# Investigation Update

June 2025

This document provides a second update on the CSB's investigation of the November 12, 2024, incident at the Givaudan Sense Colour ("Givaudan") facility in Louisville, Kentucky. The facility was operated by D.D. Williamson and Co., LLC, a fully owned subsidiary of Givaudan Flavors Corporation.

## Introduction

- On November 12, 2024, a batch reactor vessel 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 resulted in substantial property damage to the facility, as well as nearby homes and businesses [2]. Large pieces of the batch reactor, pipe fragments, instrumentation, valves, and other materials and debris were propelled into the surrounding neighborhood, with some fragments of the exploded vessel flying as far as 400 feet from the facility. 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].

- Runaway (uncontrolled) reactions inside vessels can lead—and have led—to catastrophic overpressures and explosions. The CSB has investigated multiple incidents where runaway reactions inside equipment have caused explosions and significant damage.[a] The Givaudan incident exhibited similarities to these prior incidents, including the use of a batch production process, a rapid and uncontrolled temperature and pressure rise, and an explosion that caused significant damage. To determine whether the materials in the Givaudan batch reactor experienced such a runaway reaction on the day of the incident, the CSB conducted laboratory reactivity tests on representative samples of the chemicals that were inside the batch reactor during the incident. This Investigation Update details the CSB's results from these tests.

## Chemical Reactivity Testing

- The chemicals used on the day of the incident—which included sugar,[b] phosphoric acid, sodium hydroxide, water, and an antifoam additive—were subjected to analytical tests, including Automatic

[a] The CSB investigated the 1998 runaway reaction incident at the Morton International, Inc. facility in Paterson, NJ [6]; the 2003 runaway reaction incident at the Catalyst Systems, Inc. facility in Gnadenhutten, Ohio [7]; the 2007 runaway reaction incident at the T2 Laboratories, Inc. facility in Jacksonville, Florida [8], and the 2020 runaway reaction incident at the Optima Belle, LLC facility in Belle, West Virginia [9].

[b] Givaudan used a sugar syrup called Invert, which was a mixture of glucose, fructose, sucrose, and water.

Pressure Tracking Adiabatic[a] Calorimetry (APTAC) and Accelerating Rate Calorimetry (ARC). The tests aimed to determine the chemicals' stability when heated inside an enclosed vessel.

- Both APTAC and ARC are laboratory testing methods in which materials in a reaction vessel are incrementally heated until an exotherm is detected.[b] An exotherm is an event in which test materials increase in temperature due to self-heating from a chemical reaction. In the APTAC and ARC tests, after an exotherm is detected, the temperature and pressure are measured until the reaction is complete [4] [5].

- The APTAC temperature and pressure versus time results for the mixture inside the reactor at the time of the incident[c] are shown in **Figure 1**.[d] The test identified three separate exotherms. All of the exotherms occurred at conditions within the batch reactor's normal operating limits, as shown by the maximum allowable working temperature (MAWT) and maximum allowable working pressure (MAWP) designations. The first two exotherms coincided with the injection of the phosphoric acid, sodium hydroxide, water, and antifoam into the reaction vessel. The third, and largest, exotherm started when the materials were heated to a temperature of 243°F. During that exotherm, the materials experienced a temperature rise of 284°F and generated a maximum pressure of 1,509 psig.

- Gas evolved from the materials during the test, contributing to the observed pressure rise. After the mixture was cooled, the non-condensable gas that had been produced had a pressure of 391 psig. The generated non-condensable gas was collected, tested, and found to be predominantly carbon dioxide.

[a] In an adiabatic process, heat does not leave or enter the system from the environment.

[b] Both APTAC and ARC use a Heat-Wait-Search (HWS) methodology. HWS is a sequence where the sample is heated to a specified temperature, allowed to stabilize at the temperature, and monitored to observe any increase in temperature resulting from an exothermic reaction. If no exotherm is detected, the test proceeds to the next temperature step. Upon detection of an exotherm, the equipment changes from HWS mode to adiabatic mode while the sample is monitored.

