Explosion resulting in a welder fatality, a welder sustaining life altering injuries and multiple worker medical aid injuries

December 27, 2018

The contents of this report

This document reports the Alberta Occupational Health and Safety (OHS) investigation of a fatal incident that occurred in December 2018. It begins with a short summary of what happened. The rest of the report covers this same information in greater detail.

Incident summary

A Welder was grinding an oilfield steel skid, in Bay 9 of Ja-Co Welding & Consulting Ltd. Shop 1, when sparks ignited acetylene causing an explosion and fire. The explosion resulted in a fatality, one serious life altering injury, multiple reported medical aid injuries and psychological injuries.

Background information

Employer

Ja-Co Welding & Consulting Ltd. (Ja-Co) was a family owned and operated company founded in 1987, which provided oilfield and structural steel fabricating in the Nisku Business Park. Ja-Co employed 87 people at the time of the incident. Ja-Co had two light industrial shops in Nisku located across the street from each other called Shop 1 and Shop 2. The incident took place in Shop 1.

Figure 1. Ja-Co Shop 1 - Street view image obtained by Google Maps.

A. *Acetylene shack and Bay 9.*
B. Ja-Co Shop 1 office building.

Shop Foreman

The Shop Foreman for Shop 1 was a Journeyman welder with 8 years' experience as a welder for Ja-Co and 17 years welding experience in total. The Shop Foreman turned on the acetylene manifold system on the morning of the incident and was the work site supervisor for the workers involved in the explosion.

Welder 1

Welder 1 was fatally injured in the December 27, 2018 incident (incident). Welder 1 was an experienced Journeyman welder/fabricator and had been employed by Ja-Co for approximately 17 years.

Welder 2

Welder 2 sustained physical life altering injuries from the explosion. Welder 2 was a Journeyman welder/fabricator employed by Ja-Co for four years at the time of the incident.

Welder 3

Welder 3 was a Journeyman welder, working in Bay 9 at time of the incident. Welder 3 was employed with Ja-Co for seven years and had a total of eight years' industry experience.

Welder 4

Welder 4 was employed by Ja-Co as a third year apprentice welder at the time of the incident and had a total of five years' industry experience. Welder 4 was engaged in grinding duties at the south end of Bay 9 at time of the incident.

Welder 5

Welder 5 was a Journeyman welder with seven years' experience at Ja-Co. Welder 5 was injured in the incident resulting in lost time. Welder 5 had changed the banks of acetylene over on December 22, 2018, and the same day shut down the acetylene manifold system prior to the Christmas break.

Tool Crib Attendant

The Tool Crib Attendant had been employed by Ja-Co for 15 years and had 30 years welding and fitting experience. The Tool Crib Attendant changed over the acetylene cylinders from one bank of cylinders to the other the day of the incident and was responsible for the acetylene shack maintenance and inspection.

Supplier

Messer Canada Inc. (Messer), formerly known as Linde Canada (Linde), was an industrial gas specialist with more than seventy production facilities in five countries. Messer produced and delivered industrial, medical and specialty gases. Messer, in a joint venture with CVC Capital Partners, acquired Linde's gas business in Canada during the spring of 2019. Linde was an industrial gas and engineering company that employed approximately 80 000 people in more than 100 countries worldwide. The Linde Gases Division produced and distributed the atmospheric gases oxygen, nitrogen and argon, which were manufactured in their air separation plant in the United States of America. Linde's products ranged from hydrogen, acetylene, carbon monoxide and carbon dioxide, to shielding gases for welding applications, noble gases and high-purity specialty gases. Messer had been supplying compressed gases to Ja-Co for approximately three years prior to the incident. Messer's deliveries included bringing new acetylene bottles to Ja-Co where they were placed inside the acetylene shack by the delivery driver. The empty bottles located outside the acetylene shack were then taken away by the delivery driver.

