

U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD

INVESTIGATION REPORT

HYDROGEN SULFIDE POISONING

(2 Dead, 8 Injured)

**GEORGIA-PACIFIC
Naheola Mill**

PENNINGTON, ALABAMA
JANUARY 16, 2002

KEY ISSUES

REACTIVE HAZARD IDENTIFICATION
HYDROGEN SULFIDE SAFETY
EMERGENCY RESPONSE

REPORT No. 2002-01-1-AL

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This investigation report examines a hydrogen sulfide poisoning incident that occurred on January 16, 2002, at the Georgia-Pacific Naheola mill in Pennington, Alabama. Two contractors were killed, and eight were injured. County paramedics reported symptoms of hydrogen sulfide exposure. This report identifies the root and contributing causes of the incident and makes recommendations on reactive hazard identification, hydrogen sulfide safety, and emergency response.

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Acronyms and Abbreviations

AFPA	American Forest and Paper Association
AIChE	American Institute of Chemical Engineers
ANSI	American National Standards Institute
ASSE	American Society of Safety Engineers
ATSDR	Agency for Toxic Substances and Disease Registry
CCPS	Center for Chemical Process Safety
CFR	Code of Federal Regulations
CPR	Cardiopulmonary resuscitation
CSB	U.S. Chemical Safety and Hazard Investigation Board
DHHS	U.S. Department of Health and Human Services
DOT	U.S. Department of Transportation
EMS	Emergency Medical Services
ERT	Emergency response team
H ₂ S	Hydrogen sulfide
HAZCOM	Hazard Communication Standard (OSHA)
Hazwoper	Hazardous Waste Operations and Emergency Response Standard (OSHA)
IBEW	International Brotherhood of Electrical Workers
ICChemE	Institution of Chemical Engineers
IDLH	Immediately dangerous to life or health
MMG	Medical Management Guidelines
MOC	Management of change
MSDS	Material safety data sheet
NaSH	Sodium hydrosulfide
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PACE	Paper, Allied-Industrial, Chemical & Energy Workers International Union

Acronyms and Abbreviations (cont'd)

ppb	Parts per billion
ppm	Parts per million
PPSA	Pulp and Paper Safety Association
PSM	Process Safety Management (OSHA)
SCBA	Self-contained breathing apparatus
SCT	Secretariat of Transport and Communications (Canada)
TC	Transport Canada
U.S.C.	United States Code
WTTP	Wastewater treatment plant

ES.1 Introduction

On January 16, 2002, highly toxic hydrogen sulfide (H_2S) gas leaked from a sewer manway at the Georgia-Pacific Naheola mill in Pennington, Alabama.¹ Several people working near the manway were exposed to the gas. Two contractors from Burkes Construction, Inc., were killed. Eight people were injured—seven employees of Burkes Construction and one employee of Davison Transport, Inc. Choctaw County paramedics who transported the victims to hospitals reported symptoms of H_2S exposure.

Because of the serious nature of this incident, the U.S. Chemical Safety and Hazard Investigation Board (CSB) initiated an investigation to determine the root and contributing causes and to issue recommendations to help prevent similar occurrences. CSB defines a reactive incident as:

A sudden event involving an uncontrolled chemical reaction—with significant increases in temperature, pressure, or gas evolution—that has caused, or has the potential to cause, serious harm to people, property, or the environment.

Based on this definition, the incident that occurred at the Georgia-Pacific Naheola mill is a reactive chemical incident.

CSB was assisted in this investigation by the Agency for Toxic Substances and Disease Registry (ATSDR), an agency of the U.S. Department of Health and Human Services (DHHS). One of the key functions of ATSDR is to respond to emergency releases of hazardous substances that affect public health.

. . . the incident that occurred at the Georgia-Pacific Naheola mill is a reactive chemical incident.

¹ The mill began operation in 1958 as the Marathon Southern Division of the American Can Company. It was acquired in 1982 by James River Corporation. In 1997, James River merged with Fort Howard Corporation to form Fort James Corporation. Georgia-Pacific acquired Fort James Corporation in November 2000. The mill now operates as Fort James Operating Company, a fully owned subsidiary of Georgia-Pacific Corporation. This report describes events and history at the Naheola mill and does not necessarily differentiate among owners.

ES.2 Incident

Burkes Construction employees were working on a construction project at the Naheola mill in the vicinity of the tank truck unloading station, where various chemicals could be unloaded. Sodium hydrosulfide (NaSH) was being unloaded on January 15–16.

The unloading station consists of a large concrete pad sloped to a collection drain. A shallow concrete pit containing unloading pumps and associated process piping is located directly next to the pad and collection drain. This pit—commonly referred to as the oil pit—collects rainwater, condensate, and occasionally spilled chemicals from the unloading station. Due to environmental concerns about oil from the fuel oil pumps getting into the mill effluent, the drain valve from the oil pit to the acid sewer was locked closed.

The job required Burkes employees to work in or near the oil pit, which—at the time of the incident on January 16—contained liquid. Those interviewed estimated that it was typical for approximately 5 gallons of NaSH to collect in the oil pit from various sources (pump leaking, flushing unloading lines, etc.) during each offloading of a tank truck.

Fifteen tank trucks of NaSH had unloaded in the 24 hours prior to the incident.

Fifteen tank trucks of NaSH had unloaded in the 24 hours prior to the incident. Consequently—though the material in the pit was mainly water—it also contained NaSH from the unloading of the 15 trucks. To avoid having the construction crew stand in the fluid-filled pit, an operator opened a valve to drain the oil pit;² after 5 minutes, the valve was closed and relocked.

In the same area, three Davison Transport tank trucks arrived carrying NaSH. With the assistance of two Georgia-Pacific operators, one of the truck drivers connected his vehicle to the unloading hose. Witnesses estimated that when the connection was made, up to 5 gallons of NaSH spilled to the collection drain. (The tank truck, however, was not actually unloaded.)

² There was a procedure for periodically checking the oil pit and draining it if necessary. Although the oil pit was not full, the operator followed procedure when draining the pit.

On the day of the incident, sulfuric acid was being added to the acid sewer to control pH downstream in the effluent area. NaSH from the oil pit and the collection drain drained to the sewer and reacted with the sulfuric acid to form H₂S. Within 5 minutes, an invisible cloud of H₂S gas leaked through a gap in the seal of a manway in the area of the Burkes Construction workers. Two contractors near the manway were killed by H₂S poisoning; seven other Burkes employees and one Davison Transport driver were injured due to H₂S exposure.

NaSH from the oil pit and the collection drain drained to the sewer and reacted with the sulfuric acid to form H₂S.

Seven of the injured contractors were driven in private vehicles to Thomasville Infirmary in Thomasville, Alabama. Choctaw County Emergency Medical Services (EMS) transported three other victims (including the two fatally injured) to hospitals in Meridian, Mississippi. The clothing of one victim was completely removed and placed in a bag; the clothing of the other two victims was not removed.³

Two contractors near the manway were killed by H₂S poisoning; seven other Burkes employees and one Davison Transport driver were injured due to H₂S exposure.

The six Choctaw County paramedics who transported the victims reported symptoms of H₂S exposure; however, the two paramedics who removed the clothes of their patient reported milder symptoms. All of the County paramedics were medically evaluated and then released.

ES.3 Key Findings

1. H₂S was not identified as a hazard in the immediate area of the mill where the incident occurred. For this reason, there were no monitors, alarms, or warning signs in the area.
2. Modifications to the acid sewer over a period of several years included connections to the chlorine dioxide sewer, to the sewer from the truck unloading area, and to the containment area known as the oil pit. When these changes were made, the chemicals that could be added to the sewer and their interactions with other chemicals were not identified, nor were formal hazard evaluations or management of change (MOC) analyses conducted.

³The shirt of one victim was removed to facilitate medical procedures.

Georgia-Pacific did not require detailed H₂S safety training for those working in this area of the mill.

