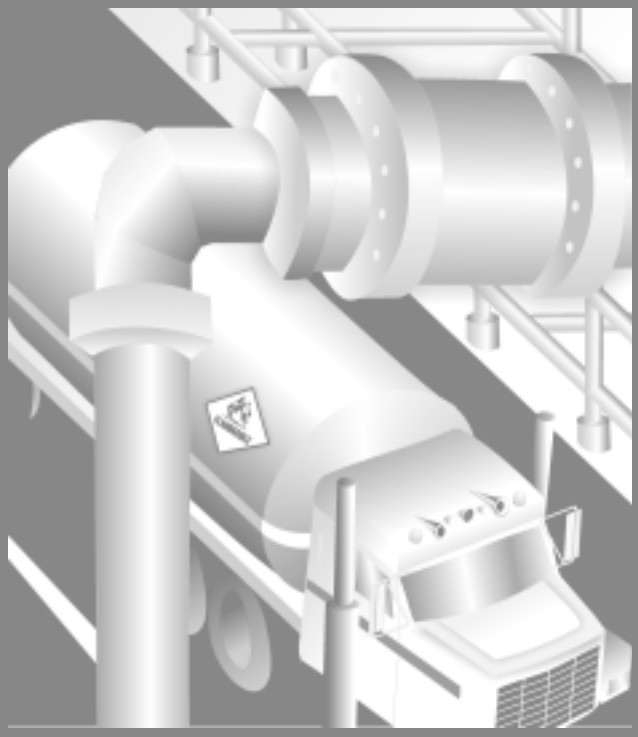
NTSB/HZM-02/01
PB2002-917002

Hazardous Materials Accident Report

Hazardous Materials Release From Railroad Tank Car With Subsequent Fire at Riverview, Michigan July 14, 2001



National Transportation Safety Board
Washington, D.C.

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PB2002-917002
Notation 7400A
Adopted June 26, 2002

National Transportation Safety Board
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

National Transportation Safety Board. 2002. ***Hazardous Materials Release From Railroad Tank Car With Subsequent Fire at Riverview, Michigan, July 14, 2001.*** **Hazardous Materials Accident Report NTSB/HZM-02/01. Washington, DC.**

Abstract: About 3:45 a.m., eastern daylight time, on July 14, 2001, at the ATOFINA Chemicals, Inc., (ATOFINA) plant in Riverview, Michigan, a pipe attached to a fitting on the unloading line of a railroad tank car fractured and separated, causing the release of methyl mercaptan, a poisonous and flammable gas. About 4:09 a.m., shortly after the Riverview Fire Department chief arrived on scene, the methyl mercaptan ignited, engulfing the tank car in flames and sending a fireball about 200 feet into the air. Fire damage to cargo transfer hoses on an adjacent tank car resulted in the release of chlorine, a poisonous gas that is also an oxidizer. The fire was extinguished about 9:30 a.m. Three plant employees were killed in the accident. There were several other injuries; most of the injured were treated for respiratory symptoms and released. About 2,000 residents were evacuated from their homes for about 10 hours. Two tank cars, railroad track, and plant equipment (including hoses and fittings) were damaged in the fire.

The major safety issues identified in this investigation are the adequacy of ATOFINA's procedures for unloading tank cars containing hazardous materials and the adequacy of Federal regulations and oversight for cargo transfer operations involving bulk containers transporting hazardous materials.

As a result of its investigation of this accident, the Safety Board makes safety recommendations to the U.S. Department of Transportation, the Federal Railroad Administration, the Environmental Protection Agency, and the Occupational Safety and Health Administration.

Contents

Executive Summary

About 3:45 a.m., eastern daylight time, on July 14, 2001, at the ATOFINA Chemicals, Inc., (ATOFINA) plant in Riverview, Michigan, a pipe attached to a fitting on the unloading line of a railroad tank car fractured and separated, causing the release of methyl mercaptan, a poisonous and flammable gas. About 4:09 a.m., shortly after the Riverview Fire Department chief arrived on scene, the methyl mercaptan ignited, engulfing the tank car in flames and sending a fireball about 200 feet into the air. Fire damage to cargo transfer hoses on an adjacent tank car resulted in the release of chlorine, a poisonous gas that is also an oxidizer. The fire was extinguished about 9:30 a.m. Three plant employees were killed in the accident. There were several other injuries; most of the injured were treated for respiratory symptoms and released. About 2,000 residents were evacuated from their homes for about 10 hours. Two tank cars, railroad track, and plant equipment (including hoses and fittings) were damaged in the fire.

The National Transportation Safety Board determines that the probable cause of the accident involving the release of methyl mercaptan from a tank car at the ATOFINA Chemicals, Inc., plant in Riverview, Michigan, was a fractured cargo transfer pipe that resulted from (1) the failure of ATOFINA to adequately inspect and maintain its cargo transfer equipment, and (2) inadequate Federal oversight of unloading operations involving hazardous materials. Contributing to the accident were ATOFINA's reliance on a tank car excess flow valve to close in the event of a leak from cargo transfer equipment and the company's failure to require appropriate safety equipment for employees involved in tank car loading and unloading operations.

As a result of its investigation of the accident, the National Transportation Safety Board identified the following safety issues:

- The adequacy of ATOFINA's procedures for unloading tank cars containing hazardous materials.
- The adequacy of Federal regulations and oversight for cargo transfer operations involving bulk containers transporting hazardous materials.

As a result of its investigation of this accident, the Safety Board makes safety recommendations to the U.S. Department of Transportation, the Federal Railroad Administration, the Environmental Protection Agency, and the Occupational Safety and Health Administration.

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Factual Information

Accident Synopsis

About 3:45 a.m., eastern daylight time, on July 14, 2001, at the ATOFINA Chemicals, Inc., (ATOFINA) plant in Riverview, Michigan, a pipe attached to a fitting on the unloading line of a railroad tank car fractured and separated, causing the release of methyl mercaptan, a poisonous and flammable gas. About 4:09 a.m., shortly after the Riverview Fire Department chief arrived on scene, the methyl mercaptan ignited, engulfing the tank car in flames and sending a fireball about 200 feet into the air. Fire damage to cargo transfer hoses on an adjacent tank car resulted in the release of chlorine, a poisonous gas that is also an oxidizer. The fire was extinguished about 9:30 a.m. Three plant employees were killed in the accident. There were several other injuries; most of the injured were treated for respiratory symptoms and released. About 2,000 residents were evacuated from their homes for about 10 hours. Two tank cars, railroad track, and plant equipment (including hoses and fittings) were damaged in the fire.

The Accident and Response

From 2:00 until 3:00 a.m. on July 14, 2001, employees at the ATOFINA plant in Riverview, Michigan, (see figure 1) removed three empty[1] tank cars from the Process 46[2] loading area and replaced them with three full tank cars. Two of the loaded tank cars were filled with chlorine, a poisonous gas, and one was filled with methyl mercaptan, a poisonous and flammable gas. In the Process 46 area, the tank cars were to be used to feed the chlorine and methyl mercaptan into the production process for the production of several other materials. (See figure 2.)

[1] These cars likely still contained a residue of product.

[2] The term *Process 46* refers to an area of the Riverview facility that is devoted to the production of methane sulfonyl chloride and methane sulfonic acid through a multi-step synthesis of methyl mercaptan with chlorine. Greater detail concerning Process 46 operations is provided in the "Plant Information" section of this report.

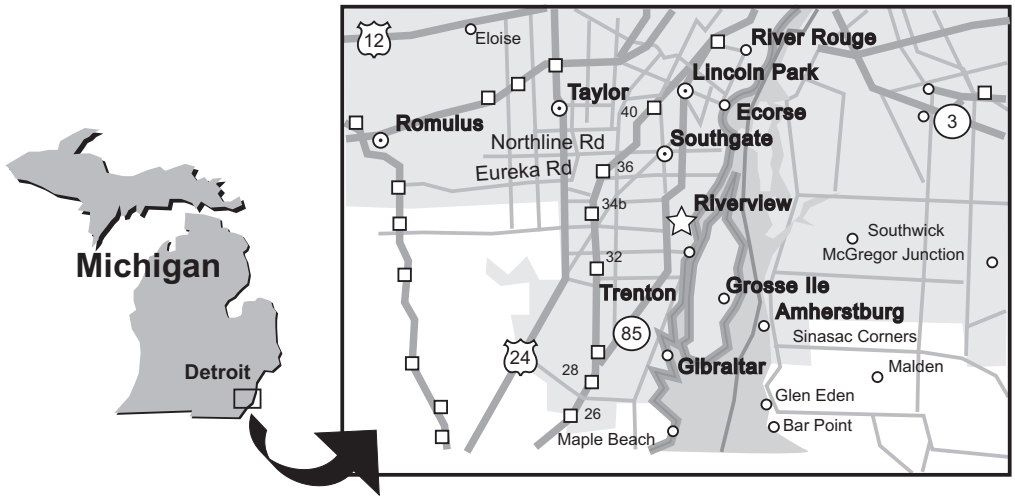

Figure 1. Accident site.

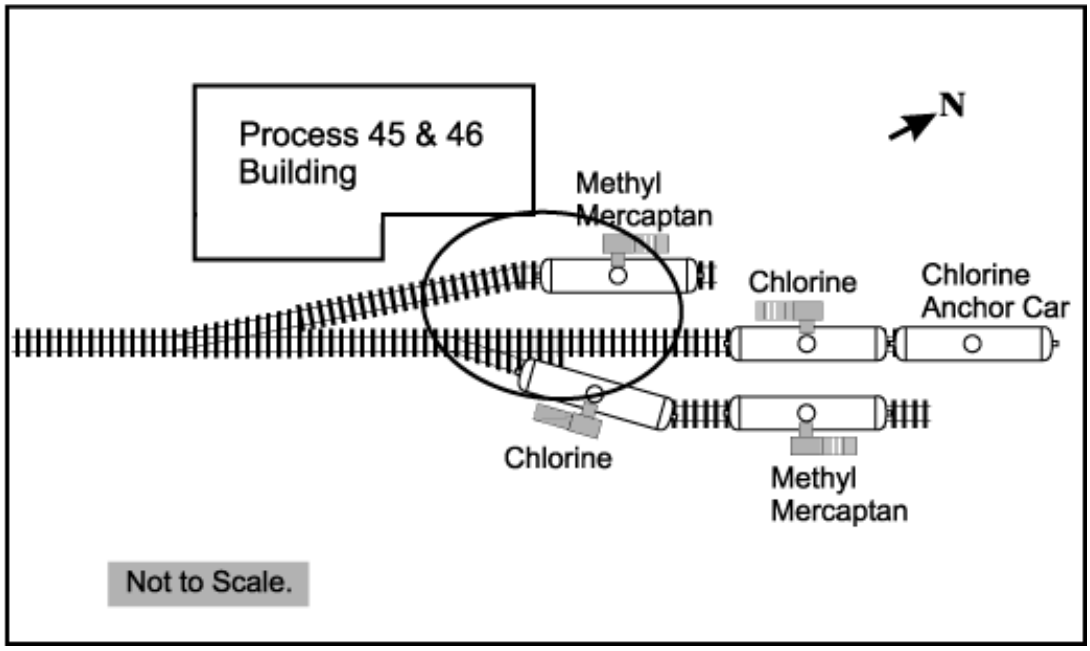

Figure 2. Accident site. (The circled area is the area of greatest fire damage.)

According to one of the employees who had placed the loaded tank cars, once the cars were positioned, two operators were assigned the task of attaching and leak-testing the unloading apparatus that connected the tank cars into the plant piping. According to the employee, the two full chlorine tank cars were attached first. The attachments were completed about 3:00 a.m., and the A operator[3] began attaching the unloading apparatus to

the methyl mercaptan tank car. ATOFINA operators told investigators that it takes about 15 minutes to attach and leak-test the tank car fittings.

ATOFINA employees first became aware of a problem in the Process 46 area at 3:45 a.m. when someone activated a fire alarm for the area.[4] Shortly afterwards, ATOFINA employees heard the shift superintendent[5] on the two-way radio asking that 911 be called. At 3:47 a.m., a methyl mercaptan sensor in the control room on the second floor of the Process 46 operations center registered an elevated level of methyl mercaptan. A process operator in the control center said she became aware of a product release when she smelled methyl mercaptan and then heard the alarms sounding at the plant. She looked out of her building and saw the shift superintendent lying on the ground near a manually operated area fire alarm about 50 feet from the tank car unloading area. She then began securing her process in accordance with company emergency response procedures.

When the Process 46 area fire alarm sounded, ATOFINA employees from two other plant process areas put on self-contained breathing apparatus (SCBA) and went to the area. Because methyl mercaptan is a flammable gas that could ignite at any time, this initial rescue attempt had to be performed quickly. The employees found the B operator and the shift superintendent and removed them from the Process 46 area. The A operator was not found at that time. The two injured employees were transported by ambulance to Riverside Osteopathic Hospital (about 2.7 miles from the plant), where they were pronounced dead.

Also in response to the fire alarm, the ATOFINA fire crew drove the plant fire engine to the Process 46 area. Once there, an employee on the fire crew reported seeing fumes coming out of the top of the methyl mercaptan tank car. The fire crew began spraying water toward the tank car to knock down the fumes.

