Explosion and Fire at AB Specialty Silicones Facility

Waukegan, IL | *Incident Date: May 3, 2019* | **No. 2019-03-I-IL**

Factual Update

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U.S. Chemical Safety and Hazard Investigation Board

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Acronyms and Initialisms

CSB	U.S. Chemical Safety and Hazard Investigation Board
CFM	cubic feet per minute
EPA	Environmental Protection Agency
OSHA	Occupational Safety and Health Administration
O	oxygen
PSM	Process Safety Management
RMP	Risk Management Plan
SDS	Safety Data Sheet
SEHSC	Silicones Environmental, Health and Safety Council of North America
Si	silicon
SiH	silicon hydride
SVEP	Severe Violator Enforcement Program

1. Incident Summary

On May 3, 2019, a silicone manufacturing process generated a flammable gas inside an enclosed production building at the AB Specialty Silicones ("AB Specialty") facility in Waukegan, Illinois (**Figure 1**). At approximately 9:30 p.m., the flammable vapor cloud found an ignition source and ignited, causing an explosion and fire. The flammable vapor originated from the area where AB Specialty was making a silicon hydride emulsion. The explosion fatally injured four AB Specialty employees [1] and caused serious injury to another AB Specialty employee. At the time of the incident there were nine AB Specialty employees onsite. The explosion heavily damaged the AB Specialty's production building. Additionally, the force from the explosion was felt up to 20 miles away in the surrounding communities [2], and some nearby businesses sustained damage from the blast [3]. Post-incident, AB Specialty has resumed some of its operations at another location [4].

2. Background

2.1 AB Specialty Silicones

AB Specialty is a U.S. manufacturer and worldwide distributor of specialty silicone chemicals headquartered in Waukegan, Illinois [5]. AB Specialty formed out of a merger between Anderson and Associates and BRB USA in February 2012.

At the time of the incident, AB Specialty had approximately 88 employees. The company typically operated its silicone manufacturing facility 24 hours a day—Monday through Friday using three shifts of workers—first, second, and third.

The silicone products made by AB Specialty[a] are used in a wide variety of industries, including: personal care, roof coatings, chemical manufacturing, adhesives, sealants, and coatings [5]. AB Specialty manufactures and distributes specialty made-to-order silicones as well as a catalog of products [5]. AB Specialty does not store chemicals in sufficient amounts for the company's operations to be regulated under the Environmental

[a] AB Specialty markets their brand under the name Andisil® [5].

Protection Agency's (EPA) Risk Management Plan (RMP) program[a] or the Occupational Safety and Health Administration's (OSHA) Process Safety Management (PSM) standard.[b]

Figure 1. AB Specialty Silicones. Photo showing the AB Specialty Silicones production area (3790 Sunset Ave.) in Waukegan, IL, before the explosion. (Source: Google Maps).

3. Silicone Chemistry

3.1 Silicones

Silicone is a synthetic polymer is composed of multiple repeating silicon (Si) and oxygen (O) bonds [6, p. 1]. The silicon-oxygen bond (siloxane functional group as seen in **Figure 2**) serves as the basis for the development of silicones [6, p. 2]. Silicon is a natural occurring element, and although silicon is abundant, it is rarely found in nature in its pure form [6, p. 2]. Silicon readily bonds with oxygen forming either silica (only silicon and oxygen components) or silicates (silicon, oxygen, and other elements) [6, p. 2]. In comparison, silicon has a moderate ability to form bonds with hydrogen [6, p. 2].

A long chain of siloxane groups is called a silicone or silicone polymer [6, p. 1]. An example of siloxane is octamethylcyclotetrasiloxane (also known as "D4"- see **Figure 2.** Siloxane Functional Group (Left) and D4 (Right). (Source: Global Silicones Council).) [6, p. 1]. Siloxanes can differ in molecular weight, shape, and

[a] The RMP rule applies to facilities that the Clean Air Act defines as stationary sources of air pollution, and that use or store specific regulated substances that the EPA has determined to be extremely hazardous in nature. If any of the specified toxic chemicals or flammable substances are present at a facility at or above established threshold quantities listed by the EPA in its regulation, then the RMP rule applies to the chemical process using that substance at that facility. 40 C.F.R. § 68.