Work site, equipment and materials

Work site

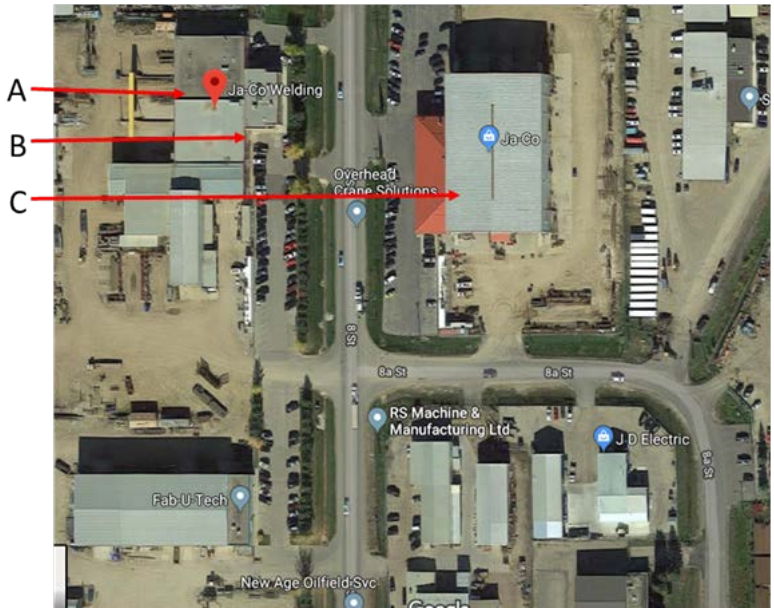


Figure 2. Ja-Co Shop 1 aerial view. Image provided by Google Maps.

A. Ja-Co Shop 1
B. Acetylene shack
C. Ja-Co Shop 2

Ja-Co Shop 1 consisted of an office building and 9 work bays for welding and fabricating. The work bays were fed acetylene from the acetylene storage shack by a manifold system to the bays to supply the cutting torching at the work site.

Figure 3. Ja-Co Shop 1 building diagram provided by Ja-Co.

A. Gas storage room where incident occurred (acetylene shack).

Figure 4. Ja-Co Shop 1 long shot view facing north. All close circuit television (CCTV) images were provided by Ja-Co.

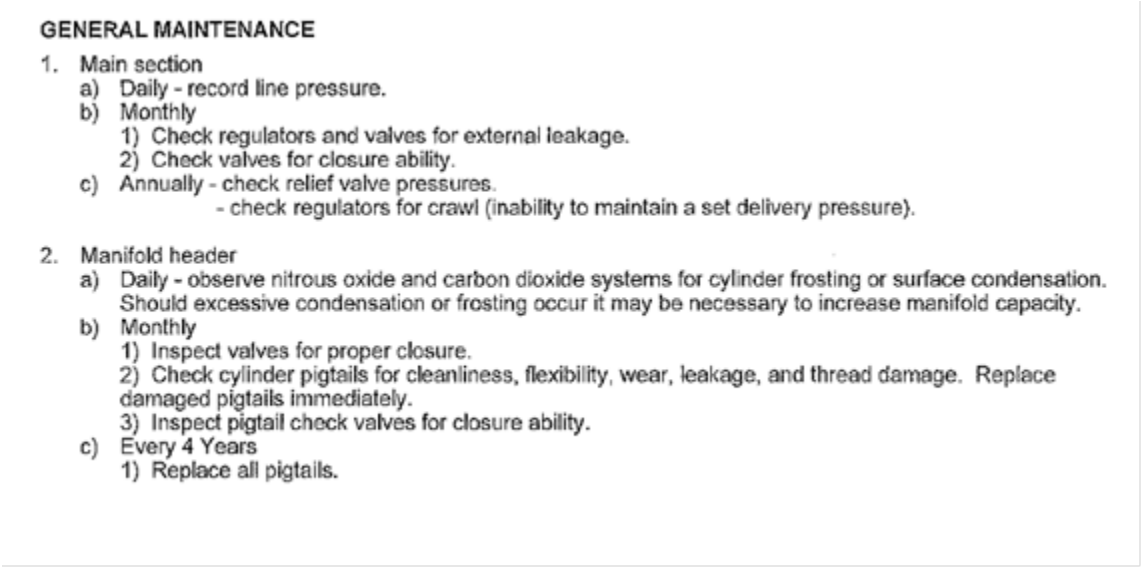
A. Exhaust from the product storage shack blowing towards Bay 9. This indicates that the air from the acetylene shack may have been pushed toward Bay 9 by the wind.

B. Acetylene shack.

C. Bay 9 doors.

Manifold

The Western Innovator manifold supplied acetylene into the work bays of Shop 1 from the acetylene shack.



GENERAL MAINTENANCE

1. Main section
   a) Daily - record line pressure.
   b) Monthly
      1) Check regulators and valves for external leakage.
      2) Check valves for closure ability.
   c) Annually - check relief valve pressures.
      - check regulators for crawl (inability to maintain a set delivery pressure).

2. Manifold header
   a) Daily - observe nitrous oxide and carbon dioxide systems for cylinder frosting or surface condensation. Should excessive condensation or frosting occur it may be necessary to increase manifold capacity.
   b) Monthly
      1) Inspect valves for proper closure.
      2) Check cylinder pigtails for cleanliness, flexibility, wear, leakage, and thread damage. Replace damaged pigtails immediately.
      3) Inspect pigtail check valves for closure ability.
   c) Every 4 Years
      1) Replace all pigtails.