At 3:48 a.m., the Riverview 911 dispatcher received a call from an ATOFINA employee reporting "a man down" at the ATOFINA facility. By 3:52 a.m., the Riverview Fire Department was en route to the scene. About the same time, the 911 dispatcher received a second call from the ATOFINA plant reporting a release of methyl mercaptan. By 3:58 a.m., the first two units of the Riverview Fire Department were on scene. At 4:08 a.m., the dispatcher received a third call from the ATOFINA plant reporting "at least four people down," the need for several ambulances, and the need for responders to wear SCBAs.

At 4:09 a.m., the leaking methyl mercaptan ignited, completely engulfing the tank car in flames. The Riverview fire chief, who witnessed the ignition, said the ignition

[3] Employees designated as *operators* perform various tasks within a production process. They are identified as "A" and "B" operators, with the "A" designation being given to the more experienced employee.

[4] The fire alarm was likely being used as a general alarm, since the first evidence of a fire was when the escaping gas ignited some 19 minutes later.

[5] The shift superintendent supervises the work of the entire plant during off shifts and is not directly involved in tank car loading and unloading operations.

resulted in a fireball that extended an estimated 200 feet into the air. When the fireball occurred, the Riverview fire chief requested mutual aid from the surrounding communities. Riverview Fire Department responders began applying water to the tank cars involved in the fire and to the adjacent tank cars to keep them cool. (See figure 3.) Units from the Wyandotte, Trenton, and Brownstown Fire Departments, and the Downriver Mutual Aid HAZMAT Team[6] responded.

Figure 3. Overview of accident site and emergency response.

About 5:00 a.m., the Grosse Ile Police Department advised the Riverview fire chief that strong odors were detected in Grosse Ile. At that time, according to the Riverview fire chief, the wind direction was out of the northwest to the southeast at about 12 to 15 mph. Grosse Ile is southeast of the ATOFINA plant. At first, the Riverview fire chief advised the Grosse Ile Police Department to have the residents shelter-in-place.[7] However, about 5:19 a.m., after re-evaluating the situation, the Riverview fire chief requested the evacuation of residents of parts of Riverview, Trenton, Grosse Ile, and Wyandotte. In all, about 2,000 residents of the surrounding communities were evacuated from their homes and businesses.

[6] The Downriver Mutual Aid HAZMAT Team comprises 30 personnel from 17 local fire departments specifically trained in handling hazardous materials emergencies.

[7] *Shelter-in-place* is an emergency response action used after the release of potentially dangerous gases or vapors from a source outside a building. It involves having occupants remain within their building with the air circulation turned off until the area is determined to be safe.

The methyl mercaptan tank car fire was allowed to burn itself out while the water streams continued to cool the tank cars. Records of the exact time the fire went out vary; however, there was general agreement that it occurred after 8:30 a.m. The Riverview Fire Department's report stated that "at 12:47 p.m. the methyl mercaptan leak and fire had stopped," but the Riverview fire chief later stated that the fire was out between 8:30 and 9:30 a.m. After the fire was out, a reconnaissance team equipped with SCBAs and protective suits entered and examined the site. The team found the partially burned body of the A operator on the tracks near the south end of the methyl mercaptan tank car.

Several entry teams were sent into the accident area after the reconnaissance team to search the site and close any open valves. One entry team found that the 1-inch-diameter transfer pipe in the unloading apparatus attached to the unloading valve for the methyl mercaptan tank car, UTLX 900558, had failed and separated. The failure occurred in the threaded section of the pipe where it entered a 2-inch to 1-inch reducer mounted on the tank car's unloading valve. The unloading valve was open, and the tank car's full load of 147,350 pounds of methyl mercaptan had been released. Both valves on the flexible hose that connected the unloading apparatus to the plant process were closed, and the hose itself was burned through. The team closed the tank car's unloading valve.

The flexible hose that connected the unloading apparatus on the adjacent chlorine car (DCTX 27444) to the plant process was found burned through. The tank car unloading valve and all in-line valves between the tank car and the plant piping were open when the entry teams arrived. These valves were then closed. Because of the relatively short time that elapsed between the damage to the flexible hose and the closing of the valves, only about 26,500 of the 178,560 pounds of chlorine in the tank car were released. At 2:48 p.m., all the plant and tank car valves were confirmed closed, and at 3:07 p.m., the evacuation was lifted.

About 1:30 p.m. on July 15, 2001, all Riverview Fire Department active units were released, with the exception of one engine and two firefighters. Riverview Fire Department personnel remained on scene until July 17, 2001, monitoring the accident site for residue of hazardous materials to ensure that it was safe to allow investigators to enter the area.

Injuries

According to the Wayne County Deputy Medical Examiner, the B operator and the shift superintendent sustained fatal injuries consisting of methyl mercaptan intoxication. The A operator had fatal injuries consisting of thermal burns and methyl mercaptan intoxication.

One ATOFINA employee was injured when, after inhaling methyl mercaptan fumes, he fell to the ground and fractured three ribs. Five other employees sustained minor injuries, including muscle strains, abrasions, and/or inhalation injuries. Three emergency responders sustained minor inhalation injuries, including nasal irritation. At least 40

residents of the communities surrounding the ATOFINA plant complained of sore throats, headaches, and/or dizziness; they were treated and released from local hospitals. (See injury table.)

Table 1. Injuries.

Injury Scale[a]	ATOFINA Employees	Emergency Responders	Others	Total
Fatal	3	0	0	3
Serious	1	0	0	1
Minor	5	3	40	48
Total	9	3	40	52

[a]49 *Code of Federal Regulations* 830.2 defines fatal injury as "any injury which results in death within 30 days of the accident" and serious injury as "an injury which: (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, or tendon damage; (4) involves any internal organ; or (5) involves second or third-degree burns, or any burn affecting more than 5 percent of the body surface."

At 5:04 a.m. on the day of the accident, some 5 to 10 minutes after the arrival of the shift supervisor and the B operator, employees at the Riverside Osteopathic Hospital began to report feeling sick. Later that day, the Western Wayne County hazardous materials response team determined that the emergency department and external area had been contaminated with methyl mercaptan, and they were closed until they could be decontaminated. The decontamination was completed at 11:45 p.m.

Tank Car Information

The methyl mercaptan car involved in the fire was UTLX 900558, a DOT 105J300W specification tank car manufactured by Union Tank Car Company in October 1988. The car was a carbon steel pressure car, with thermal protection and insulation covered by a steel jacket. The tank car's water capacity was 24,983 gallons.

The adjacent chlorine tank car also involved in the fire was DCTX 27444, a DOT 105A500W specification tank car manufactured by North American Tank Car in 1973. This car was a carbon steel pressure car, with thermal protection and insulation covered by a steel jacket. The tank car's water capacity was 17,300 gallons.

Both tank cars had liquid and vapor valves, and they each had a pressure relief device mounted within a protective dome on the top of the tank. The liquid valve opening on the methyl mercaptan tank car had a 2-inch inside diameter; the liquid valve opening on the chlorine tank car had a 1-inch inside diameter. The liquid valves were used for unloading the methyl mercaptan and chlorine from the tank cars.

Excess flow valves for each unloading (liquid) valve were installed in the eduction pipe[8] inside each tank car. According to Federal regulations, an excess flow valve is designed as a device that "closes automatically against the outward flow of the contents of the tank in case the external tank car closure valve is broken off or removed during transit."[9] According to the Chlorine Institute's *Chlorine Manual*, an excess flow valve "may close if a catastrophic leak involving a broken connection occurs but it is not designed to act as an emergency shut-off device during transfer."[10] The excess flow valve will not activate if, as in this accident, the flow rate does not exceed the normal transfer rate by a sufficient margin.

Unloading Apparatus Information

The first component of ATOFINA's unloading apparatus consisted of a 1-foot-long, 1-inch-diameter steel pipe with a 2- to 1-inch reducer threaded onto one end and a four-bolt flange threaded onto the other. In preparation for product transfer, the reducer end of the pipe was passed through an access hole on the side of a tank car dome, and the reducer was threaded onto the tank car's unloading valve. The 1-inch pipe was the one that, in this accident, failed and separated, releasing the methyl mercaptan.

Additional cargo unloading components were then attached to the 4-bolt flange. These components included a pressure gauge, a 90-degree elbow, a gate valve, two T-fittings, several lengths of 1-inch pipe, and a flexible hose that attached to the plant process piping. (See figure 4.) The total weight of the unloading apparatus was about 53 pounds. With the exception of the downstream end of the flexible hose, which was attached to the plant piping, the unloading apparatus was supported only by the reducer and the 1-inch pipe mounted in the tank car unloading valve.

[8] An *eduction pipe* is a long steel pipe attached to the liquid valve that extends to the bottom of the tank. The pipe is used to unload liquid material from the tank car.

[9] Title 49 CFR 179.100-13(d).

[10] The Chlorine Institute, *Chlorine Manual*, Sixth Edition, Washington, DC. January 1997. Section 3.2.3.3, page 14.

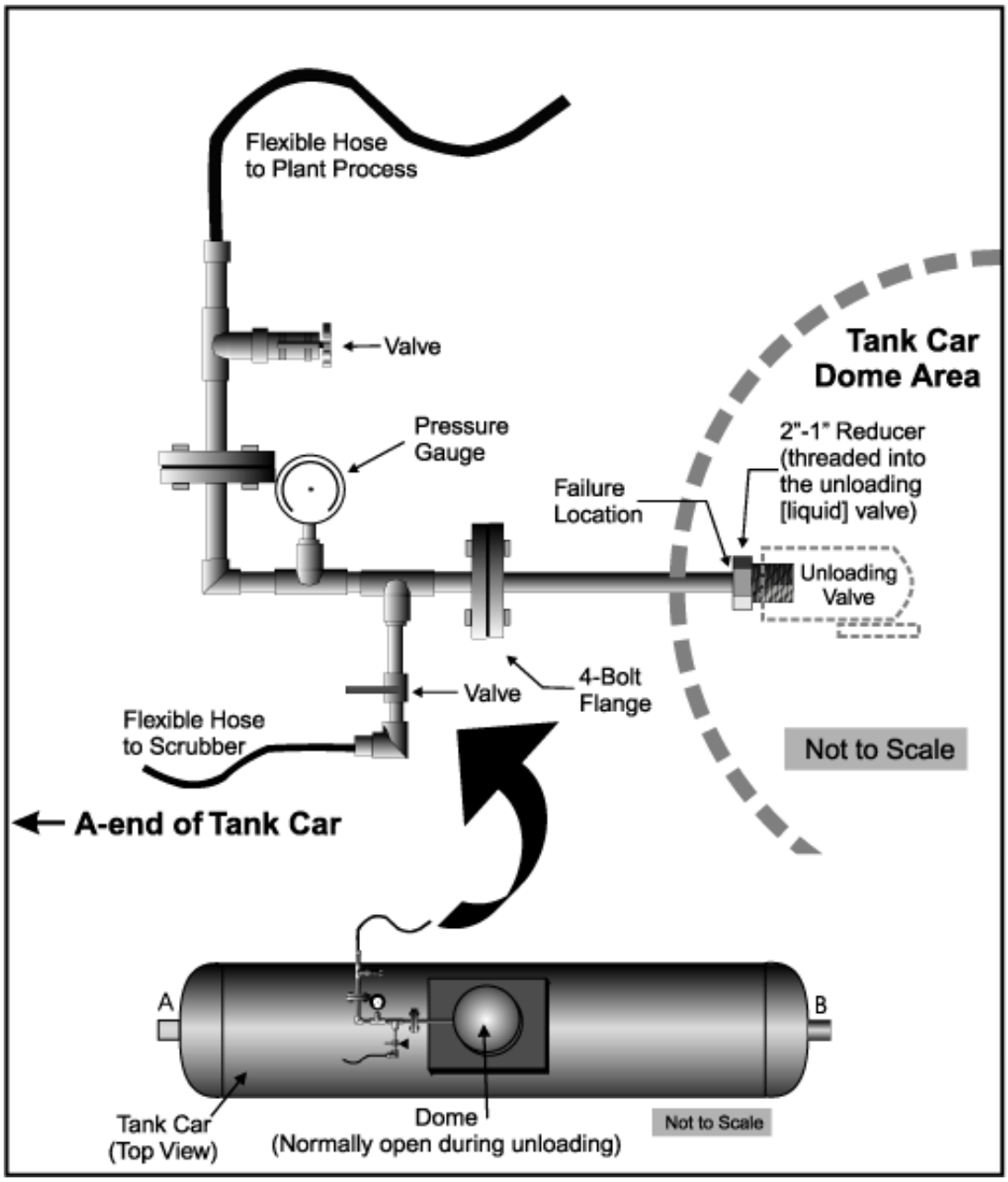

Figure 4. Overhead view of unloading apparatus. (For clarity, the pressure gauge, valves, and scrubber line have been rotated into the horizontal plane.)

Damage

Visible damage to methyl mercaptan tank car UTLX 900558 consisted of fire damage to the jacket, wheels, axles, bearings, brake components, and safety appliances. The fire affected approximately 90 percent of the car. The visible damage to chlorine tank

car DCTX 27444 consisted of fire damage to the jacket and running components on the left side (facing the B-end) of the car. This side was facing tank car UTLX 900558.

As noted earlier, a 1-inch-diameter steel pipe in the unloading apparatus of UTLX 900558 was separated at the point the pipe threads exited a 2- to 1-inch reducer installed in the tank car's unloading valve. The flexible hoses attached to the unloading apparatus on both tank cars were melted and partially consumed by the fire.

