

SS-H-13

HIGHWAY ACCIDENT REPORT

**ACCIDENTAL MIXING OF INCOMPATIBLE CHEMICALS,
FOLLOWED BY MULTIPLE FATALITIES,**

DURING A BULK DELIVERY

BERWICK, MAINE

APRIL 2, 1971

ADOPTED: AUGUST 26, 1971

NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D. C. 20591

REPORT NUMBER: NTSB-HAR-71-7

000002

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-HAR-71-7		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle HIGHWAY ACCIDENT REPORT. ACCIDENTAL MIXING OF INCOMPATIBLE CHEMICALS, FOLLOWED BY MULTIPLE FATALITIES, DURING A BULK DELIVERY, BERWICK, MAINE, APRIL 2, 1971				5. Report Date August 26, 1971	
				6. Performing Organization Code	
7. Author(s)				8. Performing Organization Report No.	
9. Performing Organization Name and Address Bureau of Surface Transportation Safety National Transportation Safety Board Washington, D. C. 20591				10. Work Unit No.	
				11. Contract or Grant No.	
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591				13. Type of Report and Period Covered Highway Accident Report April 2, 1971	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract Six tannery workers died from inhalation of a toxic gas formed by the reaction of incompatible chemicals mixed during the delivery of a bulk liquid chemical at Berwick, Maine. The transfer hose from the tank semitrailer had been connected to the wrong plant fill line connection. A need to identify risks existing at bulk delivery transportation/receiving interfaces was established, and an investigation recommended. The National Transportation Safety Board determines that the cause of this accident was the failure of the carrier's drivers and the tannery foreman to establish an error-free exchange of information required to accomplish the safe transfer of the cargo from the vehicle into a plant storage tank. The likelihood of this failure was increased by the absence of instructions or training in information validation procedures to be followed during such exchanges, and by the absence of markings, devices or other measures on the vehicle or tannery property which would have permitted such validation to be made unilaterally by either party.					
17. Key Words Accident, Hydrogen sulfide, Incompatible Chemicals, Communications, Transportation, Hazard, Regulation Descriptors: Berwick, Maine; Bulk Chemical Delivery				18. Distribution Statement Released to Public. Unlimited Distribution.	
19. Security Classification (of this report) UNCLASSIFIED		20. Security Classification (of this page) UNCLASSIFIED		21. No. of Pages 14	22. Price \$3.00

FOREWORD

The National Transportation Safety Board (NTSB) investigates transportation accidents to determine probable cause. In surface transportation, the Board usually elects to investigate those accidents that are catastrophic, that contain technical problems with widespread effect on safety or of national interest that demonstrate the greatest need for safety studies and corrective action.

This report of the Safety Board's investigation and analysis of an accident which occurred at the interface between transportation and an industrial facility is directed to the issue of conditions relating to that interface.

The cooperation of the Maine Department of Labor and Industry and the Maine State Police, during the Safety Board's investigation into the facts of this accident, is acknowledged with gratitude.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591
HIGHWAY ACCIDENT REPORT

Adopted: August 26, 1971

ACCIDENTAL MIXING OF INCOMPATIBLE CHEMICALS,
FOLLOWED BY MULTIPLE FATALITIES,
DURING A BULK DELIVERY
BERWICK, MAINE
APRIL 2, 1971

I. SYNOPSIS

On April 2, 1971, at Berwick, Maine, a hose used for transferring a bulk liquid chemical cargo from a motor carrier's tank semitrailer to a tannery storage tank was incorrectly attached to a fill line leading to an indoor open top tank. When the transfer began, the cargo mixed with the incompatible chemical stored in the indoor tank, resulting in a chemical reaction which generated toxic hydrogen sulfide gas. Six tannery workers died from inhalation of this toxic gas.

The National Transportation Safety Board determines that the cause of this accident was the failure of the carrier's drivers and the tannery foreman to establish an error-free exchange of information required to accomplish the safe transfer of the cargo from the vehicle into a plant storage tank. The likelihood of this failure was increased by the absence of instructions or training in information validation procedures to be followed during such exchanges, and by the absence of markings, devices, or other measures on the vehicle or tannery property which would have permitted such validation to be made unilaterally by either party.

