An Ethical Analysis of the MGPI Toxic Chemical Release in Atchison, Kansas 2016

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Introduction

On October 21st, 2016, a massive cloud of toxic chlorine gas billowed out from an MGPI Processing (MGPI) plant, polluting nearby Atchison, Kansas for nearly 90 minutes. Over 140 locals and employees sought immediate medical treatment because of the gas release. Subsequent investigation by the U.S. Chemical Safety and Hazard Investigation Board (CSB) revealed that a Harcros Chemical delivery truck driver had inserted the nozzle from his truck into the incorrect fill line, causing sulfuric acid to make its way into the sodium hypochlorite (bleach) storage tank. The resulting reaction formed a plume of toxic chlorine gas (CSB, 2017).

The gas release was a consequence of miscommunication between two companies: MGPI and Harcros chemicals (Harcros). MGPI distills alcohol and produces specialty wheat starches and proteins. Their industrial alcohol has many uses in food, personal care products, pharmaceuticals, and medicines. Harcros provides chemicals to various industries including agriculture, oil and gas, and water treatment industries. One of their main services involves transloading chemicals that can be hazardous, toxic, or corrosive such as sulfuric acid. Sulfuric acid was routinely delivered to Mod B at the Atchison facility, an area where “different chemicals are utilized to satisfy various desired characteristics of the specialty and commodity starches” (CSB, 2017, p. 6). MGPI uses sulfuric acid to modify starches through pH adjustment and uses sodium hypochlorite to oxidize starches.

The MGPI incident is important to examine because of its application to all chemical delivery areas where potential fill line mix-ups can occur. It highlights the need for chemical companies to continually monitor their systems and procedures to prevent harmful chemicals from hurting employees as well as the public.

This report begins with an explanation of the importance of following safety guidelines such as Chevron Phillips' Ten Tenets of Operation, which uphold the American Institute of Chemical Engineers (AIChE) code. Next, events of the accident are detailed, followed by their direct consequences. This paper shows that MGPI failed to hold public safety paramount by failing to address long-standing safety issues and by neglecting their own procedures. This paper does not evaluate the ethics of the decisions made by the Harcros Chemical truck driver, who delivered the sulfuric acid. Although the toxic gas release resulted most directly from a fill line mix-up by the Harcros Chemical truck driver, MGPI's failure to apply professional ethical codes to their procedures makes them mostly responsible for the incident. In other words, MGPI's long-term neglect of communication protocol and lack of modern safety mechanisms both led to, and greatly worsened, the harm inflicted on employees and the public.

Criteria of Ethical Evaluation

MGPI's abandonment of pertinent professional guidelines led to the toxic chemical release. According to philosopher Michael Davis, who has written extensively on Engineering ethics, engineers should practice professional guidelines that hold public safety paramount (Davis, 1991). Therefore, nonadherence to professional guidelines is unethical and deserves investigation because it threatens the welfare of employees and nearby communities. AIChE agrees with Davis, affirming in its first code of ethics that chemical engineers shall, "Hold paramount the safety, health and welfare of the public and protect the environment in performance of their professional duties" (AIChE, 2015). To ensure public well-being is held paramount, Chevron Phillips offers tenets of operation meant to reduce the likelihood of harm to employees, the public, and the environment. Following these tenets has allowed Chevron Phillips to achieve a lower Occupational Safety and Health Administration (OSHA) Recordable Incident

Rate—the ratio of recorded injuries to the number of labor hours at a company—than the top 25% of safest companies in the chemical industry (2018). Given its stellar record of minimizing incident occurrence and impact, Chevron Phillips' tenets of operation are appropriately applied to analyze the actions of MGPI's gas release in this report. A lack of safety devices and emergency procedures, failure to address abnormal conditions, and absence of designated systems—all of these violated Chevron Phillips' tenets of operation (2018). To understand how these violations played a role in the incident, one must first understand what went wrong prior to and during the gas release.

