Investigation Update

February 2025

This document provides an update on the CSB's investigation of the November 12, 2024, incident at the Givaudan Sense Colour ("Givaudan") facility in Louisville, Kentucky.

Incident Summary

- On November 12, 2024, a batch reactor vessel[a] exploded at the Givaudan facility in Louisville, Kentucky while it was producing caramel coloring for a food product [1]. The explosion fatally injured two employees, and three additional employees were seriously injured. The explosion caused equipment and debris to propel outside the facility fence line and resulted in substantial property damage to the facility, as well as nearby homes and businesses [2]. Local officials issued a shelter-in-place order for a one-mile radius around the facility. The facility has ceased operations and is now being demolished [3].

Background Information

- The Givaudan group of companies manufactures ingredients for food and beauty products [4] and is headquartered in Switzerland [5], with facilities located in North America, South America, Europe, Africa, Australia, and Asia [6]. The Givaudan facility in Louisville, Kentucky produced caramel coloring for food and beverages before the explosion and employed about 55 people [7] [8]. D.D. Williamson & Co., LLC, a fully owned subsidiary of Givaudan Flavors Corporation, operated the Givaudan facility in Louisville, Kentucky. D.D. Williamson began producing caramel coloring at the facility in 1948 and was acquired by Givaudan in December 2021 [7].

- The Givaudan facility operated in close proximity to residential properties and other businesses, as depicted in **Figure 1**. The nearest residential property is located less than 100 feet from the facility.

[a] A reactor is a vessel where a chemical reaction takes place.

Figure 1. Zoning of properties surrounding the Givaudan facility [9]. (Credit: Google Earth with annotations by CSB)

- The Givaudan facility operated six different batch reactors inside its manufacturing building to produce caramel coloring. On November 12, 2024, Givaudan was producing caramel coloring in Batch Reactor Six. A simplified schematic of the top portion of Batch Reactor Six is shown in **Figure 2**. Batch Reactor Six was equipped with a vent valve that could automatically open and close to control the batch reactor pressure. The batch reactor temperature was controlled by either steam or cooling water flowing through coils mounted to the inside wall of the reactor. The contents of the batch reactor could be mixed by an agitator. The batch reactor was also equipped with a rupture disc with a burst pressure of 75 pounds per square inch gauge (psig) and a pressure relief valve with a 75 psig set pressure. Design documents indicate that Batch Reactor Six was a 2,500-gallon vessel constructed of 316 stainless steel with a maximum allowable working pressure of 75 psig and a maximum allowable working temperature of 355 degrees Fahrenheit (°F).