Damage to the plant was limited to fire exposure on the methyl mercaptan unloading station, which resulted in melting or damaging most of the non-ferric fittings, gauges, and other apparatus; fire exposure and warping of the track under the methyl mercaptan tank car; and scorching of track ties and nearby wooden planking.

Metallurgical Examination

The Safety Board's metallurgical examination of the separated steel pipe in the unloading apparatus (figure 5) did not identify any evidence of preexisting cracks on the fracture surface; the fracture features were typical of an overstress separation. Examination of the pipe revealed evidence of corrosion, including deposits of iron oxide (rust) and pitting on both interior and exterior surfaces. (The interior surfaces of the pipe were exposed to the weather whenever the unloading apparatus was not in place on a tank car.)

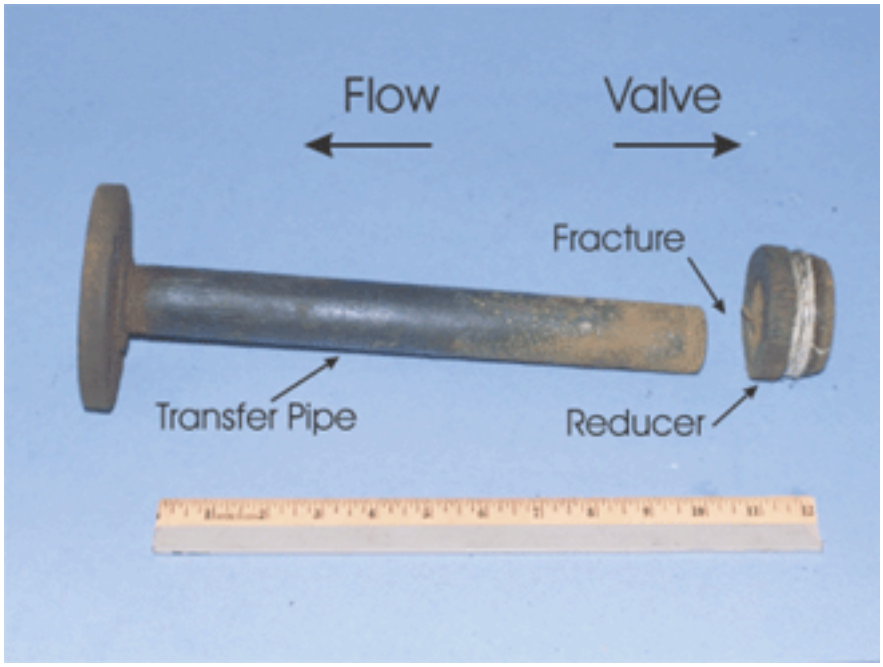

Figure 5. Separated transfer pipe.

Measurements of the interior and exterior diameters at several locations on the length of the pipe were compared with interior and exterior diameters for new pipe. These comparisons revealed that the outside diameter was comparatively the same as that of new pipe; however, the inside diameter near the end of the pipe where the failure occurred showed evidence of erosion-corrosion damage (discussed in the next section) that reduced the wall thickness near the fracture by about 23 percent as compared to the inside diameter of new pipe.

Calculations made using the weight of each of the unloading apparatus components, their distances from the pipe separation, the standard (as manufactured) wall thickness of 1-inch pipe, and standard piping design and engineering formulas indicate that bending stresses on a new pipe at the point the pipe entered the reducer would have been 20,800 pounds per square inch (psi). The wall thickness reduction of the accident pipe that resulted from erosion-corrosion resulted in a 20-percent increase in the calculated bending stress on the pipe, to 25,100 psi at the point of fracture. Comparing the bending stress to the strength of the material, Safety Board metallurgists estimated that an additional force of about 175 pounds (added to the existing force represented by the weight of the unloading apparatus), if applied at the outer end of the unloading apparatus, would cause an overstress failure (fracture) of the pipe.

Erosion-Corrosion

ASM International, a society for materials engineers and scientists, in its *Metals Handbook*,[11] defines "erosion" as the "destruction of metals or other materials by the abrasive action of moving fluids…." "Erosion-corrosion" is defined as "a conjoint action involving corrosion and erosion in the presence of a moving corrosive fluid, leading to the accelerated loss of material." It should be noted that, while methyl mercaptan is not considered to have a significant corrosive effect on steel, exposure of steel to the atmosphere does produce corrosion. And while corrosive products (rust on steel) tend to form a protective layer that retards further corrosion, ASM International notes in its *Metals Handbook* that:

> Turbulence [in the fluid] has the ability to physically disrupt and tear away the various types of protective films…exposing the bare metal for subsequent corrosion.… Turbulent conditions are created by changes in diameter in piping systems. Bends and elbows likewise create conditions conducive to changes in velocity that create turbulent conditions, sometimes called cavitation, wherein bubbles of air contained in the fluid can collapse and exert an abrasive action against any protective films formed on the pipe surface.

[11] ASM International, *Metals Handbook, Ninth Edition, Volume 13* (Materials Park, Ohio: 1987).

Hazardous Materials

Methyl Mercaptan

Methyl mercaptan is a U.S. Department of Transportation (DOT) hazard Division 2.3 (poison gas) material that is also flammable. According to U.S. Coast Guard chemical and hazardous response information system (CHRIS) data,[12] the IDLH value[13] for methyl mercaptan is 150 parts per million in air (ppm). The flash point is 0° F. Methyl mercaptan is a colorless gas that has a garlic or rotten cabbage odor. Inhalation and skin contact are the primary routes of exposure. Methyl mercaptan is irritating to the skin, eyes, mucous membranes, and respiratory tract. Persons coming in contact with methyl mercaptan may experience nausea, vomiting, headache, or dizziness, especially when exposure occurs without adequate ventilation. High concentrations may produce central nervous system effects such as staggering gait, muscular weakness, convulsions, paralysis of the respiratory center, and death. The ATOFINA material safety data sheets state that where airborne exposure to methyl mercaptan is likely, approved respiratory protection equipment is appropriate. Contact with combustible materials may enhance the risk of fire, and exposure to solid bleach or strong oxidizers may cause a violent reaction and fire.

Chlorine

Chlorine is a DOT hazard Division 2.3 (poison gas) material that is also corrosive. Chlorine is a greenish-yellow gas with a distinctive odor. According to U.S. Coast Guard CHRIS data, the IDLH value for chlorine is 10 ppm. Exposure to chlorine gas can cause severe irritation of eyes and respiratory tract with shortness of breath, choking sensation, dizziness, lung edema, and blindness. Inhalation is the primary route of exposure. The material may be fatal if inhaled. The ATOFINA material safety data sheets state:

> When airborne exposure limits are exceeded, use NIOSH [National Institute for Occupational Safety and Health] approved respiratory protection equipment appropriate to the material and/or its components (full facepiece recommended).

Personnel Information

The A operator for Process 46 was hired by Pennwalt Corporation (which later became ATOFINA) on January 5, 1983, as a utility person. In 1986, he began working as a process operator in the production department. At ATOFINA, he completed safety training in such areas as firefighting, SCBA, respirator, hazardous waste operations and emergency response (HAZWOPER), and hazard communication.

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[12] United States Coast Guard, *United States Coast Guard Chemical and Hazardous Response Information System*, COMDTINST 16465.12C, Version 1.0, January 2000.

[13] The *IDLH (immediately dangerous to life and health) value* is an atmospheric concentration of any toxic, corrosive, or asphyxiate substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects, or would interfere with an individual's ability to escape from a dangerous atmosphere. The Environmental Protection Agency uses 10 percent of the IDLH value when determining that a release has reached a level of concern for public exposure.

The B operator for Process 46 was hired on July 31, 1987, and began working as a process operator in the production department. He had completed the same safety training as the A operator.

The two operators had worked for about a week on this same shift. ATOFINA co-workers who saw the operators the night of the accident told Safety Board investigators that the operators appeared to be in good condition, and they noticed nothing unusual about the operators' performance.

Toxicological

Postaccident drug and alcohol tests were conducted on the bodies of the A operator, the B operator, and the shift superintendent who died as a result of injuries sustained during the accident. All test results were negative.

Plant Information

ATOFINA Chemicals, Inc., formerly Elf Atochem North America, Inc., is headquartered in Philadelphia, Pennsylvania. ATOFINA produces and markets chemical intermediates and performance polymers. Chemicals have been produced at the Riverview, Michigan, plant under a variety of owners since 1898. Elf Atochem North America, Inc., took over ownership after a company merger in 1990. Today, the plant manufactures 47 products and produces approximately 70 million pounds of organic chemicals annually. Approximately 190 persons are employed at the plant. Most raw hazardous materials used at the facility arrive by rail. Finished hazardous products are shipped from the plant by rail and truck. The plant has 5 processes that load or unload tank cars and 10 processes that load or unload highway cargo tanks.

Process 46

The area of the Riverview facility designated as "Process 46" produces methane sulfonyl chloride by a multi-step synthesis of methyl mercaptan with chlorine. Methane sulfonyl chloride is an intermediate material used in the photographic, agricultural, and pharmaceutical industries. Process 46 also produces methane sulfonic acid. Methane sulfonic acid is used as an intermediate chemical in the agricultural, electronics, and pharmaceutical industries. The methyl mercaptan and chlorine are offloaded from tank cars and fed to the plant process as needed.

At any given time, five tank cars are situated on tracks inside the Process 46 area. Two of the five tank cars contain methyl mercaptan. They are attached to the plant piping and are used, one car at a time, to supply the material to the process. When one car is empty, it is removed and replaced with a full one while the other car supplies material. Two chlorine tank cars are used in a similar manner, except that they are not attached

directly to the process plant piping. Instead, their piping is connected to a chlorine "anchor" tank car that is positioned permanently on a track scale. Chlorine is then fed to the process through piping from the anchor tank car.

According to the Riverview plant production supervisor, pipes and fittings for the methyl mercaptan and chlorine transfer equipment are not inspected or replaced on a routine or scheduled basis. According to ATOFINA management, a search through about 5 years of records did not reveal any inspection or replacement records for the failed 1-inch-diameter steel pipe that was inserted in the reducer on methyl mercaptan tank car UTLX 900558.

Methyl Mercaptan Unloading Procedures[14]

A Process 46 operator not on duty at the time of the accident described how two operators for this process connect the tank car to the plant piping. As soon as a new tank car is moved into position, one operator climbs to the top of the tank car using the stairs on the working platform while the other connects a ground wire to the car to protect against static electricity. No SCBAs or escape hoods are worn or carried by either operator. The operator on the top of the car then opens the cover assembly for the tank car's protective dome. If methyl mercaptan is leaking from the tank car, the operator on the car can detect its odor as soon as the dome lid is opened. If a leak is detected, the operator closes the lid and notifies the plant's emergency response team. If no leak is detected, the operators visually check all valves to verify that they are closed. Next, one of the operators removes the plug in the tank car's vapor valve opening[15] and threads a nitrogen line into the vapor valve. The nitrogen line provides additional pressure to the tank car, as needed, to assist in unloading the methyl mercaptan. An operator then removes the plug for one of the two unloading valves and passes the first component of the unloading apparatus (which includes the 1-inch-diameter pipe that failed in this accident) through an access hole in the side of the protective dome and threads the reducer into the unloading valve opening. The operators then connect the other components of the cargo unloading apparatus to the first component using the four-bolt flange on the other end of the 1-inch-diameter pipe. These components are attached to a flexible hose that leads to the plant piping.

According to the operator who provided the description of the connection process, once the attachment has been completed, the operators check the connections for leaks. First, they test the vapor connection to the tank car by turning on the nitrogen feed from the plant with the tank car's vapor valve closed; any leaks of nitrogen are audible. If they detect no leaks, the nitrogen feed is left on and the vapor valve is kept closed. Next, they test the unloading connection to the tank car. With the downstream valve on the unloading apparatus closed, the operators slowly open the tank car's unloading valve, allowing 20 or 30 psi of methyl mercaptan to enter the unloading apparatus and register on its pressure gauge. Once the desired 20 to 30 psi of pressure is reached in the unloading apparatus,

[14] Variations in tank car design may require slight modification of these procedures. The operator described the procedures that would have been used for the tank car involved in the accident.

[15] A plug is threaded into the valve opening to prevent the release of material from the tank car in case the valve opens or fails during transportation.

they close the unloading valve. The operators can detect by odor any leak of the poisonous methyl mercaptan gas from the fittings on the tank car.

Once the operators have made all connections and verified that there are no leaks, they close the tank car valves, and the tank car sits idle, grounded and ready for use. According to the operator who provided this information, all connections are rechecked just before the actual transfer process begins.

ATOFINA has written step-by-step instructions for these procedures in its *Standard Practice Instructions Manual*. The manual describes the sequence of actions necessary to connect the transfer piping to a methyl mercaptan tank car and to test the piping for leaks before the tank car is unloaded. The instructions do not require operators to wear SCBAs while working on methyl mercaptan tank cars. Further, they do not address carrying an escape hood with an emergency (5- to 10-minute) air supply when in the area of Process 46 tank cars, nor were such hoods carried by plant personnel. (In the event of release of poisonous gas such as occurred in this accident, emergency hoods can be donned and should provide sufficient oxygen to permit individuals to escape the area.)

ATOFINA's operators are provided with copies of the *Standard Practice Instructions Manual* as part of their training. Operators also go through on-the-job training with an experienced operator to reinforce these procedures.

