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Code of Practice for Warehouse and Terminal Facilities Storing Hazardous Materials

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ABSTRACT

Practical standards are needed to guide the construction and operation of Canadian warehouses and transport terminals in which packaged hazardous materials are stored. More than 800 agencies and firms throughout the world were contacted to discover existing codes and practices that currently address this need. Based on a 33-percent response rate, specific problems with the storage of hazardous materials are identified. Findings are summarized in terms of existing problems with dangerous goods storage, a review of government codes and regulations in the countries surveyed, and a summary of current industrial practices. Many government regulations and industrial guides were found to consider some commodities but not others. Some of the larger chemical firms have developed their own internal standards for storing their products. But those firms and others that have invested much time in promoting safety are reluctant to share their experiences with competitors. Small firms and those that lack the resources to develop standards have little specific guidance on design and management of interim storage facilities. The study concludes that a code of practice should be prepared to guide the storage of packaged hazardous materials. Ten objectives for a code of practice are recommended with a list of important elements that a workable code of practice should contain. A comprehensive outline for an interim set of guidelines on the safe warehousing of hazardous materials is suggested.

Packaged hazardous materials are currently being stored and handled in general warehouses and transport terminals throughout Canada without specific standards for building design or material handling. Some codes guide the design and construction of facilities in which explosives, flammable or combustible materials, and radioactive substances are stored. The design and operation features of facilities that handle other dangerous goods, however, have not been addressed from a safety perspective. In addition, storage of several classes of dangerous goods together has not been considered in Canada's design codes.

Truck and rail transfer and storage facilities

are of particular concern because they deal with large volumes of packaged freight that can represent the spectrum of dangerous goods. In the absence of specific guidelines and standards, structural and operational choices are left to owners, operators, and civil engineers, who may lack complete understanding of the consignment compatibility, emergency response requirements, and other safety considerations that are unique to dangerous goods. These problems are illustrated by some of the spectacular incidents that have occurred at storage facilities in this country and around the world. The occurrence of fires at chemical warehouses has prompted industry to examine problems related to storage of dangerous goods. This examination, however, has not yet been approached collectively in Canada.

In response to this need, the Transport Dangerous Goods Directorate of Transport Canada initiated a three-phase program to develop a code of practice for warehouses and transport terminal facilities in which packaged dangerous goods are stored in Canada. In the initial phase of research, the results of which are reported here, more than 800 government agencies and industrial firms worldwide were contacted to identify and evaluate any existing codes of practice that address the safety of facilities that store packaged dangerous goods. The study also researched industrial practices that have been developed to solve specific problems in handling and storing dangerous goods.

The research encompassed all of the dangerous goods listed in the 1985 Transportation of Dangerous Goods Regulations (1). Emphasis was placed on those commodities that are transported and stored in packaged form in recognition of consignments destined for general warehouses, in which a wide range of dangerous goods may be temporarily stored, and those destined for transport terminals, in which large volumes of a variety of goods may change hands daily. Addressed in the study were less-than-truckload and less-than-carload consignments; the study did not focus on commodities shipped or stored in bulk form only.

FINDINGS

Based on an overall response rate of about 33 percent, specific storage problems that currently exist in Canada were identified.

Major Problems Evident in Current Storage Practices

Most problems in the design and construction of general warehouses and terminal facilities storing dangerous goods are due to lack of specific guidelines. For instance, insurance standards--based primarily on engineering specifications of the Factory Mutual Research Corporation--apply only to safety of property and not to safety of life. Therefore, insurance agencies are not directly concerned with standards for storing, for example, packaged chlorine because this substance is not likely to be the cause of damage to a given structure. On the other hand, fire departments, which use the National Fire Code and the National Fire Protection Association (NFPA) codes as guidelines for fire protection, are mostly concerned with safety of life. Even with the additional references in the National Building Code of Canada and relevant labor regulations, storage of many hazardous substances, such as chlorine and corrosives, is not addressed. The result is that industry must develop specific standards to suit situational problems; otherwise, the public must face the risk of problems that have not been adequately addressed.