Beginning on the morning of January 16, sulfuric acid—used to control the pH of the mill wastewater—was continuously added to the acid sewer. . . . the volume of liquid in the acid sewer was lower than normal; and, consequently, the concentration of acid was high.

No hazard review or MOC analysis was performed when the oil pit and the collection drain from the truck unloading area were connected to the acid sewer.

3. Georgia-Pacific did not require detailed H₂S safety training for those working in this area of the mill. The contractors working on the day of the incident had only a basic awareness of H₂S and its hazards.
4. Beginning on the morning of January 16, sulfuric acid—used to control the pH of the mill wastewater—was continuously added to the acid sewer. Because the chlorine dioxide unit that emptied into the sewer line was not running at the time of the incident, the volume of liquid in the acid sewer was lower than normal; and, consequently, the concentration of acid was high.
5. During the truck unloading process, several potential sources of NaSH could leak and drain through the oil pit or collection drain to the acid sewer—such as material released from connecting and disconnecting the trucks, from flushing the loading line, or from a leaking pump seal or packing. In the 24 hours prior to the incident, 15 tank trucks of NaSH were unloaded, and one was connected to begin unloading. This activity resulted in NaSH collecting in the oil pit and draining to the sewer.
6. The manufacturer’s material safety data sheet (MSDS) for NaSH states that this substance will generate H₂S gas if it contacts acid. For large spills, it recommends that runoff be prevented from entering sewers or drains.
7. The Naheola mill did not apply the principles of process safety management to truck unloading or to the acid sewer.⁴
 - Hazard information about NaSH, available on the MSDS, was not incorporated into mill procedures or training.
 - No hazard review or MOC analysis was performed when the oil pit and the collection drain from the truck unloading area were connected to the acid sewer.

⁴The principles of process safety management are incorporated into the Occupational Safety and Health Administration (OSHA) Process Safety Management (PSM) Standard (29 CFR 1910.119); however, even a facility that is not subject to the OSHA regulation should apply the good practices of process safety. The NaSH truck unloading area at the Naheola mill was not part of a process covered by the PSM Standard.

8. The manway involved in the incident was originally an unsealed open grate. The sewer was modified to convert it to a closed sewer, and the manway was eventually outfitted with a fiberglass cover and sealed.

The manway involved in the incident was originally an unsealed open grate.

9. Interviewed employees had observed leaking chlorine dioxide from the fiberglass manway on previous occasions and recalled repairs that were sometimes documented by work orders. These events were not reported as near-miss incidents, nor were the causes of the leaks formally investigated. The Georgia-Pacific corporate investigation policy—which requires investigating near-miss incidents, including releases of hazardous materials—was not yet in place at the Naheola mill.

The victims . . . were not decontaminated at the scene.

10. The victims were removed from the incident scene and taken to the mill first-aid station prior to setup of the incident command system. They were not decontaminated at the scene. Mill guidelines did not provide for decontamination at the first-aid station.

11. The clothing of one of the three victims transported to hospitals was removed, which was not the case with the other two men. The six Choctaw County paramedics who evacuated the men from the mill first-aid station reported symptoms consistent with H₂S exposure.

The ATSDR Medical Management Guidelines do not recognize that victims . . . [could] pose a medical risk to responders.

12. The ATSDR Medical Management Guidelines (MMG) do not recognize that victims of H₂S gas exposure may release H₂S, which can pose a medical risk to responders (ATSDR, 2001).

ES.4 Root Causes

1. **Good engineering and process safety practices were not followed when joining the drain from the truck unloading station and the oil pit to the acid sewer.**
 - Neither the chemicals that could be introduced into the sewer nor the hazards of their interactions were identified.

No formal hazard review or MOC analysis was conducted when connecting sewer lines from the tank truck unloading and chlorine dioxide areas to the acid sewer.

Operating procedures . . . did not warn of the hazard of mixing NaSH with acids or the hazard of allowing NaSH to enter sewers.

- No formal hazard review or MOC analysis was conducted when connecting sewer lines from the tank truck unloading and chlorine dioxide areas to the acid sewer. Consequently, no scenarios leading to the possible release of H₂S were identified, nor were warning devices placed in the area.
2. There was no management system to incorporate hazard warnings about mixing sodium hydrosulfide (NaSH) with acid into process safety information.
 - Design information for projects involving NaSH did not specify the hazard of mixing NaSH with acid.
 - Operating procedures for NaSH tank truck unloading and oil pit operations did not warn of the hazard of mixing NaSH with acids or the hazard of allowing NaSH to enter sewers.
 - Mill personnel were not trained on the specific hazards of NaSH, such as handling spilled material or keeping it separate from acid.

ES.5 Contributing Causes

. . . the fiberglass manway was not appropriately designed to provide and maintain an airtight seal on the sewer.

1. The fiberglass manway was not adequately designed or sealed to ensure that the sewer remained closed.

The manway was originally an open grate. It was modified by adding a fiberglass cover and sealed. Those interviewed recalled prior occasions when chlorine dioxide escaped from the fiberglass manway; they also recalled repairs that were sometimes documented in work orders, but these events were not reported or investigated as incidents. Thorough incident investigation would have provided an opportunity to recognize that the fiberglass manway was not appropriately designed to provide and maintain an airtight seal on the sewer.

2. The injured contractors did not have adequate training to understand the hazards of hydrogen sulfide (H₂S).

H₂S training should include specific instruction on the importance of wearing proper protective equipment prior to attempting rescue.

Georgia-Pacific Corporation

1. Conduct periodic safety audits of Georgia-Pacific pulp and paper mills in light of the findings of this report. At a minimum, ensure that management systems are in place at the mills to:
 - Evaluate process sewers where chemicals may collect and interact, and identify potential hazardous reaction scenarios to determine if safeguards are in place to decrease the likelihood or consequences of such interactions. Take into account sewer system connections and the ability to prevent inadvertent mixing of materials that could react to create a hazardous condition.
 - Identify areas of the mill where hydrogen sulfide (H_2S) could be present or generated, and institute safeguards (including warning devices) to limit employee exposure. Require that personnel working in the area are trained to recognize the presence of H_2S and respond appropriately. Update emergency response plans for such areas, to include procedures for decontaminating personnel exposed to toxic gas.
 - Apply good engineering and process safety principles to process sewer systems. For instance, ensure that hazard reviews and management of change (MOC) analyses are completed when additions or changes are made where chemicals could collect and react in process sewers. (Such principles may be found in publications from the Center for Chemical Process Safety [CCPS].)
2. Communicate the findings and recommendations of this report to the workforce and contractors at all Georgia-Pacific pulp and paper mills.

Georgia-Pacific Naheola Mill

1. Evaluate mill process sewer systems where chemicals may collect and react to identify potential hazardous reaction scenarios to determine if safeguards are in place to decrease the likelihood or consequences of such interactions. Evaluate sewer connections and ensure that materials that could react to create a hazardous condition are not inadvertently mixed, and that adequate mitigation measures are in place if such mixing does occur.
2. Establish programs to comply with recommendations from manufacturers of sodium hydrosulfide (NaSH) regarding its handling, such as preventing it from entering sewers because of the potential for acidic conditions.
3. Establish programs to require the proper design and maintenance of manway seals on closed sewers where hazardous materials are present.
4. Identify areas of the plant where hydrogen sulfide (H_2S) could be present or generated, and institute safeguards (including warning devices) to limit personnel exposure. Institute a plan and procedures for dealing with potential H_2S releases in these areas, and require that anyone who may be present is adequately trained on appropriate emergency response practices, including attempting rescue. Require contractors working in these areas to train their employees on the specific hazards of H_2S , including appropriate emergency response practices.
5. Update the Naheola mill emergency response plan to include procedures for decontaminating personnel who are brought to the first-aid station. Include specific instructions for decontaminating personnel exposed to H_2S so that they do not pose a secondary threat to medical personnel.