Chlorine Unloading Procedures

The procedures used at ATOFINA for unloading chlorine from tank cars are similar to those used for unloading methyl mercaptan, with the following exceptions:

- Operators unloading chlorine are required to wear SCBAs when opening the tank car dome cover and making the connections.
- A spray bottle of ammonia solution is used to detect chlorine leaks from the fittings. (Ammonia reacts with chlorine to form a visible white powder.)
- Chlorine tank cars have two vapor valves; connection may be made to either valve.
- A high-pressure dry air (instead of nitrogen) line is attached to one of the two vapor valves to provide additional pressure, as needed.
- Connections are made between chlorine tank cars and the anchor tank car rather than directly to the process.

Emergency Systems

Six methyl mercaptan sensors were installed at various fixed locations throughout the Process 46 area. The sensors monitored the concentration of methyl mercaptan in the air and recorded the data. The methyl mercaptan sensors were set to detect the material and record concentrations ranging from 0 to 30 ppm.

One of the six methyl mercaptan sensors was on the tank car transfer platform where the methyl mercaptan tank car (UTLX 900558) was positioned. A review of the readout for that sensor revealed that it displayed either "0" or a signal indicating a malfunction for the 24-hour period reviewed (from about 3:15 p.m. on July 13 to 3:15 p.m. on July 14). The only sensor of the six in the Process 46 area that provided data for that 24-hour period was the one in the second-floor Process 46 control room. That sensor read "0.12" (ppm) from 3:13 p.m. on July 13 until 3:47 a.m. on July 14, at which time the readout changed to "29.88 HIHI" (indicating that the reading had exceeded a preset maximum). This reading remained until 5:12 a.m., at which time it began to gradually decline to a level of "0.94" at 3:13 p.m. on July 14.

Explosion-proof emergency switches to shut down production pumps within the process were mounted on the Process 46 transfer platforms for the methyl mercaptan and chlorine tank cars, the Process 45/46 control room, and the northeast exit door of the Process 46 building. These switches did not and were not designed to close the valves on the methyl mercaptan tank cars. The methyl mercaptan tank car was not equipped with a plant-installed remote or automatic mechanism to stop the flow of product during an emergency.

Federal/State Oversight

Federal Railroad Administration

The Federal Railroad Administration (FRA) is responsible for ensuring railroad safety throughout the Nation. FRA inspectors are assigned to one of five disciplines, one of which is hazardous materials.[16] FRA hazardous materials inspectors are responsible for ensuring that offerors[17] and transporters of hazardous materials by rail comply with applicable provisions of the hazardous materials regulations.[18] Of the approximately 450 FRA inspectors in the United States, about 50 are dedicated to enforcement of the hazardous materials regulations.

FRA hazardous materials inspectors conduct compliance reviews at offerors' facilities that ship hazardous materials, as well as at rail yards and tank car manufacture/repair facilities. Because end users of hazardous materials, such as ATOFINA, become offerors when they return tank cars containing a residue of hazardous materials to the rail carriers, the FRA also inspects end-user facilities. A single FRA hazardous materials inspector has oversight responsibility for the State of Michigan. This inspector stated that on average he inspects each of the approximately 90 offerors'

[16] The other four disciplines are track, operating practices, signal and train control, and motive power and equipment.

[17] An *offeror* is the entity (person, company, corporation, association, etc.) that offers a hazardous material for transportation.

[18] The hazardous materials regulations (49 CFR Subchapter C) are promulgated by the DOT's Research and Special Programs Administration. The FRA consults with the Research and Special Programs Administration on rulemakings specifically involving the transportation of hazardous materials by rail.

facilities within his region at least once per year. Additionally, the inspector stated he might return to a facility and conduct additional inspections during the year if an incident occurs there or if his office receives complaints about the facility.

The FRA regulations concerning loading and unloading tank cars, found in 49 CFR 174.67, require that:

- The tank car brakes are set.
- Wheels are properly chocked.
- Caution signs are placed on the track.
- Internal pressure in the tank car is relieved, as appropriate.
- All unloading apparatus, lines, and other equipment items are securely attached before tank car valves are opened.
- All connections are disconnected after the tank car is unloaded or when unloading is discontinued for any reason.
- The tank car is attended during unloading operations.
- Employees are properly trained to perform hazardous materials functions.

The FRA has issued hazardous materials bulletins that explain FRA hazardous materials policy and provide guidance about various regulated activities, including tank car unloading, attendance requirements during the unloading of tank cars, and hazardous materials training. Such bulletins are advisory in nature.

According to the FRA hazardous materials staff director, FRA's jurisdiction concerning the hazardous materials regulations encompasses hazardous materials "in transportation" by rail, but the FRA has no oversight responsibility with respect to any piece of cargo transfer equipment used to unload hazardous cargo from tank cars unless that piece is a permanent part of the car. Consequently, FRA inspectors do not inspect hazardous materials cargo transfer equipment at loading and unloading facilities. Between 1996 and June 2001, FRA inspectors performed seven inspections or audits at ATOFINA's Riverview facility. Of the seven inspections or audits, six listed some type of deficiency concerning the hazardous materials regulations. Among the problems noted were inadequate training records, inadequate markings, inadequate placards, and failure to secure all closures on tank cars, which resulted in a leak of hazardous materials. Of these violations, the FRA formally addressed one—the failure to secure tank car closures—by issuing a notice of probable violation and assessing a fine.

DOT Regulations on Loading and Unloading Hazardous Materials

The definitions of "in transportation" in both 49 *United States Code*, Section 5102, and 49 CFR 107.3 specifically identify loading and unloading of hazardous materials as part of transportation for all modes.

The DOT has developed regulations and oversees the area of loading and unloading hazardous materials. These regulations include:

- 49 CFR 173.30 concerns the loading and unloading of transport vehicles in all modes of transportation.
- 49 CFR 174.67 concerns tank car unloading.
- 49 CFR 174.101 – 174.115 concerns the loading of explosive materials being transported by rail.
- 49 CFR 177.834 concerns the general loading and unloading of highway vehicles.

On June 14, 2001, the DOT's Research and Special Programs Administration (RSPA) issued a notice of proposed rulemaking (NPRM), HM-223, entitled *Applicability of Hazardous Materials Regulations to Loading, Unloading, and Storage*.[19] The NPRM proposed, for the purposes of the hazardous materials regulations, to define "transportation" for all modes of transportation, including rail, as beginning from the moment a carrier accepts a container or package of hazardous materials to the moment the carrier relinquishes it to the consignee. In its October 29, 2001, response to the NPRM, the Safety Board expressed its concern about the proposed rulemaking and stated that "the proposed rules may result in the elimination of effective Federal oversight of hazardous materials loading/unloading operations of bulk transportation containers."

Environmental Protection Agency

The Environmental Protection Agency's (EPA's) mission is "to protect human health and to safeguard the natural environment—air, water, and land—upon which life depends." One part of that mission, safeguarding the air, is addressed in 40 CFR Subchapter C, Parts 50–99, which incorporates provisions of the Clean Air Act of 1970.[20] EPA's "General Guidance for Risk Management Programs"[21] states that:

> If you handle, manufacturer, use, or store any of the designated toxic or flammable substances listed in 40 CFR 68.130…above the specified threshold quantities in a process, you are required to develop and implement a risk management program.…

Both methyl mercaptan and chlorine are designated substances; methyl mercaptan's threshold quantity[22] is 10,000 pounds, and chlorine's threshold quantity is 2,500 pounds. The risk management program requirements became effective in June 1996.

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[19] Docket No. RSPA-98-4952, 66 *Federal Register* 32420, June 14, 2001.

[20] Title 42 *United States Code*, Sections 7401 et. seq.

[21] EPA, *General Guidance for Risk Management Programs (40 CFR Part 68)*, EPA 550-B-00-008, Washington, DC. May 2000.

[22] *Threshold quantity* is the minimum amount of toxic or flammable material in a process above which a facility is required by the EPA to develop a risk management program.

The EPA general guidance document also states that:

> [T]he goal of part 68–the risk management program–is to prevent accidental releases of substances that can cause serious harm to the public and the environment from short-term exposures and to mitigate the severity of releases that do occur.

Each risk management program must contain a hazard assessment that includes an offsite consequence analysis and a release prevention program. The EPA considers tank cars and highway cargo tanks that are interconnected with the plant's fixed equipment as parts of the plant process equipment and thus subject to EPA regulations.

The offsite consequence analysis is intended to provide information about the potential consequences of accidental releases. The analysis generally consists of a worst-case release scenario[23] involving one substance selected from all the regulated toxic substances handled at a facility, a worst-case scenario for each of the regulated flammable substances handled at a facility, an alternative release scenario for each regulated toxic substance over the threshold limit, and an alternative release scenario that represents all flammable substances over the threshold limit. Among the items included in a scenario are the quantity of the hazardous material released and the measures used to prevent or mitigate the release.

The release prevention program consists of 12 separate requirements.[24] These elements include a requirement to develop and follow a mechanical integrity program for piping systems, such as the unloading apparatus, as well as for pressure vessels, storage tanks, relief and vent systems/devices, emergency shutdown systems, controls, and pumps. The equipment covered by the mechanical integrity element must be inspected and tested using good engineering practices and must, at a minimum, be inspected in accordance with the manufacturer's recommended inspection schedule. Each mechanical integrity inspection and test must be documented.

In addition, each company must describe the risk management program in a risk management plan that must be registered with the EPA. The risk management plan does not contain all the information required in the risk management program; however, it provides the EPA with key information. The worst-case and alternative release scenarios must be included in this plan. Regulated facilities had until June 1999 to submit their first risk management plans to the EPA.

Approximately 15,000 risk management plans have been submitted to the EPA. The EPA uses a software program entitled "RMP Submit" to review the risk management plans, but this program only helps ensure that all required fields within the document contain information. Neither the EPA staff nor the software program reviews the data for content or accuracy. EPA regional staff indicated that some risk management plans (fewer

[23] The EPA defines *worst-case scenario* as the release of the largest quantity of a regulated substance from a single vessel or process line that results in the greatest distance to an endpoint.

[24] Facilities regulated under the risk management program are subject to one of three prevention program levels. Level 3 facilities, such as Riverview, are subject to the largest number of requirements.

than a dozen) have been thoroughly reviewed and that others may be audited at a later date.

The EPA received the current ATOFINA Riverview facility risk management plan on July 3, 2000. At the time the plan was submitted, 14 production processes within the facility were subject to these regulations, including Process 46.[25] The alternative toxic release scenarios for both the methyl mercaptan and chlorine tank cars involve the failure of the flexible hose that connects the unloading apparatus to the plant piping. Each scenario lists the tank car's excess flow valve as an active mitigation measure.

The release prevention program for Process 46 also cites tank car "excess flow devices" as one of the prevention methods. In addition, one of the mitigation systems involves planned and periodic inspections of critical equipment. The executive summary for the risk management plan specifically identifies the need for frequent inspection of the unloading lines. The risk management plan also lists the process gas monitoring/detection systems as methods for preventing or mitigating a release.

On-site inspection of facilities to verify the compliance with the EPA regulations has been left to discretion of each EPA region. Interviews with EPA Region V personnel, whose jurisdiction includes the State of Michigan, revealed that, between the initiation of the EPA's oversight program in June 1996 and the July 14, 2001, accident, three on-site inspections covering the requirements of the risk management program had been conducted of the approximately 2,800 facilities that submitted risk management plans within the region. ATOFINA's Riverview plant was not one of the three facilities inspected. After the accident, EPA regional personnel initiated an inspection of the portion of ATOFINA's risk management program concerning the Process 46 location of the plant.

Occupational Safety and Health Administration

The mission of the Occupational Safety and Health Administration (OSHA) is "to prevent fatalities, injuries, and to protect the health of America's workers." The Occupational Safety and Health Act of 1970 (Public Law 91-596) was enacted "to assure safe and healthful working conditions for working men and women." The general duty clause requires that "each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees." To achieve that goal, Congress delegated broad, general authority to the Secretary of Labor to regulate the working conditions that affect the occupational safety and health of the Nation's employees. OSHA is preempted from exercising its authority under this act if another Federal agency has been granted statutory authority to regulate the relevant working conditions and if the other Federal agency has exercised its authority in a manner such as to exempt the cited working conditions from OSHA's jurisdiction. As an example, vehicle operators (truckdrivers or train crews) who are regulated by the DOT are not subject to OSHA's regulations.

[25] After July 3, 2000, 1 of the 14 processes was eliminated.

The Occupational Safety and Health Act of 1970 also gives States an opportunity to assume responsibility for occupational safety and health standards and enforcement through the mechanism of an OSHA-approved State plan. Twenty-one States, including Michigan, have assumed this responsibility for private and public employees.

OSHA regulations are codified in 29 CFR. Section 1910.119 implements the program designated as the "process safety management of highly hazardous chemicals." Section 1910.119 contains requirements for preventing or minimizing the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals. The OSHA process safety management program preceded, and was used as a model for, the EPA's risk management program. Like the EPA, OSHA has certain threshold quantity limits for these materials, but the EPA and OSHA limits are not identical. In this case, OSHA's threshold quantity limits are less than the EPA's: OSHA limits are 5,000 pounds for methyl mercaptan and 1,500 pounds for chlorine.

OSHA's Process Safety Management program emphasizes the management of risks associated with highly hazardous chemicals. One requirement of the Process Safety Management program is the development of a process hazard analysis for each plant process that involves quantities of a hazardous material in excess of the OSHA threshold quantity limit. Each process hazard analysis must identify potential hazards and propose recommendations to reduce the potential risks associated with those hazards. OSHA defines a "process" as follows:

> [A]ny activity involving a highly hazardous chemical including any use, storage, manufacturing, handling, or the on-site movement of such chemicals, or combination of these activities. For purposes of this definition, any group of vessels which are interconnected and separate vessels which are located such that a highly hazardous chemical could be involved in a potential release shall be considered a single process.