II. FACTS

1. The Accident

At approximately 6:35 a.m. on April 2, 1971, the driver of a Chemical Leaman Tank Lines, Inc., tractor semitrailer tank motor vehicle began the transfer of a cargo of sodium hydro-sulfide from the semitrailer into a storage tank inside a Prime Tanning Company building at Berwick, Maine. Within a few minutes thereafter, at least 12 workers in the tannery were felled by a toxic gas which resulted from the mixing of the trailer cargo with an incompatible chemical mixture called chrome tanning liquor in the storage tank. The driver stopped transfer operations when plant workers were observed to be collapsing, and rescue operations began almost immediately thereafter. Six tannery workers died in the accident.

It was subsequently established that the transfer hose linking the semitrailer to the plant storage tank fill line had been connected, by the drivers at the direction of a plant foreman, to the wrong plant fill line connection.

2. The Drivers

Two drivers based at the carrier's Bridgeport, New Jersey, terminal operated the carrier's vehicle in a routine "sleeper" movement to Berwick. Both had been employed by and had driven for the carrier for over a year prior to this accident. The driver operating the vehicle upon arrival at the tannery had previously delivered one load of sodium hydrosulfide; his codriver had never before participated in a delivery of this cargo. Neither had made any prior deliveries to the tannery.

The drivers were dispatched from their terminal to pick up their load at Delaware City, Delaware, at 10 a.m. on April 1. They departed from Delaware City with their load at noon that day, and alternately drove or rested in the sleeper berth at approximately 4-hour intervals. There was no evidence of any deterioration of the driver's capabilities from lack of rest or other reasons during their trip to the tannery.

The driver reported arriving at the tannery at approximately 5:55 a.m., as workers for the 6 a.m. shift were arriving at the tannery. His codriver spoke to a tannery worker who told the codriver where to spot the vehicle for unloading. After the vehicle was spotted for unloading, both drivers entered the plant and asked for the foreman. The foreman was pointed out to the codriver who stated he told the foreman he "had a load of sodium hydrosulfide." The foreman accompanied both drivers to the unloading area and, according to the drivers, showed them where to connect the transfer hose by touching the connection to be used.

As the driver was connecting the transfer hose, the foreman re-entered the tannery. The driver attached an adaptor to the truck transfer hose to enable it to mate to the plant fill line connection designated by the foreman.

After the transfer hose was connected to the fill line, the foreman was requested to check the hose hookup, and was asked if the tank was vented and valves open, and when to start the transfer. Both drivers reported that the foreman told them they could start the transfer anytime.

The foreman then re-entered the tannery.

The driver proceeded to transfer approximately 160 gallons of the sodium hydrosulfide before the codriver noticed plant workers were collapsing inside the building; moments later the driver shut off the flow of cargo from the vehicle. The drivers, who were outside the tannery buildings, were not injured in the accident.

3. The Vehicle

The vehicle incorporated an MC-307 cargo tank semitrailer, equipped for transfer of the cargo by pressurization of the tank. The name of the cargo did not appear on the tank semitrailer. It carried the carrier's name and logo, and other markings in the carrier's regular color scheme. Its appearance was similar to one of the vehicles another carrier used to deliver bulk chrome tanning liquor to the tannery.

The vehicle functioned normally during the delivery operations at the tannery.

The carrier's transfer hoses carried on the vehicle were equipped with 2-inch threaded connections. Adaptors for connecting these hoses to various types of connections encountered at delivery points were carried by the drivers, which reportedly is a common practice for bulk chemical carriers.

4. The Chemicals

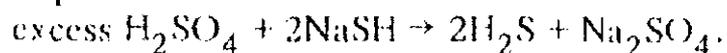
Three bulk liquid chemicals are utilized at the tannery. These chemicals are sodium hydrosulfide, sometimes called sodium sulfhydrate (NaSH), sulfuric acid (H_2SO_4), and a "chrome tanning liquor," identified as $(\text{Cr}(\text{OH})\text{SO}_4)_2 \cdot \text{Na}_2\text{SO}_4$. In solution, hydrolysis of this tanning liquor results in the release of H_2SO_4 ; the pH (or acidity) of the liquor is approximately 3. The chrome tanning liquor arrives at the plant under the trade name "Tek Chrome" in tank semitrailers.

