7. Safe Handling of Hazardous Materials

To reduce the risk of a release of hazardous materials during transit, PHMSA requires hazardous materials to be placed in proper packaging (41). The purpose of the hazardous materials packaging requirements is to ensure the materials are contained by the package during transit. There are separate packaging requirements for both bulk and nonbulk containers. A bulk container has a capacity $>$119 gal for a liquid, 882 lb for a solid, and 1000 lb of water capacity for a gas (42). The PHMSA prescribes in considerable detail specifications for the design of bulk shipping containers, tank cars, tank trucks, and intermediate

bulk containers (43). In addition, PHMSA requires continuing qualification and maintenance for the continued use of bulk containers (44).

Rather than mandating specific design specifications for nonbulk packages, the hazardous materials regulations prescribe strict performance standards that nonbulk packages must satisfy. These standards require manufacturers of packaging products intended to contain hazardous materials to ensure the packaging meets certain minimum standards, including a drop test, pressure test, and edge crush test.

Generally, shippers may accept the package manufacturer's certification of compliance or identification of the package specification as evidence that such containers conform to DOT requirements for that specification (45). For tank trucks supplied by a carrier, shippers may rely on the manufacturer's identification plate or certification by the carrier (46). The shipper is required, however, to use the packaging properly, including such functions as proper closure (47).

To further prevent the release of hazardous materials during transit, PHMSA prescribes procedures for the safe handling of these materials, including the safe loading, unloading, storage and other operating requirements. Both the shipper and the carrier are responsible to ensure hazardous materials are handled safely. These provisions include requirements to ensure the segregation of incompatable materials, securing hazardous material packages in the transport vehicle, the use of proper grounding for the transfer of flammable liquids, and ensuring all valves and hatches are properly closed (48).

When an incident does occur, carriers are required to report to DOT or other agencies any incidents involving a release or discharge of hazardous materials or wastes during transportation, or resulting in death, injury, or evacuation (49). If an enforcement action is taken, penalties can include the assessment of civil penalties as high as $50,000 for each violation and criminal penalties as high as $500,000 and 10 years imprisonment for each violation (50).

8. Hazard Communication

A key portion of the hazardous materials regulations is the proper communication of the potential hazards of the materials in the shipment. The communication requirements prescribe marking and labeling of packages, identification of the hazardous materials on shipping papers, and placarding of the transport vehicle, railcar or container (51).

8.1. Shipping Papers. An important device for communicating a materials hazard is the shipping paper. Each person offering a hazardous material for transportation must describe the material on shipping papers as prescribed in 49 CFR Part 172. A shipping paper can be any number of widely recognized shipping documents, including a Bill of Lading, a Freight Class Sheet or a Hazardous Waste Manifest (52).

In order to ensure universal recognition of the information provided on the shipping paper, the hazardous materials regulations require a shipper to identify and list on the shipping paper the proper shipping name of the material, then the hazard class or division, followed by a universally recognized identification number, and lastly the packing group. In addition, the shipping paper must include

the total quantity of hazardous materials shipped, emergency response information, the shipper and receiver's name and address, a 24-h emergency contact number, and a signed certification statement by the shipper, attesting that the shipment has been properly classified, described, packaged, marked and labeled in accordance with DOT regulations. Most shippers of hazardous materials have incorporated DOT documentary requirements into their standard bill of lading.

In order to ensure a hazardous material is properly handled and the hazards properly communicated, the proper classification and identification of the materials hazard is critical. The proper selection of chemical shipping descriptions, and the determination of the hazard class, require chemical expertise and familiarity with DOT definitions of such classes, which are provided in Part 173 of the hazardous materials regulations. The Hazardous Materials Table (the HMT) at 49 CFR 172.101 is a vital tool in the proper identification and classification of hazardous materials. The proper use of the HMT is an important skill for all shippers of hazardous materials.