Agency for Toxic Substances and Disease Registry (ATSDR)

Evaluate and amend as necessary the ATSDR Medical Management Guidelines to consider the risk to responders posed by the exposure to victims of high levels of hydrogen sulfide (H₂S) gas. Specify procedures for adequate decontamination. Communicate the results of this activity to relevant organizations, such as the American Association of Occupational Health Nurses.

Burkes Construction, Inc.

Train your employees on the specific hazards of hydrogen sulfide (H₂S), including appropriate emergency response practices, in areas where Georgia-Pacific has identified this material as a hazard.

Davison Transport, Inc.

Communicate the findings and recommendations of this report to those employees who haul or handle sodium hydrosulfide (NaSH).

American Forest and Paper Association (AFPA)

International Brotherhood of Electrical Workers (IBEW)

Paper, Allied-Industrial, Chemical & Energy Workers International Union (PACE)

Pulp and Paper Safety Association (PPSA)

Communicate the findings and recommendations of this report to your membership.

1.0 Introduction

1.1 Background

On January 16, 2002, hydrogen sulfide (H₂S) gas generated in a sewer leaked from a gap in the seal of a manway at the Georgia-Pacific Naheola mill in Pennington, Alabama. Several people working near the manway were exposed to the gas. Two contractors from Burkes Construction, Inc., were killed. Seven employees of Burkes Construction and one employee of Davison Transport, Inc., were injured. The six Choctaw County paramedics who transported the victims to hospitals reported symptoms consistent with H₂S exposure.

1.2 Investigative Process

The U.S. Chemical Safety and Hazard Investigation Board (CSB) examined physical evidence at the site, conducted interviews, and reviewed relevant documents. CSB exercised a Memorandum of Understanding with the Agency for Toxic Substances and Disease Registry (ATSDR) to assist in investigating emergency and medical response to the incident.

1.3 Georgia-Pacific Naheola Mill

The Georgia-Pacific Naheola mill is located in Pennington, Alabama, approximately 125 miles north of Mobile and 150 miles southwest of Birmingham. Pennington is also located 50 miles east of Meridian, Mississippi.

The mill began operation in 1958 as the Marathon Southern Division of the American Can Company. It was acquired in 1982 by James River Corporation. In 1997, James River merged with Fort Howard Corporation to form Fort James Corporation. Georgia-Pacific acquired Fort James Corporation in November 2000. The mill now operates as Fort James Operating Company, a fully owned subsidiary of Georgia-Pacific Corporation.

The Naheola mill produces over 650,000 tons of paper, paperboard, and pulp annually. Approximately 1,475 employees work at the mill. The Paper, Allied-Industrial, Chemical & Energy Workers International Union (PACE) and the International Brotherhood of Electrical Workers (IBEW) represent some of the mill employees.

1.4 Overview of Naheola Mill

The pulping liquor is recycled, and fresh chemicals are occasionally added to maintain the proper liquor chemistry. Sodium hydrosulfide is one of these makeup chemicals.

The overall pH of the effluent is affected by various mill operations. If the pH is low, caustic is added in the wastewater treatment area; if the pH is high, sulfuric acid is added.

1.4.1 Kraft Process

The Naheola mill uses the kraft process to produce pulp.¹ In this process, wood chips are treated with a liquor that chemically breaks them down into pulp. Kraft pulping liquor is made up of sodium hydroxide and sodium sulfide. The pulping liquor is recycled, and fresh chemicals are occasionally added to maintain the proper liquor chemistry. Sodium hydrosulfide (NaSH) is one of these makeup chemicals.

The pulp is bleached using chlorine dioxide, caustic, and oxygen. The chlorine dioxide is generated onsite. Some of the pulp is dried and sold as a final product. The remaining pulp is processed primarily into tissue, towels, and paperboard.

1.4.2 Waste Treatment Process

The Naheola mill contains a process sewer network that collects waste; the process sewers join at a mixing basin in the effluent treatment area.

The pH² of the untreated mill effluent is maintained between 7 and 9 to ensure that the waste is efficiently treated. The overall pH of the effluent is affected by various mill operations. If the pH is low, caustic is added in the wastewater treatment area; if the pH is high, sulfuric acid is added.

¹ Pulp is the fibrous material derived from wood. It is the main raw material in making paper.

² pH is a measure of the acidity or alkalinity of a solution. It is numerically equal to 7 for neutral solutions; it increases with decreasing alkalinity and decreases with increasing acidity.

The acid is manually added in a sewer line, commonly referred to as the acid sewer, which originates in the chemical area where the acid tank is located (Figure 1). Drainage from the truck unloading station flows to the acid sewer and mixes with other mill waste streams in the mixing basin. Wastewater flows from the mixing basin to one of two clarifiers. The streams from the clarifiers are combined at a lift station prior to additional treatment and discharge to the Tombigbee River.

Drainage from the truck unloading station flows to the acid sewer and mixes with other mill waste streams in the mixing basin.

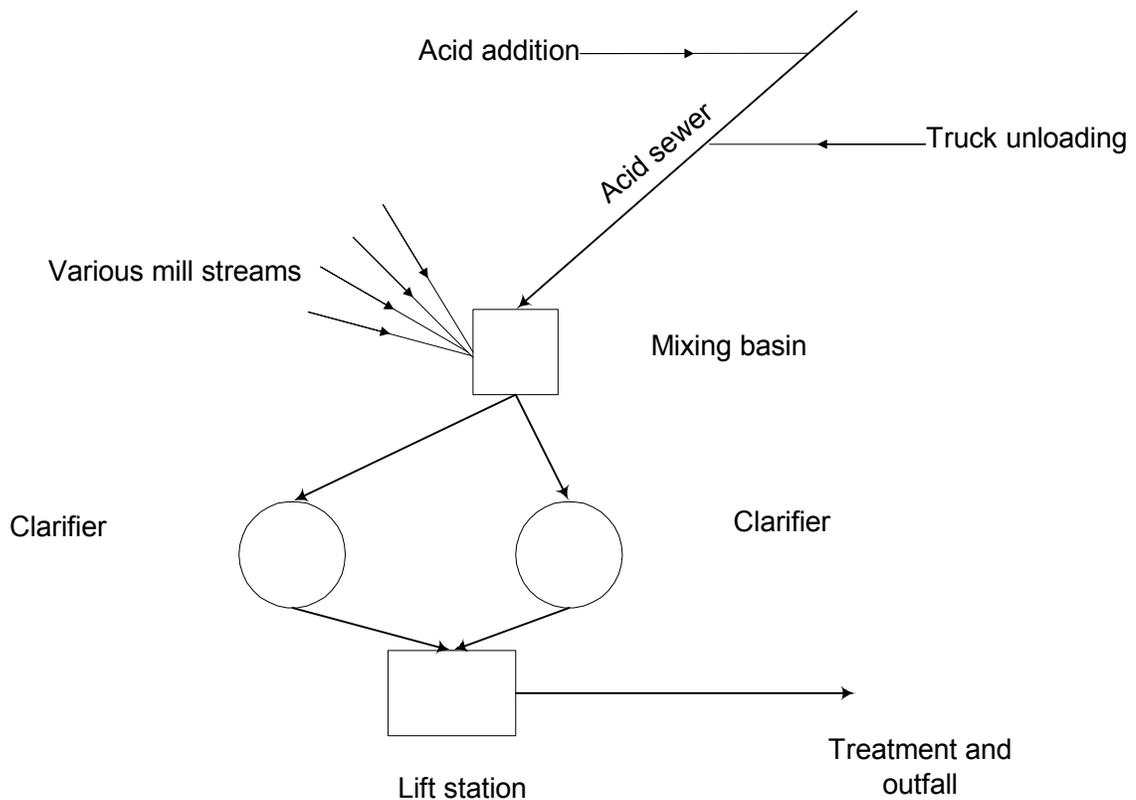


Figure 1. Naheola mill waste treatment process.

