

## Investigation Update

September 2022

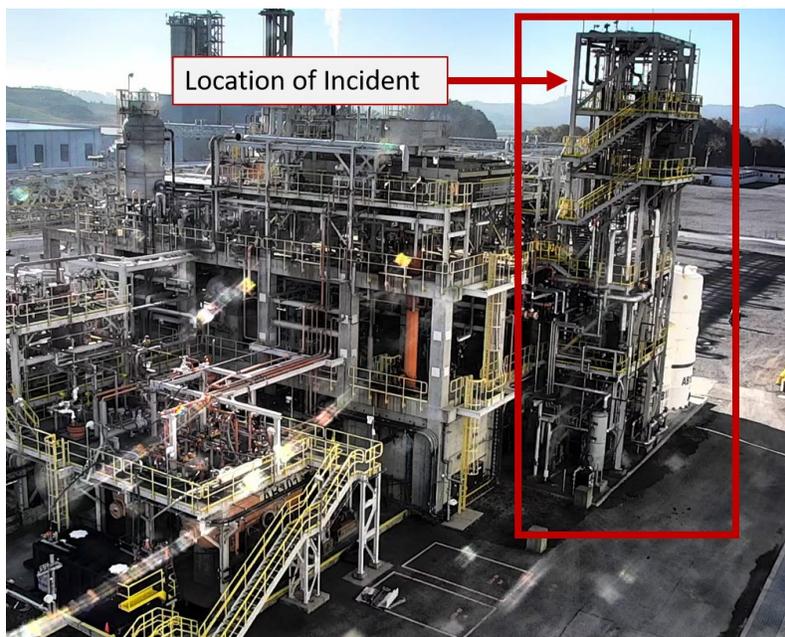
This document provides an update on the CSB investigation of the November 13, 2020, incident at Wacker Polysilicon North America LLC (“Wacker”) in Charleston, Tennessee. The investigation is ongoing. Complete findings, analyses, and recommendations, if appropriate, will be detailed in the CSB’s final investigation report.

### Incident Summary

At 10:04 a.m. on November 13, 2020, a graphite heat exchanger cracked, releasing hydrogen chloride (HCl) at the Wacker Polysilicon facility during maintenance activities. The release caused chemical burns to one contract worker. Another contract worker was injured fatally, and two others were injured seriously when they fell from an elevated structure while attempting to escape the release.

### Background Information

- The HCl release originated from a heat exchanger on the fifth floor of a five-story structure (**Figure 1**). Wacker uses the heat exchanger in its HCl regeneration process. This process converts concentrated hydrochloric acid (30% hydrogen chloride and 70% water) into anhydrous hydrogen chloride gas and dilute hydrochloric acid (18% hydrogen chloride and 82% water). The gas is used in other processes within the facility.



**Figure 1.** Five-story structure. The hydrogen chloride release occurred on the fifth floor of the structure. (Credit: Wacker)

- HCl is corrosive and can cause serious injuries to people in the event of a release [1]. HCl exposure can cause damage to the eyes, skin, and mucous membranes. When inhaled, HCl can cause inflammation of the respiratory tract and buildup of fluid in the lungs. Skin exposure can cause severe burns, ulceration, and scarring [2].