[c] The APTAC test was performed using raw materials collected from the incident site.

[d] The y-axis of the figure is in pounds per square inch absolute (psia), while the listed MAWP is indicated in pounds per square inch gauge (psig). Absolute pressure adds atmospheric pressure (14.7 psi) to the gauge pressure value.

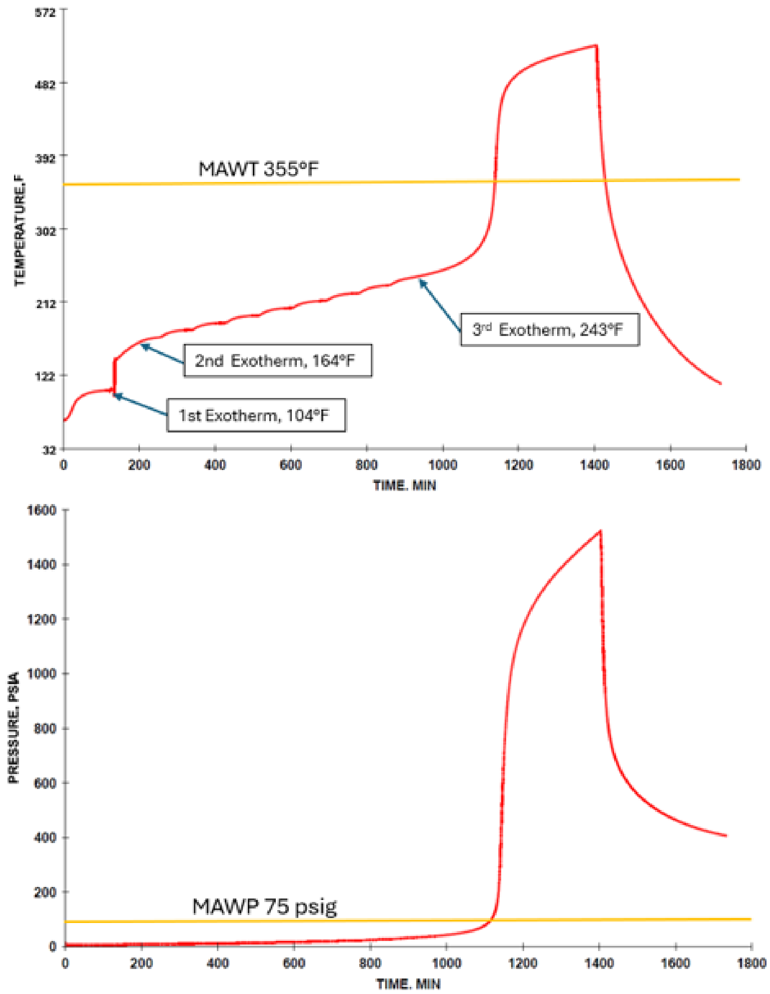


**Figure 1.** APTAC temperature and pressure versus time test results for batch reactor mixture (Credit: CSB)

- Additional reactivity tests were conducted on both the batch reactor mixture and the sugar ingredient alone using ARC[a] to determine the extent to which each might have contributed to a runaway reaction in the batch reactor. The ARC temperature and pressure versus time results from both tests are shown in **Figure 2**. Both tests identified major exotherms[b] occurring within the normal operating limits of the batch reactor, which generated high temperature and high pressure. Gas had evolved from the materials during the tests, which contributed to the observed pressure rise in each test. After the samples in each test were cooled, the non-condensable gas pressures were 490 psig (for the batch reactor mixture) and 419 psig (for the sugar ingredient alone).

- As the sugar ingredient was the sole material in the second ARC test, the non-condensable gas that evolved was likely the result of the sugar ingredient undergoing a decomposition reaction.