The HMT lists the proper shipping names recognized by the DOT for the transport of hazardous materials. Both technical and generic shipping names are provided on the HMT. Technical shipping names are recognized chemical names used in scientific and technical handbooks and journals (53). Generic shipping names are entries in the HMT that describe a materials hazardous characteristics or intended use (54). Selection of a generic shipping name requires that the name accurately describes the material and the corresponding hazard class and packing group.

The characteristic hazards of a material are identified by an assigned hazard class or classes. There are nine hazard classes, many of which are broken down further into divisions. While a material may meet the definition of more than one hazard class, each material is assigned a primary hazard class for identification purposes (55). The nine hazard classes and each of the divisions include:

Class 1: Explosives
- Division 1.1—Explosives with a mass explosion hazard
- Division 1.2—Explosives with a projection hazard
- Division 1.3—Explosives with predominantly a fire hazard
- Division 1.4—Explosives with a minor explosion hazard
- Division 1.5—Very incencitive explosives (including blasting agents)
- Division 1.6—Extremely incencitive explosives (including detonating substances)

Class 2: Gases
- Division 2.1—Flammable Gas
- Division 2.2—Non-Flammable Compressed Gas
- Division 2.3—Poisonous Gas

Class 3: Flammable Liquids

Class 4: Flammable and Unstable Materials
- Division 4.1—Flammable Solid
- Division 4.2—Spontaneously Combustible

Division 4.3—Dangerous When Wet
Class 5: Oxidizers
Class 6: Poison
Division 6.1—Poisonous Materials
Division 6.2—Infectious Substances
Class 7: Radioactive Materials
Class 8: Corrosive Material
Class 9: Miscellaneous

In addition to the proper shipping name and hazard class, each shipping paper must include the appropriate identification number. A universally recognized four-digit identification number is assigned to each proper shipping name listed on the HMT (56). The identification number is used as a quick cross-reference for material handlers and emergency responders. Each identification number is preceeded by the letters UN, for United Nations, or NA, for North America. An identification number preceeded by UN means the shipping name is universally recognized, while a shipping name preceeded by NA means the shipping name is appropriate for domestic shipments, but may not be recognized outside the United States.

Most hazardous materials are also assigned to one of three Packing Groups (PG) that designates the degree of danger presented by the material (57). A PG I designation indicates the highest degree of danger, PG II medium, and PG III, the lowest.

8.2. Marking and Labeling. Each nonbulk package containing a hazardous material will be labeled to communicate the hazard class or classes of the material (58). The hazard class label includes the hazard class number in the lower corner and further communicates the hazard with a symbol and by the color of the label. The text name of the hazard class may be placed on the label, but is not required (59). The diamond-shaped "red label" signifying the presence of a flammable liquid, eg, is almost universally recognized as indicating the presence of a possible fire hazard (Fig. 1) (60).

Each bulk package, freight container, transport vehicle or rail car must be placarded in accordance with Subpart F of Part 172 to indicate the presence of a hazardous material. The placard must be placed on each side of the vehicle or container and on both ends (61). Although similar to labels in appearance, placards are larger and more durable than labels and are affixed to the exterior of rail cars and other transport vehicles carrying hazardous materials (Fig. 2). The regulations also require that certain bulk packaging (tank cars, tank trucks, portable tanks) display the four-digit identification number, which may, except in certain cases, be substituted for the word or words, eg, Flammable or Poison, on a placard (Fig. 3) (63). In some cases, the identification number is displayed on an orange panel or a plain square-on-point configuration of prescribed specifications.

Shippers of hazardous materials must further communicate the contents of the package or container by marking the container in accordance with Subpart D of Part 172. Nonbulk packages must be marked with the shipping name and identification number (65). Additional markings, including handling instruc-

tions, and the name and address of the consignee or consignor, may also be required to be placed on the package. Markings must be placed near the hazard lable and on the same surface. All bulk packages must be marked with the identification number, and in some instances bulk packages must be marked with the shipping name, handling, handling instructions, and further descriptions of the hazards associated with the shipment. Generally, both bulk and nonbulk packagings that contain only the residue of a hazardous material are regulated as if full (66).