## Incident Description

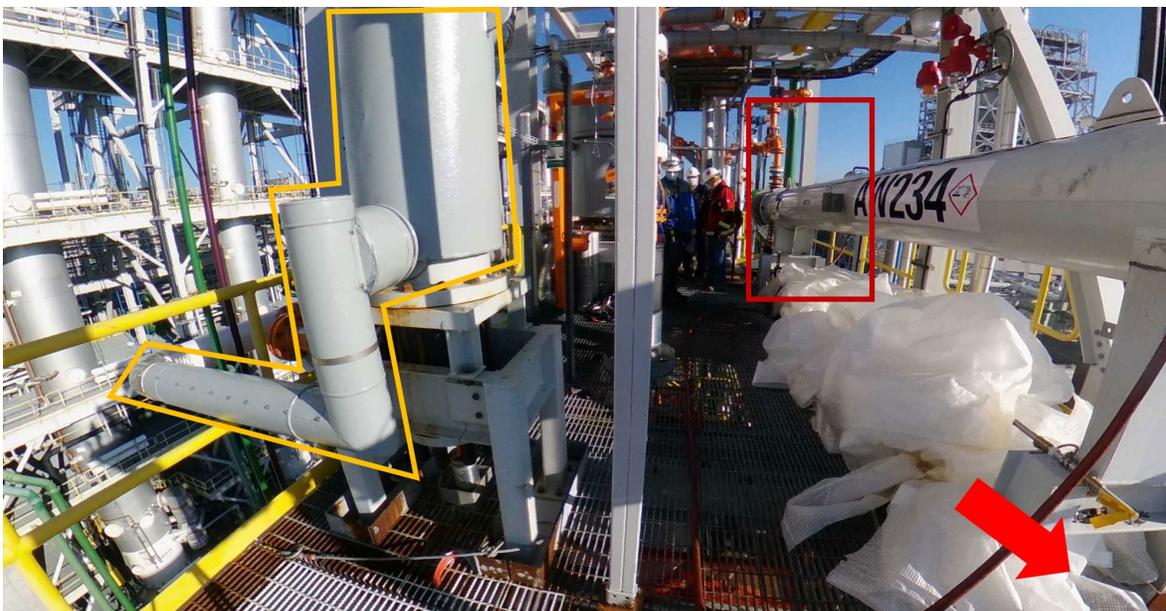
- During the night shift on November 12, 2020, Wacker operators restarted the HCl regeneration unit after it had been shut down for required repairs and routine maintenance. At approximately 7:00 a.m. on November 13, 2020, the unit reached normal operating conditions.
- At 8:00 a.m., Wacker issued a work permit to Jake Marshall LLC (“Jake Marshall”), a contract pipefitting company, to “hot torque AW234.” AW234 is a graphite heat exchanger used in the HCl regeneration process and is located on the fifth floor of the five story structure shown in **Figure 1**.
- Jake Marshall was tasked with checking the torque on all of the bolts on the heat exchanger vapor outlet piping (**Figure 2**). Earlier in the week, the piping was re-installed after maintenance work on the heat exchanger was performed. To complete the torque check, Jake Marshall employees planned to use a click type torque wrench that would “click” with both an audible and tactile response when the desired torque was reached.
- At 8:24 a.m., Wacker issued a work permit to Pen Gulf Inc. (“Pen Gulf”), an insulation and scaffolding company, to perform a separate task to repair insulation on equipment near the heat exchanger.
- The scope of work for both Jake Marshall and Pen Gulf authorized the contract employees to be on the fifth floor of the structure (**Figure 1**). There were three Jake Marshall and four Pen Gulf employees working on the platform at the time of the incident.<sup>a</sup> One Jake Marshall employee was working on the north end of the platform. The two other Jake Marshall employees and all four Pen Gulf Employees were working on the south end of the platform. The approximate work locations of the employees are shown in **Figure 3**.

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<sup>a</sup> The fifth floor is approximately 70 feet above ground level and measures 19 feet wide and 38 feet long.