OSHA considers tank cars that transfer product to and from a process to be part of that process. The Process Safety Management program requirements apply to all activities, including loading and unloading operations, that are part of a regulated process. Once completed, the process hazard analysis must be retained at the employer's facility. Unlike EPA requirements, the analysis does not have to be submitted to either Federal or State OSHA.

OSHA is authorized to conduct workplace inspections to determine whether employers are complying with its standards for safe and healthful workplaces. OSHA safety and health officers perform workplace inspections to ensure compliance. States with OSHA-approved programs use qualified State officers as inspectors.

Because some 6.2 million workplaces are covered by the Occupational Safety and Health Act of 1970, which represents a challenge to the agency's resources, OSHA has established a system of inspection priorities. First, imminent danger situations are given top priority. OSHA considers an "imminent danger" to be any condition in which there is reasonable certainty that a danger exists that can be expected to cause death or serious

physical harm immediately or before the danger can be eliminated through normal enforcement procedures. Second priority is given to investigation of fatalities and accidents resulting in the hospitalization of three or more employees. Third priority is given to employee complaints of alleged violations of standards or unsafe/unhealthy working conditions and to referrals from other government authorities about specific workplace hazards. Lastly, programmed inspections aimed at specific high-hazard industries, workplaces, occupations, health substances, or other industries are considered and identified in OSHA's current inspection scheduling procedures. Follow-up inspections may be conducted to determine whether previously cited deficiencies have been corrected.

In Michigan, the responsibility for workplace safety falls to an entity designated the MIOSHA program office, which is within the Michigan Department of Consumer and Industry Services, Bureau of Safety and Regulation. The MIOSHA program office has 76 compliance officers who enforce the workplace standards for 4 million employees working for 200,000 employers in Michigan. MIOSHA conducted 6,874 inspections in fiscal year 2000.

Within MIOSHA, the General Industry Safety Division is responsible for overseeing process hazard analysis at chemical plants. This division has two officers dedicated to compliance at chemical plants and three others who assist with chemical plant oversight as a part of their duties. In 1993, while establishing a program of chemical plant oversight, MIOSHA developed a list of the 100 facilities within Michigan that utilize the largest quantity and/or most dangerous chemicals within their processes. From the list of 100, each year since 1993, about 10 facilities, on average, have been selected at random for a scheduled program quality verification audit. This type of audit was developed to ensure comprehensive and planned compliance inspections in large petrochemical manufacturing plants with a high potential for catastrophic release. As part of the program quality verification audit, the OSHA process safety management requirements for selected plant processes were reviewed. Compliance was determined by reviewing written programs, observing the process areas, and interviewing management, union, and hourly personnel. The MIOSHA inspector for this program stated that, as of May 2002, approximately 85 of the 100 facilities on the 1993 list had been inspected.

According to MIOSHA, the ATOFINA facility in Riverview was the first of the 100 facilities inspected from the 1993 list. ATOFINA's program quality verification audit began on September 8, 1994. Audit team members were on site on a daily basis at the Riverview facility through November 2, 1994, and on an intermittent basis until December 20, 1994. The audit team comprised four MIOSHA inspectors. According to information provided by MIOSHA, a total of 960 work hours were dedicated to the inspection. The audit reviewed all processes at the Riverview facility, but only two processes received in-depth inspections. Process 46 was not one of those two processes.

The audit found that the Riverview facility had a process safety management program in place but that it contained significant deficiencies. The initial citation identified 31 "serious," 4 "other than serious," and 1 "willful" violations. Eighteen of the serious violations were related to process safety management standards. One of the serious violations was that reactors, tanks, vent systems, and process piping systems were not

being inspected or tested as required. Further, the inspection report described the Riverview facility's overall mechanical integrity program by stating:

> The employer failed to establish and implement a program to inspect and test process equipment, such as pressure vessels and storage tanks that contained highly hazardous chemicals, using inspection and test procedures which followed recognized and generally accepted good engineering practices.

To correct this deficiency, MIOSHA recommended that ATOFINA:

> [D]evelop a comprehensive list of process equipment covered by the mechanical integrity program. The list should include the equipment identity, the inspection or test reference (such as external and internal visual examination, bench tests, non-destructive tests, etc.) and an inspection and test schedule. An appropriate reference document should then exist for each inspection and test to be based on the consensus standards and codes, industry practice, plant experience or other reference sources. Inspections and tests must be properly documented as required.

According to the abatement agreement[26] submitted by ATOFINA, the company agreed to "develop written procedures to address mechanical integrity and inspection and testing of equipment and piping." ATOFINA also stated that it would "on or before November 26, 1997, document that not less than 100 percent of the process equipment and piping systems regulated by 29 CFR 1910.119 (Process Safety Management Standard) have been inspected and tested." MIOSHA conducted no follow-up inspection to ensure that ATOFINA had corrected the cited violations.

In fulfilling the abatement agreement, ATOFINA developed a mechanical integrity program. The program required periodic inspections of the wall thickness of plant piping, including the transfer piping at all of the tank car platforms. The inspection procedures did not establish specific inspection cycles but stated that inspections should be conducted "often" where deterioration is "extreme" and "seldom" where deterioration is "minimal." The mechanical integrity program also contained procedures relating to the support of cargo transfer equipment, but these procedures focused on detecting equipment distortion and broken anchors on plant piping.

Following the July 14, 2001, Riverview accident, MIOSHA inspectors audited ATOFINA and identified 22 probable violations of OSHA regulations. The enforcement action was settled on May 1, 2002, without admission of liability. The company paid a penalty of $500,000 and agreed to provide about $5 million more to make additional plant improvements to enhance employee safety, to enable local emergency response agencies to enhance the safety of the local communities, and to perform audits of other ATOFINA facilities to improve employee safety.

[26] MIOSHA defines an *abatement agreement* as a means of rapidly reducing or eliminating (abating) a hazard whereby "an employer who appeals a citation within fifteen working days of receipt of the citation, who shows good faith to comply with MIOSHA standards, and who cooperated with the department during the audit may receive a monetary penalty reduction of up to fifty percent," provided the employer abates the cited problems, provides proof of the abatement, pays the penalties, and abides by all agreed-upon actions.

Emergency Preparedness

On March 1, 2000, ATOFINA implemented an extensive general emergency plan for the Riverview facility that included emergency procedures specific to Process 46. The purpose of the plan was to minimize hazards to public health or the environment caused by fires, explosions, or releases of hazardous waste or hazardous waste constituents to the air, soil, or surface waters. A copy of the emergency plan was given to the Riverview Fire Department and the fire departments of the surrounding communities, and periodic tours and training were provided to the Riverview and Wyandotte Fire Departments.

The emergency plan also stated that the plant nurse maintains an open dialogue with the local hospitals. However, before July 14, 2001, interactions between ATOFINA and the Riverside Osteopathic Hospital focused on communications pertaining to the hospital's treatment of ATOFINA employees injured while working. After the accident, ATOFINA conducted a presentation for Riverside Osteopathic Hospital staff regarding chemical exposure, basic toxicology, decontamination, and basic hazardous materials training and recommended minimum requirements for a hazardous materials room where victims of hazardous materials accidents could be isolated. The hospital has developed procedures and identified a room to be used in the event of a future hazardous materials incident to prevent the type of contamination that occurred in this accident.

Other Information

Postaccident Activities

Since the accident, ATOFINA has made a number of changes to its plant procedures and equipment to address problems identified during the investigation. ATOFINA's mechanical integrity/preventive maintenance program now requires that the cargo unloading apparatus, including the integral piping, be removed from service every 2 years and undergo non-destructive testing to ensure that it is still safe to be used. ATOFINA has redesigned the unloading apparatus and has added a remotely operated shutoff valve. Operators are now required to wear SCBAs when working on the methyl mercaptan tank cars, and they are required to carry an escape hood with an emergency air supply when in the area of the tank cars. In addition, operators now perform leak tests on the unloading apparatus before opening the valve to the tank car. To perform the test, operators attach the apparatus to the tank car, pressurize it with nitrogen gas, and use a soap solution to visually detect leaks. ATOFINA has also redesigned the transfer connection to the methyl mercaptan tank cars. The redesigned apparatus consists of a 2-inch-diameter pipe about 1-foot long that is mounted vertically to the loading line valve on the tank car. A remotely actuated shutoff valve, which is connected to the downstream end of the 1-foot pipe section, can be closed from multiple locations during an emergency.

Industry Use of Excess Flow Valves

Following the accident, Safety Board investigators interviewed a sampling of domestic chemical companies that receive materials in tank cars concerning their use of excess flow valves. Telephone interviews with personnel responsible for the company risk management plans required by the EPA and OSHA revealed that six of nine companies surveyed rely on the tank car excess flow valves as a method of stopping or limiting a leak in the transfer equipment. Two of the nine companies did not respond to this question, and the remaining company indicated that it has remotely operated shutoff valves on the unloading piping just outside the tank car dome.

Analysis

This analysis is presented in three main parts. In the first part, the Safety Board identifies factors that can readily be excluded as causal or contributory to the accident. In the second part, the Board analyzes the causes and factors contributing to the severity of the accident. In the final part, the Board discusses the safety issues arising from the investigation:

- The adequacy of ATOFINA's procedures for unloading tank cars containing hazardous materials.
- The adequacy of Federal regulations and oversight for cargo transfer operations involving bulk containers transporting hazardous materials.

Exclusions

The following issues were examined but were not found to be factors in this accident: the tank car design, the experience and condition of the personnel involved in the accident, the failure of the methyl mercaptan sensor on the tank car platform, and the emergency response. The equipment failures that resulted in the accident occurred in the unloading apparatus, which were not part of the tank cars, and both tank cars withstood the fire without catastrophic failure. Both the operators who were working on the tank car had 14 to 15 years of experience unloading methyl mercaptan from tank cars for use in Process 46. Evidence suggests that both operators were behaving normally on the night of the accident, and postaccident drug and alcohol test results were negative. The Safety Board was concerned that the methyl mercaptan sensor on the platform near the accident tank car malfunctioned; however, ATOFINA had multiple sensors, and no action that could have been taken in response to an alarm from the platform sensor would have prevented the accident or reduced its severity. (See the discussion of the tank car's excess flow valve.) Since the accident, ATOFINA has replaced the entire alarm system and has installed additional sensors. The plant emergency response team reacted immediately to the emergency, the local emergency response agencies arrived within 10 minutes, and both sets of responders took reasonable measures to prevent the spread of the fire and the release of other hazardous materials. Additionally, the decision to evacuate local residents likely prevented their being exposed to the poisonous methyl mercaptan gas. Therefore, the Safety Board concludes that the tank car design, the experience and condition of the personnel preparing the methyl mercaptan tank car for unloading, the failure of the methyl mercaptan sensor on the tank car platform, and the on-scene emergency response were not factors in the accident.

The Accident

This accident occurred as a result of a broken transfer pipe that allowed poisonous and flammable methyl mercaptan gas to escape and contaminate the local area. While that much is known, because neither of the two employees directly involved in this accident survived, some questions about the events surrounding the accident cannot be answered with certainty. For example, it could not be determined when during the hookup operation the fractured pipe failed or what exactly caused it to fail; that is, how force was applied to the pipe sufficient to cause it to fail. Nor could it be determined why, after the leak was detected, the tank car's unloading valve was not shut off in time to prevent all three employees in the area from being overcome by the poison gas. The locations of the three employees and their specific activities at the time of the accident also could not be determined.

Despite these uncertainties, enough information about the accident could be gathered to lead investigators to examine ATOFINA's plant procedures for the inspection, maintenance, and use of cargo transfer equipment and for the unloading of methyl mercaptan tank cars. Investigators also examined ATOFINA's procedures and requirements regarding protective equipment as well as Federal oversight of chemical transfer activities.

Inspection, Maintenance, and Use of Cargo Transfer Equipment

Metallurgic examination of the failed transfer pipe revealed evidence of erosion-corrosion resulting in a significant thinning of the pipe wall. The flow of the liquefied methyl mercaptan through the pipe caused a gradual erosion of the metal. The erosion was accelerated during each exposure of the interior of the pipe to the weather, when atmospheric corrosion converted small amounts of the steel to iron oxide (rust). Subsequent liquid flow during unloading eroded, or swept away, the iron oxide on the interior of the pipe, revealing clean steel that readily corroded during its next exposure to the atmosphere. The consequence of such cyclic action is the gradual wearing away of the interior surface of the pipe wall, which reduces the strength of the pipe.

During use, the failed pipe was subjected to bending forces by the attachment of an unloading apparatus that weighed about 53 pounds. The Safety Board's metallurgy staff estimated that about 175 pounds of additional downward force applied on the outer end of the apparatus would have resulted in the failure of the pipe; however, this is only an estimate, and the actual force required may have been different. The Safety Board concludes that erosion and corrosion had weakened the transfer pipe such that application of a force such as an individual's falling, leaning, or stepping on the pipe or dropping an object on it, in combination with the weight of the unloading apparatus, could have caused the pipe to break and release the methyl mercaptan.

ATOFINA's Process 46 general operating instructions specified that operators perform a visual, external inspection of transfer piping each time unloading connections

were made to a methyl mercaptan tank car. However, external visual inspections would not have detected the reduction in wall thickness caused by the erosion-corrosion that led to the transfer pipe failure in this accident.