What Went Wrong

At about 7:35 a.m. on the morning of the incident, the MGPI operator met with the Harcros truck driver at the Mod B fill line to facilitate the transfer of sulfuric acid. The operator unlocked the sulfuric acid line padlock, removed the cap to the line, and then went back to the control room. The truck driver then attached the nozzle of the sulfuric acid hose from his truck to the nearest unlocked fill line, which happened to be the sodium hypochlorite fill line, not the sulfuric acid fill line. The CSB reports that the sodium hypochlorite fill line was open to the air at the same time as the recently unlocked sulfuric acid line because the sodium hypochlorite fill line cap had not been fastened after previous use. The CSB also observed that the fill line pipe markers were not as close to the fill line connecting points as possible, as is suggested protocol according to the American Society of Mechanical Engineers (as cited in CSB, 2017). Because both lines were open and not clearly marked, the truck driver accidentally attached his hose to the incorrect line, causing sulfuric acid to travel through the line and into the sodium hypochlorite tank. The inadvertent mixing of these two chemicals drove the reaction that led to the release of chlorine gas and other toxic chlorine byproducts (CSB, 2017).

Other mishaps that worsened the impact of the incident on the health of employees as well as the public soon followed. First, the truck driver returned to his truck cab to fill out paperwork. Busy with the paperwork, he was not monitoring the transfer of chemicals from the truck to the fill line. Therefore, he was unaware that an unintended reaction was occurring until the greenish-yellow gas began to overwhelm his truck, preventing him from accessing the sulfuric acid tank shutoff valve at the rear end of the cargo tank. Additionally, the driver did not have a chemical respirator or a full-face piece to protect himself from the toxic gas cloud (CSB, 2017).

At about the same time the driver fled from the gas cloud, the gas began to rise from the sodium hypochlorite tank and infiltrated the Mod B control room through the ventilation system, which had higher pressure than internal rooms but no pressure gradient to keep outside gases out. Without an automatic chlorine gas detector or ventilation shut-off, the control room was quickly inundated with toxic chlorine gas, forcing operators to scramble for protective escape respirators and face pieces to minimize harm from inhalation. Behind a locked cabinet, the escape respirators were inaccessible, and the face pieces were stored in a separate cabinet, making it even more difficult for the operators to don proper protective equipment before evacuating the control room. Because they were unable to access protective equipment, the operators were forced to run out of the building unprotected from the toxic chlorine gas cloud, increasing the severity of the injuries they suffered (CSB, 2017).

The reaction was highly exothermic, meaning it released large amounts of heat when the two reactants (sulfuric acid and sodium hypochlorite) mixed. Consequently, the heat released by this reaction provided a buoyant force, lifting the gases above the tank to the town of Atchison

15 miles away. (CSB, 2017). Released over the 90-minute duration of the incident, the gas cloud adversely affected many people.

Direct Consequences and Significance of Studying This Case

The chlorine gas cloud led to a shelter-in-place order for many of Atchison's 11,000 citizens, evacuation by bus for students attending schools in the path of the cloud, and hospitalization of five citizens. The MGPI toxic chemical release warrants investigation because the chlorine gas polluted air and infringed on public health (Meyers, 2020). The extent of irritation from chlorine gas depends on the concentration and duration of exposure. Figure 1 shows the detrimental effects of chlorine at various concentrations (CSB, 2017, p. 10).

Concentration	Potential health effects[18]
1-3 ppm	Mild nose irritation
5 ppm	Eye irritation
5-15 ppm	Throat irritation
30 ppm	Immediate chest pain, vomiting, changes in breathing rate and cough
40-60 ppm	Lung injury and fluid in lungs (pulmonary edema)

Figure 1. Chlorine Concentration and Potential health effects (CSB, 2017. P.10) Chlorine concentration is measured in parts per million (ppm).