Figure 5. Manifold manufacturer's specifications, Western Innovator, Installation and Operating Instructions for Manual Manifolds MD Series. This document was provided by Ja-Co.

Exemplar acetylene storage shack

The exemplar storage shack was re-constructed as part of the OHS investigation by a professional engineer to show how the acetylene shack appeared prior to the incident and to assist in determining the incident causation.

A bank of four cylinders provided acetylene until empty, requiring manual changeover to the second bank of four cylinders. The empty cylinders would be replaced with full cylinders that were stored inside the acetylene shack. The empty cylinders would be placed outside the acetylene shack and exchanged by Messer. The four individual bottles of acetylene on the right bank were in the open position post explosion.

Figure 6. Re-constructed Exemplar acetylene storage shack, front view and rear view. The manifold system provided continuous acetylene to Shop 1.

The acetylene shack also served as a storage area for acetylene and other compressed gas cylinders such as nitrogen and oxygen.

- *A. Peak of storage shack measured 3 metres.*
- *B. Acetylene storage shack with installed vent. The vent and shack allowed gases to move between the acetylene shack, outside of the acetylene shack and into Bay 9.*
- *C. Acetylene storage shack with fan vent box. See item I for the opposite view of the fan.*
- *D. Main piping and vent piping of the manifold.*
- *E. South acetylene Western Innovator manual manifold.*
- *F. North acetylene cylinders attached to Western Innovator manual manifolds.*
- *G. South acetylene cylinders.*
- *H. Opposite view of the acetylene storage shack with installed vent.*
- *I. Opposite view of the acetylene storage shack with fan.*
- *J. Acetylene manifold entrance into the shack and potential area where the acetylene leaked outside of the shack and ignited.*

Exemplar acetylene shack wall materials

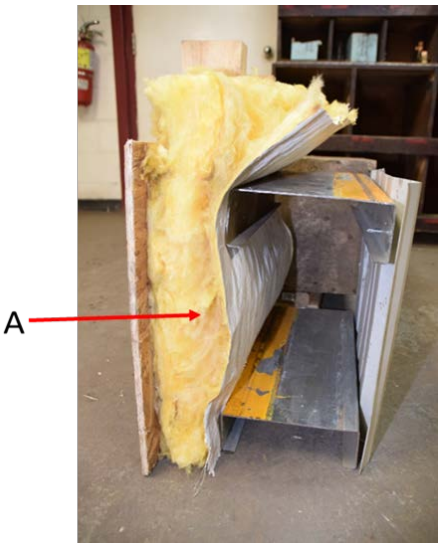


Figure 7. Re-constructed example of wall construction material and ventbox from the storage shack.

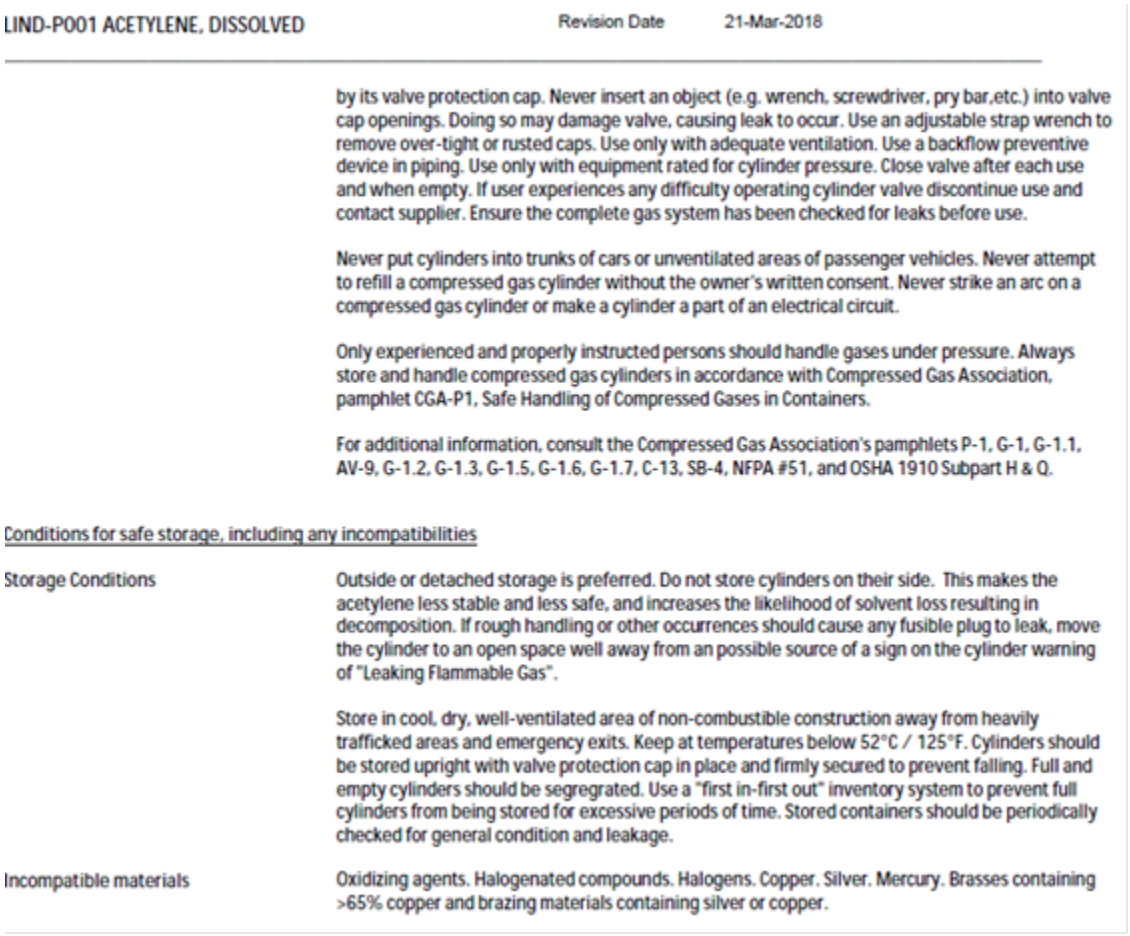
A. Exemplar side view of building materials between acetylene storage shack and Bay 9. Left wood particle board was the interior of the acetylene shack and the corrugated metal was on the inside wall of Bay 9.