ATOFINA's mechanical integrity program included written procedures that covered the inspection and maintenance of all plant equipment used in the handling of hazardous materials, including the transfer pipes used to unload hazardous materials from tank cars. But the inspection procedures under the mechanical integrity program did not establish specific inspection cycles. Instead, the procedures set out subjective and vague inspection standards such as "often" when deterioration is "extreme" and "seldom" when deterioration is "minimal."

While ATOFINA could not provide data or records to confirm whether or when the transfer pipe that failed in this accident had last been inspected under the mechanical integrity program, the erosion-corrosion that was found within the failed pipe indicated that the program had clearly not been effective. The Safety Board concludes that ATOFINA's failure to implement effective procedures for inspection and maintenance of its unloading pipes and fittings allowed the transfer pipe in this accident to gradually deteriorate and ultimately fail.

Procedures relating to the physical support for cargo transfer equipment while in use were also included in the mechanical integrity program. The procedures focused on detection of such factors as equipment distortion and broken anchors on plant piping, but they did not establish standards to ensure the transfer piping was adequately supported. Since the accident, ATOFINA's mechanical integrity/preventive maintenance program has been changed to require that the cargo unloading apparatus, including the integral piping, be removed from service every 2 years and undergo non-destructive testing to ensure that it is still safe to be used in the process. ATOFINA has also redesigned the unloading apparatus to reduce mechanical stress.

ATOFINA Policy Regarding Use of Personal Protection Equipment

The fatal injuries to the ATOFINA employees caused by methyl mercaptan intoxication raised concerns about ATOFINA's procedures for ensuring the safety of its employees working on or around tank cars containing poisonous gases. None of the employees was prepared to cope with a serious gas leak. Had they had personal protective equipment available, they may have been able to close the unloading valve and stem the flow of gas or, at a minimum, escape the area.

ATOFINA's procedures at the time of this accident did not require that employees wear SCBAs while performing cargo transfer operations on methyl mercaptan tank cars. In fact, ATOFINA's procedure for leak-testing the unloading apparatus by having the operator pressurize it with the methyl mercaptan and attempt to detect the odor of this poisonous gas actually required the operator to be unprotected to perform the test. This

procedure subjected employees to the risk of injury. In contrast, the company's procedures for transfer operations involving tank cars containing chlorine—also a poisonous gas—did require that operators wear SCBAs.

Because methyl mercaptan, like chlorine gas, is toxic by inhalation, the use of approved respiratory protection equipment is appropriate to prevent inhalation exposure that could lead to incapacitation and death. An operator wearing such equipment when the release occurred would not have been incapacitated and would have had time to escape the area and/or respond successfully to the emergency. Even an escape hood with an emergency air supply that can be donned in the event of a sudden and unexpected release of poisonous gas would have provided sufficient oxygen to permit an individual to escape the area in the case of such an emergency. Therefore, the Safety Board concludes that the use of proper personal protective equipment, such as SCBAs or escape hoods, would likely have allowed the employees in this accident to survive the initial release of methyl mercaptan and either safely evacuate the area or close the unloading valve and stop the leak.

Since the accident, ATOFINA has implemented procedures that require operators to wear SCBAs when making cargo transfer connections to methyl mercaptan tank cars. ATOFINA has also changed its leak-testing procedures and now tests the tank car unloading apparatus by pressurizing it with nitrogen gas and using a soap solution to detect leaks before the unloading valve on the tank car is opened. In addition, all workers in the area of tank cars containing poison gases must now carry an escape hood with an emergency air supply.

Reliance on the Tank Car's Excess Flow Valve

Both the EPA and OSHA required ATOFINA to develop and document safety plans for the Riverview facility that included safeguards intended to reduce the risk and consequences of catastrophic releases of hazardous materials. ATOFINA's risk management plan (mandated by the EPA) and process hazard analysis (mandated by OSHA) included an accident scenario that involved the failure of a flexible hose on the unloading apparatus for a methyl mercaptan tank car—a scenario similar to this accident. Under both plans, ATOFINA indicated that the release of methyl mercaptan would be stopped by the automatic closure of the tank car's excess flow valve. Further, ATOFINA's risk management plans explicitly noted that excess flow valves on the tank car would activate in the event of a pipeline or unloading hose rupture. However, when the transfer pipe failed on July 14, 2001, the excess flow valve on the tank car did not close and stop the release of the methyl mercaptan.

Calculations made by Safety Board engineers and parties to the investigation indicated that the flow rate of methyl mercaptan through the broken transfer piping was insufficient to cause the excess flow valve to close. Excess flow valves are designed to close and stop the release of product from the tank car in the event a tank car valve or fitting is broken or sheared off during transit. Attaching cargo transfer apparatus to a tank

car can change product release rates and flow rate characteristics and can prevent the excess flow valve from closing in the event of an emergency. As noted by the Chlorine Institute in its *Chlorine Manual* and by the Safety Board in its investigation of a July 30, 1983, accident at the Formosa Plastics plant in Baton Rouge, Louisiana[27] tank car excess flow valves are not designed to act as an emergency shutoff device during cargo transfer.[28]

Therefore, the Safety Board concludes that reliance on tank car excess flow valves to stop leaks during tank car cargo transfer operations is inappropriate.

To determine whether reliance upon tank car excess flow valves as safety mechanisms during transfer operations is restricted to ATOFINA or is a broader problem, Safety Board investigators interviewed a sampling of domestic chemical companies. Interviews with personnel responsible for company safety plans revealed that six of nine companies surveyed rely on tank car excess flow valves as a method of stopping or limiting a leak in the transfer equipment. Only one company reported having remotely operated shutoff valves on the unloading piping just outside the tank car dome. (The other two companies did not respond to the Safety Board's inquiry.) Although the Safety Board's sampling was limited, the results suggest that the inappropriate use of tank car excess flow valves may be a widespread practice in the chemical industry. To address this issue, the Safety Board believes that the FRA should issue a hazardous materials bulletin to warn companies involved in tank car loading and unloading operations that tank car excess flow valves cannot be relied upon to stop leaks that occur during those operations.

The Safety Board further believes that the EPA should notify all facilities that are required to submit risk management plans to the EPA that tank car excess flow valves cannot be relied upon to stop leaks that occur during tank car loading and unloading operations and that those companies that have included reliance on such valves in their risk management plans should instead identify and implement other measures that will stop the uncontrolled release of product in the event of a transfer line failure during tank car loading or unloading.

Federal Oversight of Loading and Unloading Operations

Several Federal agencies, including DOT modal agencies, the EPA, and OSHA, provide safety oversight for elements of hazardous material bulk container loading and unloading operations. None of these programs provided the level of oversight necessary to prevent the Riverview accident.

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[27] National Transportation Safety Board, *Vinyl Chloride Monomer Release From a Railroad Tank Car and Fire, Formosa Plastics Corporation Plant, Baton Rouge, Louisiana, July 30, 1983*, Hazardous Material Accident Report NTSB/HZM-85/08 (Washington, D.C.: NTSB, 1985).

[28] Although excess flow valves are routinely used as safety mechanisms in the piping systems of fixed facilities, those excess flow valves are designed and constructed for specific piping systems and the properties of the material flowing through the pipe.

EPA and OSHA

The EPA and OSHA each have multiple program responsibilities mandated by several statutes. Under the authority of the Clean Air Act and the Occupational Safety and Health Act, the EPA and OSHA exercise some oversight at chemical plants, which includes oversight of hazardous materials transfer operations involving tank cars, highway cargo tanks, and other bulk containers. However, oversight of hazardous materials cargo transfers is only a minor element of these agencies' chemical plant oversight programs, which are themselves elements of still larger programs.

Also, the number of inspectors each agency has assigned to oversee these operations is limited compared to the number of chemical facilities and plants that fall under the agencies' respective programs. The EPA estimates that its risk management program regulates at least 15,000 facilities within the United States; about 2,800 facilities are in Region V, which covers a five-State area that includes Michigan. The EPA had only three inspectors to oversee its risk management program in Region V, and those personnel had conducted only three inspections between the inception of the program in 1999 and the 2001 Riverview accident.

Because of the scope of its oversight responsibilities, OHSA delegates some of those responsibilities to State agencies. MIOSHA, the Michigan agency that has been delegated to provide OSHA oversight within the State, has only two chemical plant inspectors for the entire State. Since 1993, MIOSHA inspectors have conducted approximately 85 plant inspections. Thus, after more than 8 years, the agency has not been able to inspect all of the 100 facilities that, because of the quantities and types of chemicals they use, were identified in the 1993 OSHA oversight program plan as the highest priority plants.

The inspections that EPA and OSHA inspectors must conduct are complicated and intensive because, according to Federal requirements, each EPA or OSHA inspector is expected to oversee all plant operations for each of the regulated facilities. With a chemical plant the size of ATOFINA, this could mean inspecting more than a dozen processes, each with numerous procedures and employees, and hundreds of pieces of equipment. Each piece of equipment may be subject to as many as 12 different safety requirements. For example, the 1994 MIOSHA audit of the ATOFINA Riverview plant took approximately 960 hours to conduct, yet it covered only 2 of the 14 processes at the facility in depth. In addition, although 35 violations were noted during the audit (including ATOFINA's failure to implement a mechanical integrity program for its plant piping system), MIOSHA conducted no follow-up inspection to ensure that ATOFINA had corrected the cited violations.

The EPA and OSHA oversight programs have additional weaknesses. For instance, although the EPA and OSHA both require each facility to develop a written plan that describes the procedures and mechanisms in place under each safety program, neither agency routinely evaluates the plans to determine the effectiveness or appropriateness of the procedures and mechanisms. Also, other than such reviews as take place during the

rare plant inspections, neither agency verifies that the plants comply with the standards identified in their own plans.

FRA

The FRA has 50 inspectors to determine compliance with the hazardous materials regulations. Although the single FRA inspector responsible for the State of Michigan has approximately 90 facilities to oversee, he generally has been able to inspect all of those facilities annually. In fact, the FRA has inspected the Riverview plant seven times in the past 6 years. The FRA inspectors are able to perform more frequent inspections than either the EPA or OSHA because, at least in part, FRA inspections focus on the limited requirements relating to tank car loading and unloading that are contained in the hazardous materials regulations. These regulations cover the setting of tank car brakes, the chocking of wheels, the placing of caution signs on the track, and attendance during unloading operations. They do not address the inspection, maintenance, and support of cargo transfer fittings; the development of safe unloading procedures, including leak-test procedures for fittings; or the use of personal protection equipment by the operators unloading the tank car.

The Safety Board therefore concludes that effective oversight of hazardous materials loading and unloading operations from tank cars and other bulk containers is not provided by the FRA, the EPA, or OSHA.

Previous Safety Recommendations

Over a number of years, the Safety Board has attempted to address the safety problems associated with hazardous materials loading and unloading operations from bulk containers by making individual recommendations to the various Federal agencies—including the EPA, OSHA, the FRA, RSPA, and the DOT—that share elements of the responsibility for providing safety oversight of these operations.

For example, many of the deficiencies with Federal oversight identified during this investigation are almost identical to the safety issues the Safety Board noted in its report on the previously referenced accident at the Formosa Plastics plant in Baton Rouge, Louisiana. That accident involved the release and ignition of a toxic gas from a tank car during transfer operations at a petrochemical facility. As a result of its investigation, the Safety Board concluded that contributing to the accident was the fact that Federal regulations concerning working conditions and the equipment used at the transfer station were not being enforced at the plant because neither the FRA nor OSHA had inspected the plant between 1977 and 1983.

As a result of its investigation, the Safety Board issued the following safety recommendation to RSPA:

R-85-70

Establish safety standards and inspection procedures for loading facilities at petrochemical plants.

In a March 27, 1987, response to Safety Recommendation R-85-70, RSPA agreed that further refinements to the regulations pertaining to the operation of safe loading and unloading facilities would lead to safety improvements at those facilities. RSPA subsequently provided details on how it intended to specify training requirements for critical functions relating to the transportation of hazardous materials (including the loading process) and use safety regulations published by OSHA to develop and implement specific loading standards and procedures. Based on this information, the Safety Board determined that this framework met the objective of the recommendation and classified Safety Recommendation R-85-70 "Closed—Acceptable Alternate Action" on December 20, 1993.

The Safety Board also issued the following safety recommendation to the FRA:

R-85-68

Establish a program to inspect rail loading facilities at petrochemical plants on a regular basis.

In a March 15, 1989, response to Safety Recommendation R-85-68, the FRA stated that its hazardous materials inspectors would inspect the entirety of the loading and unloading areas during their on-site inspections and notify OSHA of any conditions presenting potential hazards. The FRA stated that its hazardous materials inspectors would devote 40 percent of their time to inspections at facilities where loading and unloading of tank cars was conducted. Accordingly, the Safety Board classified Safety Recommendation R-85-68 "Closed—Acceptable Action" on May 21, 1991.

In addition, the Safety Board recommended to OSHA:

R-85-71

Evaluate your ability to conduct inspections of petrochemical plant loading facilities and your method for establishing inspection priorities for general inspection and make necessary changes to provide for regular inspection.

In responses to Safety Recommendation R-85-71, OSHA described a "special emphasis" program for the chemical industry that became effective in November 1985. OSHA stated that the program would be conducted in areas with the greatest concentration of petrochemical plants. OSHA also pledged to notify the FRA of any potential violations of the DOT hazardous materials regulations. Based on these

responses, the Safety Board classified Safety Recommendation R-85-71 "Closed—Acceptable Alternate Action" on September 24, 1986.