Two major problems associated with storing dangerous commodities in warehouses are the transient nature of the goods and the constantly varying stock levels of the different materials. These problems are apparent in facilities owned and operated by manufacturers and distributors as well as in those operated by third parties (leased facilities). It has been discovered that often the layout of stock is not classified or segregated. Moreover, information on stock materials, qualities, or types is not readily available.

Storage problems are complicated by the existence of many different kinds of operations, each having varying levels and types of stock. The American Trucking Associations (ATA) has indicated that it is essential to understand that a truck terminal handling general freight is not the same as a warehouse handling general freight, and that one standard cannot appropriately apply to both types of operations. The ATA argues that although there may be peak periods during which significant amounts of freight may be present, such periods are short and requirements for costly provisions to deal with hazardous materials are not warranted.

If it is important for producers and distributors of dangerous goods to maintain adequate records on current levels and types of stock, then this must also apply to third-party warehouses. Third-party warehouses are a problem because these storage sites are not directly under control of chemical producers. Economics influences whether a company should construct its own storage building or lease public facilities. Therefore, it is possible for some firms that ship and store dangerous goods to do business at a distance from their products.

The principle of segregation of materials is important. Because this principle applies to third-party, or public, warehouses handling a varying level of inventory and materials, it appears that companies supplying the products would also have to provide even general product information. However, this does not always happen. Numerous problems have been encountered in the handling of dangerous goods, for example, inexperienced and unwary warehouse personnel have been in contact with substances about which they have no knowledge. This research indicates that only the larger chemical producers and distributors conduct adequate safety training programs for their employees.

The lack of information on handling and storing dangerous goods, from operations and training perspectives, is evident in the need for a proper flow of accurate details--starting from the supplier--about the hazard potential of the product. Without reliable information from the supplier, it is difficult for warehousers to develop a comprehensive storage layout with a plan for emergencies based on the degree of hazard for the various products.

The Saskatoon Emergency Measures Organization explained that foodstuffs are often stored next to dangerous goods without consideration of the multiple dangers involved. They also observed that there are several products that, while coming under the description of dangerous goods, do not require special packaging or restrictive containers. It was suggested that these products are often handled in an unsafe manner and stored under unsafe conditions. The data and literature indicate a situation in which many firms that are engaged in storage of dangerous goods are unaware of the nature of the products they are handling, and are unaware of the concepts of separation and segregation of materials except for the most common products.

An additional problem related to the design and construction of a facility that will store hazardous substances is land use. Land use is less of a prob-

lem when trying to situate new facilities in compatible locations than when dealing with encroachment of sensitive land uses on existing warehouses. For example, the new Canadian Industries Limited (CIL) Terminal Avenue plant in Vancouver, British Columbia, was originally located near the Canadian National Railways (CNR) terminal, where its only neighbor was Canada Packers, situated at a safe distance. Today, the CIL plant, regarded by some as a model facility, is surrounded by many sensitive commercial and residential properties. Terminal Avenue is now a major thoroughfare, and the new Automated Light Rapid Transit (ALRT) line has an overpass along this route leading to the Expo '86 site. There is some concern by the Vancouver Fire Department that a chlorine leak from the plant could affect commuters, workers, and residents of the area.

Also, it is evident that in many instances there is little established liaison between suppliers and warehousers and the local fire departments. This is supported by the data, which indicate that many municipal fire departments have little or no knowledge about facilities that store dangerous goods in their communities. As a result of the Salford incident in Great Britain, local authorities began a special investigation of the use of industrial and commercial premises. They found more than 100 previously unknown installations at which chemicals were likely to be stored.

One reason it can be difficult to identify warehouses storing hazardous substances is that the warehousers themselves are unaware that these goods are in their inventory. The Mississauga Fire Department stressed that numerous dangerous situations are found during normal inspections. Dangerous goods have been found in facilities in which sprinkler systems have been installed to minimum standards for general merchandise. It is a misconception in the warehousing industry that because the building has a sprinkler system and the required fire extinguishers, this is sufficient protection for any commodities that might be stocked.

Fire departments face the task of providing fire protection not only to the producers, distributors, and keepers of dangerous commodities, but also to adjacent industries, commercial properties, and residential properties. The tasks faced by fire departments in providing protection to warehouses and adjacent properties are sometimes hindered by poor access to a site, inadequate facilities and layout, and lack of information on stock classification and segregation.