The sodium hydrosulfide transported in the carrier's tank semitrailer was an alkaline and mildly corrosive 44% to 45% solution, with a

freezing point slightly below 60°F. This material is not regulated under Federal Hazardous Materials Regulations, 49 CFR 170-177.

The inventory of these bulk chemicals at the tannery was under the supervision of the foreman with whom the drivers spoke. Orders had been placed by the foreman for both sodium hydrosulfide and the chrome tanning liquor for delivery on April 2. At least four different common or private carriers had made recent deliveries of these two products at the tannery. Although the foreman was responsible for the inventory, three different plant employees, including the foreman, had signed carriers' delivery receipts on behalf of the tannery.

As soon as the sodium hydrosulfide flowed into the chrome tanning liquor storage vat, the materials reacted, as described by the following principal chemical reaction:



One of the reaction products, hydrogen sulfide gas, is essentially insoluble in the acidic chrome tanning liquor solution. Therefore, H₂S gas, formed during the reaction resulting from the mixing of the incompatible sodium hydrosulfide and tanning liquor, rapidly escaped from the tanning liquor storage vat into the occupied work area surrounding the vat.

Hydrogen sulfide is a toxic, asphyxiant gas. Human exposure to concentrations above 600 parts per million can be fatal within 30 minutes through respiratory paralysis. Exposure to very high concentrations is almost immediately fatal. This gas felled the exposed workers as it spread into the areas occupied by the workers in the tannery buildings.

The plant management reported that the foreman had been instructed in the hazards of these chemicals in the section of the plant in which he worked. This training was not documented. No documentation of the instructions conveyed to the person who assumed the responsibilities of the deceased foreman was available. No posted warnings of the chemical hazards were found at the tannery after the accident.

5. The Tannery

The tannery regularly received the three bulk chemicals in tank semitrailer vehicles. Each connection to which the transfer hoses from delivering tank vehicles were attached to the piping leading into the storage tanks at the plant, was equipped with a different fitting. The connection for receiving sodium hydrosulfide consisted of a plain 2-inch screwed pipe nipple, connected to a shutoff valve (from which the handle was missing). The connection for receiving the tanning liquor was a 2-inch female "quick connect" fitting. The connection for receiving sulfuric acid was a 2-inch, four-bolt, flanged fitting. None of the connections were color coded, labeled, or otherwise identified to link them to the specific products they were intended to receive. The piping for the tanning liquor was gray plastic; the other pipes were bare steel.

The tank in which the tanning liquor was stored in the plant was an open-top vat, located in an area regularly occupied by plant workers. There were no shutoff valves between the female "quick connect" fitting and the tanning liquor storage vat.

6. The foreman

The 48-year-old tannery foreman upon whom the drivers relied for directions had held his position as foreman for approximately 1-½ years. One of his assigned duties was a responsibility for supervising the unloading of bulk chemicals for the tannery. This responsibility apparently was shared with at least two other plant supervisory personnel, based on signatures on carriers' prior delivery receipts.

This delivery was tendered just as the foreman was organizing work for the oncoming shift, but there is no evidence to suggest the foreman might have been preoccupied or distracted. The drivers noted nothing unusual about his responses, appearance, behavior, or physical condition during their communications with him.

The foreman was fatally overcome by the

hydrogen sulfide gas during the accident.

7. Regulations

At the time of this accident, there were no regulatory hazard control or monitoring requirements applicable to the conditions at the transportation/receiving interface for interstate movements of the cargo involved. The accident is not a recordable accident under 49 CFR 394; therefore, the involvement of the carrier or the commodity in this accident would not, routinely, come to the attention of the Bureau of Motor Carrier Safety of the Federal Highway Administration, Department of Transportation, which is responsible for regulating interstate motor carrier transportation safety. Therefore, a compilation of the involvement of carriers in such accidents is not available from the regulators.