Other accidents, including the October 7, 1986, fire on board the Panamanian tank ship *Shoun Vanguard* in Deer Park, Texas,[29] and the March 6, 1984, release of hazardous waste acid from a cargo tank truck in Orange County, Florida,[30] heightened the Safety Board's concerns about the transfer of hazardous materials between and within all modes of transportation. Because this concern involved several modes of transportation, the Safety Board issued the following intermodal safety recommendation on March 14, 1988, to the DOT:

> I-88-2
>
> Strengthen minimum safety requirements for loading and unloading of hazardous materials to provide adequate, uniform safety in all modes of transportation.

In a September 30, 1988, response, the DOT stated that it was examining issues related to the loading and unloading of hazardous materials at intermodal facilities through several rulemaking activities, but the DOT did not complete action on most of these initiatives. After the Safety Board requested an update on the status of its actions, the DOT indicated in a September 2000 response that it had focused primarily on a proposed rule under docket HM-223 that would be published within the upcoming fiscal year (FY 2001). According to the DOT, HM-223 would address the applicability of the hazardous materials regulations to loading, unloading, and storage. The DOT stated that the goal of the rulemaking under HM-223 was to "clarify" the applicability of the hazardous materials regulations and the jurisdictional relationship between the hazardous materials regulations and regulations promulgated by the EPA and OSHA. On December 5, 2000, the Safety Board determined that, although the DOT was undertaking a strategic realignment of the management of the department's hazardous materials program, there had not been any significant progress on the recommendation in more than 12 years. Consequently, the Safety Board classified Safety Recommendation I-88-2 "Closed—Unacceptable Action."

On June 14, 2001, RSPA published its NPRM under docket HM-223, *Applicability of Hazardous Materials Regulations to Loading, Unloading, and Storage*. Under the rulemaking, RSPA proposed to limit the definition of "transportation" to include only the period from the moment a carrier accepts a container or package of hazardous materials until the carrier relinquishes it to the consignee. The proposed rule would thus apply to loading and unloading operations only if those operations are performed by the carrier. The Safety Board is concerned that, because the loading of tank cars and other bulk

[29] National Transportation Safety Board, *Fires on Board the Panamanian Tank Ship* Shoun Vanguard *and the U.S. Tank Barge* Hollywood 3013*, Deer Park, Texas, October 7, 1986,* Marine Accident Report NTSB/MAR-87/08 (Washington, D.C.: NTSB, 1987).

[30] National Transportation Safety Board, *Release of Hazardous Waste Acid from Cargo Tank Truck, Orange County, Florida, March 6, 1984*, Hazardous Materials Accident Summary Report NTSB/HZM-85/01 (Washington, D.C.: NTSB, 1985).

containers is typically performed by the offeror before the carrier accepts the vehicle or bulk container and because unloading is frequently performed by the consignee after the carrier relinquishes it, these operations would, in most cases, not be covered by the regulations or be subject to DOT oversight. The Safety Board's October 29, 2001, letter to RSPA concerning the NPRM expressed these concerns in detail. (See appendix B.)

The Safety Board believes that hazardous materials cargo loading and unloading operations deserve more oversight and that therefore the DOT should, with the assistance of the EPA and OSHA, develop safety requirements that apply to the loading and unloading of railroad tank cars, highway cargo tanks, and other bulk containers that address the inspection and maintenance of cargo transfer equipment, emergency shutdown measures, and personal protection requirements. The Safety Board further believes that the DOT should, once these safety requirements are adopted, implement an oversight program to ensure compliance with the requirements.

Conclusions

Findings

1. The tank car design, the experience and condition of the personnel preparing the methyl mercaptan tank car for unloading, the failure of the methyl mercaptan sensor on the tank car platform, and the on-scene emergency response were not factors in the accident.

2. Erosion and corrosion had weakened the transfer pipe such that application of a force such as an individual's falling, leaning, or stepping on the pipe or dropping an object on it, in combination with the weight of the unloading apparatus, could have caused the pipe to break and release the methyl mercaptan.

3. ATOFINA's failure to implement effective procedures for inspection and maintenance of its unloading pipes and fittings allowed the transfer pipe in this accident to gradually deteriorate and ultimately fail.

4. The use of proper personal protective equipment, such as self-contained breathing apparatus or escape hoods, would likely have allowed the employees in this accident to survive the initial release of methyl mercaptan and either safely evacuate the area or close the unloading valve and stop the leak.

5. Reliance on tank car excess flow valves to stop leaks during tank car cargo transfer operations is inappropriate.

6. Effective oversight of hazardous materials loading and unloading operations from tank cars and other bulk containers is not provided by the Federal Railroad Administration, the Environmental Protection Agency, or the Occupational Safety and Health Administration.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident involving the release of methyl mercaptan from a tank car at the ATOFINA Chemicals, Inc., plant in Riverview, Michigan, was a fractured cargo transfer pipe that resulted from (1) the failure of ATOFINA to adequately inspect and maintain its cargo transfer equipment, and (2) inadequate Federal oversight of unloading operations involving hazardous materials. Contributing to the accident were ATOFINA's reliance on a tank car excess flow valve to close in the event of a leak from cargo transfer equipment and the company's failure to require appropriate safety equipment for employees involved in tank car loading and unloading operations.

Recommendations

As a result of its investigation of the July 14, 2001, accident at Riverview, Michigan, the National Transportation Safety Board makes the following safety recommendations:

To the U.S. Department of Transportation:

Develop, with the assistance of the Environmental Protection Agency and the Occupational Safety and Health Administration, safety requirements that apply to the loading and unloading of railroad tank cars, highway cargo tanks, and other bulk containers that address the inspection and maintenance of cargo transfer equipment, emergency shutdown measures, and personal protection requirements. (I-02-1)

Implement, after the adoption of safety requirements developed in response to Safety Recommendation I-02-1, an oversight program to ensure compliance with these requirements. (I-02-2)

To the Federal Railroad Administration:

Issue a hazardous materials bulletin to warn companies involved in tank car loading and unloading operations that tank car excess flow valves cannot be relied upon to stop leaks that occur during those operations. (R-02-16)

To the Occupational Safety and Health Administration:

Assist the U.S. Department of Transportation in developing safety requirements that apply to the loading and unloading of railroad tank cars, highway cargo tanks, and other bulk containers that address personal protection requirements, emergency shutdown measures, and the inspection and maintenance of cargo transfer equipment. (I-02-3)

To the Environmental Protection Agency:

Assist the U.S. Department of Transportation in developing safety requirements that apply to the loading and unloading of railroad tank cars, highway cargo tanks, and other bulk containers that address personal protection requirements, emergency shutdown measures, and the inspection and maintenance of cargo transfer equipment. (I-02-4)

Notify all facilities that are required to submit risk management plans to the Environmental Protection Agency that tank car excess flow valves cannot be relied upon to stop leaks that occur during tank car loading and unloading operations and that those companies that have included reliance on such valves in their risk management plans should instead identify and implement other measures that will stop the uncontrolled release of product in the event of a transfer line failure during tank car loading or unloading. (R-02-17)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

MARION C. BLAKEY
Chairman

CAROL J. CARMODY
Vice Chairman

JOHN A. HAMMERSCHMIDT
Member

JOHN J. GOGLIA
Member

GEORGE W. BLACK, JR.
Member

Adopted: June 26, 2002

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Appendix A

Investigation and Hearing

The National Transportation Safety Board was notified of the accident about 8:05 a.m., eastern daylight time, on July 14, 2001. A full go-team was dispatched from Washington, D.C., to Riverview, Michigan. No Board Member went with the team. Investigative groups were established for hazardous materials, survival factors, human performance, railroad, and metallurgy.

Parties to the investigation were the Federal Railroad Administration; the Environmental Protection Agency; the City of Riverview, Michigan; ATOFINA Chemicals, Inc.; Union Tank Car Company; Midland Valve Company; and the Canadian National/Illinois Central Railroad.

The Safety Board did not conduct a public hearing during this investigation.

Appendix B

NTSB Response to NPRM Docket HM-223

National Transportation Safety Board

Washington, D.C. 20594

Office of the Chairman

OCT 2 9 2001

Dockets Management System
U.S. Department of Transportation
Room PL 401
400 Seventh Street, S.W.
Washington, D.C. 20590-0001

Dear Sir or Madam:

The National Transportation Safety Board has reviewed the Research and Special Programs Administration's (RSPA's) notice of proposed rulemaking (NPRM), "Applicability of Hazardous Materials Regulations to Loading, Unloading, and Storage," Docket No. RSPA-98-4952 (HM-223), published at 66 *Federal Register* 32420 on June 14, 2001.

RSPA is proposing in the NPRM that the applicability of the hazardous materials regulations (HMR) to loading and unloading activities be based on a "carrier-controlled" criterion under which transportation would begin when the container/package comes under the control of the carrier and end when the carrier relinquishes control. As stated in the preamble, "the HMR would apply to all carrier activities after the carrier takes possession of the hazardous material from an offeror for purposes of transporting it until the package is delivered to its destination, including loading and unloading activities conducted by carrier personnel."

RSPA further states in the preamble that "consignee unloading is not part of transportation in commerce as we propose to apply that term because it occurs after movement in commerce is completed" and that "loading of a tank car by a shipper and unloading of a tank car by a consignee within a facility would not be subject to the HMR." As RSPA is likely aware, rail carriers are not involved with the loading and unloading of tank cars unless a tank car begins to release its cargo during transit and the cargo must be transferred to another tank car. As for motor carriers, carrier personnel may or may not be involved with the loading and unloading of cargo tanks at shippers' and consignees' facilities, depending upon the hazardous material to be handled and the procedures at the facility. Consequently, the Safety Board is concerned that the HMR would not apply to loading and unloading operations for railroad tank cars, highway cargo tanks, and other bulk containers.

The Safety Board has historically and consistently considered loading and unloading operations, particularly of bulk containers such as railroad tank cars, highway cargo tanks, and intermodal bulk containers, to be transportation-related functions. Title 49 *United States Code* Section 5102 defines "transportation" as "the movement of property and loading, unloading, or storage incidental to movement." The U.S. Department of Transportation (DOT) HMR at 49 *Code of Federal Regulations* (CFR) 107.4 similarly defines transportation "as any movement of property by any mode, and any loading, unloading, or storage incidental thereto."

Accordingly, the Safety Board believes that the DOT has both the statutory mandate and authority to regulate loading and unloading operations. The Safety Board notes that the DOT has exercised its authority to regulate loading and unloading operations in the past with the adoption of such regulatory provisions as 49 CFR 173.30 (loading and unloading of transport vehicles in all modes), 174.67 (tank car unloading), 174.101 – 174.115 (loading explosive materials by rail), and 177.834 (general loading and unloading requirements for highway). Also, the Federal Railroad Administration (FRA) has issued hazardous materials bulletins that explain FRA policy and provide guidance about various regulated activities, including tank car unloading, attendance requirements during the unloading of tank cars, and hazardous materials training. In the Board's view, the DOT has, by these actions, established that loading and unloading operations are properly regulated by the HMR.

The carrier-controlled criterion proposed by RSPA, as it applies to loading and unloading operations for hazardous materials being transferred to (or from) railroad tank cars, highway cargo tanks, and other bulk containers, will have a significant impact on public safety. The Safety Board has investigated more than 15 accidents since 1971 that have involved the loading or unloading of hazardous materials transported in bulk containers and has issued 18 safety recommendations addressing loading and unloading operations to the DOT and its modal administrations. (See enclosures 1 and 2.) Collectively, these accidents have resulted in 18 fatalities; 261 injuries; 6,600 evacuations; and more than $28.5 million in damage. The impact of these accidents upon public safety has been significant and demonstrates the need for effective federal oversight of loading and unloading operations involving bulk transportation containers containing hazardous materials. Further, the Safety Board is currently investigating an accident that occurred on July 14, 2001, at the ATOFINA Chemicals, Inc., plant in Riverview, Michigan. The accident involved the release of methyl mercaptan (a poisonous and flammable gas) and resulted in 3 fatalities; 6 injuries; and the evacuation of nearly 2,000 local residents. The release of the methyl mercaptan was from a tank car being prepared for offloading.

Also, recent statistics obtained through the DOT's Hazardous Materials Information System (HMIS) indicate that from 1995 through July 27, 2001, there were 6,947 incidents related to the unloading of hazardous materials from highway cargo tanks. These statistics also reveal that 16 fatalities and more than 250 injuries were associated with these incidents. During the same time, there were 186 railroad tank car unloading incidents, causing a total of 1 fatality and more than 45 injuries. Under this proposed rule, written incident reports on many of these accidents may not be submitted to RSPA and entered into the HMIS, and the capability to detect accident trends and causes in future loading and unloading accidents would be lost.

In two recent Safety Board investigations that involved unloading operations, the June 4, 1999, Whitehall, Michigan,[1] and November 19, 1998, Louisville, Kentucky,[2] accidents, the Safety Board determined that enhanced safety requirements were needed for loading and

[1] Hazardous Materials Accident Brief—*Chemical Reaction During Cargo Transfer, Whitehall, Michigan, on June 4, 1999*. NTSB/HZM-00/03. National Transportation Safety Board, Washington, D.C., 2000.

