Investigation Update

September 2022

This document provides an update on the CSB investigation of the January 24, 2020, incident at the Watson Grinding and Manufacturing Co. facility in Houston, Texas. The investigation is ongoing. Complete findings, analyses, and recommendations, if appropriate, will be detailed in the CSB's final investigation report.

Incident Summary

Shortly before 4:30 a.m. on January 24, 2020, an explosion fatally injured two employees and injured two other employees at the Watson Grinding and Manufacturing Co. ("Watson Grinding") facility in Houston, Texas [1]. A third individual, a nearby resident, died a week later, reportedly from injuries caused by the explosion. The explosion also injured other local residents and damaged hundreds of nearby structures, including homes and several businesses [1]. The explosion was fueled by propylene that had accidentally released and accumulated inside an enclosed workshop. Watson Grinding used propylene as fuel to apply protective coatings to metal parts.

Background

Company History

Watson Grinding began as a small specialty grinding shop in 1960 (**Figure 1**). The company expanded its facilities by adding a full-scale machine shop[a] and offering specialty thermal spray coatings to customers, particularly using a High Velocity Oxygen Fuel (HVOF) coating process[b] [2].

[a] Watson Grinding was bounded, on its East and West sides, primarily by Gessner Road and Steffani Lane, respectively. The facility was closed after the incident and remains so today. An associated, but separate, company operated in a facility adjacent to Watson Grinding, Watson Valve Services, Inc. ("Watson Valve").

[b] High Velocity Oxygen Fuel (HVOF) coating is a thermal spray process in which a fuel (at Watson Grinding, propylene) and oxygen are mixed, fed into a combustion chamber, and ignited.

Figure 1. Watson Grinding. This photo shows the pre-incident condition of the Watson Grinding (and related) facilities located in Houston, Texas. (Source: Watson Grinding [3]; Annotations: CSB)

HVOF Coating Process at Watson Grinding

The High Velocity Oxygen Fuel (HVOF) coating process is one of the different thermal spray coating processes provided by Watson Grinding. HVOF applies carbides and metal or alloy coatings at high temperatures. HVOF coatings can improve corrosion protection and wear resistance in specific applications. In the HVOF coating process, the material being applied as a coating and a fuel are fed into a “spray gun.”

Watson Grinding conducted thermal spray coating operations in separate coating booths situated inside the coating building. A coating operator ran each coating booth. Watson Grinding performed the HVOF coating both manually and by using industrial robotic arms programmed by the booth operator (**Figure 2**). Watson Grinding had ten coating booths, with eight located in the coating building (**Figure 3**). The first two booths, Coating Booths 1 and 2, were not equipped for HVOF spray coating; instead, they were equipped for “Plasma Spray” coating.[a] The other six coating booths in the coating building (Booth 3 through Booth 8) were equipped for HVOF spraying. In addition to the eight booths in the coating building, Watson Grinding had two additional HVOF booths (Booth 9 and Booth 10) located in separate, standalone buildings.

[a] Plasma spraying, like HVOF spaying, is a thermal spraying process. In a plasma spraying process, an inert gas (rather than fuel), typically argon or an argon-hydrogen or argon-helium mixture, is superheated and ionized by an electrical arc, generating a gas plasma.