Although there was no real time data of the concentration in the nearby area, 140 individuals sought medical attention due to throat irritation after the MGPI gas release, suggesting that the gas plume was likely within 5-15 ppm. However, some injuries revealed that individuals were exposed to higher, more dangerous concentrations. For example, one MGPI employee, who was directly exposed to the toxic cloud, was released from the hospital after three

days, four hospitalized residents were released after four days, and another hospitalized resident was released after five (CSB, 2017).

The MGPI gas release offers perspective into the dire consequences of mixing large volumes of incompatible chemicals, or chemicals that react with each other. Chemical deliveries occur daily nationwide, offering many potential opportunities for similar incidents to occur. The CSB notes that between 2014-2017, there have been eight similar incidents involving incompatible chemicals leading to chemical reactions. The CSB also found that "unloading incidents involving hose connections to incorrect tanks occur frequently", even though most of those incidents involve compatible chemicals, or chemicals that do not react with each other (2017, p. 33). Large volumes of product can greatly increase the severity and scale of potential accidents. In 2016, 40 million tons of chemicals were delivered about every eight seconds in the U.S. (CSB, 2017). At this volume, the danger of failing to realize and mitigate dormant threats can lead to disastrous unintended outcomes.

The frequency and scale of chemical delivery incidents poses hazards to the environment and public safety. Therefore, it is crucial to investigate the actions of the companies responsible for the incident.

Safety History of Responsible Parties

The two companies involved in the incident were Harcros and MGPI. Scrutinizing the safety history of these companies offers insights into a general quality of safety for each company that may have affected operations involved in the incident.

Harcros

Harcros has a history of safety violations. In April 2016, only months before the MGPI incident, Harcros was fined for 14 serious violations of the United States' Department of Labor

safety regulations at their own Wichita plant (OSHA, 2016). Some violations were for Harcros' lack of an emergency response plan and their failure to develop procedures to conduct operations safely. In response, Harcros paid $80,000 in fines and was given a recommendation to monitor procedures and retrain their workers (OSHA, 2016). However, this recommendation was not enough to prevent the same mistakes made by the Harcros chemical driver during the gas release later that year.

MGPI

On the other hand, MGPI received both an Occupational Health and Safety Assessment Series (OHSAS) 18001 certification and initial International Organization for Standardization (ISO) 14000 certification in 2009 from a third-party accreditor (MGP, 2020). The former certification acknowledges that operational health and safety management system guidelines are in place, while the latter verifies adherence to ISO's environmental management system. However, these certifications are regarded as minimal safety requirements in the industry and are not indicative of safe practice. Therefore, to operate safely and ethically, MGPI should have maintained their own standards for safety and continuously monitored for changes. In March 2015, MGPI received a Process Hazard Analysis (PHA) recommendation from an employee identifying the potential for a wrong chemical transfer that could be caused by an operator error (CSB, 2017). Unfortunately, this recommendation was not enough to prevent the gas release the following year without proper action.

While MGPI does not have a history of safety violations as Harcros does, MGPI's failure to address long standing safety deficiencies ultimately makes them more responsible for the incident.

Pertinent Ethical Tenets Were Not Followed

MGPI's failure to address long standing procedural safety deficiencies, as well as their lack of appropriate safety technology, caused and sharply worsened the impact of the incident. MGPI's neglect of procedural safety guidelines is unethical because they failed to hold the safety of the public paramount.

Nonadherence to written safety practices

Inconsistencies between MGPI's safety procedures for different chemicals threatened public safety. Even though the plant passed third party evaluations from OHSAS and ISO 14000 prior to the incident, they failed to follow pertinent professional safety guidelines such as those found in Chevron Phillips' Tenets of Operation, listed in figure 2. These tenets have guided an impressive safety record for Chevron Phillips, as noted earlier in this report. Therefore, we will use Chevron Phillips' tenets of operation to analyze the safety of MGPI's procedures and actions.