2.0 Description of Incident

2.1 Background

2.1.1 Sewer Operation

On January 16, the pH of the wastewater at the mill effluent treatment plant was high. To ensure efficient wastewater treatment and to comply with environmental permits, sulfuric acid was added to the acid sewer per normal procedure, as described in Section 1.4.2. Acid was continuously added to the sewer on the day of the incident; at the same time, the chlorine dioxide generator was not running, which resulted in a lower than normal flow of water through the sewer. This combination of acid volume and low water flow accounted for the high concentration of acidic water in the sewer.

To ensure efficient wastewater treatment and to comply with environmental permits, sulfuric acid was added to the acid sewer per normal procedure . . .

[The] combination of acid volume and low water flow accounted for the high concentration of acidic water in the sewer.

2.1.2 Tank Truck Unloading

NaSH³ is used in the kraft process to make up pulping liquors. It is delivered by tank truck and stored onsite. The Naheola mill may go several months without a delivery and then bring in several tank trucks in a short span of time to replenish the supply. NaSH is delivered to an unloading station located in a typically unoccupied area near the maintenance shops, between the chemical area and the wastewater treatment area. Fuel oil and caustic are unloaded in the same area.

The tank truck unloading station (Figure 2) is located on a large concrete pad sloped to a collection drain. The drain is routed through two normally open valves (valves 2 and 3) to the acid sewer. The process piping and various unloading pumps are located on a shallow curbed concrete containment area, directly next to the pad and collection drain (Figure 3). This area is commonly referred to as the oil pit (Figure 4).

NaSH is delivered to an unloading station located in a typically unoccupied area near the maintenance shops . . .

³The Naheola mill used a solution of 30 percent NaSH in water.

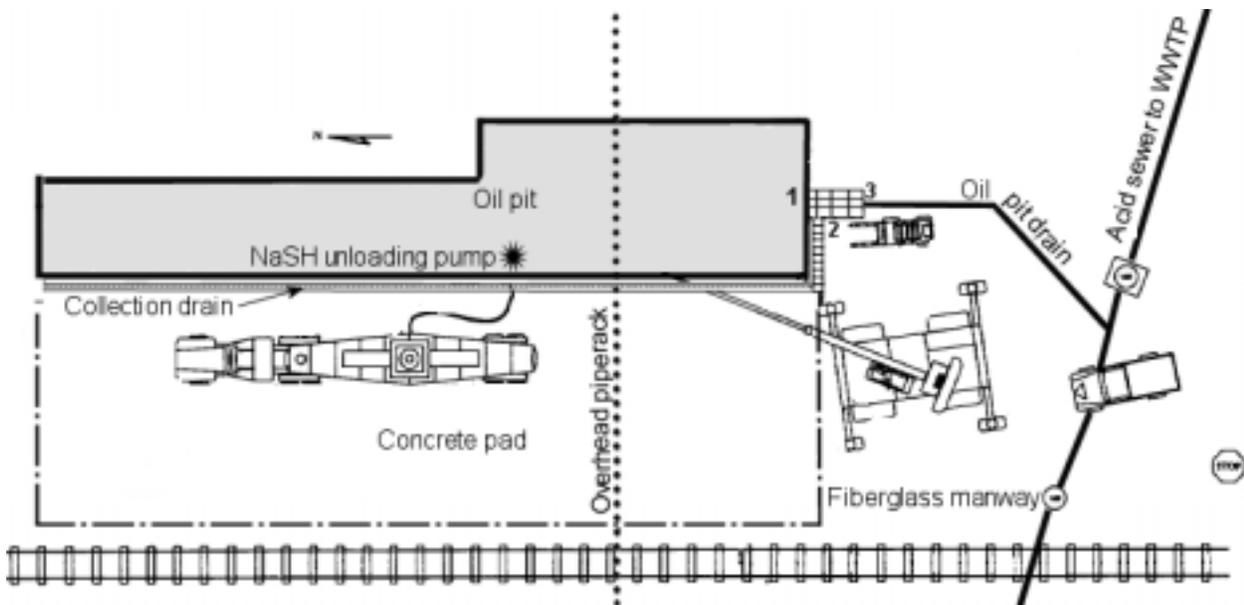


Figure 2. Tank truck unloading station.



Figure 3. Collection drain next to tank truck unloading station.



Figure 4. Oil pit and adjacent tank truck unloading station.

The oil pit (with a maximum depth of 20 inches) collects rainwater, condensate, and incidentally spilled chemicals from the tank truck unloading station. It is emptied through two valves (see also Figure 5). The drain valve (valve 1) on the pit is kept closed and locked due to environmental concerns about oil getting into the mill effluent; valve 3 is kept open. Per procedure, operators periodically inspect the oil pit; if no oil is present, they unlock valve 1 and drain the pit to the acid sewer.



Figure 5. Oil pit control valves.

Personnel interviewed estimate that it is typical for approximately 5 gallons of NaSH to collect in the oil pit from various sources (pump leaking, flushing unloading lines, etc.) during each offloading of a tank truck. NaSH spilled during hose connections to the truck flows through the collection drain to the acid sewer. Material lost from the pump or piping during the unloading process accumulates in the oil pit until drained.

At the time of the January 16 incident, the mill was replenishing its NaSH inventory. In the 24 hours preceding the release of H₂S gas, 15 truckloads of NaSH were unloaded and a sixteenth was being prepared for unloading.

The oil pit . . . collects rainwater, condensate, and incidentally spilled chemicals from the tank truck unloading station.

In the 24 hours preceding the release of H₂S gas, 15 truckloads of NaSH were unloaded and a sixteenth was being prepared for unloading.

2.1.3 Construction Work

Burkes Construction was contracted to replace supports on an overhead piperack located near the fiberglass manway . . .

Burkes Construction was contracted to replace supports on an overhead piperack located near the fiberglass manway; the piperack crossed over the tank truck unloading station and the oil pit, as shown in Figure 2. As the supports were removed, they were placed on the side of the road, directly in front of the manway.⁴ On the day of the incident, the contractors were working in the area of the tank truck unloading station.

2.2 Incident Description

. . . the Burkes Construction employees . . . were standing on level ground in an open area adjacent to the tank truck unloading station, near the fiberglass manway.

At approximately 3:15 pm on January 16, the Burkes Construction employees finished their afternoon break and prepared to return to work (see the timeline in Appendix A). They were standing on level ground in an open area adjacent to the tank truck unloading station, near the fiberglass manway.

The piperack work required some Burkes employees to be in or near the oil pit, which contained liquid at the time; the material was primarily water and NaSH that had collected during unloading of the 15 tank trucks.⁵

The Burkes contractors asked a Georgia-Pacific operator to drain the oil pit. After inspecting for oil, the operator opened valve 1; the pit drained for approximately 5 minutes, and then the valve was closed.

Meanwhile, with the assistance of two Georgia-Pacific operators, the Davison truck driver connected his vehicle to the unloading hose. Witnesses estimated that when the connection was made, up to 5 gallons of NaSH spilled to the collection drain. Unloading had not actually begun.

⁴There is a possibility that one of the supports contacted the manway and compromised its seal.

⁵Those interviewed estimated that—during the unloading process—it is typical for up to 5 gallons of NaSH to collect in the oil pit from various sources (i.e., pump leaking, flushing unloading lines, etc.).

Also on the same day, sulfuric acid was being added to the acid sewer to control pH downstream in the effluent area. The NaSH draining to the acid sewer from the oil pit and the collection drain around the truck unloading station reacted with sulfuric acid (present in the sewer) to form H₂S.

Within 5 minutes of the material draining from the oil pit and collection drain to the acid sewer, an invisible cloud of highly toxic H₂S gas leaked through a gap in the seal of the manway near the Burkes Construction workers. Three contractors (A, B, and C in Figure 6) were immediately overcome by H₂S and fell down. Another contractor (D) passed out as he rushed to aid a coworker (A). Simultaneously, one contractor (I) left the area, and four others (E, F, G, and H) walked to fresh air. One of these men (F) passed out momentarily before he and another contractor (E) realized that their coworkers had fallen; the two returned to the area to assist in removing the others to fresh air. Contractor (F) passed out a second time while attempting to assist his coworkers. Georgia-Pacific operators working in the vicinity of the NaSH tank truck saw the Burkes employees falling and went to the control room to report the incident.