[b] The PSM standard applies to "(i) A process which involves a chemical at or above the specified threshold quantities listed in appendix A to this section; (ii) A process which involves a Category 1 flammable gas (as defined in 1910.1200(c)) or a flammable liquid with a flashpoint below 100°F (37.8°C) on-site in one location, in a quantity of 10,000 pounds (4,535.9 kg) or more except for: (A) Hydrocarbon fuels used solely for workplace consumption as a fuel (e.g., propane used for comfort heating, gasoline for vehicle refueling), if such fuels are not a part of a process containing another highly hazardous chemical covered by this standard; (B) Flammable liquids with a flashpoint below 100°F (37.8°C) stored in atmospheric tanks or transferred which are kept below their normal boiling point without benefit of chilling or refrigeration." The PSM standard does not apply to "(i) Retail facilities; (ii) Oil or gas well drilling or servicing operations; or (iii) Normally unoccupied remote facilities" (29 C.F.R. § 1910.119(a)).

functional chemical groups attached to the silicon-oxygen backbone [6, p. 1]. Siloxanes are critical in developing silicone products because the siloxane functional group serves as the backbone of silicones [6, p. 1].

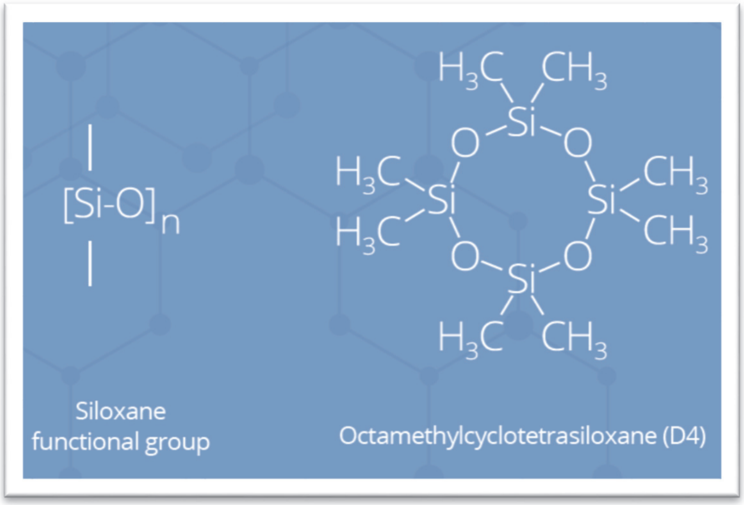

Figure 2. Siloxane Functional Group (Left) and D4 (Right). (Source: Global Silicones Council).

Silicone polymers may be linear or branched, but they are considered individual polymer strands [6, p. 1]. These individual strands can cross-link with each other or with other molecules to form the structure of a new polymer [7], [6, p. 1].

Silicones are used in a variety of applications such as sealants, adhesives, coatings, plastics, cosmetics, medical devices, hygiene products, food contact materials, and many other industrial applications. Silicone polymers have a variety of physical properties (i.e., mechanical/optical/thermal resistance) that are useful in developing specialized products—adhesives, insulation, etc.[a] Silicone products are manufactured in many forms: solids, liquids, semi-liquid viscous pastes, greases, and rubber. Typically, silicone polymers are sold as liquids with varying levels of viscosity [6, p. 1].

[a] Silicones have a wide variety of physical and chemical characteristics, including a broad range of thermal stability (high and low temperature); resistance to oxidation, ozone, ultraviolet exposure; low surface tension (good wetting, spreading flow and antifoaming); good dielectric properties; water repellency (hydrophobicity); low flammability; high gas permeability; high compressibility and shear resistance; adhesive or non-adhesive properties; and softness/flexibility [6, p. 1].

3.2 Silicon Hydride[a] Compounds (SiH)

Silicon hydride compounds (SiH) include some silanes, siloxanes, and silicones. These compounds come in many forms such as emulsions,[b] fluids, elastomers[c] and resins.[d] SiH compounds are reactive under certain conditions and can produce flammable hydrogen gas [8, pp. 1-2].[e]

According to the Silicones Environmental, Health and Safety Council of North America (SEHSC),[f] SiH compounds can be stored, handled, and used safely, but there are a number of scenarios where they can generate hydrogen, including:

- SiH products (e.g., SiH emulsions, fluids, elastomers, and resins) may evolve hydrogen on contact or when mixed with strong acids or bases; amines; primary or secondary alcohols and water in the presence of acids, bases or catalytic metals; some catalytic and reactive metals; or metal salt-forming compounds. When contacting these materials, SiH compounds can rapidly generate hydrogen gas and form flammable and explosive mixtures in air.
- Many SiH emulsions will generate hydrogen continuously under normal conditions of storage and use, without any additional catalytic or reactive agents [8, pp. 1-2].