On the plant side of the interface, the U.S. Department of Labor has authority to prescribe reporting and safety requirements for the plant facilities under the Occupational Safety and Health Act of 1970; at the time of the accident, the Department of labor had not yet adopted standards addressed to this problem area. Rules applicable within Maine were adopted shortly after the accident. (Exhibit 2.)

Terms and conditions applicable to the contract for carriage, between the carrier and the shipper, are described in Tariff No. 5, Bulk Carrier Conference, Inc., Agent, on file with the Interstate Commerce Commission. Section 4(f) of this tariff delineates the interface at the unloading point. This section also describes which party shall bear the risk of the property (cargo) at the interface. (See Exhibit 1.)

There is currently no interagency arrangement to provide for the coordination of requirements at this interface between the responsible Federal jurisdictions.

III. ANALYSIS

While the casualties occurred inside an industrial facility, they occurred as the cargo in a

transport vehicle was being transferred across the interface between a transportation vehicle and the receiving industrial facility. From the evidence developed, two conditions must have existed for the accident to have occurred:

- (1) The carrier's personnel did not recognize that they had connected their hose to the incorrect plant transfer line, and
- (2) The plant foreman did not recognize the true identity of the cargo.

This constituted a critical communications failure in both directions across the interface.

The information required to accomplish a delivery of the sodium hydrosulfide without error in this situation was divided between the carrier's drivers and the tannery foreman. The drivers knew the identity of the material they were transporting, but needed information to make the correct transfer hose connection. The foreman knew the piping systems and connections for each material he received, but needed information about the identity of the product being tendered for delivery to designate the correct hose connection to the drivers. Each party had to receive additional information from the other party, which then had to be linked to his pre-existing information to arrive at correct decisions. For error-free decisions, this exchange of information required correct transmission of information, correct receipt of information, and correct linkage of the new information to pre-existing information by both parties. The occurrence of this accident indicates that the parties failed to establish an adequate mutual exchange of information to achieve an error-free delivery.

Analysis of the circumstances which increased the likelihood of the existence of this communications failure is informative.

The carrier's drivers relied solely upon the directions given them by the plant foreman to accomplish the delivery of their cargo to the satisfaction of the receiver. They had made no prior deliveries to the tannery, and therefore had no prior information about either the facility or

the tannery personnel to guide them. They had no knowledge of the chemical hazards which existed within the plant, and therefore no indication of a need for extraordinary precautions to guard against delivery of their cargo into an improper line. The difference in the three fill line connections did not constitute a signal for special caution, because the drivers' experience at other delivery locations led them to be prepared to mate their hoses with most types of fittings they might encounter; this practice was sanctioned by the carrier. In the absence of placards, markings, tags, or other identification scheme at the fill connections, the tannery offered the drivers no opportunity to validate the foreman's verbal instructions, nor did the carrier require that they seek such validation from any other source. The carrier indoctrinated drivers to rely solely on the receiver's personnel for directions, and in this delivery the drivers apparently conformed to the required practice.

The plant foreman would not have permitted the transfer to proceed had he recognized the correct identity of the vehicle's contents. The identity of the contents was apparently communicated to him only one time, and that was an oral communication. He was not offered the opportunity to examine the driver's documents which properly described the contents, nor, apparently, had he been instructed to check these documents before the delivery commenced. He was expecting truckload deliveries of both chemicals involved in this accident, and there was nothing unusual about a new driver tendering him a delivery of either chemical. The foreman was offered only one opportunity to recognize the identity of the lading, because it was not marked on the truck or repeated to him during subsequent conversations with the drivers. The foreman did not examine the shipping papers or take any other positive steps or measures to identify the product in the truck, but rather he apparently relied upon his understanding of the information he received verbally from the drivers. His response to the second contact with the drivers was to answer questions (Tank vented? Valves open? When to start?) that, in the circumstances, could convey one meaning to the driver posing the questions, and

another, different meaning to the hearer of the questions. The driver's questions did not relate to the *identity* of the cargo, but rather to the *readiness* of the plant facility to receive the cargo.

As with the drivers, the plant foreman was offered no opportunity to validate the information upon which he acted, nor apparently did he seek such validation. Both parties communicated information to each other without testing the information feedback to determine that the information had been correctly received and that they had communicated *with* each other. Thus, *interlocking* communications were absent in this accident.