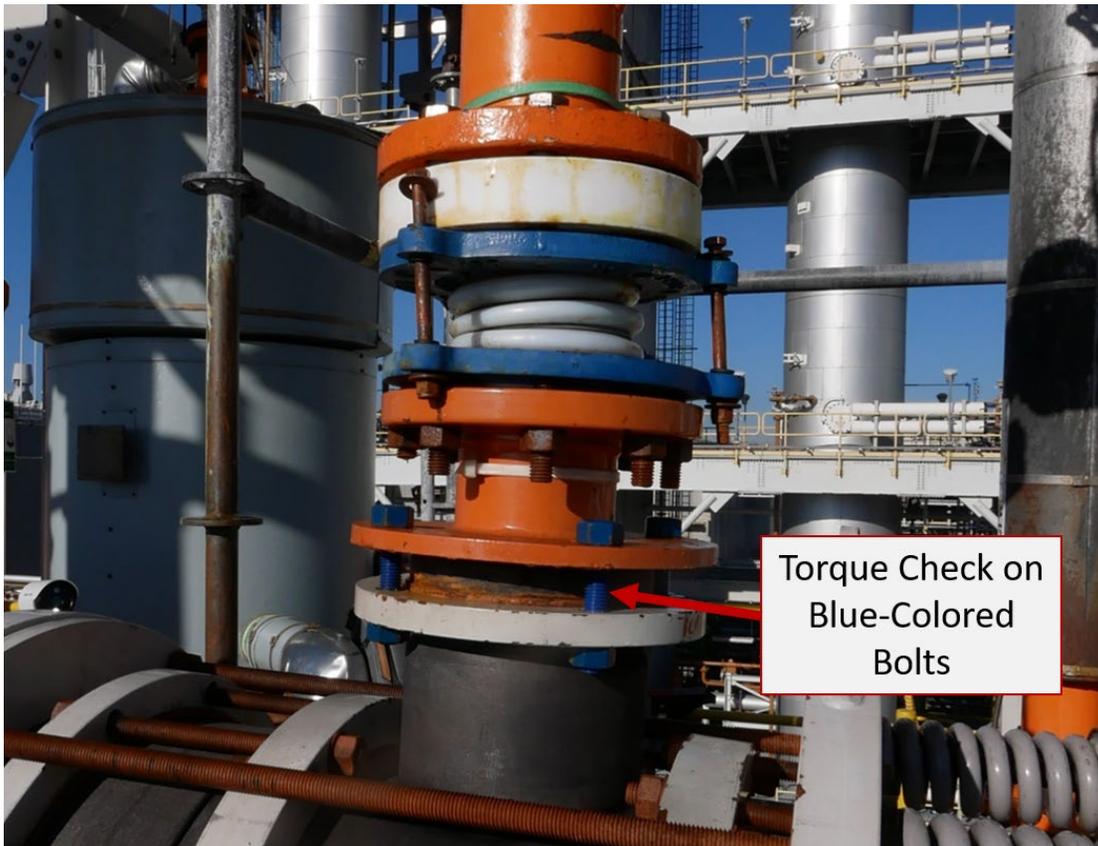


**Figure 2.** Jake Marshall Scope of Work. Wacker employees verbally requested the Jake Marshall employees check the torque on all of the bolts on the heat exchanger vapor outlet piping, which had been installed earlier in the week. (Credit: CSB)



**Figure 3.** Pen Gulf and Jake Marshall work locations. Four Pen Gulf employees were repairing/replacing damaged insulation within the yellow lines on the south side of the platform. One Jake Marshall employee was working on the north end of the platform (red box). The other two Jake Marshall employees were also working on the south end of the platform next to the Pen Gulf employees (red arrow). (Credit: CSB)

- Jake Marshall employees wore full-body chemical resistant suits, rubber boots and gloves, and full-face respirators with acid-gas cartridges. Pen Gulf employees were wearing flame-resistant clothing, steel-toe safety boots, and hard hats.
- Just after 10:00 a.m., as a Jake Marshall employee was checking the torque on the blue-colored bolts shown in **Figure 4**, a loss of containment occurred, resulting in an HCl release (**Figure 5**).



**Figure 4.** Torque check location. A Jake Marshall employee was checking the blue bolts in the image when the release occurred. (Credit: CSB)



**Figure 5.** Image of HCl Release. Image taken during the release of HCl. (Credit: Wacker)

- The 5th floor platform was equipped with a single staircase for access and egress. No other mode of egress was present.
- When the Jake Marshall employee attempted to move away from the release, his chemical suit became entangled and tore open. The tear allowed HCl to get inside the suit, injuring the employee (chemical burns). Due to poor visibility on the platform as a result of the release, the employee was unable to go to the single staircase to exit the platform. The employee was able to go to the south side of the platform where the other Jake Marshall and Pen Gulf employees were working (**Figure 6**).
- The location of the release and resulting lack of visibility prevented all of the workers from being able to access the single staircase to exit the platform.