3.3 SiH Emulsions

The components of a typical SiH emulsion include a SiH fluid, water, emulsifiers, and buffering agents.[g] SiH emulsions usually emit hydrogen continuously at a slow rate because one of the main components, water, has an "unlimited" supply of active hydrogen [8, p. 8].

According to the SEHSC, the rate that SiH emulsions emit hydrogen depends on such factors as:

- pH: levels over 8 or under 3 greatly increases the rate of hydrogen production;
- temperature: long-term exposure to temperatures over 86 degrees Fahrenheit increases the rate of hydrogen release;

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[a] The term silicon hydride compound is interchangeable with the term hydrogen-bonded silicon compounds.

[b] According to AB Specialty, an emulsion is a dispersion (droplets) of one liquid into another immiscible liquid. A common example of an emulsion is mayonnaise [34]. Mayonnaise is a mixture of two liquids (egg yolks and vinegar or lemon juice) that normally will not mix [34]. Oil is added very slowly to the egg yolks and lemon juice and rapidly mixed, producing mayonnaise [34].

[c] An elastomer is a "substance or material that has the ability to return to its original shape after an external force has been applied and removed. Natural and synthetic rubber or related rubberoid materials are elastomers [32, p. 121]."

[d] A resin is a polymer material that is usually a viscous fluid at ambient temperature [33, p. 348].

[e] For an SiH compound to produce hydrogen, three conditions, known as the "gassing triangle," are needed. These conditions are the following: the presence of SiH, a proton donor (or available hydrogen source like water), and a catalyst [8, p. 3]. In certain products, the hydrogen source can also serve as a catalyst [30, p. 4].

[f] SEHSC became a sector group of American Chemistry Council (ACC) in 2013. SEHSC aims to promote "the safe use of silicones through product stewardship, outreach and environmental, health and safety research [24]." SEHSC members represent over 90 percent of manufacturing capacity in North America [24]. Although most of its members adhere to Responsible Care through their membership in ACC, SEHSC membership does not require participation in Responsible Care. AB Specialty is a member neither of SEHSC or ACC.

[g] AB Specialty defines an emulsion as an oil (silicone fluid), water, and surfactant (one part hydrophobic and one part hydrophilic). The company delineates three types of emulsions: mechanical, emulsion polymer, and micro-emulsions. These emulsions differ in how a shearing device is used and particle size.

- degree of hydrogen substitution on the SiH material (the more SiH bonds present the more hydrogen is available for release);
- degree of branching in the SiH polymer (branched SiH polymers react more readily than linear polymers); and,
- quantity of SiH material in the emulsion (the higher the percentage of SiH polymer in an emulsion the more potential there is for gassing to occur) [8, p. 8].

SiH emulsions are very reactive to contact with catalysts and catalytic metal compounds and mixing with catalytic preparations or active metals can promote the rapid release of hydrogen [8, p. 8]. In viscous products, hydrogen generation can cause foaming and overflowing of containers [8, p. 5].

3.4 Safety Considerations

According to SEHSC, with consideration of a new process, a robust safety assessment should occur prior to starting a process to ensure that proper equipment, appropriate operating procedures, and adequate safeguards are in place. SEHSC, in its *Materials Handling Guide: Hydrogen-Bonded Silicon Compounds*,[a] outlines multiple safety approaches and methods to control hazards [8]. These approaches and methods depend on the specific application.

4. Process Description

AB Specialty Silicones produces many silicone products at its Waukegan production facility. The production facility is separated into two portions—the “High Bay” and the “Low Bay”—named after the physical height of structure (**Figure 3**). These bays were further subdivided into areas depending on the chemicals being produced.

[a] The term silicon hydride compound is interchangeable with the term hydrogen-bonded silicon compounds.

Figure 3. High Bay and Low bay. Photo showing the AB Specialty Silicones production area (3790 Sunset Ave.) in Waukegan, IL, before the explosion, with both the High Bay and Low Bay marked. Overhead view (Left) and back view (Right). (Source: Google Maps with annotations by CSB).