Two Burkes employees (B and C) in the immediate area of the manway were killed. Seven other Burkes employees and one Davison truck driver (J) were injured.

The NaSH draining to the acid sewer from the oil pit and the collection drain . . . reacted with sulfuric acid (present in the sewer) to form H₂S.

Within 5 minutes of the material draining . . . to the acid sewer, an invisible cloud of highly toxic H₂S gas leaked through a gap in the seal of the manway . . .

Two Burkes employees in the immediate area of the manway were killed.

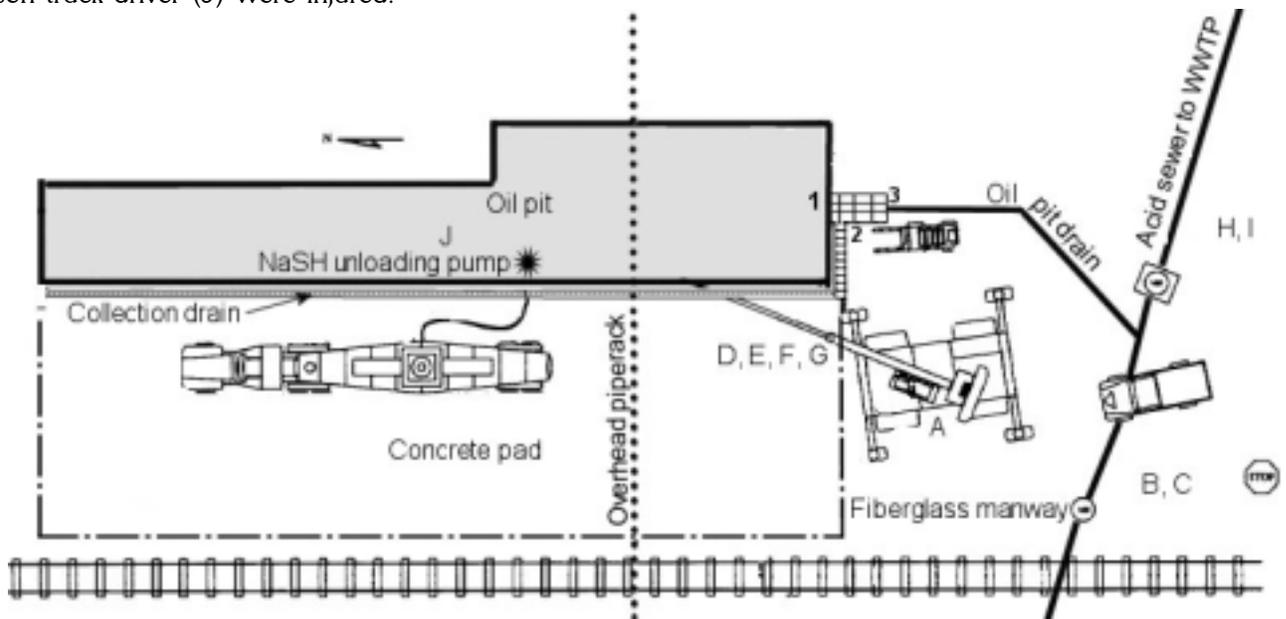


Figure 6. Approximate locations of the 10 victims ("A" through "J").

2.3 Incident Response

The injured were not decontaminated at the scene or at the first-aid station.

The six paramedics who transported the victims to hospitals . . . all described a strong odor in the ambulance bays.

Two of the paramedics reported less severe exposure symptoms—probably because their patient was exposed to a lower level of H₂S and his clothing had been removed.

The injured Burkes employees assisted each other and carried their fatally injured coworkers from the area closest to the release, as described in Section 2.2. The mill emergency response team (ERT) was notified. Others who came to the area performed cardiopulmonary resuscitation (CPR) on the two fatally injured men, who were transferred by mill ambulance to the first-aid station.⁶

The other injured personnel were transported by pickup trucks and motorized carts. The injured were not decontaminated at the scene or at the first-aid station. The incident commander arrived shortly after the victims had left the scene. He and the ERT evacuated the area, began search/rescue, set up zones, and began air monitoring.

Four Choctaw County ambulances—staffed with two paramedics each—arrived at the mill first-aid station. Two ambulances transported the fatally injured men, and a third ambulance transported the injured truck driver.⁷ Two victims were taken to Rush Hospital and one to Riley Hospital, both located in Meridian, Mississippi, a 45-minute drive. Burkes and Georgia-Pacific employees transported the other injured Burkes employees to nearby Thomasville Infirmary, where six were admitted and one was sent to a hospital in Mobile because of a previous heart condition.

The six paramedics who transported the victims to hospitals in Meridian all described a strong odor in the ambulance bays. They opened windows and turned fans on to reduce the odor. After delivering the victims to the hospitals, the paramedics reported symptoms consistent with H₂S exposure. They were medically evaluated and released.

Two of the paramedics reported less severe exposure symptoms—probably because their patient was exposed to a lower level of H₂S and his clothing had been removed.

⁶ The mill first-aid station is located near the front gate of the mill, a considerable distance from the incident scene.

⁷ The fourth ambulance remained at the scene on standby and did not transport patients.

3.0 Analysis of Incident

The sewer line from the oil pit to the acid sewer was installed as part of a project to direct water from various storage pits to a process sewer. The work was completed in 1995 when the mill was owned by James River Corporation.

CSB did not find any procedures that described the engineering process. However, the James River capital appropriations request contained a Project Impact Statement checklist. The checklist asked general safety and environmental questions, focusing mainly on regulatory compliance. There was no detailed information on chemicals that could be present in the oil pit and drain to the acid sewer—nor was there a management of change (MOC) analysis or formal hazard review.⁸

The NaSH material safety data sheet (MSDS) and manufacturer's information explain the hazards of NaSH and state that its interaction with acid will produce H₂S. For large spills, it recommends that runoff be prevented from entering sewers or drains. Another NaSH manufacturer's product literature cautions against allowing NaSH to drain to sewers because their contents are often acidic. If James River had identified the chemicals that could potentially drain to the acid sewer and completed a proper hazard review, it would likely have realized the risk of allowing NaSH to enter the sewer.

Drawings of the new sewer connections were made for construction. However, it was not James River's practice to update overall mill sewer drawings to reflect modifications. Therefore, at the time of the incident, no drawing of the mill sewer system accurately portrayed its layout.

Good engineering practices during the conceptual design phase of a capital project such as this include identifying all chemicals that could be directed to the sewer, their hazards, and the hazards of their interactions.⁹ The design information found for this project did not list NaSH or other substances that collected in the oil pit and could

3.1 Good Engineering Practices

There was no detailed information on chemicals that could be present in the oil pit and drain to the acid sewer—nor was there a management of change analysis or formal hazard review.

The NaSH material safety data sheet and manufacturer's information explain the hazards of NaSH and state that its interaction with acid will produce H₂S.

If James River [Corporation] had identified the chemicals that could potentially drain to the acid sewer and completed a proper hazard review, it would likely have realized the risk of allowing NaSH to enter the sewer.

⁸ A hazard review is a systematic process to investigate hazards, assess potential consequences, and establish a design and operating basis for safety.

⁹ The American Institute of Chemical Engineers (AIChE) Center for Chemical Process Safety (CCPS) describes good engineering practices for various phases of a capital project (CCPS, 1989).

The design information found for this project did not list NaSH or other substances that collected in the oil pit and could enter the acid sewer.

enter the acid sewer. Identification of the chemicals and their hazards, and a proper hazard review, would have identified the likely consequences and also the modifications required to eliminate or control the hazard. The Naheola mill did not follow these practices.