Acetylene

Acetylene (C2H2) is the hottest and most efficient of all fuel gases. Acetylene provides high levels of productivity due to good localized heating with a minimum of thermal waste. It also requires the least amount of oxygen to ensure complete combustion. This flammable, colourless, odourless gas is lighter than air so it does not accumulate at low levels. It was generally supplied dissolved in acetone or DMF (dimethylformamide) in specially designed cylinders to prevent decomposition. Acetylene is lighter than air and was used to weld steel at the work site.

A low flame moisture content made this fuel gas a common choice for many critical heating processes. Typical applications included flame heating, flame gouging, welding, flame hardening, flame cleaning, flame straightening, thermal spraying, spot-heating, brazing, texturing, profile-cutting, branding wooden pallets, wood-aging and carbon coating.

The information above was provided from the Linde website.



LIND-P001 ACETYLENE, DISSOLVED Revision Date 21-Mar-2018

by its valve protection cap. Never insert an object (e.g. wrench, screwdriver, pry bar,etc.) into valve cap openings. Doing so may damage valve, causing leak to occur. Use an adjustable strap wrench to remove over-tight or rusted caps. Use only with adequate ventilation. Use a backflow preventive device in piping. Use only with equipment rated for cylinder pressure. Close valve after each use and when empty. If user experiences any difficulty operating cylinder valve discontinue use and contact supplier. Ensure the complete gas system has been checked for leaks before use.

Never put cylinders into trunks of cars or unventilated areas of passenger vehicles. Never attempt to refill a compressed gas cylinder without the owner's written consent. Never strike an arc on a compressed gas cylinder or make a cylinder a part of an electrical circuit.

Only experienced and properly instructed persons should handle gases under pressure. Always store and handle compressed gas cylinders in accordance with Compressed Gas Association, pamphlet CGA-P1, Safe Handling of Compressed Gases in Containers.

For additional information, consult the Compressed Gas Association's pamphlets P-1, G-1, G-1.1, AV-9, G-1.2, G-1.3, G-1.5, G-1.6, G-1.7, C-13, SB-4, NFPA #51, and OSHA 1910 Subpart H & Q.

Conditions for safe storage, including any incompatibilities

Storage Conditions	Outside or detached storage is preferred. Do not store cylinders on their side. This makes the acetylene less stable and less safe, and increases the likelihood of solvent loss resulting in decomposition. If rough handling or other occurrences should cause any fusible plug to leak, move the cylinder to an open space well away from an possible source of a sign on the cylinder warning of "Leaking Flammable Gas". Store in cool, dry, well-ventilated area of non-combustible construction away from heavily trafficked areas and emergency exits. Keep at temperatures below 52°C / 125°F. Cylinders should be stored upright with valve protection cap in place and firmly secured to prevent falling. Full and empty cylinders should be segregrated. Use a "first in-first out" inventory system to prevent full cylinders from being stored for excessive periods of time. Stored containers should be periodically checked for general condition and leakage.
Incompatible materials	Oxidizing agents. Halogenated compounds. Halogens. Copper. Silver. Mercury. Brasses containing >65% copper and brazing materials containing silver or copper.