The Low Bay and High Bay shared a mechanical ventilation system that consisted of air movers and exhaust fans throughout the building. On the east side of the production building in the emulsions area, there was one main air mover (12,000 cubic feet per minute (CFM)) and one smaller air mover (2,000 CFM) on the Low Bay roof that pulled in outdoor air and dispersed this air throughout the building (**Figure 4**). The main air mover was located in the emulsions area and provided approximately 86 percent of the total makeup air flow into the production building. The Low Bay area had four 1,500 CFM roof exhaust fans, two 1,500 CFM east wall exhaust fans, and one 5,000 CFM roof exhaust fan that ran continuously. In addition, on the east side on the High Bay end, there were two exhaust fans with a total capacity of about 44,000 CFM (**Figure 4**). These exhaust fans did not run continuously and had to be manually activated by a switch located in the maintenance area. The building was not equipped with functioning hydrogen gas[a] or flammable gas detection systems.[b] The production building was equipped with a fire alarm system that was to be activated in case of emergencies, including flammable gas releases, to notify workers[c] to evacuate the production building.

[a] AB Specialty asserts that it had installed a hydrogen gas detection system in the production building and that it was not working because no hydrogen gas detection system can operate in a silicone environment.

[b] AB Specialty had installed flammable gas (lower explosive limit) detectors, but these detectors were not functioning at the time because the silicone vapors caused the detectors' sensors to fail after a couple of months.

[c] Workers did not have radios to communicate with each other inside the production building.

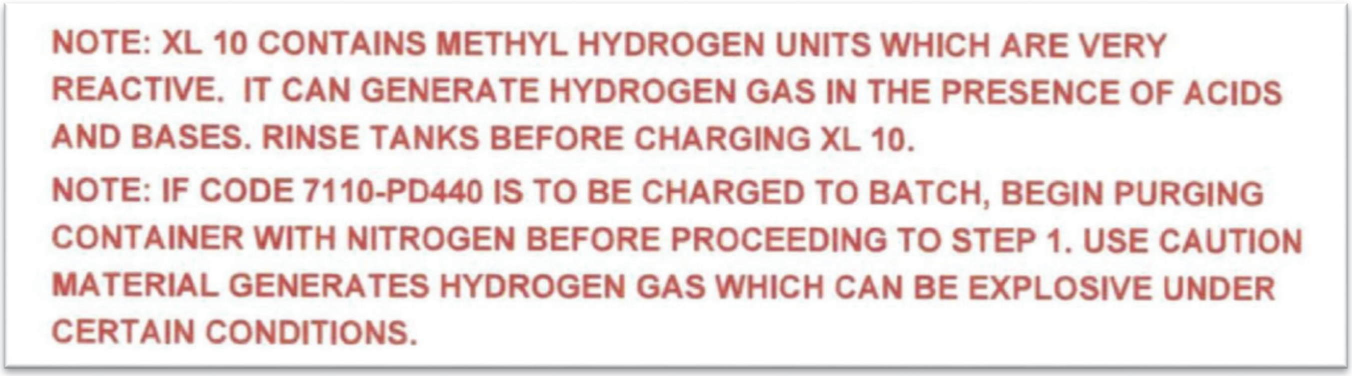
Figure 4. Location of the Emulsions Area and the Ventilation System on the East Side of the Building. Photo on the left shows where the Emulsions Area (yellow box) is located. Photo on the right shows the location of the Air Mover in the Emulsions Area (red box) and the Exhaust Fans in the High Bay (blue boxes). (Source: Google Maps with annotations by CSB).

The production building had multiple vessels in the High and Low Bays, including storage vessels, reactors, and mixing tanks.

One of the products that AB Specialty was making in the emulsions area at the time of the incident was an SiH emulsion called EM 652.[a] According to AB Specialty, EM 652 is an emulsion of silane and siloxane polymers. One of the raw materials used to make this emulsion is a methylhydrogen polysiloxane copolymer, called XL10,[b] which is an SiH compound. Both XL10 and the EM 652 have the capability of producing explosive amounts of hydrogen gas under certain conditions (**Figure 5**).

[a] EM 652 is AB Specialty's trade name for the SiH emulsion. EM 652 is used to improve water repellency. According to an AB Specialty document, EM 652 is a mechanical emulsion which is an emulsion of an existing polymer that uses a shear device to create particle size.

[b] XL10 is AB Specialty's trade name for the methylhydrogen polysiloxane copolymer.


NOTE: XL 10 CONTAINS METHYL HYDROGEN UNITS WHICH ARE VERY REACTIVE. IT CAN GENERATE HYDROGEN GAS IN THE PRESENCE OF ACIDS AND BASES. RINSE TANKS BEFORE CHARGING XL 10.