1. Always operate within design or environmental limits
2. Always operate in a safe and controlled condition
3. Always ensure safety devices are in place and functioning
4. Always follow safe work practices and procedures
5. Always meet or exceed customer's requirements
6. Always maintain integrity of dedicated systems
7. Always comply with all applicable rules and regulations
8. Always address abnormal conditions
9. Always follow procedures for high risk or unusual situations
10. Always involve the right people in decisions that affect procedures and equipment

Figure 2. Chevron Phillips' Tenets of Operation (Chevron Phillips, 2018) Highlighted are tenets applicable to this report.

The fill line mix-up was most directly caused by MGPI plant violation of Chevron Phillips' sixth tenet in figure 2. The sodium hypochlorite and sulfuric acid fill line openings were

poorly labeled and crammed closely together, as seen in figure 3, creating the potential for the fill lines to be contaminated.

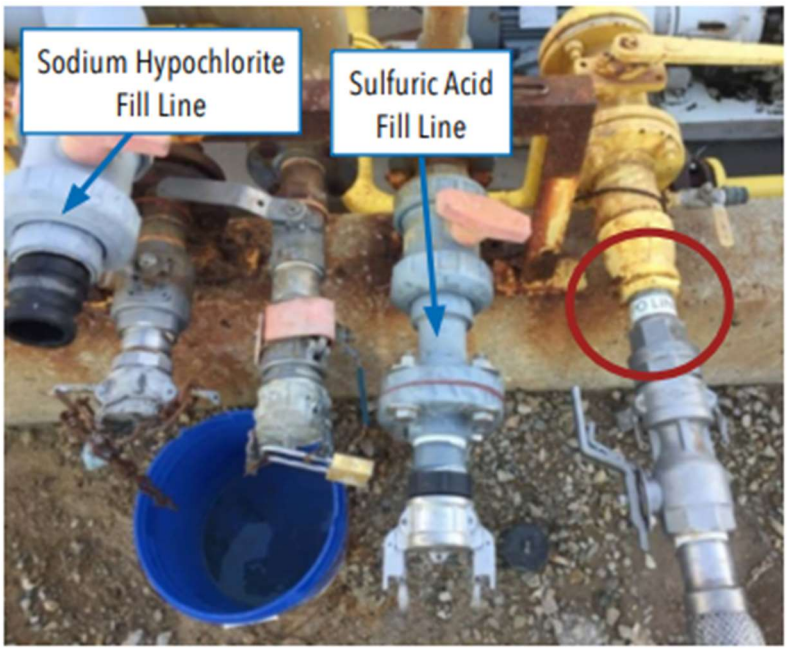

Figure 3. The fill lines involved in the incident lacked labeling and were only 18 inches apart. The red circle points out better fill line markings on the propylene oxide line near the connection point (CSB, 2017).

The CSB found that the two lines were only 18 inches apart and lacked pipe markers to identify intended fill line contents (2018). By failing to appropriately identify and separate the fill lines, MGPI's fill line system was compromised. Had MGPI placed pipe markers on all fill line connection points and separated the lines farther apart, it is likely that the truck driver would have readily identified which line to fill. Instead, he relied on tradition that only one fill line would be unlocked and ready to fill, which was not the case because the sodium hypochlorite cap had not been reattached after a prior delivery.

Another main event that led to the inadvertent gas release violated Chevron Phillips' fourth tenet. The MGPI operator went back to the control room after verbally suggesting which line should be filled to the driver. In interviews with the CSB, it was found that the operators

were unaware that procedures for receiving sulfuric acid deliveries required that they stay with the truck driver to verify the correct connection of hose to fill line. Instead, they followed an informal rule of letting the truck drivers open the fill line valve and connect the hose from the truck on their own, reasoning that the truck drivers had the appropriate protective gear in the event of a spill or leak from the fill line (2018). Reliance on informal procedures rather than established written procedures made the interaction at chemical deliveries unsafe. However, blame cannot be placed solely on the operator; the written chemical unloading procedures missed crucial details and may not have emphasized key points enough for operators to understand the instructions.

