

## Investigation Update

June 2024

This document provides an update on the CSB investigation of the July 14, 2023 incident at Plaquemine, Louisiana.

### Incident Summary

- On July 14, 2023, at approximately 9:15 p.m., an explosion occurred at the Dow Louisiana Operations' Glycol II plant in Plaquemine, Louisiana. Multiple subsequent explosions and fires damaged nearby piping and equipment, including a reflux drum.
- This incident resulted in substantial property damage at the facility but no injuries. However, over 31,000 pounds of ethylene oxide (EtO), a cancer-causing substance, were released during the incident. Local authorities also issued a shelter-in-place, affecting hundreds of nearby residents. This document provides an update on the ongoing CSB investigation of this incident.

### Background Information

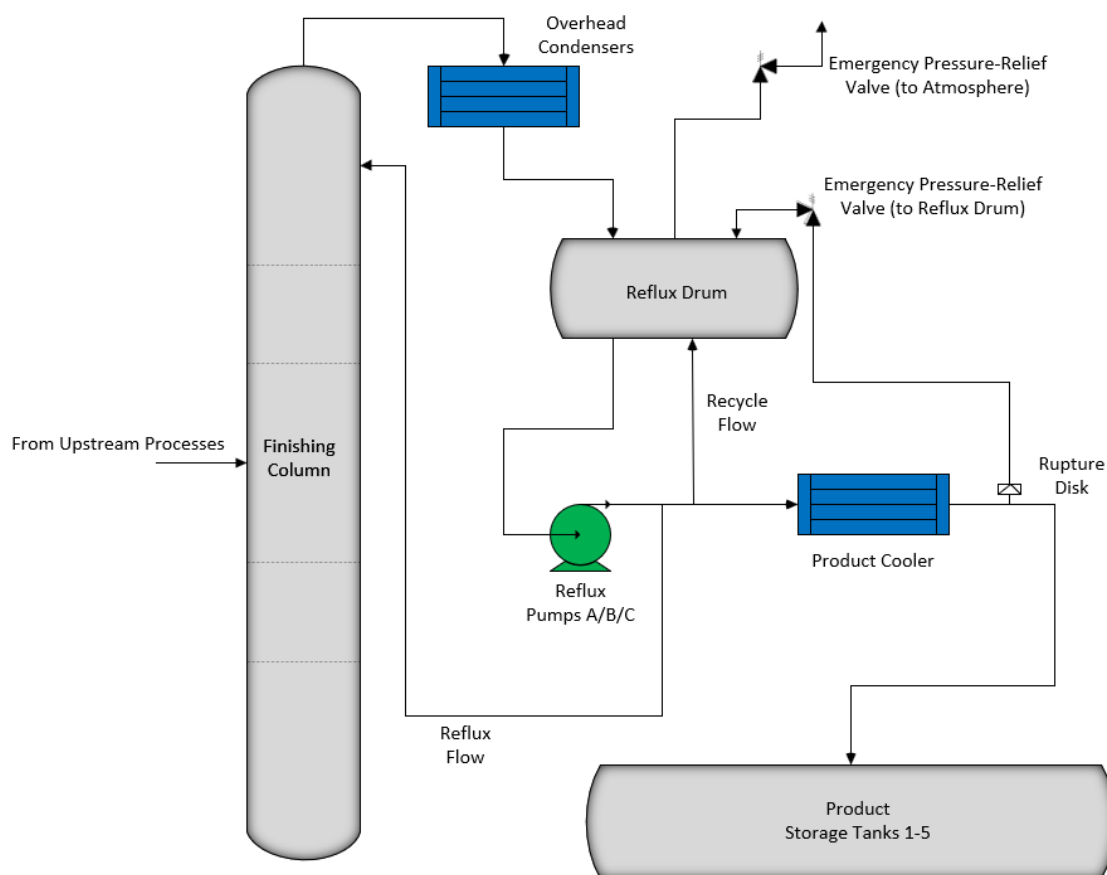
- The Dow Louisiana Operations (LAO) facility is located near Plaquemine, Louisiana. The site's industrial park has 23 production units that manufacture more than 50 different intermediate and specialty chemical products used to produce many other compounds [1]. One chemical manufactured at the Dow LAO facility's Glycol II plant is ethylene oxide (EtO). As of June 10, 2024, there were 1,274 Dow employees at this facility.
- EtO, a known carcinogen, is a flammable, colorless gas. It is a reactive chemical with a lower flammability limit of 2.6 percent and an upper flammability limit of 100 percent. EtO can ignite without the presence of oxygen, but oxygen makes EtO more reactive and likely to ignite [2, 3, pp. 229-234].
- According to the U.S. Environmental Protection Agency (EPA), the most common way that people are exposed to EtO is by inhaling air that contains EtO. Long-term regular exposure to EtO can be harmful, as it is carcinogenic and mutagenic [4].<sup>a</sup> According to the National Institute for Occupational Safety and Health (NIOSH), an EtO minimum concentration in air of 800 parts per million (ppm) is "immediately dangerous to life or health" (IDLH) [5].<sup>b</sup>