NOTE: IF CODE 7110-PD440 IS TO BE CHARGED TO BATCH, BEGIN PURGING CONTAINER WITH NITROGEN BEFORE PROCEEDING TO STEP 1. USE CAUTION MATERIAL GENERATES HYDROGEN GAS WHICH CAN BE EXPLOSIVE UNDER CERTAIN CONDITIONS.

Figure 5. XL 10 Hydrogen Generation Warning. The batch sheet for making EM 652 includes this warning about the potential for XL 10 to generate hydrogen gas. (Source: AB Specialty).

The EM 652 process, an SiH emulsion, did not have dedicated equipment. Specifically, the company did not equip these vessels to mitigate all potential process hazards, such as the capability to generate flammable gas. To produce this SiH emulsion, raw materials must undergo two phases—"thick phase" and "water phase." Use of thick and water as descriptors generally refers to the viscosity of the liquid. Each of these phases were made in atmospheric tanks that were loosely sealed. Workers would open the top of these tanks during the production process to, among other things, perform visual observations (**Figure 6**). These atmospheric tanks had no engineered system to direct flammable gas, including hydrogen, to a safe location. According to Dow, a leading manufacturer of silicones, reactors and storage vessels for silicon hydride-containing polysiloxanes, like XL 10 and EM 652, "should be provided with vent systems to release any hydrogen generated and other gases during normal process operations. Great care should be exercised to prevent unintended contamination of storage tanks or process vessels with alkalis [bases]/acids, for example by back flow from caustic vent scrubbing systems. This could result in excessive rapid pressure generation through hydrogen evolution which is considered to be impractical to vent through standard relief systems [9, p. 3]."

Because the tanks were not completely sealed, these tanks could not hold pressure and any gases generated during a process could have vented into the production building. In addition, because the main air mover was located in the emulsions area and provided approximately 86 percent of the makeup air, any gases generated could become a well-mixed cloud in the production building.

