



(Reprinted from Activities Report, Vol. 5, No. 1,
Published by The Research Development Associates,
Food and Container Institute, Inc.)

PACKAGING CHEMICAL SUPPLIES OF A HAZARDOUS NATURE

In the title of the General Supplies, Clothing, and Equipage Division of the Institute's Container Laboratories, the term "General Supplies" denotes a classification that in itself covers a multitude of categories—including Household Appliances, Furniture, Office Supplies and Equipment, and Hazardous and Dangerous Commodities, to mention a few—all considered necessary for the general maintenance of the serviceman. It is with the packaging and packing of the last-named category—Hazardous and Dangerous Commodities—that this article is concerned. Here indeed is a complex problem, for not only must hazardous materials be protected from the myriad hazards of the military supply line, but the supply line itself and its personnel must be protected against them. The author, after describing the "nature of the beast," explains how this twofold objective is accomplished.

Packaging and packing chemical supplies for the Armed Forces emphasizes the importance of utilizing specially developed containers that can withstand the punishment of the military supply lines out to the final point of use, wherever it might be during this age of global warfare. These containers are built to provide the following qualities:

1. Ability to withstand rough handling which includes resistance to vibration, compression, and shocks of impact;
2. Ability to protect contents from effects of water-vapor, water, and the extremes of high and low temperatures;
3. Utilization of packaging and packing materials and containers which are feasible, practical, and readily available from industry;
4. Ability to fulfill the military requirements for the performance and end use of the container in the field operations of the Armed Forces.

This last involves many considerations, a few of which are:

- a. Container size and quantity of contents for issue to the using elements in the field;
- b. Requirements for easy opening and multiple re-use;
- c. Requirements as to size and shape for convenience in handling and degree of fragility to prevent breakage;
- d. Requirements as to cleanliness of contents and non-contamination of other supplies;
- e. Requirements of high altitude conditions encountered in air transport where increased internal pressure is exerted on containers and particularly the closures;
- f. Requirements of compatibility with materials handling equipment encountered along the supply lines.

In addition to the above-named essential considerations for containers employed in packaging and packing

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ing military supplies, the packing of chemical supplies demands the additional consideration of protection to human life and property during shipment and subsequent storage. There is nothing more calamitous than to learn of a supply train or ship or supply dump going up in flames and smoke and to realize that the conflagration may have been caused by a flammable or explosive chemical improperly packaged. Not only property but life itself may be the penalty of such a container failure. Nor are such obvious combustibles as gasoline or naphtha the only potential culprits. Improperly packed oxidizing materials, corrosive liquids, compressed gases, or flammable solids are just as likely to cause fires which may vitally affect the success of a military operation.

oops! there goes gus!

Shipment of dangerous materials through military supply channels will always involve some personnel at various points who are not adequately informed as to the dangerous nature of the chemicals and the proper methods of physical handling of the packed chemicals for shipment and storage. This fact is an additional basis for using containers which have the extra and additional factor of safety built into them as a safeguard and protection to minimize the danger involved. Highly informed personnel and rigid enforcement of rules and regulations are absolutely necessary, since any relaxation of attention to all safeguards will only invite disaster.

In handling and shipping dangerous material, there is always a question as to just how much danger or hazard is involved. Visual inspection generally determines that acceptable, suitable, and standard containers are being used and as such they are accepted as being sat-

isfactory and safe. However, behind this assumption is the confidence that the procurement documents specified the *correct container* with the *best and safest closures* and that the shipper met all the requirements of the specification and performed his duty in following proper filling procedures for containers, especially, in reference to outage and pressure allowances, and effected *tight sealing* of all closures.

Personnel assigned to handling shipments and cargoes are guided by the following rules:

1. All packages and containers are handled with the greatest care to avoid dropping, jarring, breakage, or spillage.
2. Use of hooks is not permitted.
3. Placement of cargo in sunlight should be avoided.
4. Placement of cargo only in well ventilated areas, wherever possible.
5. Certain materials, as indicated by freezing points and proper markings, are to be protected from freezing temperatures.
6. Placement of packages of dangerous materials away from sources of any heat, flames, sparks, and away from materials which are not compatible and which, if they came in contact, would cause combustion.