Process sewers are an integral part of a waste collection, treatment, and disposal process that presents unique hazards. Additionally, the various effluents collected present their own hazards (e.g., mixing and cross-reactions). There is considerable documentation of incidents that have occurred in sewers and drains. Appropriate techniques used for other chemical processes should also be applied to the design and hazard evaluation of process sewers (Lees, 1996; CCPS, 1995; Kletz, 1999).

3.2 Principles of Process Safety Management

The inadvertent mixing of incompatible chemicals is not uncommon. However, the Naheola mill had no formal reactive hazard management system to identify and control reactive hazards.

Process safety management is the application of management systems to control hazards and to ensure the safety of a process. The use of such systems is considered good practice for handling chemical processes.¹⁰

3.2.1 Reactive Hazard Management

NaSH from the tank truck unloading station was released to the acid sewer, where it inadvertently reacted with sulfuric acid to produce H₂S. The inadvertent mixing of incompatible chemicals is not uncommon. However, the Naheola mill had no formal reactive hazard management system to identify and control reactive hazards.

¹⁰The principles of process safety management are incorporated into the Occupational Safety and Health Administration (OSHA) Process Safety Management (PSM) Standard (29 CFR 1910.119); however, even a facility that is not subject to the OSHA regulation should apply the good practices of process safety management.

The first step in a reactive hazard management program is to determine whether a material has reactive hazards (CCPS, 2001). Reactive hazard information is found in literature and on some MSDSs. The MSDS collected by the mill from its NaSH supplier indicated that this substance readily reacts with acid to form H₂S—which clearly indicates a potential reactive hazard.

After the identification of a reactive hazard, precautions should be taken to mitigate the hazard. If such precautions were in place at the Naheola mill, the oil pit containing NaSH would likely not have been tied into the acid sewer.

3.2.2 Process Safety Information

The NaSH MSDS contains warnings about the hazards of combining NaSH solution with acid. It notes that the reaction will produce toxic H₂S. The MSDS also specifies that large spills should be cleaned up using absorbent material, and that the substance should be prevented from entering sewers or natural waterways. Additionally, it notes that the headspace of a tank truck could contain H₂S vapors that evolve from the solution. The NaSH MSDS was available in the control room and at the tank truck unloading station.

The mill used a chemical approval form to collect information on all chemicals brought onsite. Although the form for NaSH contained information about its hazards, none of this information was incorporated into operating procedures or training. Process safety information should be incorporated into policies, procedures, and programs. (CCPS, 1995b) Had this been done, employees would likely have understood the hazards of NaSH, including the manufacturer's recommendation that spills be cleaned up with absorbent material instead of being washed into a sewer.

The MSDS collected by the mill from its NaSH supplier indicated that this substance readily reacts with acid to form H₂S—which clearly indicates a potential reactive hazard.

If [mitigative measures] were in place at the Naheola mill, the oil pit containing NaSH would likely not have been tied into the acid sewer.

Although the [chemical approval] form for NaSH contained information about its hazards, none of this information was incorporated into operating procedures or training.

Interviewed employees reported prior instances of chlorine dioxide leaking from the manway involved in the January 16 incident. . . . however, these events were not reported as incidents or investigated.

Because of the design of the sewer, maintenance personnel were unable to ensure that the manway was adequately sealed even after repairing it.

3.2.3 Incident Investigation

Incident investigation is an important element of a safety management system. It allows companies to assess and correct underlying causes of near misses and accidents (CCPS, 1989). Georgia-Pacific has a corporate policy for investigating incidents.

Interviewed employees reported prior instances of chlorine dioxide¹¹ leaking from the manway involved in the January 16 incident. Some employees recalled repairs, and at least some of these were documented by work orders to reseal the manway; however, these events were not reported as incidents or investigated. The Georgia-Pacific corporate incident investigation policy—which requires investigation of near-miss incidents, including releases of hazardous materials—had not yet been put in place at the Naheola mill.

Because of the design of the sewer, maintenance personnel were unable to ensure that the manway was adequately sealed even after repairing it. If earlier incidents had been investigated, it is likely that management would have determined that the manway required design modification.

3.3 Hydrogen Sulfide Safety

The majority of fatalities associated with H₂S exposure occur in confined spaces . . . In this case, however, the H₂S poisoning occurred in a flat unconfined area.

H₂S is a colorless, extremely flammable toxic gas. Although it has a characteristic “rotten egg” odor detectable at concentrations as low as 0.5 part per billion (ppb), olfactory fatigue¹² occurs rapidly and at low concentrations. Exposure to concentrations of 500 parts per million (ppm) causes loss of consciousness, and exposure to concentrations as high as 700 ppm can cause immediate death.

The majority of fatalities associated with H₂S exposure occur in confined spaces, such as sewers, waste dumps, sludge plants, tanks, and cesspools (ATSDR, 1999). In this case, however, the H₂S

¹¹Employees identified chlorine dioxide by its color; it is a greenish-yellow manufactured gas. Breathing air containing chlorine dioxide gas may cause nose, throat, and lung irritation.

¹²Olfactory fatigue refers to cessation of the sense of smell.

poisoning occurred in a flat unconfined area. When identifying areas with potential H₂S hazards, both confined and unconfined spaces should be considered.

According to ATSDR, the men who died were likely exposed to H₂S concentrations greater than 700 ppm. The injured victims were exposed to lower, but still dangerous, concentrations. Some of the injured reported smelling an odor for an instant, but then their sense of smell was deadened.

H₂S was not identified as a hazard in the typically unoccupied area where the incident occurred. There were no monitors or alarms to warn of a release. Personnel had only their sense of smell to indicate the possible presence of H₂S; however, smell is not a reliable indicator because the gas causes olfactory fatigue.

The Burkes employees had a general awareness of H₂S. More detailed safety training would have covered how to identify H₂S and how to respond in an emergency. Emergency training should instruct individuals to leave the area and not to attempt rescue of others unless they themselves are trained and wearing the proper protective equipment.

Per Georgia-Pacific policy, Burkes construction workers wore the Scott Speed Evac disposable mouth bit respirator (model 90 AG) on their belts and were trained in its use. These respirators are used for escape in situations where unexpected releases result in atmospheres containing low levels of chlorine, chlorine dioxide, sulfur dioxide, H₂S, or hydrogen chloride. They are not intended for use in immediately dangerous to life or health (IDLH) atmospheres.

Several Burkes employees tried to use the respirators, but H₂S levels were too high for the equipment to be effective. Only a self-contained breathing apparatus (SCBA) would have provided adequate protection at the exposure levels present on January 16.

The Naheola mill did not adequately identify areas that contain—or have the potential to contain—dangerous levels of H₂S gas. All areas of H₂S hazard should have been identified; and personnel, including contractors, should have been trained on how to respond in the event of an H₂S release.

According to ATSDR, the men who died were likely exposed to H₂S concentrations greater than 700 ppm.

H₂S was not identified as a hazard in the typically unoccupied area where the incident occurred. . . . Personnel had only their sense of smell to indicate [its] possible presence . . . however, smell is not a reliable indicator because the gas causes olfactory fatigue.

Emergency training should instruct individuals to leave the area and not to attempt rescue of others unless they themselves are trained and wearing the proper protective equipment.

3.4 Emergency Response

The mill ambulance arrived at the scene and removed the injured prior to arrival of the incident commander. Mill personnel did not remove the victims' clothing at the first-aid station because there was no visible contamination.

Paramedics were initially told that the victims had been exposed to either chlorine dioxide or H₂S. . . . [They] had only the [DOT] Emergency Response Guidebook to refer to for treatment of these chemical exposures.

Injured personnel were not decontaminated—neither at the scene of the incident nor at the mill first-aid station. The mill's emergency response plan contains procedures for decontamination, but it is a function of the incident command system. The mill ambulance arrived at the scene and removed the injured prior to arrival of the incident commander. Mill personnel did not remove the victims' clothing at the first-aid station because there was no visible contamination.