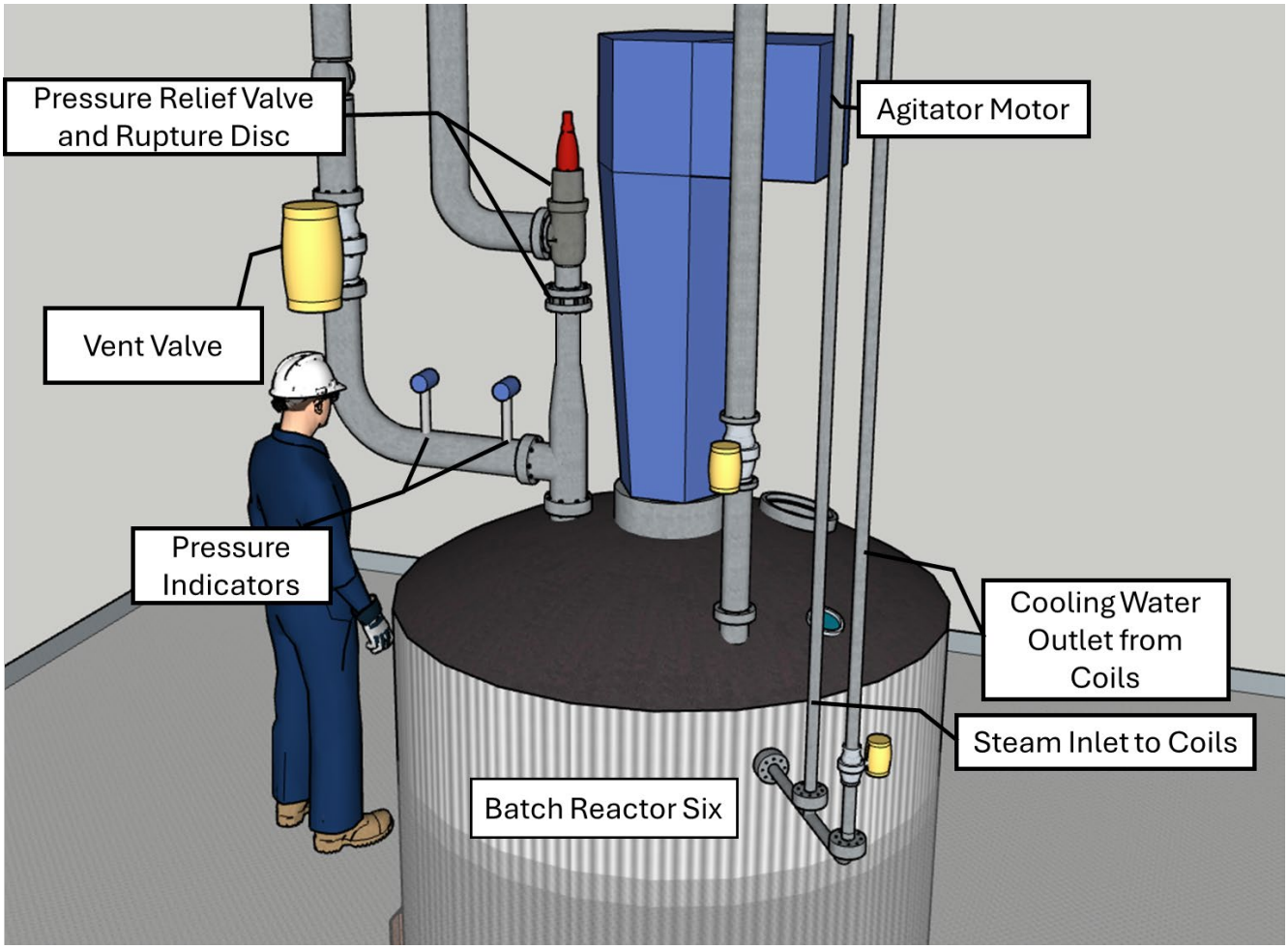

Figure 2. Depiction of the top portion of Batch Reactor Six. (Credit: CSB)

Incident Description

- To produce the caramel coloring on the day of the incident, operators followed a batch instruction that detailed (1) the types and quantities of materials to add to Batch Reactor Six, (2) the material feed sequences, and (3) important process conditions such as temperature and pressure set points. The caramel coloring batch being prepared at the time of the incident included the following raw material ingredients: sugar, water, sodium hydroxide, and phosphoric acid.[a] An antifoam additive was also used to reduce foaming during the batch operation.

- On November 12, 2024, at 10:22 a.m., operators began the caramel coloring batch operation. Operators followed the batch instruction, and normal operations were observed during the first half of the batch production process.

[a] 21 CFR § 73.85

- At 2:17 p.m., in accordance with the batch instruction, operators set the Batch Reactor Six pressure setpoint to 12 psig and the temperature setpoint to 300°F. The programmable logic controller (PLC) automatically closed the vent valve at the top of Batch Reactor Six to allow the pressure inside the reactor to increase. Steam flowed through the coils to increase the reactor temperature to the setpoint. After these adjustments, both the temperature and pressure inside Batch Reactor Six began to rise. When the pressure reached the 12 psig set point, the vent valve automatically modulated and maintained the pressure at 12 psig for approximately 16 minutes.