The Mississauga Fire Department also observed that few fire departments have the resources to cope with a major warehouse fire and therefore rely heavily on the buildings' protection systems to control fires. The North Vancouver Fire Department suggests that protection requirements for dangerous goods are dependent on the hazards and classifications of the stock. If the products and the protection do not match, a fire will be almost impossible to extinguish.

Currently, there are no requirements for roof venting of major warehouses and terminals. There have been several incidents in which a fire was in progress in remote areas of a building, and the structure rapidly filled with smoke and fire gases. In structures with few windows and doors, ventilation is a major problem for fire fighters.

No Storage Standards Exist

Research to date has found no single document in Canada that addresses the design and operation of warehouses or transport terminals in which packaged dangerous goods are stored. There are, however, a multitude of national acts, regulations, and codes that deal with related factors, such as the packaging and labeling of dangerous goods, operator training, fire prevention, transportation, and working conditions. Other codes and regulations address certain classes of dangerous goods and not others. Nothing has been found that specifically relates to the storage of multiple packaged dangerous goods in Canada.

None of the Canadian provinces or territories reported use of existing codes or regulations that specifically address the problem of storing packaged dangerous goods. The most relevant and widely adopted document is the National Fire Code of Canada (NFCC) (2). With the exceptions of Prince Edward Island and Saskatchewan, all provinces and most municipalities use various editions of the NFCC in whole or in part.

Current provincial controls reflect the variety of statutes and regulations that address the safety of workers and the public, as well as the protection of the environment. Each province relies on a collection of legislative provisions to ensure safety in dangerous goods warehouses and transport terminals. In general, the most relevant provisions represent five major groups:

1. Building codes,
2. Fire codes,
3. Occupational health and safety regulations,
4. Environmental protection measures, and
5. Dangerous good controls.

It is apparent that most Canadian municipalities have adopted building and fire codes that mirror provincial codes and those of the National Building Code of Canada (NBCC) (3) and the NFCC. Fire and building codes are usually the responsibility of the municipalities, and will vary to some degree from place to place. Municipal building commissioners in Ontario, for example, have jurisdiction over building codes that regulate the construction of storage facilities, but must comply with minimum requirements of the Ontario Building Code.

Significant information on the storage of dangerous goods was received from important contacts in the United States. Although there is no single document that addresses design and operation factors of warehouses and terminals that store dangerous goods, there are several excellent sources that could be used to prepare such a document.

Model building codes in the United States contain requirements for structures that are occupied by hazardous materials (Group H); these codes affect building construction, height and area limitations, protective devices, and restrictions on allowable quantities of hazardous materials. For example, Section 305.3 of the Basic Building Code of the Building Officials & Code Administrators International provides a tabular listing of the regulations dealing with high-hazard buildings (4). Similar information is contained in the Uniform Building Code of the International Conference of Building Officials and the Building Code of the Southern Building Code Congress International. The U.S. government generally does not issue regulations concerning the construction and operation of warehouses, other than those regulations involving employee safety. The model building codes are, however, available for adoption by agencies at the state, county, and local levels.

Several federal statutes address the transportation and handling of hazardous materials in the United States. The most relevant is the Hazardous Materials Transportation Act, which authorizes the Department of Transportation to issue regulations

concerning the transport of hazardous materials. The Toxic Substances Control Act empowers the Environmental Protection Agency (EPA) to regulate designated chemical substances. Most of EPA's control activities, however, take place under the Resource Conservation and Recovery Act, which requires EPA to regulate hazardous wastes.

The most commonly referenced codes pertaining to safe handling and storage of dangerous goods are the National Fire Codes, a registered title of publications by the National Fire Protection Association (NFPA). The NFPA has developed voluntary consensus standards and industrial practices that involve a large number of dangerous goods. These are updated and compiled annually in a multivolume set of National Fire Codes (5).