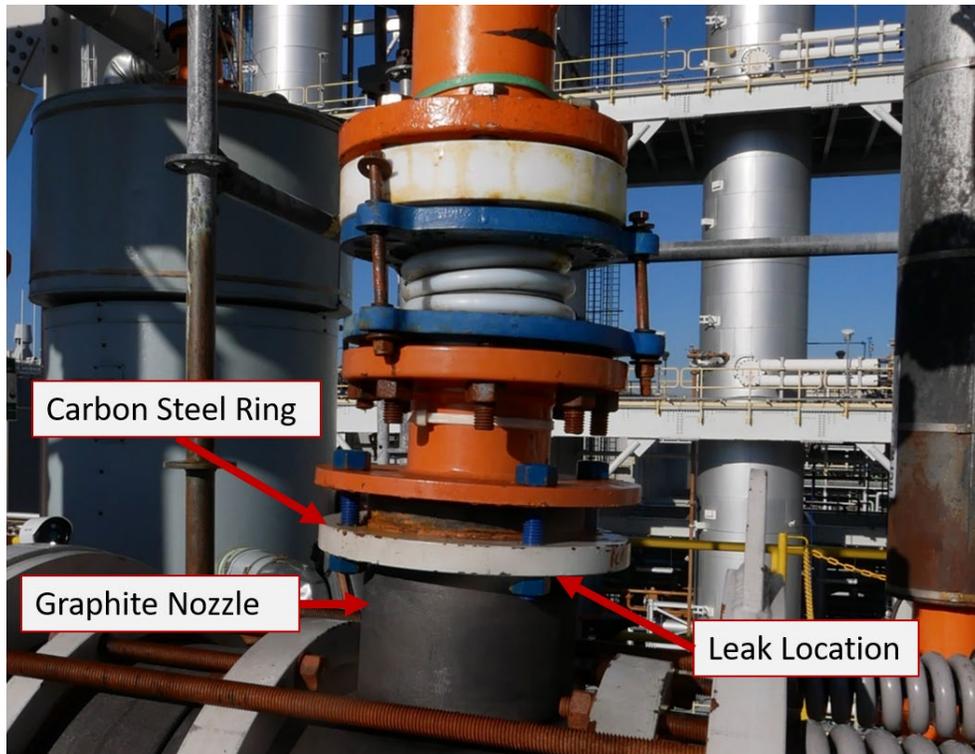


**Figure 6.** Location of Trapped Workers. When the release occurred, two Jake Marshall employees and four Pen Gulf employees were working on the south end of the platform. (Credit: CSB)

- To escape from the release, three of the four Pen Gulf employees began climbing down piping on the side of the structure. While climbing down, all three employees fell to the ground. One employee was fatally injured from the fall and two sustained serious injuries.
- After the release stopped, the three Jake Marshall employees and one Pen Gulf employee used the staircase to evacuate the area and reach the ground.