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<sup>a</sup> If a substance is mutagenic, it can damage human DNA

<sup>b</sup> NIOSH defines IDLH as "The Immediately dangerous to life or health air concentration values (IDLH values) developed by NIOSH characterize these high-risk exposure concentrations and conditions and are used as a component of respirator selection criteria first developed in the mid-1970s. IDLH values are established (1) to ensure that the worker can escape from a given contaminated environment in the event of failure of the respiratory protection equipment and (2) to indicate a maximum level above which only a highly reliable breathing apparatus, providing maximum worker protection, is permitted." [9]

- The Glycol II plant contains multiple processing areas, including the EtO production unit. To produce EtO, Dow's EtO production unit reacts ethylene and oxygen. The EtO is then further processed through finishing operations, which purify the EtO. The EtO finishing operations contain distillation columns to remove impurities from the final EtO product.
- In the EtO finishing operations section of the Glycol II plant, purified EtO flows from the top of a distillation tower, is condensed, and then sent to a reflux drum. The EtO in the reflux drum flows to multiple locations through its reflux pumps.<sup>a</sup> The EtO can be pumped back to the distillation column to be used as reflux, recycled back to the reflux drum, or sent to storage tanks as a final product. EtO flow to the storage tanks also includes pumping the EtO through a heat exchanger, called the product cooler. **Figure 1** provides a simplified graphical depiction of portions of the EtO finishing operations process related to this incident.



**Figure 1.** Simplified process flow diagram of the EtO Finishing Process. (Credit: CSB)

<sup>a</sup> To maintain desired EtO production rates, Dow used two pumps running in parallel with one spare pump. At the time of the incident, one of the three pumps was out of service.

- The reflux drum was a horizontal vessel<sup>a</sup> constructed of SA-285-C carbon steel. Its maximum allowable working pressure (MAWP) was 75 pounds per square inch gauge (psig) at a temperature of 450 °F. An emergency pressure-relief valve set to relieve at 75 psig protected the reflux drum from overpressure. A turnaround<sup>b</sup> was performed on the Glycol II plant from May to June 2023. As part of the turnaround work, the reflux drum was internally cleaned and inspected.
- The product cooler had an MAWP of 570 psig on its tube side, where EtO was present. Dow equipped the product cooler with a rupture disk and an emergency pressure-relief valve installed in series for overpressure protection. The rupture disk had a rated burst pressure of 248 psig at a temperature of 104 °F, and the emergency pressure-relief valve was set to relieve at 265 psig. The piping between the rupture disc and the emergency pressure-relief valve was a four-inch diameter pipe approximately 80 feet in length. The discharge piping from the emergency pressure-relief valve was directed back into the vapor space of the reflux drum.

## Incident Description

- On the night shift of July 14, 2023, the Glycol II plant was operating under normal conditions.
- At approximately 6:52 p.m., high vibration triggered an automatic shutdown of one of the two reflux pumps operating at the time. Dow operations employees began troubleshooting the pump. Dow operations personnel were able to return the pump to operation at approximately 6:54 p.m.; however, the reflux pump's vibrations were still higher than normal but below the high-high vibration interlock alarm setting.
- Following the reflux pump shutdown, from 6:52 p.m. to 9:15 p.m., the EtO finishing operations process experienced numerous upsets, which resulted in multiple high-level alarms in the reflux drum. Process operators continuously tried to stabilize the level in the reflux drum until approximately 9:15 p.m.
- At approximately 9:15 p.m., an explosion occurred in the vicinity of the reflux drum. Two Dow operators were working nearby, observed the explosion, and then quickly returned to the control room.
- Following the initial explosion, a fire developed near the reflux drum. Shortly after the initial explosion, the reflux drum, which was approximately half-full of liquid EtO, exploded. At the time of the incident, the reflux drum was equipped with an emergency pressure-relief valve, but the valve was unable to prevent the reflux drum from exploding.
- Witnesses reported additional explosions as the fire continued to burn through the night.

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<sup>a</sup> The reflux drum diameter measured 96 inches with a tangent-to-tangent length of 16 feet.