At the first-aid station, mill personnel continued to aid the victims until the Choctaw County Emergency Medical Services (EMS) team arrived. The first-aid station was staffed by five registered nurses¹³ who provided 24-hour coverage; two nurses were on duty at the time of the incident. When the County paramedic units arrived at the mill, they took over treatment of the most critical victims.

The first Choctaw County ambulance arrived 3 to 5 minutes after being notified (and 19 minutes after the incident began). Paramedics were initially told that the victims had been exposed to either chlorine dioxide or H₂S. The victims were treated for their symptoms.

The responding paramedics had only the Emergency Response Guidebook (DOT/TC-SCT, 2000) to refer to for treatment of these chemical exposures. This guidebook is intended to be used by first responders to hazardous material transportation incidents. It contains only cursory information on first aid and decontamination, and advises that contaminated clothing and shoes be removed. The two paramedic teams that did not remove the victims' clothing stated that they saw no obvious signs of contamination.

The six paramedics stated that during the 40- to 50-minute trips to hospitals, they noticed a strong odor and opened the vehicle windows and turned on the exhaust fans. The paramedic team transporting the truck driver initiated decontamination of the victim by removing his clothing.

¹³ The plant nurses are members of the American Association of Occupational Health Nurses.

Each of the paramedics was evaluated for symptoms of H₂S exposure, including burning throat and eyes and nausea. The paramedic team that removed the truck driver's clothing had less severe symptoms than the other two crews. Collectively, the paramedics may have experienced fewer symptoms if the clothes of all the victims had been removed at the scene or at the first-aid station.

The paramedics did not have hazardous material training, nor were they trained on use of the Emergency Response Guidebook (DOT/TC-SCT, 2000)—though they did refer to it. The paramedics should have received more detailed information on H₂S at the scene.

The ATSDR Medical Management Guidelines (MMG) were designed for emergency medical personnel (ATSDR, 2001); however, the responders were not aware of this guidance at the time of the incident. The MMG on H₂S exposure states that responders are not at risk when they assist a victim of H₂S gas exposure.

However, H₂S is released from the clothing and skin, and via gas that expires from the lungs. The threat to responders may be greater when the situation occurs in a confined space, such as an ambulance. Through its participation in this investigation, ATSDR has concluded that persons who are exposed to elevated levels of H₂S (i.e., greater than 500 ppm) may pose a threat to responders who come into contact with them.

Each of the paramedics was evaluated for symptoms of H₂S exposure, including burning throat and eyes and nausea. The paramedic team that removed the truck driver's clothing had less severe symptoms than the other two crews.

The ATSDR Medical Management Guidelines . . . [state] that responders are not at risk when they assist a victim of H₂S gas exposure.

. . . H₂S is released from the clothing and skin, and via gas that expires from the lungs.

ATSDR has concluded that persons who are exposed to elevated levels of H₂S (i.e., greater than 500 ppm) may pose a threat to responders . . .

4.0 Regulatory Analysis

4.1 OSHA Process Safety Management

The OSHA PSM Standard (29 CFR 1910.119) is intended to prevent or minimize the consequences of a catastrophic release of toxic, reactive, flammable, or explosive chemicals. Paper mills are not exempt from the standard, which applies to processes¹⁴ containing more than a threshold quantity of any one of 137 OSHA-listed highly hazardous chemicals or substances classified by OSHA as flammable. Substances are listed based on their toxic or reactive properties. OSHA lists H₂S as a highly hazardous chemical; NaSH is not listed in the PSM Standard.

OSHA lists H₂S as a highly hazardous chemical; NaSH is not listed in the PSM Standard.

The PSM Standard covers certain processes at the Naheola mill; however, the area where the incident occurred was not part of a PSM-covered process. Although OSHA lists H₂S as a highly hazardous chemical, it is not present in sufficient quantities¹⁵ or—in this case—is not part of an OSHA-defined covered process. There were no other OSHA PSM highly hazardous chemicals in the area of the release.

. . . the area where the incident occurred was not part of a PSM-covered process.

The Naheola mill applied the site process safety management plan only to areas of the facility that were covered by the PSM Standard. Section 3.2 discusses the elements of a process safety management program that are causally related to this incident.

4.2 Hazard Communication

The OSHA Hazard Communication (HAZCOM) Standard (29 CFR 1910.1200) requires companies to provide their employees with information on the hazardous chemicals to which they may be exposed.

If the good engineering and process safety management practices outlined in Section 3.0 had been followed, mill personnel would likely have determined that H₂S could possibly be present at the location of the incident. Good practice would have required the

¹⁴ OSHA defines a process as any activity involving a highly hazardous chemical, including any use, storage, manufacturing, handling, or onsite movement of such chemicals, or any combination of these activities.

¹⁵ The threshold quantity for H₂S is 1,500 pounds.

communication of H₂S hazards to Naheola mill employees; similarly, Burkes Construction would have to communicate the hazards of H₂S to its employees. The HAZCOM Standard requires that this be done by a formal communication program, to include labels, MSDSs, and training.

4.3 Hazardous Waste Operations and Emergency Response

The OSHA Hazardous Waste Operations and Emergency Response (Hazwoper) Standard (29 CFR 1910.120) details requirements for emergency response activities associated with the release of hazardous substances. The Naheola mill is subject to Hazwoper requirements; among other things, the standard mandates specific emergency response training.

The Hazwoper Standard allows for an exemption if employees will be evacuated in the event of a release, which applies to Burkes Construction. Accordingly, it was not bound to meet the Hazwoper requirements.

5.0 Root and Contributing Causes

5.1 Root Causes

1. Good engineering and process safety practices were not followed when joining the drain from the truck unloading station and the oil pit to the acid sewer.
 - Neither the chemicals that could be introduced into the sewer nor the hazards of their interactions were identified.
 - No formal hazard review or MOC analysis was conducted when connecting sewer lines from the tank truck unloading and chlorine dioxide areas to the acid sewer. Consequently, no scenarios leading to the possible release of H₂S were identified, nor were warning devices placed in the area.
2. There was no management system to incorporate hazard warnings about mixing sodium hydrosulfide (NaSH) with acid into process safety information.
 - Design information for projects involving NaSH did not specify the hazard of mixing NaSH with acid.
 - Operating procedures for NaSH tank truck unloading and oil pit operations did not warn of the hazards of mixing NaSH with acids or the hazards of allowing NaSH to enter sewers.
 - Personnel were not trained on the specific hazards of NaSH, such as handling spilled material or keeping it separate from acid.

Neither the chemicals that could be introduced into the sewer nor the hazards of their interactions were identified.

Personnel were not trained on the specific hazards of NaSH, such as handling spilled material or keeping it separate from acid.

5.2 Contributing Causes

1. The fiberglass manway was not adequately designed or sealed to ensure that the sewer remained closed.

The manway was originally an open grate. It was modified by adding a fiberglass cover and sealed. Those interviewed recalled prior occasions when chlorine dioxide escaped from the fiberglass manway; they also recalled repairs that were sometimes documented in work orders, but these events were not recorded or investigated as incidents. Thorough incident investigation would have provided an opportunity to recognize that the

Those interviewed recalled prior occasions when chlorine dioxide escaped from the fiberglass manway . . . but these events were not recorded or investigated as incidents.

H₂S training should include specific instruction on the importance of wearing proper protective equipment prior to attempting rescue.

fiberglass manway was not appropriately designed to provide and maintain an airtight seal on the sewer.

2. The contractors injured during the incident did not have adequate training to understand the hazards of hydrogen sulfide (H₂S).

H₂S training should include specific instruction on the importance of wearing proper protective equipment prior to attempting rescue.