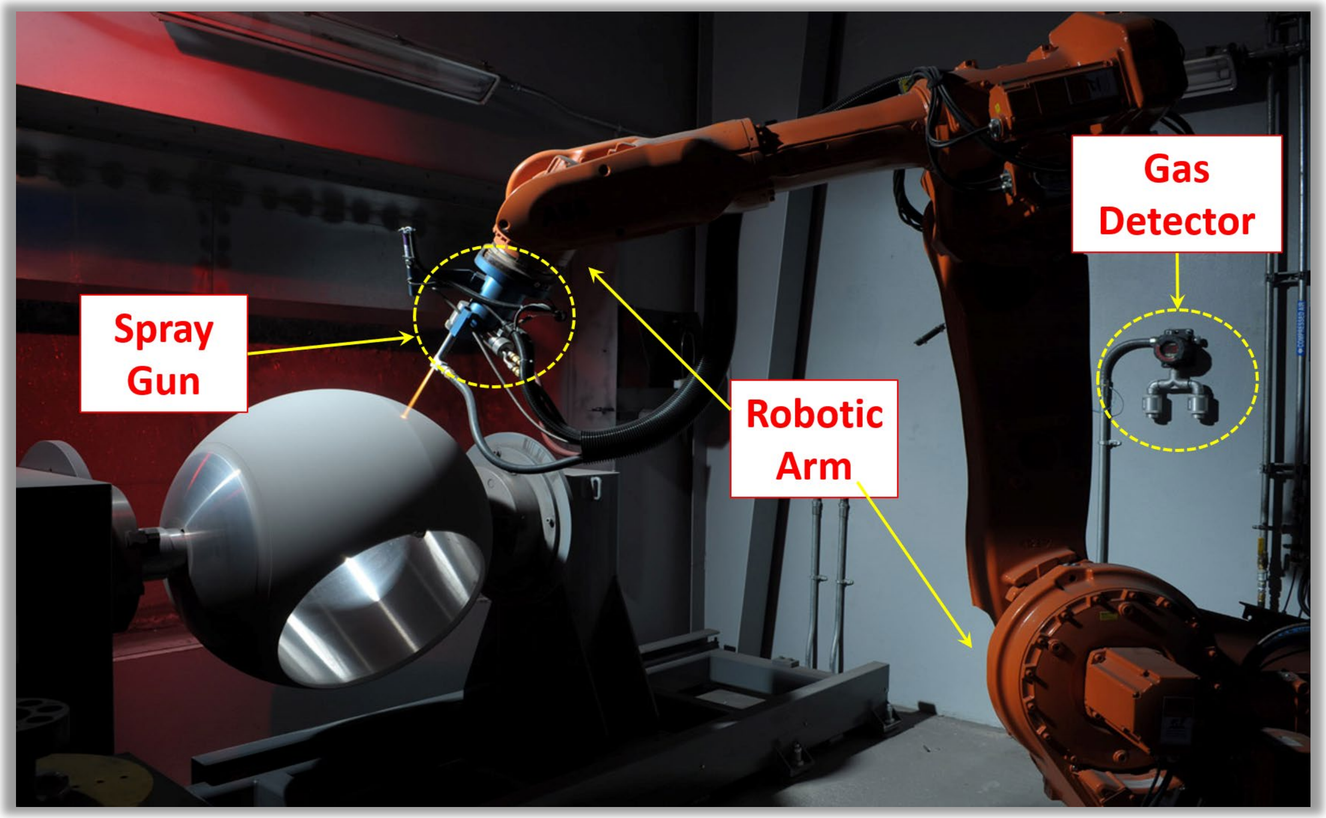

Figure 2. HVOF Booth. Inside an HVOF coating booth, during the remote spray coating of a ball valve component. The spray gun is attached to the robotic arm. (Source: Watson Grinding [4]; Annotations: CSB)

Figure 3. The Coating Building. The interior of the coating building was taken soon after construction was completed, circa 2010. (Source: Watson Grinding [3]; Annotations: CSB)

Watson Grinding's Propylene Storage and Piping System

Watson Grinding used propylene gas as the fuel for the HVOF coating process. Propylene (C3H6) is an extremely flammable,[a] colorless gas that is sometimes characterized as having a faint petroleum odor [4, 5]. Under specific temperature and pressure conditions, propylene can be a liquid. Propylene gas is heavier than air[b] and tends to accumulate near the floor of rooms or buildings [4].

The company stored propylene in a 2000-gallon bulk tank (propylene storage tank). Propylene flowed from the propylene storage tank and into the propylene supply piping, which ran along the buildings' exteriors (see red dashed line in **Figure 4**) to the branched "tee" takeoffs into each of the eight HVOF coating booths (Booths 3 through 10).[c] At each booth, the propylene takeoff piping entered near the top, about fifteen feet above ground level. The piping ran downward near ground level and connected to the booth's control equipment and the robotic arm. Each robotic arm was equipped with a spray gun to apply the HVOF coating (**Figure 4**).

Figure 4. Propylene Supply Piping. This photo shows how Watson Grinding routed the propylene supply piping from the propylene storage tank to the eight HVOF coating booths. (Source: Google Earth Pro image from before the incident [7]; Annotations: CSB)[d]

[a] Propylene's lower explosive limit/lower flammable limit (LEL/LFL) in air is 2 percent and its upper explosive limit/upper flammable limit is 11.1 percent (UEL/UFL) [6].
[b] Propylene gas has a specific gravity of 1.45 (at 70 °F and atmospheric pressure (air = 1)), making it heavier than air [6].
[c] Propylene was not piped into Booth 1 and Booth 2 because the plasma spray process did not use propylene.
[d] Booth annotations in this diagram have been included to represent their relative positioning and are not drawn to scale.

Watson Grinding's Propylene Piping Control Systems

The propylene in the supply piping was controlled through a series of valves and regulators. At the propylene storage tank, the propylene flowed from the tank through an isolation valve[8] and a regulator. Next, the propylene flowed through three more isolation valves (these valves were located at ground level and on the side of the tank).[a] The propylene then flowed into the propylene supply piping and routed to the coating booths.

The propylene piping pressure and flow in each booth were individually controlled. Once entering each coating booth, the propylene flowed through the key components of the booth's pressure piping system in the following order:

1. a manual isolation valve;
2. an adjustable pressure regulator; and
3. an automated isolation valve (**Figure 5**).[b]

[a] Isolation valves are also referred to as "shut-off valves."