Procedural deficiencies

MGPI's operations violated the fourth tenet in figure 2 because they did not consistently apply the sodium hypochlorite handling precautions to the more dangerous sulfuric acid. The sodium hypochlorite unloading procedures are more thorough than the sulfuric acid procedures, including blanks to write and verify the time, date, and person unloading the chemical. Having blank lines for employees to sign off is a critical verification step that increases the likelihood that steps in the unloading procedure are followed (CSB, 2017). Thus, the CSB notes that the details applied to the sodium hypochlorite unloading procedure should have been at least matched or surpassed for sulfuric acid because it is an "extremely hazardous substance" according to the Environmental Protection Agency, as cited by the CSB (2017).

Therefore, failure to apply the verifiable, specific steps from the sodium hypochlorite unloading procedures to the sulfuric acid unloading procedures was unethical because it reduced the chance that an employee would correctly follow the sulfuric acid unloading procedures, putting the safety of employees and the public at risk.

Insufficient safety technology

The absence of warnings for hazardous chemicals entering the control room through the ventilation system violates Chevron Phillips' third tenet in figure 2 that engineers should "Always operate with safety devices armed." As mentioned earlier, the ventilation system in the control room allowed outside air in and did not have any way to monitor concentrations of chlorine gas or other possible vapors that could be released in the unloading area. Without a way to monitor for hazardous vapor concentrations before they enter the control room, the operators were caught unaware by the chlorine gas cloud, exposing them to the toxic chlorine gas as they scrambled for protective equipment to escape (CSB, 2017). Failure to operate with appropriate safety devices armed was unethical because it increased the harm inflicted on the MGPI operators by increasing their exposure time to the toxic gas cloud.

Lastly, MGPI again violated tenet 3 in figure 2 by not having equipment to automatically shut down the transfer of chemicals in the event of a process deviation, such as a temperature or pressure exceedance in the sodium hypochlorite tank. The tank did have a level indicator that sounds an alarm when the level approaches tank capacity, but it was incapable of automatically shutting down chemical transfer from fill line to tank. Thus, on the morning of the incident, the flow of sulfuric acid to the tank triggered the warning alarm, but without an automatic shutoff, could not be stopped. Additionally, the only emergency stop buttons in the control room were for the Mod B process, not flow into the storage tank, so they could not have mitigated the reaction either (CSB, 2017). Without an automatic remote shutoff for chemical flow from fill lines to storage tanks, MGPI could only stop the process by manually shutting valves at the unloading zone, which was surrounded by the chlorine gas cloud. Therefore, MGPI's failure to implement automatic safety systems put the health of emergency responders at risk because they had to

wade through a toxic gas cloud to stop the gas release. A lack of automatic safety systems also put the health of the public at risk because it delayed the stoppage of the reaction, causing a much greater volume of toxic gas to be released.

Company Response

Overall, MGPI did an adequate job responding to the incident by notifying the authorities and public quickly. In response to the incident, MGPI set up a hotline with the Federal Agency for Toxic Substance and Disease Registry for questions regarding the chemical release (MGP, 2016). However, they could have provided more information in a timely manner about the chemicals released to the hospitals treating patients for injuries to help with treatment. Taking responsibility for the incident, MGPI voluntarily compensated for the medical bills of the affected individuals as well as for any property damage that may have occurred (Margolies, 2019). In addition, MGPI agreed to continue to undergo audits and comply with all investigations regarding the chemical mix-up. Additionally, MGPI and Harcros paid $1 million in fines for violating the Clean Air Act by allowing the release of toxic chemicals to pollute the environment (District of Kansas, 2020).