- At 2:39 p.m., the batch reactor pressure began to exceed the 12 psig setpoint (**Figure 3**). The process data indicates that the vent valve was commanded to fully open at 2:40 p.m. The purpose of this action was to reduce the batch reactor pressure, but the pressure continued to rise even after the valve was commanded to fully open, as the valve might not have physically opened (see Additional Information below). At 2:47 p.m., the batch reactor temperature exceeded the 300°F setpoint. Operators observed the abnormal pressure and temperature increases, and cooling water was introduced to the coils at 2:49 p.m. The temperature and pressure continued to rise even after the cooling water system was activated.

- Process data indicates the pressure relief valve opened at 2:54 p.m., and the pressure temporarily reduced before it again began to rise (**Figure 3**). Both the temperature and pressure continued to rise until Batch Reactor Six catastrophically ruptured at 2:57 p.m. The maximum temperature observed before rupture was 385°F, thirty degrees above the maximum allowable working temperature of 355°F. The maximum pressure observed before rupture was 237 psig, more than three times the maximum allowable working pressure of 75 psig.

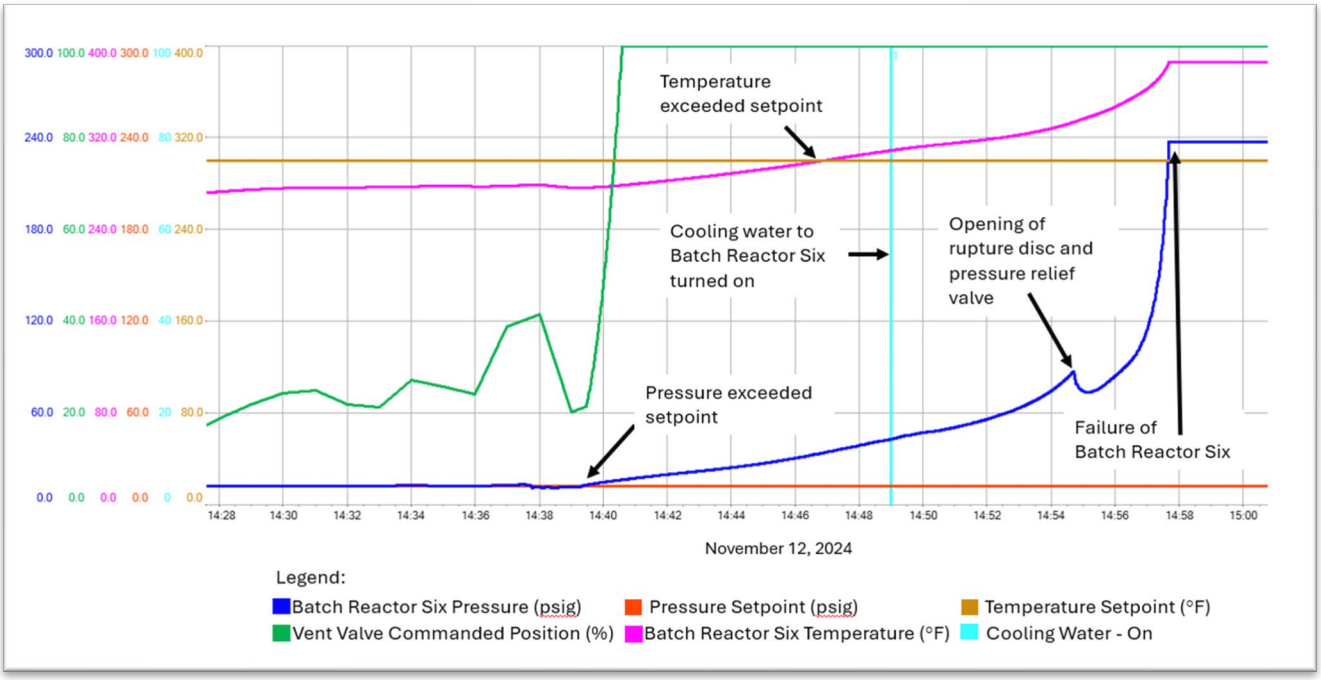

Figure 3. Process data from Batch Reactor Six leading up to the explosion. (Credit: CSB)

- As a result of the explosion, two employees were fatally injured, and three employees were seriously injured. The two fatally injured employees, along with four additional employees, were inside the control room at the time of the incident (**Figure 4**).