The practices and conditions described above did not permit, require, or encourage either party to validate the representations of the other, which increased the likelihood of a communications failure across the interface between the transportation and receiving facilities. Means to allow and require representatives of each party to validate representations by the other party would appear desirable.

In the absence of comprehensive regulatory carrier accident-reporting requirements encompassing deliveries, the extent of the involvement of transportation companies in accidents occurring at the delivery interface cannot be ascertained. This gap in the reporting requirements may be obscuring a safety problem area involving substantial risks, as demonstrated in this accident. During the course of this investigation, information brought to the Board's attention by the carrier and the Maine Department of Labor and Industry indicates that the hazardous conditions and approaches to safety found in this case are not uncommon. A comparison between the number of regulatory and tariff requirements addressed to the risks at the shipper/transportation interface at origin, and the transportation/receiving interface at destination, suggests that the risks involved in the delivery of bulk cargoes from motor vehicles warrant greater attention. The complexity of the receiving interface, in terms of the variety of types of motor carriers, documentation, diver-

sity of products, hazards from mixing of incompatible bulk liquids, variety of equipment, and unfamiliar personnel involved should not deter inquiry into these risks at the transportation/receiving interface. To the contrary, this complexity emphasizes the need for greater attention than has been given to this safety area in the past by the regulators and the parties involved.

IV. CONCLUSIONS

1. The identity of the cargo being tendered for delivery was conveyed to the tannery foreman only one time by the drivers.

2. The drivers connected the transfer hose to the plant fill line connection designated by the tannery foreman.

3. The drivers were not instructed in procedures requiring validation of information solicited or received from consignee's representatives, upon whom they were instructed to rely for unloading directions.

4. The tannery foreman was not instructed in procedures requiring validation of information solicited or received from carriers' drivers, tendering delivery of bulk liquid shipments at the tannery, prior to furnishing such drivers with unloading directions.

5. Neither the tannery nor the carrier provided, on the vehicle or at the plant facility, a visible display of information, devices, or other measures by which the foreman or drivers could reasonably be expected to be able to establish unilaterally the validity of the information received from the other party.

6. The tannery foreman did not recognize, or he misunderstood, the true identity of the cargo being tendered for delivery by the carrier in this instance.

7. The carrier's drivers did not recognize that their transfer hose was connected to the improper plant fill line connection prior to starting up the transfer operation.

8. Neither the drivers nor the foreman encountered anything unusual to their experience during the delivery preparations which might reasonably have been expected to suggest to them that a communications failure had occurred.

9. The procedures in which the employees had been instructed, and the conditions provided or sanctioned by the employers, present in this accident, are not uncommon at the transportation/receiving interface in locations receiving bulk liquid deliveries from motor carrier vehicles.

10. A gap in motor carrier accident-reporting regulations prevents a comprehensive assessment of the scope of this safety problem area.

11. An imbalance exists between the extensive amount of regulation addressed to risks at the shipper/transportation interface as compared with the lesser amount of regulation addressed to risks at the transportation/receiving interface, for both regulated hazardous bulk liquid materials and unregulated bulk liquids which, in view of this accident, may not be justified.

12. The Safety Board believes that the complexities of the transportation/receiving interface result in risks which are substantial enough to warrant a comprehensive investigation to determine the scope of the safety problems which may exist at this interface.

13. Under existing statutes, correction of practices or conditions which create unacceptable risks at the transportation/receiving interface will require the regulatory cooperation of the Department of Transportation, the Department of Labor, and, possibly, the Interstate Commerce Commission, at the Federal level.

V. CAUSE

The National Transportation Safety Board determines that the cause of this accident was the failure of the carrier's drivers and the

tannery foreman to establish an error-free exchange of information required to accomplish the safe transfer of the cargo from the vehicle into a plant storage tank. The likelihood of this failure was increased by the absence of instructions or training in information validation procedures to be followed during such exchanges, and by the absence of markings, devices, or other measures on the vehicle or tannery property which would have permitted such validation to be made unilaterally by either party.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Department of Transportation, with the participation of the Department of Labor and, if required, the Interstate Commerce Commission, conduct a comprehensive investigation into the risks associated with the delivery of bulk liquid cargoes from motor carrier vehicles, and initiate the implementation of risk-reduction measures.