After the incident, MGPI modified their procedures and plant. For the unloading area, MGPI implemented new company guidelines. They now require a safety observer when connecting and disconnecting cargo tank hoses to chemical fill lines (CSB, 2017). Operators also must ensure that all dust caps are secured before and after deliveries to ensure drivers cannot access the wrong fill line. Working together, the drivers and operators are required to complete written verification forms to check procedures are followed and to certify the correct connection. Within the Mod B control room, one cabinet contains both hoods and supplied air bottles that are easily accessible in case of emergency. Furthermore, MGPI took initiative and asked employees

for safety modification suggestions, unlike before when they ignored recommended changes from PHAs in 2015. Additionally, they now require that fill line connection points have a minimum of three feet between each line to prevent proximity between incompatible chemicals. To improve the capacity to remotely stop unintended reactions like the one that occurred, more alarms and emergency shutdown devices were implemented. To protect operators from being suddenly overwhelmed with gas vapors, ventilation design changes were made in the control room to prevent flow of chemical vapors from outside. Lastly, to make it impossible to connect the incorrect chemical to a fill line, MGPI and Harcros coordinated uniquely shaped transfer equipment for each hose and line (CSB, 2017).

Recommendations

While MGPI made many modifications in response to the accident, additional changes can be made. For example, the fill lines could be separated into different areas, with strong acids such as sulfuric acid on one side of Mod B and strong bases like sodium hypochlorite on the other to prevent chemical reactions with incompatible chemicals. Also, MGPI could hire an independent evaluator to check the design changes made in the control room and fill lines and see if they can respond appropriately in the event of an emergency as well as during normal operations. Running drills to prepare for an emergency and frequently having retraining sessions and independent evaluations, can help prevent a similar accident from occurring.

Conclusion

MGPI's gas release highlights the risk that frequent deliveries of large quantities of chemicals pose to the chemical industry. The release resulted from an unethical long-term nonadherence to professional safety guidelines, such as Chevron Phillips' tenets of operation. MGPI's safety infrastructure was not appropriate for dealing with a high-volume chemical

interface of routine deliveries because fill lines were not kept far enough apart, and any nozzle could fit in any fill line. Consequently, the sodium hypochlorite fill line was accidentally filled with incompatible sulfuric acid.

Additionally, safety procedures were inconsistent throughout the plant, and lacked accountability mechanisms such as signatures. Thus, operators began to use informal safety procedures such as returning to the control room while fill lines were being filled because the delivery driver had better protective equipment. These informal procedures as well as inconsistencies throughout the plant, increased the risk of mishandling chemicals, leading to the inadvertent reaction between incompatible chemicals. Once the gas release had begun, operators had no means to stop it immediately because there was no automatic shutoff for flow into the storage tank. Also, they could not use information from the control room to help mitigate the gas release because the control room had been inundated by chlorine gas without any warning, forcing the operators to scramble to escape. Overall, deficiencies in safety technology prolonged the gas release and increased the harm inflicted on the MGPI employees by increasing their exposure time to the gas.

In response to the accident, MGPI set up a hotline for questions and paid for all medical bills and property damage incurred. Additionally, they paid for the environmental damage and modified their procedures as well as fill lines and safety devices. They heeded employee PHA recommendations and addressed those changes when remodeling their plant systems. Hopefully these changes will encourage chemical operators nationwide to proactively limit other dormant threats to prevent similar accidents from occurring.

Although changes were made, the accident raises the question of whether MGPI is still continually monitoring their own procedures. Additionally, while Harcros worked with MGPI to

establish unique fill lines for each chemical delivered, it is not known whether these changes were made with all their other clients as an updated safety measure. To make these changes for all chemical companies in the United States, OSHA would need to enforce a standard of unique fill line shapes and sizes and other precautionary devices to keep incompatible chemicals separate. It is unclear whether OSHA can or will do so.

In the meantime, engineers and plant managers should monitor employee compliance with procedures, determine if appropriate safety devices are in place, and continue to heed PHA recommendations. That way, accidents like the gas release at MGPI can be prevented.

Word Count: 3969

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