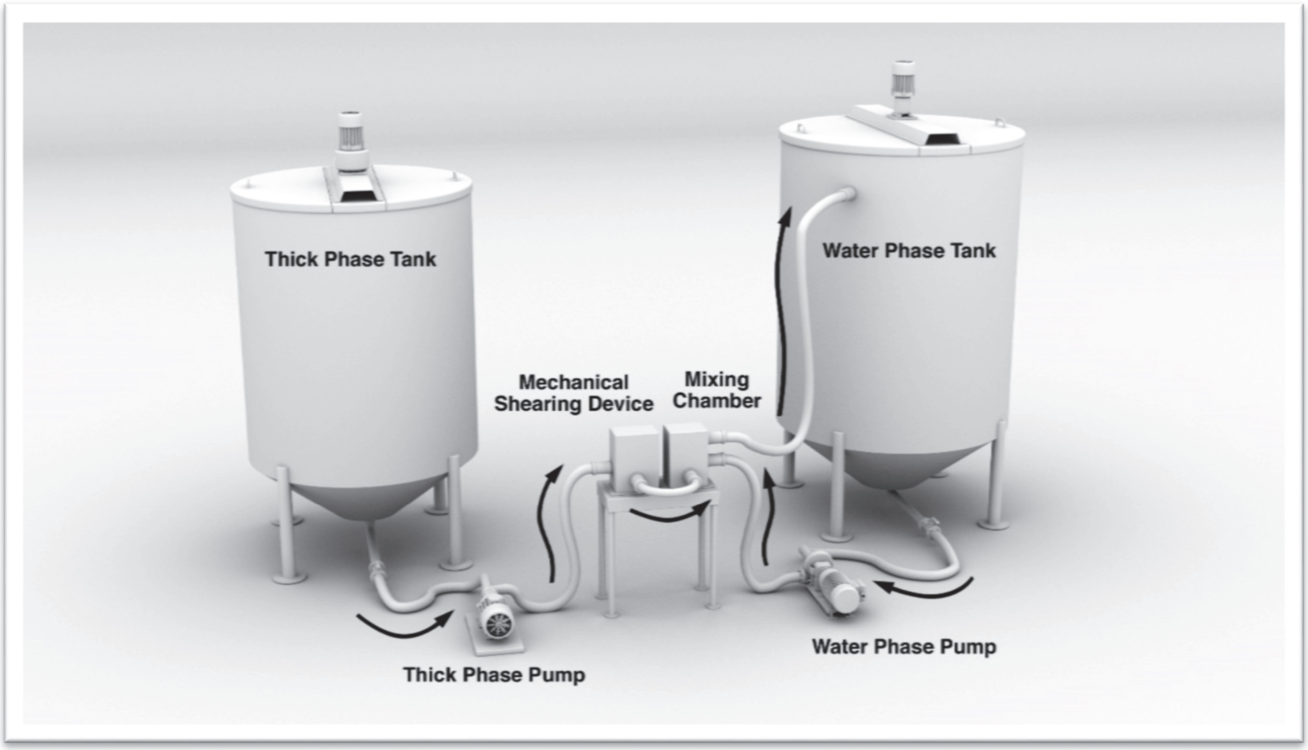


Figure 6. EM 652 Process Flow Diagram. Process flow diagram shows the Thick Phase Tank, Water Phase Tank, and mechanical shearing device. Raw materials are first added into the Thick Phase Tank. It is then processed into the Water Phase Tank. (Source: CSB).

AB Specialty made each of these phases in a set of two atmospheric tanks equipped with agitators (**Figure 6**). Before starting the process, operators would retrieve a "batch ticket," which contains the operating procedures, the quantities of raw materials needed, and raw material verification.[a] Operators were required to have another person verify the codes on the raw material containers before using them for production.[b] These vessels did not have automatic feeds—requiring operators to add raw materials into tanks manually. In addition, operators would have to mix some of the raw materials in a separate vessel before adding it into either the Thick or Water Phase Tank.

The first raw material put into the Thick Phase Tank was XL 10. After that material was added, operators started the agitators. Subsequently, more ingredients were added and mixed into the Thick Phase Tank. Operators would then have to visually observe the materials in the tank to determine whether the process was ready to continue to the next step. While the Thick Phase Tank ran, water was added to the Water Phase Tank.

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[a] One safeguard SEHSC discusses in its *Materials Handling Guide* is raw material verification [8, pp. 11-12]. Robust procedures should be in place to ensure that the wrong raw materials are not added to the reactor [8, p. 11]. As discussed earlier, SiH material can be reactive with many different materials and produce explosive hydrogen gas. SEHSC discusses doing a raw material verification before adding raw materials and one before the reaction is started [8, pp. 11-12]. The order of the addition of raw materials can impact whether a dangerous reaction occurs [8, p. 12].

[b] AB Specialty uses a double signature for its raw material verification. Before a material is charged, the operator for the process is required to verify that the codes for the materials match and another operator or supervisor is required to confirm the codes on the raw material matched the material.

When the process was completed in the Thick Phase Tank, the product would turn from a liquid to a stiff gel. Meanwhile, the water in the Water Phase Tank was circulating through a mixing chamber.

The stiff gel would be pumped from the Thick Phase Tank to a mechanical shearing device. This material was processed through the mechanical shearing device and into the mixing chamber with water from the Water Phase Tank, creating the right consistency in the product, which is like that of milk. The material from the mixing chamber was then fed into the Water Phase Tank. When the product was in the water phase, AB Specialty employees conducted several tests to ensure product quality. These tests were conducted by a QA chemist. Depending on the results of these analytical tests, AB Specialty employees might adjust the pH by adding an acid (glacial acetic acid) or a base (potassium hydroxide)[a] to bring the product into specification.

5. The Incident

On May 3, 2019, operators in the emulsions area (**Figure 7**) were making back-to-back batches of EM 652. AB Specialty had started the first batch of EM 652 earlier in the week. The quality control analysis of the first batch of EM 652 began on May 2, during the second shift, and continued into the second shift on May 3. During the second shift on May 3, the first batch of EM 652 was packaged into totes, and Operator 1 began production of the second batch in the emulsions area. There were eight employees working on the second shift on May 3—the Shift Supervisor, a QA Chemist,[b] and six operators.

[a] Although potassium hydroxide is used for adjustments, this ingredient addition is not included on the batch ticket.

[b] A QA chemist performs analytical testing of products to ensure the products meet specifications and determines adjustments that are needed.

Figure 7. Emulsions Area. On the left, photo of location of the emulsions area prior to the incident. On the right, photo of the emulsions area post-incident. (Source: Google Maps (left); CSB (right)).