2. The National Tank Truck Carriers, Inc., the Private Truck Council of America, Inc., and State trucking associations, pending implementation of the above recommendation, call their members' attention to the risks associated with communications failures during bulk liquid deliveries from motor carrier vehicles, and to the

need, demonstrated in this accident, for development of, training in, and enforcement of procedures which incorporate information validation techniques to be used during such deliveries.

3. The Department of Labor and the agencies having jurisdiction in each State, pending implementation of recommendation No. 1, consider the establishment of rules, regulations, or standards which require the display of the name of the material to be delivered into each fill line connection at these connections in all facilities where bulk liquid materials are delivered from a motor carrier vehicle, similar to the rules adopted by the Maine Department of Labor and Industry after this accident.

4. The Department of Labor and the agencies having jurisdiction in each State consider developing and implementing requirements which would reduce the risks to employees and carrier personnel in the event of accidental mixing of incompatible bulk liquid materials at all locations where such materials are delivered by motor carrier vehicles.

5. The Department of Transportation initiate rulemaking action to amend 49 CFR 394 to require all carriers to report accidents occurring in connection with the delivery of bulk liquid materials from motor carrier vehicles, whether or not the carrier's employees, vehicle, or cargo suffered damages in the accident.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ OSCAR M. LAUREL
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

Francis H. McAdams, Member, was absent,
not voting.

EXHIBIT 1

BULK CARRIER CONFERENCE, INC., AGENT

MF-III. C.C. No. 5
P.S.C.I. No. T.R. 3
M.P.S.C. No. 3
P.S.C. Mo. No. 3

MF-I.C.C. No. 44
F.S.C. N.Y. M.T. No. 2
Freight Pa. P.U.C. 2
MF P.S.C. W. Va. 1

TARRIF NO. 5

▲CONTRACT TERMS AND CONDITIONS

SECTION 4 (Concluded)

(f) Except as provided provided for in Key Stop Agreements between carrier and shipper, property shall, except in case of carrier's negligence, be entirely at risk of owner at loading point until it leaves loading device to funnel said property into carrier's equipment and at unloading point when it leaves carrier's equipment to enter unloading device to funnel said property into consignee's designated point of receipt. However, when carrier furnishes hose, pipe or other device at loading or unloading point to funnel property into or out of carrier's equipment, carrier's responsibility commences when property enters such hose, pipe or other device at loading point, and ends when product leaves such hose, pipe or other device to enter into consignee's designated point of receipt at destination.

ISSUED: JULY 15, 1970

EFFECTIVE: AUGUST 20, 1970

ISSUED BY:
WILLIAM M. WATT, GENERAL MANAGER
2001 JEFFERSON DAVIS HIGHWAY
ARLINGTON, VA. 22202

EXHIBIT 2

STATE OF MAINE

REGULATIONS FOR FILLING, HANDLING,
MIXING, AND DRAINING OF CHEMICALS
IN MANUFACTURING ESTABLISHMENTS

1971 Edition

Department of Labor and Industry
Augusta, Maine 04330

DLI NO. 460-8

EFFECTIVE AUGUST 26, 1971

1. Filler Pipes and Drain Pipes.

All chemical filler and drain pipes shall be labeled to show the liquid received and dispensed through the pipe. Such pipes shall be labeled with black letters not less than 1" high on yellow background.

2. Containers

The contents of all chemical storage containers, either permanent or portable, over one (1) gallon but less than sixty (60) gallons capacity shall be labeled on at least two sides or ends with black letters not less than 1½" high on yellow background. Any such containers with a capacity of over sixty (60) gallons shall be labeled on at least two sides or ends with black letters a minimum of 4" high on yellow background. Such labels shall show tank capacity in addition to contents.

This rule shall *not* apply to glass containers, carboys, or cylinders labeled by the manufacturer or supplier and not under the full control of the user.

3. Handling Procedures.

In any manufacturing plant using chemicals as part of their manufacturing operation written procedures shall be adopted and enforced for the filling, handling, mixing, and draining of such chemicals.