The NFPA publications contain numerous practical recommendations and standards that could be applied to warehouses and transport terminals in which dangerous goods are stored. Storage and handling of several classes of goods are specifically addressed. The NFPA standards also consider the design and construction of motor vehicle terminals, freight terminals, and general indoor storage facilities. The codes do not, however, address the storage of all packaged dangerous goods or the multiple storage of incompatible materials. Design guidelines for motor freight facilities do not specifically consider the hazards inherent in storing dangerous goods.

Recently, there has been a significant movement among state and local governments in the United States to control storage of dangerous goods. Most of the effort to date has focused on disclosure requirements in which businesses must report the types and quantities of hazardous materials stored on their premises. Eight states have already passed legislation requiring disclosure, and another 20 states are considering similar bills. Colorado, for example, requires businesses storing significant quantities of hazardous materials to report types and amounts to the State Department of Health and a local emergency response authority. Response agencies such as local fire departments may inspect business premises at any time.

The storage of hazardous substances in the United Kingdom is guided by a complex array of legislation, codes of practice, and guidelines. The principal piece of legislation dealing with health and safety in the workplace is the Health and Safety at Work, etc., Act of 1974 (6). This legislation does not contain detailed requirements, but instead allows specific regulations to be made, and provides for the publication of approved codes of practice.

Under the Health and Safety at Work Act, each occupier or owner of warehouse facilities needs to ensure that he has knowledge of the substances that are stored, their hazards, and the necessary safety precautions to be taken. Fire Certificates are also required and are issued under the Fire Precautions Act of 1971. Certain facilities are designated as "special premises," certified under the Fire Certificates (Special Premises) Regulations of 1976.

A warehouse that has sufficient quantities of hazardous substances many be defined as a "hazardous installation," and the Notification of Installations Handling Hazardous Substances Regulations 1982 will come into effect. For hazardous materials that are transported by road, the Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981 will apply.

The lead agency for control of dangerous goods in the United Kingdom is the Health and Safety Executive (HSE), established in 1974 by the Health and Safety at Work, etc., Act. HSE issues regulations and publishes guidance notes and codes of practice affecting the work environment.

As a result of several serious explosions and fires in U.K. warehouses in recent years, HSE has specifically addressed the problem of storage of dangerous goods in warehouses. In 1983 HSE participated in a 1-day conference in Manchester, England, with interested representatives of emergency response agencies, local governments, and chemical industries. The conference addressed three issues: safety guidelines for chemical warehouses, the training of operators, and fire protection of warehouse property (7). HSE recently prepared a Guidance Note on the storage of dangerous substances in packages, freight containers, and tank containers.

Much of the U.K. legislation is affected by decisions made in the European Economic Community (EEC). Concern has been expressed recently in the United Kingdom and within the EEC about storage of dangerous goods, particularly in warehouses. Currently, various aspects of U.K. legislation are being reviewed and revised.

Several international organizations and foreign governments reported numerous pieces of legislation and guidance dealing with dangerous goods. In Europe, the main sources of information include the Committee of Experts on the Transportation of Dangerous Goods (and its subsidiary bodies, the Group of Rapporteurs and the Group of Experts on Explosives) and the Economic Commission for Europe Group of Experts on the Transportation of Dangerous Goods. The majority of work by these groups addresses classification of hazardous products, packaging, labeling, and control of vehicles and their construction. None of these groups has yet dealt with storage of dangerous goods or safety of storage facilities.

In New Zealand, storage of dangerous goods is covered by a number of acts, regulations, and bylaws at both federal and local levels. Permanent storage of hazardous materials is governed by the Dangerous Goods Regulations of 1974, which are currently under review and revision. The Dangerous Goods Division is headed by the Chief Inspector of Explosives, who is responsible for licensing premises for storage and use of dangerous goods. Local authorities operate as licensing bodies under the Act. Similar legislation exists in Australia under the New South Wales Dangerous Goods Act, 1975.

Lack of Uniformity in Industrial Practices

Industrial safety practices in Canada, the United States, and elsewhere in the western world vary, depending on the following factors:

- Type of operations;
- Size of operation;
- Location or site;
- Building, fire safety, and labor regulations;
- Insurance standards;
- Local bylaws and ordinances;
- Economics; and
- Industry commitment

Add to this list varying stock levels of a wide range of dangerous goods and it is not difficult to see why there is no uniformity of practice in the industrial sector.