Around 9:30 p.m., a few minutes before the incident, workers told the CSB that Operator 1 began yelling, apparently concerned and frustrated by a problem developing in the EM 652 process. The Shift Supervisor was in the production office with Operator 2 (**Figure 8**) working on the shift turnover document. The yelling captured Operator 2's and the Shift Supervisor's attention and they ran towards Operator 1's location, where Operator 1 was making EM 652. Once Operator 2 made it to the emulsions area, he could see the EM 652 Thick Phase Tank overflowing with foam. Operator 1 was standing on the staircase that led to the catwalk by the emulsions area (**Figure 8**). The Shift Supervisor and Operator 2 asked Operator 1 what was happening. Operator 1 said that he had just added the first two ingredients of the EM 652 process into the tank.[a] While the Shift Supervisor, Operator 1, and Operator 2 were talking, Operator 3 observed one of the tanks making a "very strange sound" and the tank "erupt[ing]" material onto the floor. Material "foam[ed] out [of] the tank." The area "was really smoky, hazy." Operator 2 felt the area get hotter.

There were no flammable gas detectors or hydrogen gas detectors with alarms to warn workers of a flammable gas. The generation of gas in the Thick Phase tank could produce foaming, however, foaming does not normally occur during this portion of the EM 652 process. The placement of the main air mover near the EM 652 process further increased the potential explosion danger from flammable gases generated in the emulsions area.

The Shift Supervisor directed workers to ventilate the hazy vapor from building. He asked Operator 2 to open the garage doors by the locker room (**Figure 8**). The Shift Supervisor also told Operator 3, who had gone to the emulsions area after observing Operator 1's distress with the process, to go to the maintenance area and turn on the switch for the fans. This switch would turn on the exhaust fans located in the High Bay (**Figure 8**).

[a] The ingredients Operator 2 listed indicated that the process would have been in the beginning of the EM 652 process (thick phase).

Operator 2 headed towards the garage doors and he was outside the locker room (**Figure 8**) when the explosion occurred. Operator 3 was not able to turn on the fans before the explosion occurred.

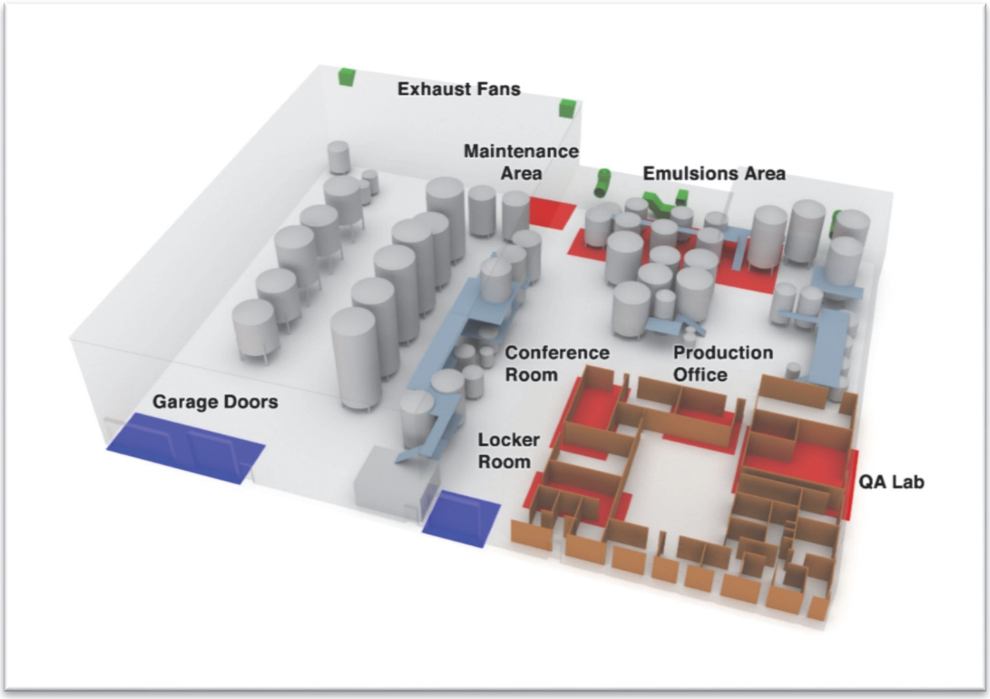

Figure 8. Production Building Layout. Depicts relevant areas of the production building. Note: There are garage doors by the locker room. (Source: CSB).

Operators 4 and 5 were working in another part of the building before the explosion. Operator 4 realized something was happening when he heard a hissing sound through their ear plugs. He looked around and saw a fog coming from the emulsions area (**Figure 8**). After the explosion, Operator 5 reported that the haze in the area was "pale yellow." Both Operators 4 and 5 escaped the area together after the explosion. Operator 5 reported two explosions—the first being extremely loud and a second explosion followed by fire. He described the second explosion as not as powerful as the initial one.