[a] The difference between ARC and APTAC is that APTAC has a larger sample size and lower thermal inertia [4], which makes it useful for analyzing large vessels like a batch reactor. ARC testing achieves similar results to APTAC but requires scale-up calculations [5].

[b] Other small exotherms occurred during these tests and are not indicated in the figure.

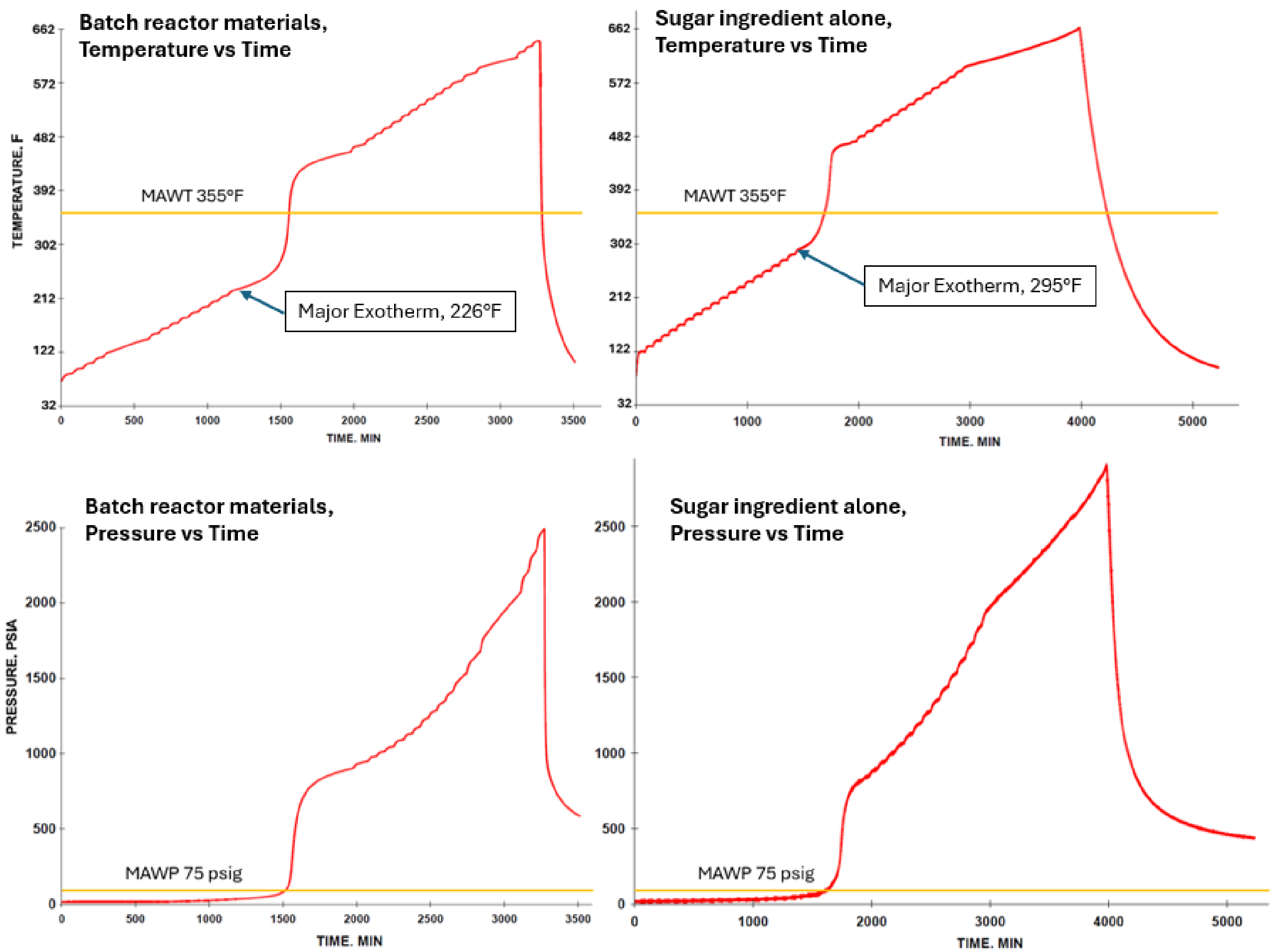


**Figure 2**. ARC temperature and pressure versus time test results for batch reactor mixture and sugar ingredient alone (Credit: CSB)