Storage and Loading compatibility charts and regulations of the various classes of dangerous and hazardous chemical materials are issued by the Interstate Commerce Commission. The instructions are based on the facts that the materials are packed in the containers specified by the regulations. These regulations prescribe safe distances for stowage between different classes of chemicals and include restrictions on intermingling or mixing cargoes of chemicals of more than one classification. Essentially the following conditions are stipulated:

1. Oxidizing materials and flammable solids are not to be mixed with or placed near corrosive liquids or flammable liquids.

2. Corrosive liquids are not to be mixed with poisonous materials.

3. Explosives, fuels, oxidizers, and chemical munitions are to be stored and stowed in accordance with the Loading and Storage chart of Explosives and Other Dangerous Articles (contained in Freight Tariff No. 8, ICC Regulations).

a brief "dictionary of danger"

Dangerous materials which must be handled with special consideration are classified as follows:

Dangerous Material.¹ Any material because of its inherent qualities or properties is considered dangerous when it is flammable, corrosive, combustible, explosive, toxic, radioactive, magnetic to a high degree, or an oxidizing agent.

Explosives. Any material which will produce a sudden instantaneous combustion with a destructive, violent expansion of air.

Flammable Liquid. Any liquid material which will give off vapors capable of combustion at or below a temperature of 80 degrees Fahrenheit.

Flammable Solid. Any solid substance or material which is not clas-

¹ A consideration in packing liquids is to provide for the necessary outage (expansion room) in the container which is a requirement for various flammable liquids. The container must not be entirely filled as sufficient, vacant space must be provided for expansion under temperature rises thus preventing spillage through forcing closures to open or bursting of the containers. The outage is based upon the thermal coefficient of expansion of the liquid and the temperature of the liquid when the container is being filled. The outage provides for expansion of the liquid within the maximum normal temperature rises.

sified as an explosive, and which during normal transportation is likely to cause fires through friction, through absorption of moisture, through spontaneous chemical changes or through retention of heat resulting from the manufacturing or processing of the material.

Oxidizing Material. Any substance which due to oxidation may cause fire when in contact with organic matter or with other chemicals.

Corrosive Liquid. Any liquid, either acid or alkaline caustic liquid and any other corrosive liquid which, when in contact with living tissue will cause severe damage to the tissue by chemical action, or in case of leakage will damage or destroy other cargo by chemical action or is liable to cause fire when in contact with organic matter or with other chemicals.

Compressed Gases. Any material or mixture of materials having in the container either an absolute pressure exceeding forty pounds per square inch at 70° F. or an absolute pressure exceeding 104 pounds per square inch at 130° F., or both. Compressed gas also is any liquid material which is flammable, having a Reid vapor pressure exceeding 40 pounds per square inch, absolute pressure at 100° F. Flammable compressed gas is a compressed gas in which a mixture of 13% or less by volume with air forms a flammable mixture or the flammability range with air is greater than 12% regardless of the lower limit.

Poisonous Materials. Poisonous materials can be in the form of gases, liquids, or solids and are of such a nature that their contact with the body, ingestion or inhalation endangers life or results in damage or disturbance to body functions with an adverse effect on well being and health.

Radioactive Materials. Any material or combination of materials which spontaneously emits ionizing radiation is radioactive.

The specifications for shipping containers contained in Tariff No. 8, published in Interstate Commerce Commission Regulations for Transportation of Explosives and Other Dangerous Articles by Land and Water in Rail Freight Service and by Motor Vehicle and Water are the minimum requirements for packaging and packing chemicals of a dangerous nature. However, additional requirements are specified for chemical supplies for the Armed Forces because of the above normal shipping hazards expected and the exacting performance demanded of the containers to lessen the danger attendant in the shipment of these chemicals on personnel, property, and equipment.

Special consideration is always given to the proper marking of dangerous materials with the correct labels which draw attention to the hazardous lading. These requirements are also contained in the Interstate Commerce Commission Regulations. The labels are required to be placed conspicuously on the shipping container which identifies the contents as to class of material so that care will be exercised in the handling of the chemical supplies.