Figure 8. Linde, Acetylene Safety Data Sheet that specifies the storage conditions. Provided by Messer.

Sequence of events

December 22, 2018, was the final day of operations at Ja-Co Shop 1 before the Christmas break. That day, Welder 5 switched over the acetylene manifold from the empty south bank of four cylinders to the north bank at approximately 11:00 a.m., while the other welders continued fabricating in Shop 1.

A few hours later, at approximately, 2:30 p.m., Welder 5 shut down the acetylene manifold system in the acetylene shack by turning off the master valve on the acetylene Shop 1 supply line in preparation for Ja-Co to be closed for the following five days.

Following the Christmas break, and upon returning to work at Shop 1 on December 27, 2018 at 5:30 a.m., the Shop Foreman began turning on lights, heaters, unlocking the doors and entered the acetylene shack at 5:38 a.m. The Shop Foreman turned on the acetylene manifold system in preparation for the work crew to continue fabricating an oilfield skid (Figure 9).

Welder 1's shift began at 6:00 a.m. At 6:44 a.m., the Shop Foreman started preparations to begin fabricating on the south end of the skid.

At 6:35 a.m., the Tool Crib Attendant entered the acetylene shack for approximately one minute to perform a check of the acetylene manifold system. A check was performed by listening for leaks and smelling for acetylene.

Welder 2 arrived at 7:00 a.m., had a morning meeting with the Shop Foreman and signed in on the Supervisor's Pre-Job Hazard Assessment Sign-In Sheet. During this time, Welder 1 was fabricating in Bay 9 using the grinder.

At 7:06 a.m., Welder 3, Welder 4 and Welder 2, joined Welder 1 in fabricating the steel oilfield skid in Bay 9. The workers were observed to be reviewing drawings and taking measurements.

At 7:19 a.m., Welder 1 was observed in Bay 9 moving to the southeast corner of the bay wearing a welder's mask, picking up the cutting torch and exiting the camera view. Light flashes were then visible consistent with using the cutting torch.

Welder 2 began at 7:23 a.m., using a cutting torch on the east side of Bay 9 to cut a steel I beam. Welder 1 and Welder 2 appeared to be using their cutting torches at the same time.

Welder 1 put the welding torch down on the southeast end of the oilfield skid at 7:27 a.m., and moved to the southwest side of the skid where the overhead crane rigging began to move. Welder 2 continued to use the cutting torch on the steel I beam. At the same time, sparks appeared in the southeast corner of Bay 9.

Welder 2 put the cutting torch down on the steel I beam and left Bay 9 to go to the acetylene shack. Welder 2 entered the acetylene shack at 7:32 a.m., to assess the acetylene level, as there was a reduction in acetylene flow while cutting.

One minute later, the Tool Crib Attendant went into the acetylene shack and determined the acetylene cylinders were empty and needed to be switched over from one bank of four cylinders to the other bank of four cylinders on the manifold. The Tool Crib Attendant switched the manifold over from the south to north bank.

At 7:45 a.m., the Tool Crib Attendant re-entered the acetylene shack for one minute to check the flow rate and perform a leak test. The Tool Crib Attendant assessed for acetylene leaks by smell and sound. See Figure 6 for reference on how the acetylene cylinders appeared prior to the explosion.

At the same time, Welder 1 was grinding in the northeast corner while Welder 2 was positioning a beam in the northwest corner of Bay 9 to fabricate the skid. Further south in Bay 9, two other Ja-Co employees were working on the oilfield skid. Welder 4 was on the west side of the building positioning the skid sections while Welder 3 was grinding near the southwest corner.

Welder 1 was in the southwest corner of Bay 9 at 8:12 a.m. There were flashes of light off camera showing on the wall which indicated the use of the cutting torch. At 8:13 a.m., Welder 1 picked up a grinder off the southwest corner of the oilfield skid.