Because specific guidelines are lacking, industry must take on the responsibility of developing specific standards to suit situational problems. As an illustration of the complex problems presented by existing codes that directly affect the design and construction of storage facilities for dangerous goods, the following steps outline a procedure followed by a Canadian chemical manufacturer when undertaking a major building project:

1. Contact a reputable insurance consultant or authority on NFPA regulations regarding fire codes, sprinkler, and ventilation systems.
2. Consult with the local or municipal fire chief to discuss type of alarm system, sprinkler system, or combination of the two to be installed, as well as city water pressure.
3. Refer to the NBCC to verify that the correct type of construction, equipment, electronics, and so forth be used.
4. Verify that all existing municipal and provincial codes regarding construction and design are adhered to.
5. Consult with other manufacturers and suppliers for type of equipment and machines, requesting information on the recommended codes, for example, explosion proof, Classes I, II, III.
6. After documentation is prepared on each of these five points, submit final designs for construction to engineers for review.

In general, chemical companies follow production standards designed by engineers relative to a given process. This practice is also true of responsible distributors and warehousers of dangerous commodities for cases in which adequate product information is available. Most of the larger enterprises associated with the chemical and petrochemical industries conform to existing codes, regulations, and bylaws--particularly those companies that have a high public profile. According to several of these large Canadian firms, it is the small, unobtrusive operator who is more likely to circumvent regulatory requirements. With respect to the quantity of dangerous goods stored at a given facility, current limitations are decided by the size of the structure and the dictates of the marketplace.

Several major Canadian and U.S. chemical firms supplied details on safety practices currently employed on a individual basis in Canada. Although there is no uniformity of practice in the industrial sector, many of the private standards far exceed those required by existing legislation. One of the largest international chemical producing firms in the world (the company chooses to remain anonymous) implements its own Fire Protection Engineering Standard. The standard provides fire safety and fire protection guides to be used in (a) the design, construction, and evaluation of buildings for occupancy as warehouses owned or leased by the company, and (b) the evaluation of public warehouses used for storage of company-owned materials. The company stresses that some flexibility in this standard is required to meet various business needs.

Those in industry who have adopted stringent practices have done so because (a) safety is good business, and (b) under existing codes and regulations, insurance industry standards require compliance with a minimum standard of safety, although the insurance industry had not developed specific guidelines for storing dangerous goods in warehouses and terminal facilities. The process of preparing industrial practices is time-consuming, expensive, and produces variable results. Moreover, there is little information sharing on this subject among business competitors; consequently, those practices that have been developed lack uniformity.

CONCLUSIONS

The conclusions from our research on the question of storing packaged hazardous materials are summarized here. The authors believe that a code of practice is needed in Canada, and offer the following six reasons why:

1. Dangerous goods require special attention.
2. Designers and officials rely on published standards.
3. No single source of standards exists for storage of dangerous goods.
4. Existing codes are insufficient in providing guidance.
5. Inconsistencies in standards lead to unsafe conditions.
6. Public safety is threatened.

Dangerous Goods Require Special Attention

The unique characteristics of dangerous goods require that they be given special attention in the design and management of transport terminals and warehouses. Because of their nature, dangerous goods may be inappropriate materials to store in the same manner as general freight items, such as furniture, business equipment, or household goods.

The hazards of handling and storing dangerous goods are not readily apparent to facility operators, workers, response personnel, or the public. This is especially true for packaged goods transhipped through third-party premises where contents are largely unknown. Certain dangerous goods can quickly turn a minor accident into a major disaster by causing an explosion, fire, or toxic hazard. In addition, the effects of combining incompatible commodities can be significantly greater than the effects of separate accidents.

Adverse consequences from dangerous goods incidents can spread quickly and uncontrollably to neighboring buildings and sections of the community in which unprotected property and populations are threatened. Correct emergency response procedures vary for different materials; using water in firefighting may be appropriate in one case and disastrous in another.