- The results of the chemical reactivity testing show that even within the batch reactor's normal operating temperature and pressure range, both the caramel coloring ingredient mixture as well as the sugar ingredient alone could experience a hazardous runaway reaction, producing dangerously high temperatures and pressures far beyond the reactor's safe limits, which in turn could cause the reactor to explode.

- A hazardous runaway chemical reaction can cause an explosion of a batch reactor similar to the batch reactor at the Givaudan facility.

# Path Forward

- The CSB is continuing to gather facts and analyze several key areas, including conducting additional chemical testing, analyzing the equipment recovered from the incident site, and evaluating the reactor's relief system design. The investigation is ongoing. Complete findings, analyses, and recommendations, if appropriate, will be detailed in the CSB's final investigation report.

# References


[1] Givaudan, "Our statement on the tragic, fatal incident at our Sense Colour Factory in Louisville, USA," 15 November 2024. [Online]. Available: https://www.givaudan.com/media/media-releases/2024/statement-on-incident-louisville-usa. [Accessed 29 January 2025].

[2] N. Vancampen, "Louisville factory explosion causes damage to nearby homes, businesses," WHAS11, 13 November 2024. [Online]. Available: https://www.whas11.com/article/news/local/louisville-kentucky-factory-explosion-damage-homes-businesses/417-06e14c69-72a3-4e45-9287-5e696d25e4c1. [Accessed 27 January 2025].

[3] C. Giffin, "Givaudan will not rebuild plant in Clifton following November explosion, company says," Louisville Courier Journal, 21 January 2025. [Online]. Available: https://www.courier-journal.com/story/news/local/2025/01/21/clifton-plant-will-not-be-rebuilt-after-explosion-company-says/77852734007/. [Accessed 22 January 2025].

[4] ioKinetic, "Automatic Pressure Tracking Adiabatic Calorimetry Testing," ioKinetic , [Online]. Available: https://www.iokinetic.com/services/chemical-reactivity-testing/aptac-testing. [Accessed 6 June 2025].

[5] ioKinetic, "Accelerating Rate Calorimeter Testing," ioKinetic, [Online]. Available: https://www.iokinetic.com/services/chemical-reactivity-testing/arc-testing. [Accessed 6 June 2025].

[6] U.S. Chemical Safety and Hazard Investigation Board (CSB), "Morton International Inc. Runaway Chemical Reaction," CSB, 16 August 2000. [Online]. Available: https://www.csb.gov/morton-international-inc-runaway-chemical-reaction/. [Accessed 12 June 2025].

[7] U.S. Chemical Safety and Hazard Investigation Board (CSB), "Catalyst Systems Inc. Reactive Chemical Explosion," CSB, 29 October 2003. [Online]. Available: https://www.csb.gov/catalyst-systems-inc-reactive-chemical-explosion/. [Accessed 12 June 2025].

[8] U.S. Chemical Safety and Hazard Investigation Board (CSB), "T2 Laboratories Inc. Reactive Chemical Explosion," CSB, 15 September 2009. [Online]. Available: https://www.csb.gov/t2-laboratories-inc-reactive-chemical-explosion/. [Accessed 12 June 2025].

[9] U.S. Chemical Safety and Hazard Investigation Board (CSB), "Optima Belle Explosion and Fire," CSB, 6 July 2023. [Online]. Available: https://www.csb.gov/optima-belle-explosion-and-fire/. [Accessed 12 June 2025].