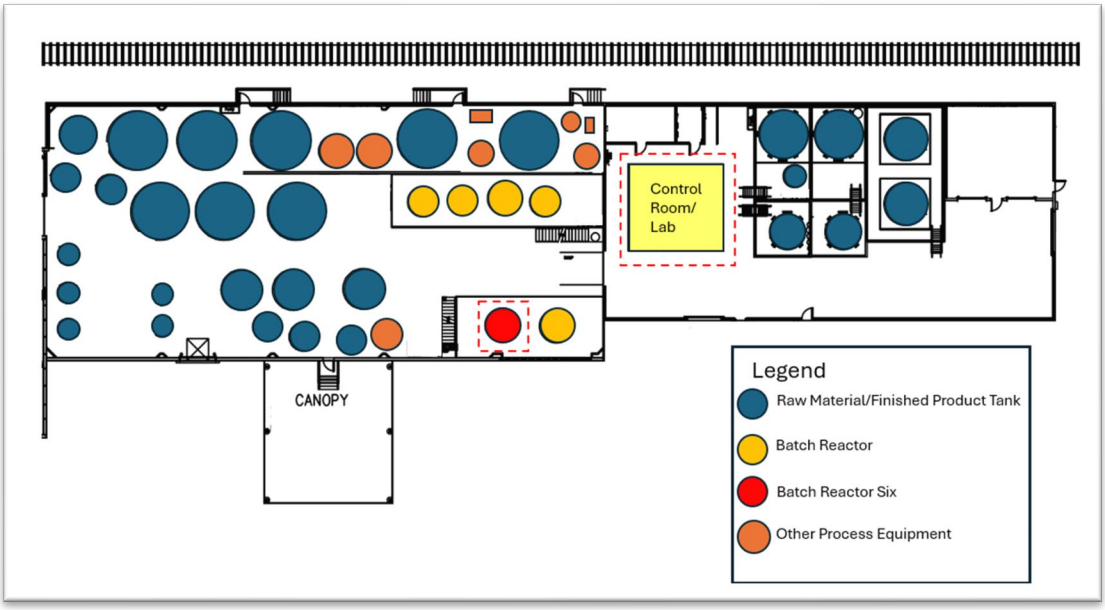

Figure 4. Simplified map of Givaudan manufacturing facility in Louisville, Kentucky. (Credit: Givaudan with annotations by CSB)

- The facility was severely damaged by the explosion (**Figure 5**). Debris from the explosion of Batch Reactor Six was ejected outside the fence line and into the nearby neighborhood. Debris that was found in the neighborhood included large pieces of Batch Reactor Six (**Figure 6**), pipe fragments, instrumentation, valves, and other building materials. Fragments of the exploded vessel flew as far as about 400 feet from the facility.

Figure 5. Property damage at the Givaudan facility in Louisville, Kentucky. (Credit: CSB)

Figure 6. Locations of Batch Reactor Six debris scattered throughout the surrounding neighborhood. (Credit: Map: Google Earth with annotations by CSB; Photo 1: Dylan Lovan, Associated Press via Louisville Public Media [10]; Photo 2: WDRB News [11]; Photo 3: Louisville Courier Journal [12])

- Nearby homes and businesses experienced shattered windows, property damage, and power outages as a result of the explosion. Local officials issued a shelter-in-place order for a one-mile radius around the facility. Two elementary schools and one K-12 school were ordered to shelter-in-place after the explosion, and dismissal at the schools was delayed [13].