6.0 Recommendations

Georgia-Pacific Corporation

1. Conduct periodic safety audits of Georgia-Pacific pulp and paper mills in light of the findings of this report. At a minimum, ensure that management systems are in place at the mills to:
 - Evaluate process sewers where chemicals may collect and interact, and identify potential hazardous reaction scenarios to determine if safeguards are in place to decrease the likelihood or consequences of such interactions. Take into account sewer system connections and the ability to prevent inadvertent mixing of materials that could react to create a hazardous condition. (2002-01-I-AL-R1)
 - Identify areas of the mill where hydrogen sulfide (H₂S) could be present or generated, and institute safeguards (including warning devices) to limit personnel exposure. Require that personnel working in the area are trained to recognize the presence of H₂S and respond appropriately. Update emergency response plans for such areas to include procedures for decontaminating personnel exposed to toxic gas. (2002-01-I-AL-R2)
 - Apply good engineering and process safety principles to process sewer systems. For instance, ensure that hazard reviews and management of change (MOC) analyses are completed when additions or changes are made where chemicals could collect and react in process sewers. (Such principles may be found in publications from the Center for Chemical Process Safety [CCPS].) (2002-01-I-AL-R3)
2. Communicate the findings and recommendations of this report to the workforce and contractors at all Georgia-Pacific pulp and paper mills. (2002-01-I-AL-R4)

Georgia-Pacific Naheola Mill

1. Evaluate mill process sewer systems where chemicals may collect and react to identify potential hazardous reaction scenarios to determine if safeguards are in place to decrease the likelihood or consequences of such interactions. Evaluate sewer connections

and ensure that materials that could react to create a hazardous condition are not inadvertently mixed, and that adequate mitigation measures are in place if such mixing does occur.

(2002-01-I-AL-R5)

2. Establish programs to comply with recommendations from manufacturers of sodium hydrosulfide (NaSH) regarding its handling, such as preventing it from entering sewers because of the potential for acidic conditions. (2002-01-I-AL-R6)
3. Establish programs to require the proper design and maintenance of manway seals on closed sewers where hazardous materials are present. (2002-01-I-AL-R7)
4. Identify areas of the plant where hydrogen sulfide (H₂S) could be present or generated, and institute safeguards (including warning devices) to limit personnel exposure. Institute a plan and procedures for dealing with potential H₂S releases in these areas, and require that anyone who may be present is adequately trained on appropriate emergency response practices, including attempting rescue. Require contractors working in these areas to train their employees on the specific hazards of H₂S, including appropriate emergency response practices. (2002-01-I-AL-R8)
5. Update the Naheola mill emergency response plan to include procedures for decontaminating personnel who are brought to the first-aid station. Include specific instructions for decontaminating personnel exposed to H₂S so that they do not pose a secondary exposure threat to medical personnel. (2002-01-I-AL-R9)

Agency for Toxic Substances and Disease Registry (ATSDR)

Evaluate and amend as necessary the ATSDR Medical Management Guidelines to consider the risk to responders posed by exposure to victims of high levels of hydrogen sulfide (H₂S) gas. Specify procedures for adequate decontamination. Communicate the results of this activity to relevant organizations, such as the American Association of Occupational Health Nurses. (2002-01-I-AL-R10)

Burkes Construction, Inc.

Train your employees on the specific hazards of hydrogen sulfide (H₂S), including appropriate emergency response practices, in areas where Georgia-Pacific has identified this material as a hazard. (2002-01-I-AL-R11)

Davison Transport, Inc.

Communicate the findings and recommendations of this report to those employees who haul or handle sodium hydrosulfide (NaSH). (2002-01-I-AL-R12)

American Forest and
Paper Association (AFPA)

Communicate the findings and recommendations of this report to your membership. (2002-01-I-AL-R13)

International
Brotherhood of
Electrical Workers (IBEW)

Communicate the findings and recommendations of this report to your membership. (2002-01-I-AL-R14)

Paper, Allied-Industrial,
Chemical & Energy
Workers International
Union (PACE)

Communicate the findings and recommendations of this report to your membership. (2002-01-I-AL-R15)

Pulp and Paper
Safety Association (PPSA)

Communicate the findings and recommendations of this report to your membership. (2002-01-I-AL-R16)

By the

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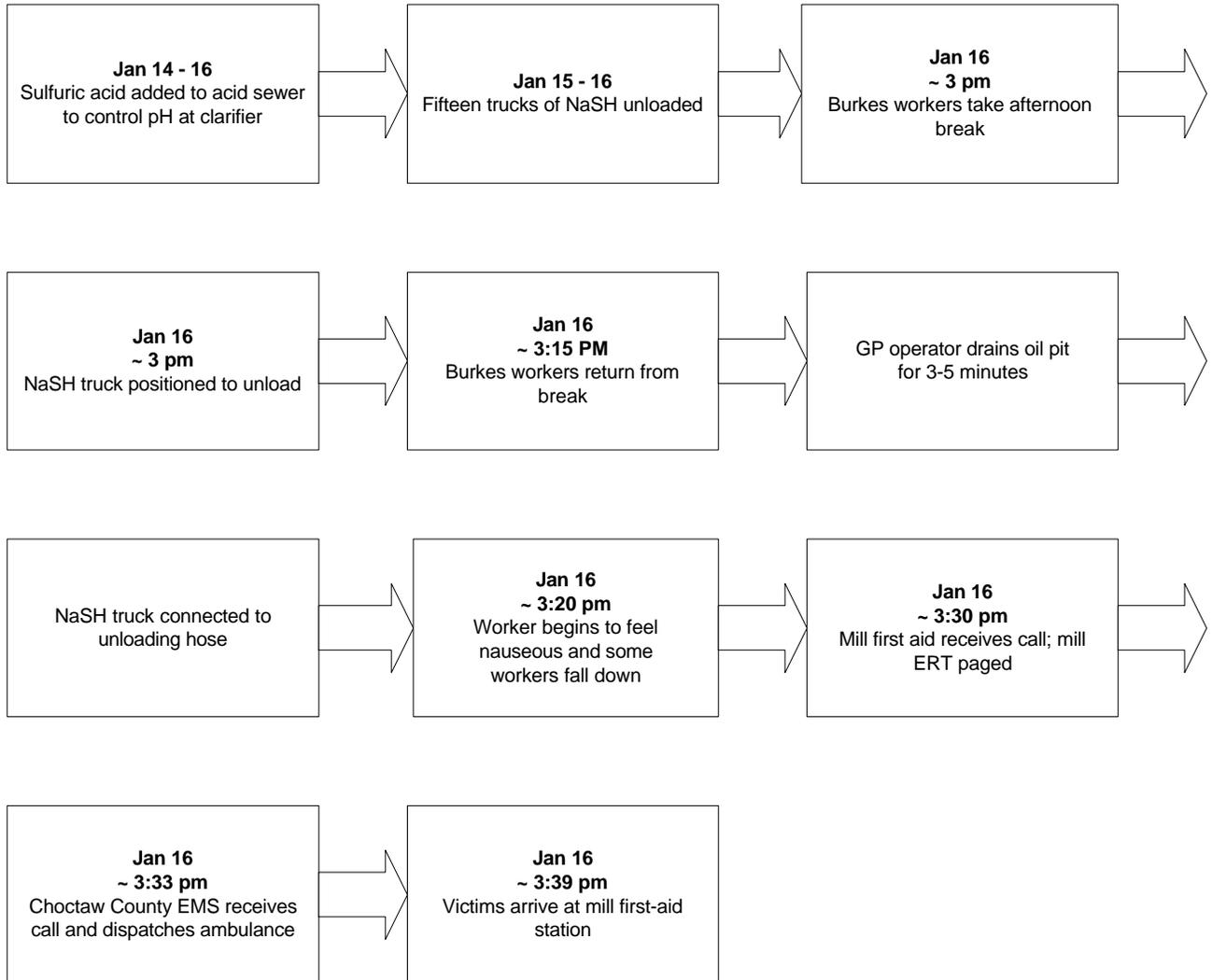
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November 20, 2002

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APPENDIX A: Incident Timeline



APPENDIX B: Logic Diagram