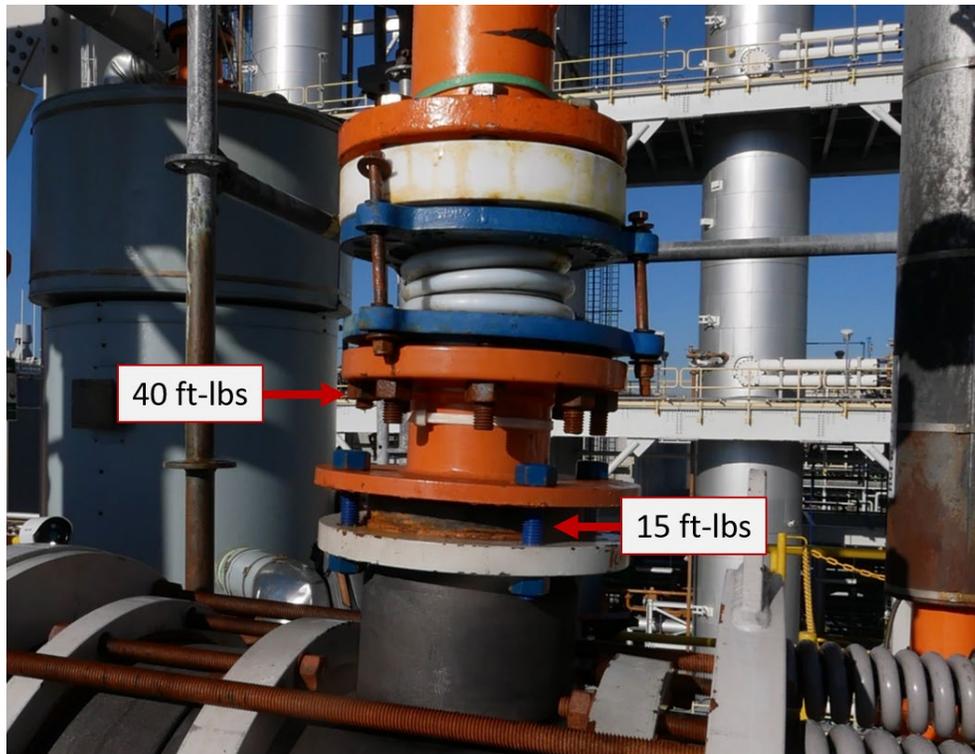
## Heat Exchanger Leak

- After the incident, the CSB oversaw a leak test on the heat exchanger involved in the incident. The test identified a leak on the heat exchanger vapor outlet nozzle. The leak was under a carbon steel ring that was connected to the bolts that the Jake Marshall employee was torque checking (**Figure 7**).



**Figure 7.** Location of Leak. Leak tests on the heat exchanger revealed a leak from the graphite nozzle underneath a carbon steel ring used to attach the nozzle to carbon steel piping. (Credit: CSB)

- The heat exchanger vapor outlet nozzle was constructed of graphite. The vapor outlet piping was constructed of Resistoflex brand Polytetrafluoroethylene (PTFE) lined carbon steel pipe manufactured by Crane ChemPharma & Energy.
- For exchanger-to-piping connections, the manufacturer of the heat exchanger states the recommended bolt torque is 15-foot pounds (ft-lbs).
- For piping-to-piping connections, the Resistoflex manual specifies the minimum required torque is 40 ft-lbs (**Figure 8**).
- A Jake Marshall employee reported that on the day of the incident, the torque wrench used to torque the bolts was set to 40 ft-lbs.



**Figure 8.** Bolt torque requirements. Two sets of bolts on the vapor outlet nozzle of the heat exchanger have different torque requirements. (Credit: CSB)

## Path Forward

- The CSB is continuing to gather facts and analyze several key areas, including:
  - Failure analysis of the heat exchanger vapor outlet nozzle
  - Wacker safety and work management systems, including:
    - Mechanical integrity
    - Maintenance work management
    - Equipment design
    - Personal protective equipment requirements
    - Training
- The investigation is ongoing. Complete findings, analyses, and recommendations, if appropriate, will be detailed in the CSB's final investigation report.

## References

- [1] National Oceanic and Atmospheric Administration, "Chemical Datasheet - Hydrochloric Acid Solution," CAMEO Chemicals, [Online]. Available: <https://cameochemicals.noaa.gov/chemical/3598>. [Accessed 12 January 2021].
- [2] U.S. Environmental Protection Agency (EPA), "hydrochloric-acid.pdf," [Online]. Available: <https://www.epa.gov/sites/production/files/2016-09/documents/hydrochloric-acid.pdf>. [Accessed 19 February 2021].