[2] Hazardous Materials Accident Brief—*Chemical Reaction During Cargo Transfer, Louisville, Kentucky, on November 19, 1998*. NTSB/HZM-00/02. National Transportation Safety Board, Washington, D.C., 2000.

unloading hazardous materials involved in transport and recommended on June 29, 2000, that RSPA:

> I-00-6
> Within 1 year of the issuance of this safety recommendation, complete rulemaking on Docket HM-223 "Applicability of the Hazardous Materials Regulations to Loading, Unloading and Storage," to establish, for all modes of transportation, safety requirements for loading and unloading hazardous materials.

In addition, as a result of the Clymers, Indiana,[3] accident, the Safety Board reiterated Safety Recommendation I-00-6 on March 5, 2001. In an April 5, 2001, response, RSPA noted that publication of the NPRM was scheduled for mid-2001, but it did not indicate whether the NPRM would address Safety Recommendation I-00-6. In a July 23, 2001, letter to RSPA, the Safety Board stated that it considered the establishment of safety standards and requirements for loading and unloading operations to be an essential part of HM-223. The Safety Board also expressed its concern about RSPA's lack of progress in addressing these issues in HM-223 and noted that the DOT is not providing sufficient direction to ensure that personnel involved in these operations are properly trained and provided with clearly written procedures. Safety Recommendation I-00-6 remains classified "Open—Unacceptable Response."

RSPA's own accident data from the HMIS indicate that loading/unloading accidents significantly affect public safety, and yet the proposed criterion excludes the submission of incident/accident notification reports about loading/unloading accidents and negates the improvements being proposed under the "Hazardous Materials: Revisions to Incident Reporting Requirements and the Hazardous Materials Incident Report Form," Docket No. RSPA-99-5013 (HM-229), rulemaking.

The Safety Board is also concerned that certain proposed standards undermine RSPA's longstanding policy of encouraging uniform national standards for transporting hazardous materials. Under this NPRM, highway cargo tank loading and unloading is covered by the HMR if it is performed by carrier personnel, but the same loading or unloading operation would be exempt from the rules if performed by non-carrier personnel. In other words, application of the HMR to loading/unloading operations would depend solely on the status of the person or persons performing the operation. This would very likely result in different standards being imposed by different agencies (federal, state, or local) for loading/unloading operations performed at a given facility with the same equipment. Further, the proposed NPRM does not explain which standards apply to loading or unloading operations that are jointly completed by carrier and facility personnel.

RSPA notes in the NPRM that the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and local jurisdictions such as fire

[3] Hazardous Materials Accident Report—*Rupture of a Railroad Tank Car Containing Hazardous Waste, near Clymers, Indiana, on February 18, 1999*. NTSB/HZM-01/01. National Transportation Safety Board, Washington, D.C., 2001.

departments would oversee loading and unloading operations of tank cars, cargo tanks, and other bulk containers performed by shippers and consignees at shippers' and consignees' facilities. RSPA, however, is silent in the NPRM as to whether it has coordinated with either the EPA or OSHA about accepting these oversight responsibilities and whether RSPA has evaluated either agency to determine if they have the expertise and resources to effectively oversee these transportation-related operations. The Safety Board is specifically concerned about the lack of expertise that personnel from these agencies have in rail tank car design, cargo tank design, and the operational parameters associated with bulk container loading and unloading. The Safety Board is not convinced that, if RSPA relinquishes its regulatory authority over hazardous materials loading/unloading operations, other federal and state agencies will be able to effectively exercise the necessary safety oversight of these very specific areas of transportation.

The statutory mandates for both the EPA and OSHA are quite broad. The EPA's regulatory areas include air and water pollution, toxic waste dumping/cleanup, and pesticides, to name a few. OSHA's regulatory responsibilities include a wide spectrum of workplaces, from office environments to major manufacturing facilities, agricultural activities, and diving operations and cover all aspects of these various workplaces. OSHA does have regulations pertaining to loading and unloading of tank cars and cargo tank trucks transporting flammable liquids, liquefied petroleum gas, and anhydrous ammonia. These regulations include requirements such as the use of level track, display of warning signs, blocking of wheels, attendance by properly trained personnel, separation distances of transfer facilities from other buildings, placement of shutoff valves, and electrical bonding, but do not include specific requirements for written procedures and training that have been the subject of previous Safety Board recommendations. The Safety Board is not aware of any EPA regulations that specifically address the transfer of hazardous materials from tank cars, cargo tanks, and other bulk containers or that focus on the operating procedures or training of personnel involved in loading/unloading operations. Neither agency's regulations require the gathering of data about the failure of bulk container packaging in transportation-related accidents.

Further, OSHA regulations grant individual states the authority to develop and operate their own State Implementation Plans (SIPs) to enforce federal occupational, safety, and health regulations in conjunction with the state's own regulations. Michigan and Kentucky are 2 of the 23 states that have approved SIPs; however, as a result of the Safety Board's investigations of the Whitehall and Louisville accidents, the Safety Board discovered that neither state's OSHA had inspected the loading/unloading operations at either plant. Further, neither state's OSHA had personnel trained in or knowledgeable about the transportation of bulk hazardous materials. The Safety Board is concerned that state OSHAs lack the resources and expertise to provide effective oversight of loading/unloading operations of hazardous material bulk containers.

In summary, the Safety Board believes that the proposed rules may result in the elimination of effective federal oversight of hazardous materials loading/unloading operations of bulk transportation containers. The Safety Board believes that the DOT should strengthen its oversight rather than ignore these issues. Further, the proposed rules will exclude the submission of incident/accident notification reports of loading/unloading accidents to the DOT for placement in the HMIS. Consequently, the Safety Board believes that the HMR should continue to apply to

the loading/unloading of tank cars, cargo tanks, and other bulk containers and therefore strongly urges RSPA to modify this rulemaking accordingly.

The Safety Board is concerned that RSPA also proposes in this NPRM to exempt from the HMR "any matter subject to the postal laws and regulations." RSPA does not provide a reason for this exemption or indicate what precautions are in place or are being implemented to justify this position. The fact that all items transported by the U.S. Postal Service (USPS) will enter the transportation system at some point and will be transported by commercial carriers should be of utmost interest and concern to RSPA.

Problems with undeclared hazardous materials in the mail have been addressed in previous Safety Board investigations, and the Safety Board has issued recommendations to the USPS (A-97-79 and A-00-54)[4] regarding this issue. Further, the Safety Board has investigated several accidents that have involved undeclared hazardous materials that were shipped in U.S. mail.

On October 19, 1993, on a USAir flight scheduled to leave for Rochester, New York, ramp agents found a toilet cleaner containing a 23-percent concentration of hydrochloric acid. They found it after they noticed an unusual odor in the forward cargo compartment. A search revealed a partially destroyed mail sack containing a wet and partially destroyed box that was marked "corrosive." The markings on the box were not visible inside the mailbag, nor did the mailbag have any hazardous materials markings on it. The shipment was sent as an internal postal shipment consigned to the post office in Holcomb, New York. The compartment had to be neutralized and cleaned.

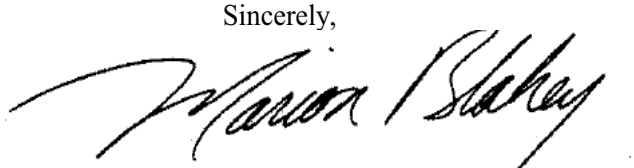
On April 6, 1994, a Continental Airlines plane en route to Houston, Texas, experienced a mercury spill in a shipment of mail. The mailbag contained a box with two bottles of mercury, one of which had split open during transport. The mercury was found beaded on the aluminum floor of the cargo compartment. Mercury is a corrosive material, particularly to aluminum. The shipper said that he was unaware that shipping substances such as mercury by mail was illegal.

Thus, based on its experience with the USPS being used for the transport of hazardous materials, the Safety Board does not believe that any exemption to the HMR should be made for shipments that are subject to postal rules and regulations without first demonstrating that a proactive program within the DOT and/or the USPS is capable of detecting and intercepting all such mail shipments and ensuring that all hazardous materials shipments are properly packaged and identified before they enter the transportation system.

[4] National Transportation Safety Board, *In-Flight Fire and Impact with Terrain, Valujet Airlines Flight 592, DC-9-32, N904VJ, in the Everglades, near Miami, Florida, on May 11, 1996*, Aviation Accident Report. NTSB/AAR-97/06. National Transportation Safety Board, Washington, D.C., 1997, and National Transportation Safety Board, *Spill of Undeclared Shipment of Hazardous Materials in Cargo Compartment of Aircraft, Northwest Airlines Flight 957, Memphis, Tennessee, on October 28, 1998*, Hazardous Materials Incident Brief. NTSB/HZB-00/ 01. National Transportation Safety Board, Washington, D.C., 2000.

The Safety Board appreciates the opportunity to comment on this proposed rulemaking. If additional clarification or information is needed regarding our comments, feel free to contact us.

Sincerely,



Marion C. Blakey
Chairman

Enclosures:
(1) List of Loading/Unloading Accident Investigations
(2) List of Safety Recommendations Issued

Enclosure 1

List of Loading/Unloading Accident Investigations

Accident Location	Accident Date	Mode
Berwick, Maine	4/02/1971	Highway
Gadsen, Alabama	8/31/1976	Highway
Baton Rouge, Louisiana	7/30/1983	Railroad
Pascagoula, Mississippi	7/31/1986	Marine
Deer Park, Texas	10/7/1986	Marine
Bay City, Michigan	9/16/1990	Marine
Montgomery County, Maryland	5/12/1993	Highway
Gainesville, Florida	6/17/1994	Highway
Bogalusa, Louisiana	10/23/1995	Railroad
Stock Island, Florida	6/29/1998	Highway
Biloxi, Mississippi	8/9/1998	Highway
Louisville, Kentucky	11/19/1998	Highway
Clymers, Indiana	2/18/1999	Railroad
Whitehall, Michigan	6/4/1999	Highway
Riverview, Michigan [5]	7/14/2001	Railroad

[5] Currently under investigation.

Enclosure 2
Safety Recommendations Issued to
the U.S. Department of Transportation and its Modal Administrations

To U.S. Department of Transportation:

H-71-65:

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.

H-71-69:

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.

I-88-01:

Establish safety requirements for the movement and temporary storage of hazardous materials at intermodal transportation facilities.

I-88-02:

Strengthen minimum safety requirements for loading and unloading of hazardous materials to provide adequate, uniform safety in all modes of transportation.

To the Research and Special Programs Administration:

H-93-34:

Require that the remote control mechanisms for internal shutoff valves be marked for emergency use on all cargo tanks authorized for the transportation of hazardous materials.

H-99-57:

Promulgate regulations requiring motor carriers that transport hazardous materials in cargo tanks to develop and maintain specific written cargo loading and unloading procedures for their drivers.

I-00-06:

Within 1 year of the issuance of this safety recommendation, complete rulemaking on Docket HM-223 "applicability of the hazardous materials regulations to loading, unloading and storage," to establish, for all modes of transportation, safety requirements for loading and unloading hazardous materials.

R-85-70:

Establish safety standards and inspection procedures for loading facilities at petrochemical plants.

To the Federal Railroad Administration:

R-85-68:

Establish a program to inspect rail loading facilities at petrochemical plants on a regular schedule.

R-85-69:

Develop a memorandum of understanding with the Occupational Safety and Health Administration to define the extent of each agency's responsibility for safety inspections of hazardous materials loading/unloading facilities at petrochemical plants to eliminate gaps or overlaps in responsibility.

To the Federal Highway Administration [Federal Motor Carrier Safety Administration]:

H-99-30:

Add elements to training programs for Federal and State inspectors that include instruction on determining whether motor carriers have adequate written procedures for and driver training in loading and unloading cargo tanks.

H-99-31:

Evaluate the adequacy of cargo-tank loading and unloading procedures of and driver training for hazardous-materials motor carriers and require changes as appropriate.

H-99-32:

Issue an "on guard" bulletin to emphasize the danger of splash filling materials into cargo compartments and of switch loading materials having flash points at or above 100^{o} F (National Fire Protection Association Class II and III liquids) into

compartments that last contained materials having flash points below 100° F (National Fire Protection Association Class I liquid).

H-99-59:

Once the federal regulations requiring motor carriers that transport hazardous materials in cargo tanks to provide written cargo loading and unloading procedures are promulgated, ensure that the motor carriers are in compliance with the regulations.

To the U.S. Coast Guard:

M-87-21:

Establish a safety zone around the wharves of the Chevron Refinery in Bayou Casotte, Mississippi, when there are vessels moored at the facility. Examine the conditions at other facilities that transfer hazardous materials and, where risks are evident, establish similar safety zones to exclude unauthorized persons.

M-91-31:

Amend 33 CFR Part 154, Oil Pollution Prevention Regulations for Marine Oil Transfer Facilities, to require that the Facility Operating Manual include procedures for stopping the transfer of product between a vessel and the terminal when a danger of surging exists from passing vessels.

M-91-32:

Direct the captain-of-the-port of Detroit to instruct the officer-in-charge of Coast Guard Station Saginaw River to notify in a timely manner area marine bulk oil/hazardous material terminals in the Bay City/Saginaw Port area within Coast Guard jurisdiction of impending river traffic so that personnel at the terminals and aboard moored vessels can take appropriate measures to suspend the transfer operations, thereby enhancing safety.

M-91-36:

Disseminate the information contained in this accident report to the marine industry by means of Coast Guard publications and notices, emphasizing the requirements of 33 CFR Part 164.