8.3. Hazardous Materials Security. Although accidental release of hazardous materials in transit is relatively rare, the potential for significant harm is of constant concern to the public and industry. This concern is magnified by post-9/11 concerns. In response to concerns over possible terrorist attacks involving hazardous materials shipments, the DOT now requires hazardous materials shippers to develop a hazardous materials security plan. A hazardous materials security plan must address personnel security, unauthorized access to a shipping facility, and en route security (67). Additionally, the Department of Homeland Security and DOT now requires fingerprinting and a background check for drivers applying for a hazardous materials endorsement on their state-issued commercial drivers license (68).

Also in response to post-9/11 terrorism concerns, some states and local governments have attempted to restrict the transportation of hazardous materials through certain gerographic areas. Thus far, the courts have determined that such restrictions are preempted by federal law.

8.4. Emergency Response. With the heightened concerns over hazardous materials transportation safety, both federal and state agencies have increased the training of emergency responders to deal with an incident involving hazardous materials in transit. The chemical industry has also responded to assist emergency responders during incidents involving hazardous materials. The Chemical Transportation Emergency Center (CHEMTREC) was formed in 1971 by the American Chemistry Council to provide a 24-h ermergency response hotline number. CHEMTREC provides immediate and reliable information to carriers and public officials at the scene of an emergency. Since its formation, CHEMTREC has responded to hundreds of thousands of emergency calls, providing information from its files containing millions of Material Safety Data Sheets. Similarly, the Chlorine Institute has organized a mutual aid program, called CHLOREP, which offers assistance at the scene of emergencies involving chlorine. Furthermore, industrial response teams are usually available for assistance in connection with cleanup of spills which may be hazardous to the public or environment.

9. Outlook

Transportation and distribution costs constitute a substantial portion of the total cost of the chemical industry. Most chemical producers, therefore, can be expected to pay continuing attention to the control of such costs and to the maintenance and development of more sophisticated distribution methods. Significant recent changes in the nature and extent of economic regulation in the transpor-

tation field promise new challenges to industrial distribution managers, especially in the areas of railroad and motor-carrier transportation. Rail carriers, armed with the freedom to price their services, to abandon unprofitable lines, and to merge with other railroads, have already demonstrated a tendency to increase rates on captive chemicals traffic. At the same time, however, the removal of regulatory restraints on contracts between shippers and railroads has generated a revolution in transport pricing.

In the motor-carrier field, increased competition resulting from the virtual elimination of economic regulatory controls has given motor carriers a degree of efficiency enabling them to challenge proprietary transportation in both cost and service. The availability of energy resources and the adequacy of the highway infrastructure may impose the most substantial constraints on the continued growth of motor transportation.

Without a breakthrough in energy usage, the technology of transportation is not expected to change dramatically in the foreseeable future. Improvement is likely to be concentrated on the transport infrastructure including intelligent transport systems, using electronic technology to increase the efficient use of highways and vehicles and to enhance traffic safety. Transportation safety will continue to be of concern to government at all levels, but such concern may be directed less at new regulations and restraints and more on the application of existing computer and communications technology to more effective emergency response.

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Fig. 1. Label signifying the presence of a flammable liquid. The numeral in the lower corner represents the primary hazard class of the material in the labeled package.

Fig. 2. Placard signifying the presence of a flammable gas. The numeral in the lower corner represents the primary hazard class of the material in the transport vehicle (62).

Fig. 3. Illustration of an identification number on a placard for acetone. The numeral in the lower corner represents the primary hazard class of the material (64).

Table 1. **U.S. Freight Shipments by Tons and Value**[a]

	Tons (millions)			Value (billions $)		
Mode	1998	2010	2020	1998	2010	2020
total	15,271	21,376	25,848	9,312	18,339	29,954
domestic						
air	9	18	26	545	1,308	2,246
highway	10,439	14,930	18,130	6,656	12,746	20,241
rail	1,954	2,528	2,894	530	848	1,230
water	1,082	1,345	1,487	146	250	358
Total domestic	*13,484*	*18,820*	*22,537*	*7,876*	*15,152*	*24,075*

[a]Ref. 1.