As demonstrated in a number of recent catastrophes, the design and function of the storage building itself can significantly affect the hazards posed by dangerous goods. An open-flame boiler in the basement of one warehouse, for example, was responsible for igniting a damaged propane tank in Buffalo, New York, in 1983. The resulting explosion killed 6 persons and injured 70 others (8). The potential hazards of dangerous goods must be acknowledged and considered in design and operation to preserve safety in interim storage facilities.

Designers and Officials Rely on Published Standards

To assess the hazardous aspects of dangerous goods and to apply this knowledge, technical expertise is needed. Summaries of state-of-the-art knowledge about safety aspects in construction are usually published for general use as codes of practice, standards, and regulations. Businesses and public agencies concerned with the storage of hazardous materials rely on published codes to evaluate the safety aspects of proposed or existing operations.

At various times in the life cycle of a building, codes may be vital to the work of industrial designers, building owners and operators, employees, insurance representatives, municipal building officials and fire departments, occupational health and safety officers, and those responsible for the resale or demolition of the building. One of the architect's first tasks is usually to assemble and review federal, provincial, and local regulations and bylaws pertaining to the building and its use.

Government officials responsible for preserving the public interest and safety will use published guides such as the NBCC and the NFCC to review pre-

liminary drawings and to conduct mid- and post-construction inspections. Insurance companies use both public and private sector standards to analyze risks, review construction plans, and assess protection measures afforded to dangerous goods storage properties. Standards are such a vital tool in ensuring safety measures that some private sector representatives have gone to great expense to fill perceived gaps in existing public codes.

No Single Source of Standards Exists for Storage of Dangerous Goods

Despite the existence of many federal, provincial, and local regulations currently in Canada, there is no single collection of standards that addresses the problems of storing packaged dangerous goods. There are many requirements on aspects tangential to the problem; such as requirements for packaging, labeling, worker safety, operator training, site drainage, and emergency response measures. No code of practice, however, yet exists that addresses the key issues that are unique to storing dangerous goods.

Currently, a firm that wants to design a storage facility for hazardous materials must consider more than a dozen federal, provincial, and local regulations. Building codes vary from province to province and among municipalities. Provincial labor departments have certain requirements that must be met in the construction of a facility. Regional and local municipalities issue building permits, and the detailed design must meet their requirements. The NFCC is used almost across the country, but each municipality may have specific requirements.

Insurance companies also have an interest in consolidating regulations. Currently in Canada, most insurance companies rely on the NBCC, the NFCC, the NFPA standards, Factory Mutual Research Corporation standards, and Industrial Risk Insurers standards.

Existing Codes Are Insufficient in Providing Guidance

When viewed as guidance documents for designing and managing storage areas for dangerous goods, existing federal standards exhibit significant gaps in some respects, duplicate requirements in others, and generally fail to address principal issues of concern. Most of the Canadian-designated dangerous goods are addressed by the NBCC, the NFCC, the Explosives Act, and the Atomic Energy Act. There remain, however, a significant number of individual commodities that are not covered. Corrosives, for example, are not addressed by any existing storage regulation in Canada. Neither the Canada Dangerous Substances Regulations (9) nor the Transportation of Dangerous Goods Regulations (1) requires specific design or operation features for storage facilities.

Full and fairly complete treatment is given to flammable and combustible goods, as well as explosives, toxic substances, and radioactives. No standards, however, address in sufficient detail concern about storage of multiple incompatible dangerous goods. No guidelines address the operation of terminals and transit warehouses where at peak periods considerable freight may be present for short periods of time.

Existing codes and standards also fail to address the important issues implicit is storing packaged dangerous goods, such as encroachment, expansion of storage area, changes in commodity classes, resale of facilities, disposal of waste from housekeeping maintenance, and other related concerns. Some requirements are noticeably vague and open to interpretation, and there is little guidance on which to base decisions. Among the fire protection codes, for example, there is sometimes no clear guidance whether
property or lives are the main items to be saved.

Inconsistencies in Standards Lead to Unsafe Conditions

To accomplish an adequate review of relevant standards, business firms and public agencies must not only assemble the appropriate documents, but also must be able to interpret vague requirements and fill gaps in technical information. For cases in which interpretation or supplement of sketchy regulations is necessary, architects and building officials may rely on their own judgments or those of expert consultants. In many cases, decisions are made with an incomplete technical knowledge of and concern for the hazards of dangerous goods storage. One misconception in the warehousing industry, for example, is that a sprinkler system and the required fire extinguishers are enough to protect any commodities that might be stored.