The labels are required to be of a diamond shape, measuring four inches on each side, with printing inside a border on each side. The prescribed colors for typical classes of dangerous chemicals are:

Flammable liquids — Bright red, black printing, and border.

Flammable solids and oxidizing materials — Bright yellow, black printing and border.

Acids and corrosive liquids— White label, black printing and border.

Flammable gases — Bright red, black printing and border.

Non-flammable gases — Bright green, black printing and border.

Poison gases and poisonous articles—White label, red printing and border.

Explosives — Bright red, black printing and border.

drums, barrels, pails

Steel drums, barrels, and pails are extensively utilized in packing chemical supplies as they are readily available from industry, are economical, and provide to a high degree the desired safety factor during shipment and storage.

Steel drums are readily available from the steel shipping container suppliers, and manufacturers as the 18-gage 55-gallon drum and the 5-gallon pail represent the major proportion of the production, and as such are the sustaining production items of the industry. For military purposes the drums are required to be grease-, dirt-, and scale-free, and rust-inhibited. This is accomplished by spray cleaning the steel sheets followed by a rust-inhibiting treatment comprised of a water-insoluble zinc phosphate coating. To avoid loss of the coating along the welded seam of the body of the containers, it is necessary to apply the protective coating after fabrication rather than to the flat sheets prior to fabrication.

The 18-gage metal drums are used for single trip shipments while 16-gage and occasionally 14-gage drums are used where multiple re-use of drums is a factor or where the chemical supply item is considered extremely dangerous. The drums are of either closed top or full removable head types with gaskets required for plug and flange or bolted cover closures. Gaskets are always required for the lug covered steel pails. To ensure well made and leakproof steel

containers, air pressure and hydrostatic and drop tests as applicable are prescribed for the containers.

Special consideration is given to obtaining specific interior and exterior coating for steel containers. Interior coatings are required for protection to the container against attack by the specific product being packed, and also to ensure that the product being packed will not be contaminated by the coating being used or by the container.

For extremely corrosive liquids where coatings provide inadequate protection for the interior surfaces of metal drums, the drums are required to be provided with suitable special linings such as rubber, monel, lead, stainless steel, and aluminum.

A baked-on rust-inhibiting enamel is required to be applied to the exterior surfaces of the metal containers to prevent corrosion and deterioration of the metal surfaces from exposure to all types of adverse weather conditions.

cans

Cans which may be round, oval, rectangular or oblong in shape, made of tinfoil or terneplate, and which may range from two-ounce to five-gallon in capacity are employed to package chemical supplies as these cans are adaptable to many classes and types of supplies. These cans are required also to have protective interior coatings, where the cans are used to package materials which have a deleterious effect on the metal, and the protective exterior coating of rust-inhibiting enamel. Closures of the cans must be liquid tight or leakproof and are effected by one of the following methods: hermetically sealing of tops with solder; screw cap with the cap provided with a liner pad to effect a tight closure; snap-on closure with the cap provided with a liner pad

and an overseal metal band which is crimped in place; metal or plastic spout fitted with a threaded cap provided with a liner pad; multiple-friction plug closure; and special closures of lever type snap-on or quarter-turn type closures with the caps supplied with liner pads and flexible spout closures. Closures are further protected to be leakproof by application of tight fitting inner seals which are tapped into the neck after the cans have been filled or overseals of self-shrinking plastic bands or tear-off type metal bands. Multiple-friction plug closures, after filling of the containers are spot-soldered to the rings at three equidistant points to prevent loosening of plugs as a result of rough handling. The filled cans are overpacked in fiberboard or wooden shipping containers for shipment.

In addition to packaging in suitable interior paperboard and fiberboard interior packages which are packed in wood and fiberboard shipping containers, flammable solids are packed in steel drums, fiber drums, and plywood drums. Compressed gases are packed in cylinders with service pressure ranging between 200-1800 pounds per square inch. Cylinders are required to be provided with protection caps for the valves except when the cylinders are boxed or crated for shipment or where the valves are recessed into cylinder walls so that the valves will not be subject to a blow, when dropped on a flat surface. The cylinder must be filled so that the pressure within 70°F. does not exceed the service pressure of the cylinder except under specific circumstances.

packaging in glass

Oxidizing materials may be either liquid or dry substances. Highly oxidizing and powerful liquid agents are packed in glass bottles equipped

with liquid-tight closures and protected with a secondary closure which is either of a spring type, wax covering, or tape. The bottles must be cushioned at all points with incombustible cushioning material of sufficient quantity to absorb contents of each bottle. Each cushioned bottle is packed in a fiberboard box which is overpacked in exterior wood shipping containers.