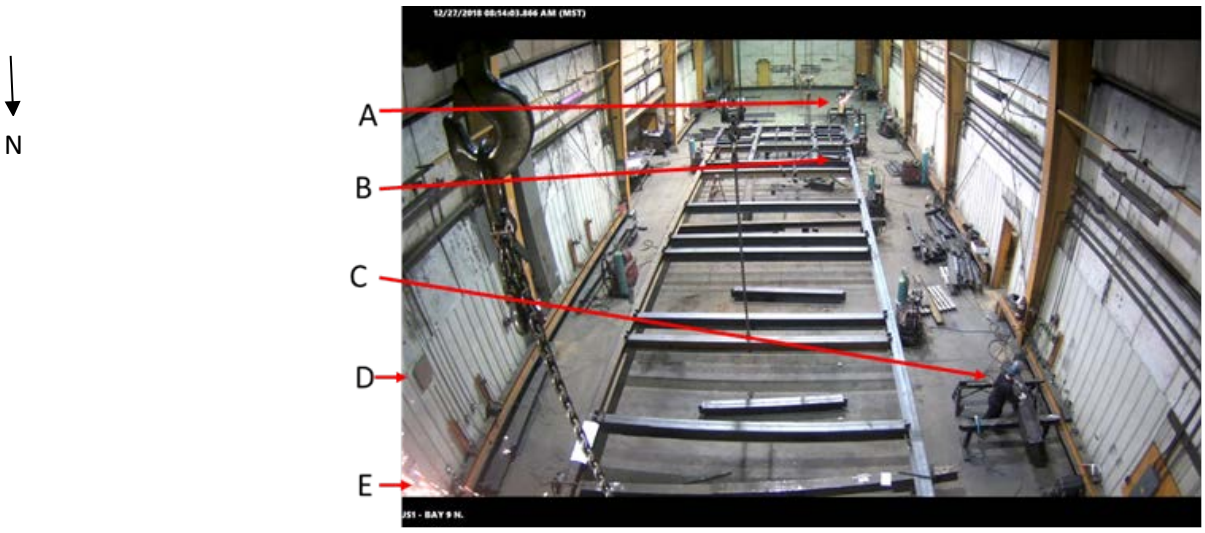


Figure 9. Ja-Co Shop 1 interior view of the steel skid being fabricated in Bay 9 prior to Incident. CCTV image provided by Ja-Co.

A. Welder 3.
B. Welder 4.
C. Welder 2.
D. Covered wooden vent box leading to the acetylene shack.
E. Sparks from the grinder Welder 1 was using prior to the explosion.

At 8:13:58 a.m., Welder 1 was using a grinder to bevel the edge of the oilfield skid, creating sparks which flew in the vicinity of a plywood covered wood vent box on the wall between Bay 9 and the acetylene shack.

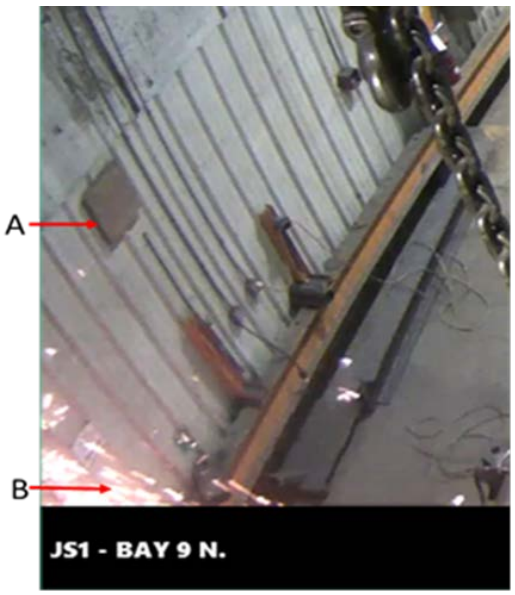


Figure 10. Close up CCTV image provided by Ja-Co of the work being conducted by Welder 1 shortly before the explosion.

A. Close up of the plywood covered vent box that led into the acetylene shack.
B. Sparks from a grinder being operated by Welder 1 prior to the explosion near the double doors leading to Bay 9.

At some point between December 22, 2018 and December 27, 2018, there was a significant release of acetylene from the acetylene shack manifold. The acetylene was released into the atmosphere and migrated from the acetylene shack outside the Bay 9 exteriors doors while hot work was being conducted inside.