More common is the practice of strict interpretation of published codes and regulations. The private sector may ignore gaps in existing standards and provide only those safety measures required by law. Fire protection in most warehouse facilities, for example, includes sprinkler systems installed to minimum standards for general merchandise. The actual materials stored in some cases have been found to include whole warehouses of motor oil, rubber tires, plastic materials, solvents, and paints.

Although this research has not been comprehensive on this point, it is apparent that relatively few chemical and transportation firms spend significant effort in developing their own standards. In the absence of government controls, some companies develop codes of practice on an individual basis. Such standards are developed to serve the company's interests but, because of the competitive nature of the private sector, they fail to share their knowledge and experiences with other firms.

Several respondents to the survey suggested that, based on their experiences, more problems with storage of dangerous goods arise from the disregard of the regulations than from inadequacies in them. One journal article discusses the fringe element of the chemical transportation industry--usually smaller firms that lack the resources, manpower, or interest necessary for implementation of safety measures (10). The inconsistencies in existing regulations provide what may be seen as realistic justification for failure to provide comprehensive safety measures.

The transient nature of the merchandise passing through general warehouses and terminal facilities makes inspection and control difficult. Several fire departments reported finding dangerous situations during normal inspections, but when they later returned to initiate action, the subject material was no longer stored in significant quantities.

In summary, observed deficiencies in current codes place a severe hurdle between the operators of storage facilities for dangerous goods and acceptable practices that ensure public and environmental safety.

Public Safety Is Threatened

The end result of the current system of controlling storage of hazardous materials is the increase in actual and perceived threat to the public in Canada. Reports of dangerous goods incidents, many of which involve packaged commodities at storage or transport facilities, communicate the reality of these hazards.

Without consistent and complete standards for storage of hazardous materials, it is difficult for government officials at all levels to successfully protect the public from unwise development and insufficient preparation. Without enlightened and specific codes of practice, the private sector is forced to either ignore deficiencies or heavily invest in developing their own standards. Usually, concern for public protection takes second place to day-to-day economic requirements. Problems repeatedly arise from this conflict between goals of the public sector and those of the private sector.

In conclusion, the authors believe that sufficient evidence exists to support a need for a code of practice for storing packaged dangerous goods. The technical knowledge required for safe design and management is not conveniently assembled in usable and widely published codes in Canada. No single set of standards exists, and current regulations are insufficient in addressing the issues and safety concerns of storage. The lack of specific codes and statutory requirements places additional hurdles between the private sector and the public's right to safety.

RECOMMENDATIONS

Efforts to prepare a code should proceed with specific goals and objectives. The overriding goal of a code of practice should be to promote safety in the transportation of dangerous goods, specifically during the storage and handling of packaged dangerous commodities. With this goal in mind, the following objectives for a code of practice are offered for consideration:

1. To consolidate and clarify current regulations to eliminate confusion caused by inconsistent, vague, and duplicative requirements.
2. To fill gaps in existing codes to synthesize a comprehensive and specific set of standards that addresses all matters pertaining to safe storage.
3. To aid industry in adopting workable, economic, and safe practices in the design and operation of interim storage facilities, and to reduce for industry the costs of regulatory compliance and safety provisions caused by multiple, diverse, and inconsistent requirements.
4. To improve the effectiveness of public officials responsible for public safety, particularly at the local level.
5. To promote uniformity in dangerous goods regulations and reduce the need for costly duplication of effort by both private and public sectors.

The existence of a code of practice on the subject will also serve other related goals. It will communicate the importance of considering design and safety practices for locations where dangerous goods are stored. A code of practice would provide a vehicle for government and industry cooperation in preparing pragmatic and effective standards. The most direct means of influencing safety necessitates recognizing and working within established procedures for design and management of target facilities. Such procedures involve two principal groups to which a code should be addressed: (a) chemical and transport industry representatives, and (b) building and fire prevention officials, primarily at the local level.