<sup>b</sup> The Center for Chemical Process Safety (CCPS) explains that a turnaround is “a scheduled shutdown period when planned inspection, testing, and preventive maintenance, as well as corrective maintenance such as modifications, replacements, or repairs is performed” [8].



**Figure 2.** Surveillance footage of the explosion at approximately 9:15 p.m. (Credit: Dow)

- Dow reported that approximately 31,525 pounds of EtO were released during the incident, which included the de-inventorying and cleanup following the fire.
- After the explosion, during the night of July 14, 2023, the Iberville Parish Council Office of Emergency Preparedness issued a shelter-in-place for residents living within a half-mile of the Dow facility. The shelter-in-place was lifted at approximately 3:40 a.m. on Saturday, July 15, 2023 [6].
- The fire from the incident was fully extinguished by approximately 5:00 a.m. on Sunday, July 16, 2023 [7]. Dow spent the remainder of the day ensuring all fires associated with this incident had been put out. At approximately 8:19 p.m. that evening, the company reported to the Louisiana Department of Environmental Quality that all the fires had been extinguished at the facility.
- No injuries were reported as a result of the incident. Dow estimated this incident's property damage to be \$1.5 million. Local officials ordered a shelter-in-place for hundreds of residents within a half-mile of the plant.

## Path Forward

- The CSB launched the investigation into this incident on April 4, 2024, after the Agency eliminated CSB's long-standing backlog of investigation reports [8]. Eliminating the large backlog has allowed the CSB to address now other serious chemical incidents reported to the Agency in recent years under the CSB's Accidental Release Reporting Rule.
- The CSB is continuing to gather facts and analyze several key areas involved in this incident, including:
  - Emergency pressure-relief systems scenarios
  - Reactive chemical hazards
  - Reactive material emergency pressure-relief system design
  - Maintenance procedures and practices
  - Relevant facility, corporate, and industry standards
- The CSB's investigation of this incident is ongoing. Complete findings, analyses, and appropriate recommendations will be detailed in the CSB's final investigation report.

## References

- [1] Dow Chemical, "Dow in Louisiana," 2024. [Online]. Available: <https://corporate.dow.com/en-us/locations/louisiana.html>. [Accessed 1 May 2024].
- [2] American Chemistry Council, "Ethylene Oxide Product Stewardship Guidance Manual," Washington, DC, 2023.
- [3] Center for Chemical Process Safety (CCPS), "7.6. Temperature-Sensitive Materials: Ethylene Oxide," in *Guidelines for Safe Storage and Handling of Reactive Materials*, 1995, pp. 229-234.
- [4] U.S. Environmental Protection Agency, "Our Current Understanding of Ethylene Oxide (EtO)," U.S. Environmental Protection Agency, 3 April 2024. [Online]. Available: <https://www.epa.gov/hazardous-air-pollutants-ethylene-oxide/our-current-understanding-ethylene-oxide-eto>. [Accessed 6 May 2024].
- [5] National Institute for Occupational Safety and Health, "Table of IDLH Values - Ethylene Oxide," National Institute for Occupational Safety and Health, 4 December 2014. [Online]. Available: <https://www.cdc.gov/niosh/idlh/75218.html>. [Accessed 6 May 2024].
- [6] WAFB9, "Explosions, fire at Dow Chemical in Iberville Parish Friday evening," [Online]. Available: <https://www.wafb.com/2023/07/15/small-flame-still-burning-following-explosions-dow-chemical-iberville-parish-friday-evening/>. [Accessed 1 May 2024].
- [7] American Fuel & Petrochemical Manufacturers (AFPM), "Refinery turnarounds 101: What are turnarounds and why do we need them?," 2024. [Online]. Available: <https://www.afpm.org/newsroom/blog/refinery-turnarounds-101-what-are-turnarounds-and-why-do-we-need-them>. [Accessed 1 May 2024].
- [8] Center for Chemical Process Safety (CCPS), "CCPS Process Safety Glossary: Turnaround," [Online]. Available: <https://www.aiche.org/ccps/resources/glossary>. [Accessed 3 May 2024].
- [9] National Institute for Occupational Safety and Health (NIOSH), "Immediately Dangerous To Life or Health (IDLH) Values," NIOSH, 19 05 2019. [Online]. Available: <https://www.cdc.gov/niosh/idlh/default.html#:~:text=The%20Immediately%20dangerous%20to%20life%20or%20health%20air,respирator%20selection%20criteria%20first%20developed%20in%20the%20mid-1970s..> [Accessed 07 05 2024].