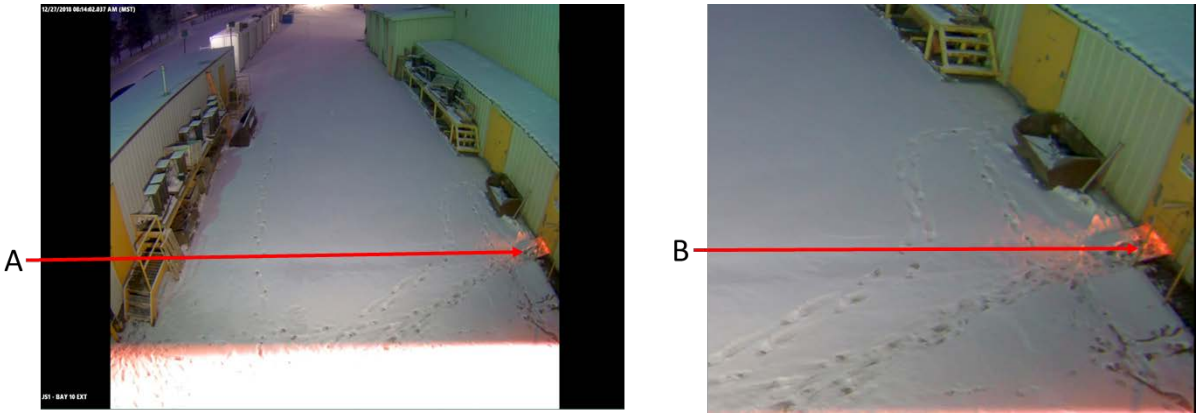


Figure 11. Exterior view of the acetylene storage shack

A. Large flash of light at bottom of screen combined with glow under the acetylene shack door seconds before the explosion indicates the ignition of the atmosphere to cause the light flash, and the large explosion occurred outside the shack on the right hand side when facing north.

B. Close up of the acetylene shack door prior to the explosion.

Figure 12. Acetylene storage shack. The top left hand corner of the photo shows the time of 8:14:03 a.m. December 27, 2018, when explosion occurred.

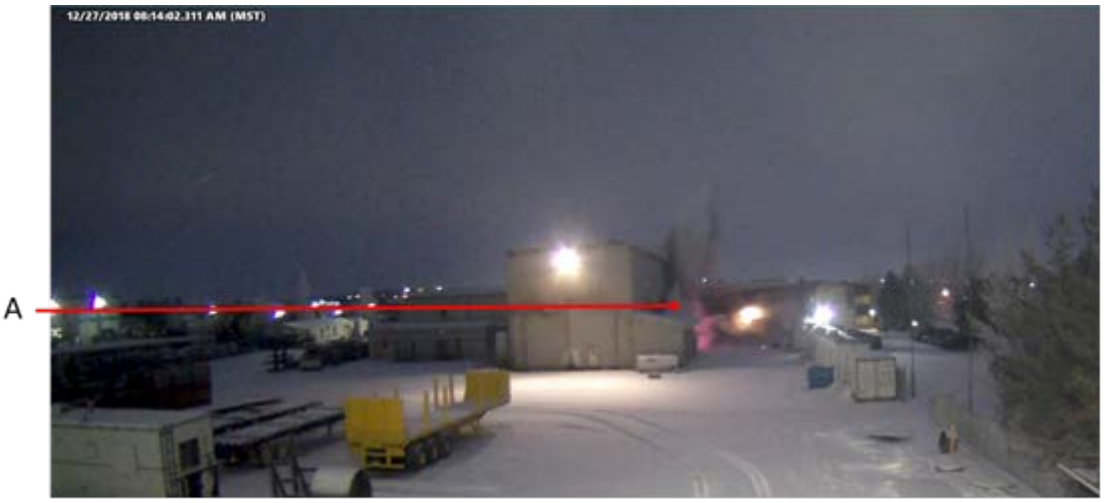


Figure 13. CCTV image provided by Ja-Co of Shop 1 long shot facing north.

A. Explosion outside the acetylene shack with flash and smoke plume.

An explosion ensued at 8:14:03 a.m. that appeared to originate outside the acetylene shack in front of the Bay 9 doors. At the time, Welder 1 was standing approximately 1.5 metres from the acetylene shack wall and Welder 2 was on the west side of Bay 9 directly across from the acetylene shack. When the blast occurred, Welder 1 and Welder 2 were struck by debris along with other welders in Bay 7.

Figure 14. Acetylene shack post explosion facing north long shot of the incident location from outside Bay 9.

A. Acetylene shack and double doors location leading into Bay 9.

Figure 15. Acetylene shack post explosion overhead view facing north.

A. Location of the acetylene shack and manifold.

Shortly after the explosion, co-workers came to Bay 9 and assisted bringing the injured welders out of the building and performed first aid while a fire was burning inside.

Figure 16. Acetylene shack post explosion from inside Bay 9 facing east. Mid shot view showing the area where the acetylene shack had been located and attached to Bay 9.

- *A. Orphan cylinders were from an unknown supplier along with nitrogen cylinders.*
- *B. Oxygen cylinders with blue tops (also referred to as Odorox and O2), some of the cylinders' original coating was burnt off during the explosion and fire.*
- *C. Mison 8 CL, also with a blue top and blue and green cylinder.*
- *D. Acetylene cylinders were brown.*
- *E. Concrete pad of the acetylene shack shows the original footprint of the structure.*
- *F. South manifold with attached acetylene cylinders.*
- *G. North manifold with attached acetylene cylinders where the fire continued after the explosion.*

At 8:19 a.m., 911 was called by a Ja-Co manager. At 8:23 a.m., the Royal Canadian Mounted Police (RCMP) arrived at Ja-Co and the first ambulance arrived at 8:28 a.m., along with the Leduc fire department. An acetylene tank continued burning in the explosion zone for several hours following the incident.