It is important that owners and operators of warehouse and terminal facilities be aware of the factors that should be considered in the interim storage of hazardous materials. The Chemical Industries Association of London, England, has suggested a number of factors for warehouse keepers and owners of hazardous materials to consider (11):

1. Safety information about the materials, including data on containment, handling spillages, and the behavior of materials in a fire.
2. The risk associated with the physical, chemical, and biological properties of the commodities, taking into account the quantity stored.
3. The compatibility of hazardous materials and the extent to which they should be separated from each other.
4. Potential consequences of accidental releases of dangerous goods on nearby population, property, and environment.
5. The layout of the warehouse facility, its design, construction, location, and relation to adjacent land use.
6. Measures necessary to control inspection, receipt, storage, and dispatch procedures, including checking incoming packages, using special equipment, and controlling support operations.
7. The availability of safety equipment and materials required to contain or neutralize releases.
8. The involvement of public emergency services and the establishment of response procedures and communication during emergencies.
9. The training of safety personnel and warehouse operators, including first-aid instruction.
10. Applicable legislation and relevant codes of practice.

The Transport Dangerous Goods Directorate of Transport Canada has embarked on a three-phase process to develop a code of practice for warehousing packaged hazardous materials. The first phase was a discovery process that provided background material for this paper. The second phase is currently under way to produce a single set of guidelines for the safe warehousing of dangerous goods. Because a formal code of practice may take years to develop, the guidelines will provide interim aid to those interested in the design and operation of new warehouses and in the renovation of existing storage facilities. Because the guidelines are intended for general application, they will not present detailed technical information, but instead will underline the principles of safe storage practice.

A tentative outline of the guidelines has been prepared to identify the elements that should be considered in the construction or renovation of a structure in which packaged dangerous goods may be temporarily stored. The document will also address factors that are important in the safe operation of such facilities.

Outline of Guidelines Document

1.0 Introduction
- 1.1 Background
- 1.2 Application
- 1.3 Scope
- 1.4 Definitions

2.0 Factors Considered and Key Responsibilities
- 2.1 Factors Considered
- 2.2 Key Responsibilities
  - 2.2.1 The Supplier or Owner of Dangerous Goods
  - 2.2.2 The Warehouse Manager
  - 2.2.3 The Warehouse Foreman
  - 2.2.4 The Warehouse Employee

3.0 The Hazards of Dangerous Goods
- 3.1 The Principles of Dangerous Goods Storage

Basic Principles of Warehousing

Some basic principles of safe warehousing of dangerous goods are evident. The various hazardous properties of chemicals (e.g., flammability, toxicity, and corrosivity) should be noted and, if possible, inventories of an incompatible type minimized in a single location. Care should be taken in the layout of the warehouse to ensure that adjacent stocks do not interact under emergency conditions to produce compound risks. Liquids should be separated from solids and gases when the control measures related to each of the different materials vary significantly.

Early detection of spills and leaks is important in minimizing risks. Operators should always take the proper precautions before attempting to contain an incident. In-house training of personnel should concentrate on formal safety guidelines in the workplace. Training should include practical demonstrations of potential hazards, proper handling practices, use of equipment, and correct preventive and emergency response procedures to follow. To perform these demonstrations, it is necessary that a proper product information flow be maintained. An emergency plan should be prepared.

Building construction should be noncombustible with blowout panels and adequate dyking to contain the products. Adequate roof vents aid the expulsion of smoke and gases. Spills or leaks of chemicals having a vapor explosion hazard can be quickly vented to the atmosphere without danger of triggering an explosion if proper equipment is provided. Fire protection can be provided by a number of systems, including automatic sprinklers. Well-designed sprinklers can reduce overall product damage by limiting water application to only the affected areas of the warehouse. Fire protection can be enhanced by providing adequate emergency access to the storage structure. Three aspects of site location should be considered: prevailing winds, population density, and existence of other industries in the immediate area. Care should be taken in protecting the environment, particularly in avoiding accidental discharges into aquatic areas.

Knowledgeable respect is considered to be most important in handling dangerous goods. Respect can be gained by minimizing avoidable risks, instituting good documentation procedures, training personnel in safe practices, and ensuring that products are well labeled. A high standard of housekeeping should be maintained.

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