[b] Booth 6 is indicative of the arrangement of piping and pressure control system components inside of an HVOF control booth. The piping configuration to other coating booths might differ, slightly.

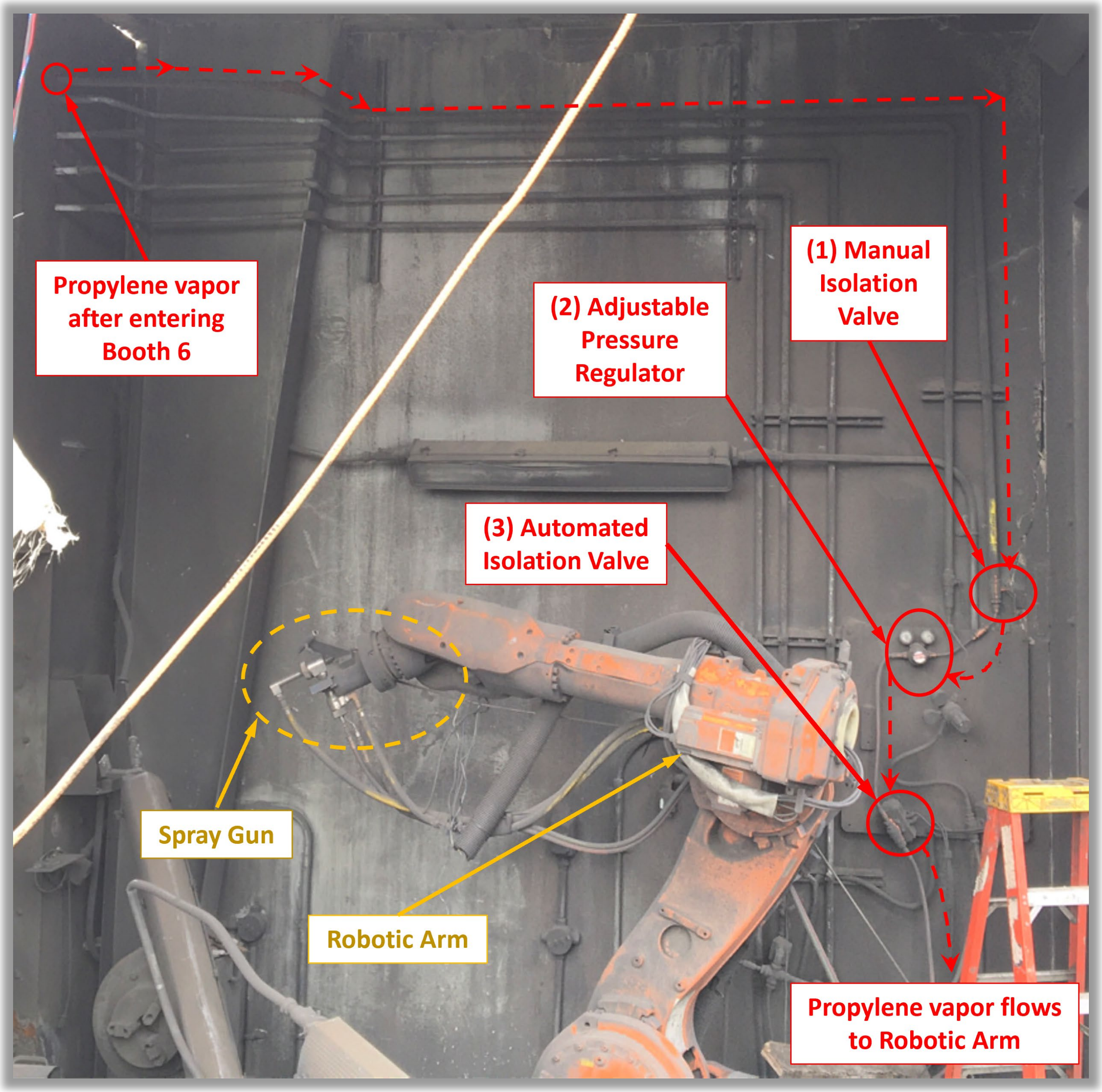

Figure 5. Propylene system inside Booth 6. This post-incident photo shows the location of the propylene piping after entering the top of Booth 6, flowing through the booth's propylene pressure control system and continuing to the robotic arm. (Source: Watson Grinding; Annotations: CSB)

Watson Grinding's Propylene Safety System

Watson Grinding designed the HVOF coating process with a safety system that included the following elements:

- Daily manual leak checking of some propylene piping components inside each booth;
- Automated controls to start and stop propylene flow during the coating application;
- Multiple buttons, located at each of the three exit doors inside of the coating building, to allow employees to remotely shutoff (isolate) the supply of propylene and other gases from entering the coating building, whenever propylene was not being used or upon notification of a leak or suspected leak; and
- Every HVOF coating booth was designed to include fixed atmospheric monitoring equipment, with reported design features including, that upon detection of a propylene gas leak above a predetermined threshold:
    - automatically isolating the propylene supply to the coating building[a]; and
    - automatically initiating an audible alarm and visible flashing lights.[b]

Preliminary Incident Timeline

On Friday morning, January 24, 2020, at about 3:37 a.m., Employee One arrived at Watson Grinding to use the exercise equipment at the Watson Gym (which was located in the Watson Valve building).[c] At around 3:55 a.m., Employee Two arrived at the Watson Gym and detected a chemical odor while outside the building. Upon entering the Watson Gym, Employee Two asked Employee One if he also smelled the chemical odor. Although Employee One replied that he did not, Employee Two insisted that they go together to investigate the source of the odor.[d]

At about 4:00 a.m., the two employees left the Watson Gym and walked to the coating building (located next door). While standing outside of the coating building (in the area directly behind Booth 4; see **Figure 4**), they smelled a "strong" propylene odor and heard a "really loud hissing" noise coming from inside the coating building. Employees later stated the propylene leak sounded like it was originating about three to four feet above ground level. After smelling and hearing the leaking propylene, both employees returned to the Watson Gym and resumed exercising. Shortly after, Employee Two stopped exercising, contacted two Watson Grinding supervisors, and informed them of the suspect propylene leak. Neither supervisor reported directing Employee Two to evacuate himself and others from the facility immediately. After alerting these supervisors, Employee Two left the Watson Gym to investigate the propylene leak further.

At about 4:23 a.m., Employee Three arrived at Watson Grinding and parked his car just outside the door on the west side of the coating building (the side facing Steffani Lane). Employee Three, a coating operator, had a key to the coating building and, in his supervisor's absence, would open up the coating building and start work.

[a] Isolating the propylene supply would limit additional gas available to be leaked inside of the coating building.
[b] The audible and visual alerts would be to notify nearby personnel to take emergency response actions.
[c] Watson had a fitness facility onsite for exclusive use by its employees, inside of the Watson Valve building and was referred to as the Watson Gym.
[d] Employee One did not work in the coating building and was unaware of the smell or danger of a propylene leak. However, Employee Two was a maintenance technician, who worked throughout the Watson Grinding facility and was familiar with the odor of propylene having repaired previously a propylene leak.

Approximately one minute later, at about 4:24 a.m., Employee Four arrived at the facility. As he stopped and prepared to park his truck, he noticed Employee Three's car was parked just outside of the coating building and saw Employee Three enter the coating building's open west door. As Employee Four backed his truck into a parking space, there was an explosion inside the coating building.[a] The explosion fatally injured Employees Two and Three, and injured Employees One and Four.

Investigation Path Forward

The CSB is continuing to gather facts and analyze several key areas, including:

- Operating procedures;
- Mechanical integrity systems;
- Equipment design;
- Safety system design; and
- Emergency response to gas leaks.

The investigation is ongoing. At the conclusion of the investigation, the CSB will publish a final investigation report which will include findings, analysis, and recommendations if appropriate.

References

[1] C. Matthews, "Third person dies after Watson Grinding explosion, authorities investigating cause of death," Houston Business Journal, 10 February 2020. [Online]. Available: https://www.bizjournals.com/houston/news/2020/02/10/third-person-dies-after-watson-grinding-explosion.html. [Accessed 29 June 2020].

[2] Watson Grinding and Mfg., "Company; History," [Online]. Available: www.watsongrinding.com/company/history/. [Accessed 25 June 2020].

[3] Watson Grinding and Mfg., "HVOF," [Online]. Available: http://www.watsongrinding.com/products-services/thermal-spray-coatings/hvof/. [Accessed 25 June 2020].

[4] Watson Grinding and Mfg., "Media; Pictures," [Online]. [Accessed 26 June 2020].

[5] ASM Thermal Spray Society, "Health and Safety," in *ASM Handbook Volume 5A Thermal Spray Technology*, Materials Park, Ohio, ASM Thermal Spray Society and ASM International, 2013, pp. 135-178.

[6] Western International Gas and Cylinders, Inc., "Propylene Physical Properties," 2005. [Online]. Available: http://westernintl.com/gases/propylene_properties.shtml. [Accessed 23 June 2020].

[7] Google Earth Pro, "4525 Gessner Road, Houston, Texas," [Online]. [Accessed 22 June 2020].

[a] At the time of the explosion: Employee One was exercising in the gym; Employee Two was investigating the propylene leak; Employee Three was entering the coating building; and Employee Four was parking his pickup truck.