Additional Information

- After the incident, at the direction of the CSB, Givuadan inserted a borescope into piping connected to the recovered vent valve to identify the valve's position. Borescope photos show that, at the time of inspection, the vent valve is almost fully closed (**Figure 7**). The vent valve is a ball valve. When the ball opening is aligned with the attached piping, process fluid can flow through the valve. When the ball opening is perpendicular to the attached piping, process fluid cannot flow through the valve. Givaudan had specified that the vent valve actuator was to be configured to "fail open,"[a] meaning that the valve should automatically open in the event the instrument air pressure to the actuator was lost [14] [15]. The CSB will inspect the recovered vent valve actuator as part of the ongoing investigation.

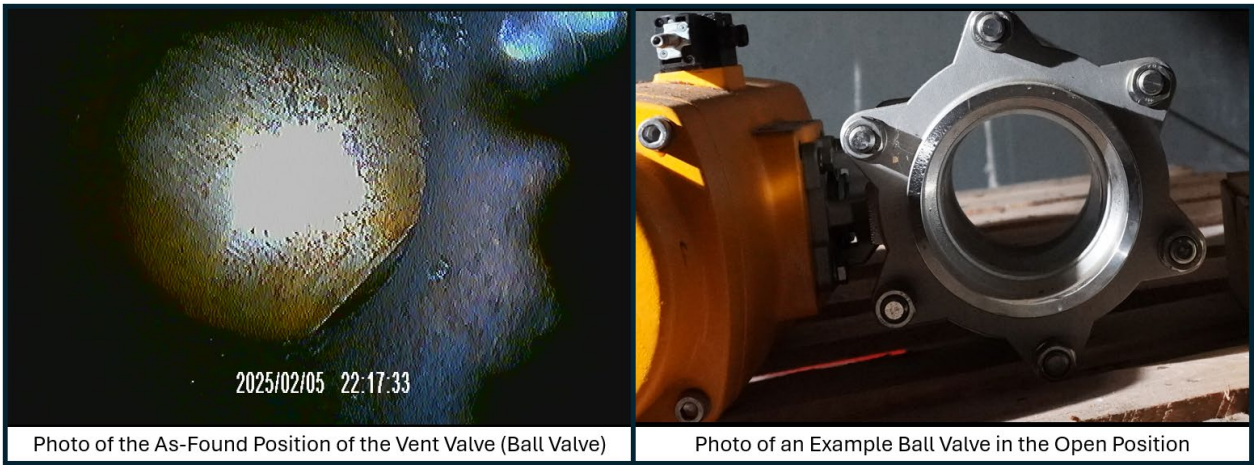

Figure 7. Photo of the as-found position of the vent valve (left), and photo of an example ball valve in the open position (right). (Credit left photo: Givaudan; Credit right photo: CSB)

- The CSB investigated another vessel overpressure incident at this site in 2003.[b] On April 11, 2003, a vessel explosion fatally injured one operator at the site, released 26,000 pounds of aqueous ammonia, and forced the evacuation of as many as 26 residents and the shelter-in-place of 1,500 people. The vessel in the 2003 incident likely ruptured from excessive internal pressure due to overheating the caramel liquid [16].

- Givaudan has announced it will not be rebuilding the caramel coloring manufacturing facility at its current location. After the conclusion of the CSB's on-site investigation efforts, Givaudan will complete the demolition of the site [3].

[a] The Center for Chemical Process Safety (CCPS) defines fail-safe as "A feature incorporated for automatically counteracting the effect of an anticipated source of failure [14]."

[b] D.D. Williamson & Co. Catastrophic Vessel Failure | CSB Investigation

Path Forward

- The CSB is continuing to gather facts and analyze several key areas, including:
    - Testing the raw materials to identify potential reactive hazards
    - Analyzing the batch reactor relief system
    - Reviewing process data and process conditions leading to the incident
    - Further analyzing the recovered vent valve and actuator
    - Evaluating emergency response efforts
    - Analyzing the building design
- The investigation is ongoing. Complete findings, analyses, and recommendations, if appropriate, will be detailed in the CSB's final investigation report.

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