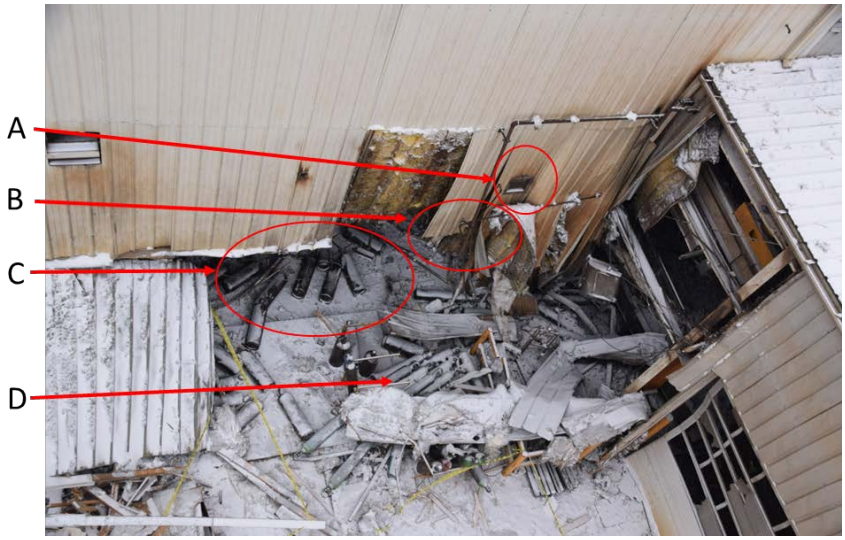


Figure 17. Acetylene shack post explosion overhead view facing west. Possible acetylene migration routes into Bay 9 in photo:

- *A. Fan unit that was functioning prior to the explosion. Possible atmospheric migration route into the welding bay or ignition source.*
- *B. Acetylene piping that led out of the acetylene shack and through a pipe hole into Bay 9. This was another possible atmospheric migration route into the welding Bay 9.*
- *C. Acetylene cylinders attached to the manifold system. The large opening was where the shack was located and on the right next to the shack was an entrance with double metal doors which were blown off during the explosion and found to the east of Bay 9. The professional engineer found this to be the area the explosion originated from.*
- *D. Full cylinder storage area on the acetylene shack pad.*

Welder 1 was fatally injured at the scene from blast injuries, and Welder 2 was seriously injured requiring hospital admission and multiple surgeries. Welder 2's injuries proved to be life altering. Additionally, eight other Ja-Co employees sustained physical and psychological injuries resulting in medical aid and lost time but were not admitted to hospital.

Completion

A review for enforcement action was completed on January 29, 2020, and it was determined that the file would be referred to Alberta Justice for review. The entire file was sent to Alberta Justice on March 3, 2020. Charges were laid on October 6, 2020.

On February 24, 2021, Ja-Co Welding & Consulting Ltd. pled guilty to the following counts:

On or about December 27, 2018, at or near Nisku, Alberta, being an employer, did fail to ensure, as far as it was reasonably practicable to do so, the health and safety of Welder 1, a welder engaged in the work of that employer, contrary to Section 3(1)(a)(i) of the *Occupational Health and Safety Act*.

On or about December 27, 2018, at or near Nisku, Alberta, being an employer, did fail to ensure, as far as it was reasonably practicable to do so, the health and safety of welders engaged in the work of that employer by failing to use a leak detection system in the acetylene shack, contrary to Section 3(1)(a)(i) of the *Occupational Health and Safety Act*.

At sentencing, Ja-Co Welding & Consulting Ltd. was ordered, under Section 75 of the *Occupational Health and Safety Act, to pay* $300,000 in favour of Safety in Schools to collaborate with the Manufacturers Health and Safety Association to fund the expansion of online occupational health and safety education focussed on manufacturing and fabrication (welding hot work). Additionally, a stand alone Order was issued for $25,000 to be paid to the deceased welder's mother in care of the deceased welder's children. Ja-Co Welding & Consulting Ltd. was also placed on 24 months of enhanced regulatory supervision.

This investigation was completed on March 31, 2021.

Signatures

ORIGINAL REPORT SIGNED	March 31, 2021
Lead Investigator	Date
ORIGINAL REPORT SIGNED	March 31, 2021
Manager	Date