Nitrates and other oxidizing materials are packed in either metal cans and drums, fiber and plywood drums, or multiwall paper sacks. Where special provision is necessary to prevent exposure of contents to moisture, when metal containers are not used, water-vaporproof barrier materials embodying metal foil, polyethylene, or polyvinyl are built into the walls of the fiber drums and the inner plies of multiwall sacks.

The main hazard in handling corrosive liquids is the effect on humans, of the liquid or its vapors. Some corrosive liquids embody additional hazards of toxicity, flammability, and explosiveness. In filling the containers, outage requirements must be strictly complied with. All glass and other fragile containers are required to be cushioned at all points with incombustible cushioning materials such as asbestos, mineral wool, whiting, or infusorial earth. Glass bottles and glass carboys are used extensively as the preferred containers for corrosive liquids. Metal drums with special acid resistant linings are also used. All containers are required to be securely sealed employing gaskets which are not affected by the materials being packed with secondary seals applied to ensure safe closures.

The considerations involved in packing explosives, and chemical munitions materials are manifold and no discussion of them will be

attempted. The Ordnance Corps and Chemical Corps have issued regulations and manuals which cover those problems. The considerations involved and the packing requirements of radioactive materials are covered by publications of the Atomic Energy Commission, and by regulations issued by the Interstate Commerce Commission. In brief, the main consideration in packing radioactive materials whether they are liquid, solid, or gaseous, is to package the materials in suitable interior containers which are completely surrounded or placed within the proper shielding material which will lessen or minimize within safe limits the ionizing radioaction of the material.

an interesting new development

No discussion of packaging problems is complete without making reference to the possibilities of utilizing the important newly developed thermoplastic compound polyethylene. Polyethylene has a very good water and water-vapor resistance, chemical resistance, heat sealability, and low-temperature flexibility. It is a pure plastic and ages well because of its inertness. Polyethylene coated papers are being used extensively for protection against water and water-vapor in packaging many types of articles and substances. Bags made of this material are being utilized extensively in packaging dry chemicals where moisture protection and cleanliness is required. Multiwall paper bags employ inner liners of polyethylene coated papers as also do liners for drums where water resistance and chemical resistance are requisites.

Polyethylene bottles and carboys are showing favorable results when used for packaging chemical liquids. However, their relatively high cost

over glass bottles is a deterring factor for general acceptance in addition to size limitations. Tests have proven that leakproof closures of polyethylene bottles require the use of threaded caps and cap gaskets made of the same material. A very practical and ingenious application of the flexibility of polyethylene is in its adaptability to the manufacture of a flexible and retractable leakproof and tamperproof spout closure for metal containers. The spout is made from full strength polyethylene and consists of the spout with a diaphragm closure over which is a threaded cap all of the same material. The spout is clinched on the container and covered with a tamperproof outer seal made of special coated terneplate which is destroyed when removed for use. The assembled spout when clinched is required to withstand the same air pressure test as that required for the container.

Vinyl chloride copolymers and vinylidene chloride copolymers, like Saran are another class of plastics

being used to coat papers in order to provide resistance to water and water-vapor. They also have good resistance to common gases, grease, oil, and hydrocarbons. One major use of this plastic coated paper in packaging chemicals is its use as a cap liner for sealing containers liquid tight.

Perhaps the reader now has in mind the resources available for the proper packaging of the various items of supply that have hazardous characteristics. It will be agreed, no doubt, that the careful and painstaking work that has gone into properly containing these materials within "safe bounds" is eminently worthwhile. Costwise the failure of a weak container for these items can be staggering; even more important is that the casualties that could result might well mean not only the loss of combat troops but a definite depression of morale for a whole regiment.

*C. P. Klingler
Assistant Chief, General Supplies,
Clothing and Equipage Division*