The remaining workers on the AB Specialty property were scattered in various areas around the facility: Operator 6 was taking his break in his car, the QA Chemist was performing his duties in the lab, and the shift supervisor for the third shift (Shift Supervisor 2) was waiting in the conference room for shift change to occur (**Figure 8**).

6. Incident Response

The explosion and fire occurred at approximately 9:30 p.m. Waukegan Fire Department responded to the scene, engines began to arrive at 9:43 p.m. A Unified Command was established. Mutual Aid from surrounding areas responded and provided support. Hazardous Materials and Special Technical Rescue also responded. Operator 1 escaped the building and was transported in critical condition to a hospital in Cook County and died there [10]. The fire was mostly extinguished by 3:30 a.m. on May 4, 2019. Four other workers were evaluated at the hospital and released—one operator suffered more extensive injuries. The efforts to recover all the workers from the explosion area took four days, requiring debris, equipment, and structures to be moved under the direction of the Lake County Coroner [11]. The Shift Supervisor, Shift Supervisor 2, QA Chemist, and Operator 1 were fatally injured as a result of the incident.

7. Post-Incident Events

Several local and federal agencies have either investigated cause or evaluated the incident's impacts. The Illinois Environmental Protection Agency (IEPA) referred an enforcement action to Illinois's Attorney General for alleged releases to the air and surface water [12]. On May 30, 2019, Attorney General Kwame Raoul and Lake County's State Attorney Michael G. Nerheim filed a complaint that alleged the explosion at AB Specialty "resulted in an unknown amount of chemicals being released into the air, causing air pollution and threatening land and water near the facility. Additionally, the complaint alleges that contaminants released by the explosion and water used to extinguish the fire allowed chemicals to seep into storm sewers, contaminating a wetland and Osprey Lake, located approximately one mile away from the plant [13]." AB Specialty entered into a consent decree with the IEPA.

The Waukegan Fire Department and an investigator from the Office of the Illinois Fire Marshal conducted a cause and origin investigation. The Waukegan Fire Department determined that the fire event was "undetermined[a] in nature" [14]. The Waukegan Fire Department believed that flammable vapors formed from a chemical process and ignited from an unknown source. Due to numerous energized sources at the time of the incident, the department was unable to determine the ignition source.

In addition to the CSB, OSHA and EPA responded to the incident at AB Specialty. The EPA (Region 5) provided an on-scene coordinator for clean-up efforts at the site and surrounding areas to direct and monitor response actions for releases or threats of releases of hazardous substances and contaminants [15], [16]. OSHA conducted its own inspection of AB Specialty. On October 24, 2019, OSHA issued 12 willful violations of federal OSHA regulations and proposed a penalty of approximately $1.6 million [17], [18]. OSHA's citations alleged multiple incidences of electrical violations, including the incorrect electrical classification of the area where the explosion likely originated. OSHA also placed AB Specialty in the Severe Violator Enforcement Program (SVEP)[b] [17]. AB Specialty is contesting the allegations.

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[a] Under *NFPA 921: Guide for Fire and Explosion Investigations*, the finding "cause undetermined" means that in "circumstances where all hypothesized fire causes have been eliminated and the investigator is left with no hypothesis that is evidenced by the facts of the investigations, the only choice for the investigator is to conclude that the fire cause, or specific causal factors, remains undetermined. It is improper to base hypotheses on the absence of any supportive evidence. That is, it is improper to opine a specific fire cause, ignition sources, fuel or cause classification that has no evidence to support it even though all other such hypothesized elements were eliminated [31, p. 221]."

[b] OSHA's Severe Violator Enforcement Program concentrates resources to inspect "employers who have demonstrated indifference to their OSH Act obligations by committing willful, repeated, or failure-to-abate violations. Enforcement actions for severe violator cases include mandatory follow-up inspections, increased company/corporate awareness of OSHA enforcement, corporate-wide agreements, where appropriate, enhanced settlement provisions, and federal court enforcement [35]."

8. CSB Investigation Plans

The CSB investigation is ongoing. Investigators will continue developing the incident causal analysis based on evidence collected during the investigation. The CSB is evaluating the source of the flammable vapor to determine the type of safety precautions needed to prevent a similar incident from occurring. A detailed final report will be published at the conclusion of the investigation, which will include additional information, analysis, findings, and safety recommendations, as appropriate.

9. References

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