# Incident Investigation Report

1. Location & Date of Incident: Penrith, Australia (O-I) – July 15, 2014

2. Personnel involved: Mark Randle, Jason Tomkins, Chris Barker, Kitirat Kaenthao, Rob Ward, David Cobane

3. Incident as reported:
   At 6am, the crew started the O-I pumps to supply water to the Hotwork drain pipe. At 7am, Hotwork and O-I agreed that everything was ready, and Hotwork proceeded to start the drain. With Chris, David, and Rob standing by with water lances, Jason pulled the safety shut off ball back to allow access to the drain hole. The hole had been drilled the day before, the core had been pushed out of the hole by hot glass, and the glass had been stopped initially by the shut off ball and later with a brick held against the hole with the shut off ball. When Jason pulled the ball back and the brick was removed, the glass was too cold to run on its own.

   Mark went down in the hole area with an oxygen/acetylene cutting torch to heat the cold glass in the hole to allow the drain to start. After a period of five minutes, he noticed that the outer glass had started to bulge out, so he ceased heating the glass with the hand torch. The glass then started to flow from the hole.

   The cold scab of glass from the hole that had been holding back the glass flow, flushed from the hole and stuck to the cover tile at the hole. When Jason tried to insert the shut off ball into the hole to control the flow of hot glass, the scab of cold glass restricted the insertion of the ball. This restriction resulted in the hot glass being able to flow very quickly in an uncontrolled manner around and over the top of the ball.

   Jason tried to jack the ball into the hole, but within one or two minutes, the excessive amount of hot glass flowing down the Hotwork trough and into the receiver was too much for the water in the receiver to carry, and the drain pipe became blocked. Once this happened, the water coming through the receiver from the pump started to 'erupt' with hot glass and steam.

   Hotwork and O-I had agreed upon a plan prior to the start of the job that a clear line of radio communication was required at all times between the person monitoring the water pit, the person at the boost pump, and a plant designated person at the tap site. It was communicated to O-I to turn off the pump to stop the eruptions as soon as they began, but due to some confusion, this took approximately 8-10 minutes, during which time it was nearly impossible to safely access the tap area due to the eruptions. David and Rob continued to spray water lances at the hole. Chris went under the port, found Neil Missen of O-I, and together they got a plant emergency fire hose and directed it at the hole. After an indeterminate amount of time, a fire brigade showed up with more fire hoses to help assist in freezing the glass.

After an estimated one and a half hours of concentrating the hoses and lances at the tap site, it was decided to stop the hose and lance water, allow the hole to heat up, and then attempt to further insert the ball into the hole. After several attempts by both Mark and Jason, the ball was sufficiently inserted into the hole to stem the flow of glass.

The water lances remained on and pointed at the drain area for a period of approximately one hour to allow the area to sufficiently cool, at which point the process of cleaning up the frozen glass in the trough and receiver began. The drain was re-set and the area prepared for a retry the following day.

This event -- from the time the drain was started until the crew stopped the flow of glass -- lasted a total of two and a half hours, and it is estimated by the client that 30 tons of glass was spilled into the basement.

The following day, the crew restarted the drain without incident. After draining glass for approximately six hours, the crew observed glass oozing above the cover tile. Steve Town of O-I was consulted and he instructed that the drain be shut down. The leaking glass was assessed to be a safety hazard.

4. Injuries: None

5. Property damaged: A new concrete floor located below the tank was damaged and had to be replaced.

6. Remedial Actions:
   1st Event: Crew took action to get the pump water shut off after the drain pipe become blocked and used water lances and fire hoses to freeze the glass before it completely drained itself into the basement.
   2nd Event: Crew shut the drain off immediately when the situation was assessed to be unsafe.

7. Immediate Action: To prevent a similar occurrence on the second day, Mark stood by the hole with a large pair of tongs so that if a scab of glass came out of the hole like before, he could grab it with the tongs so that the ball would not be obstructed in the same way as the first day. A scab of cold glass did in fact come out of the hole upon start up, and Mark carried out his plan.

8. Situational Assessment (1st Event):
   a. Root Cause: There was an obstruction in the trough (cold glass) that prevented the ball from performing its intended function of controlling the flow of glass.
   b. Contributing Factors:

i. Unsuccessful "freeze off" after drilling allowed glass to follow the drill out of the hole
ii. Low viscosity (flint) type glass
iii. Hole was drilled 10" from bottom on the sidewall insuring hot glass
iv. The hole was drilled at an elevation in the cover tile that left about ¾"freeboard below the hole
v. Confusion and communication issues in responding to the emergency

c. Corrective Actions:
   i. New Standard Operating Procedure for Drilling & Quenching: Drill at least halfway through the sidewall, remove drill, break off core → Finish drilling through into glass → Back drill up about 3" → Lock drill into place and let run for 15 minutes with full water on the drill → Run drill back towards glass; go as far as it takes to break the core from the frozen glass; this is done by feel and the sound of the drill motor → Back drill up 3" or 4", lock in place and freeze for another 20 minutes → Slowly back up drill, when close to the edge of the hole, if red glow is still showing, freeze for another 15 minutes → Remove drill, place at least 2 (more if possible) wet ceramic fiber balls into the hole → Place cover tile core into hole, then insert shutoff ball into position.
   ii. The practice of appropriate freeboard distance (distance from bottom of drill hole to the top of the trough splits) was re-emphasized with every Senior Drain Technician: 2" freeboard for a 3" hole, 3" freeboard for a 4" hole. This distance will allow adequate clearance for debris and/or cold glass to pass through without potentially getting caught between the safety shutoff ball and the cover tile. Technicians are required to send a picture of this setup showing adequate freeboard distance prior to starting the drain.
   iii. New Standard Operating Procedure for Emergency Response: Lead Technician must discuss emergency procedures with the client prior to starting the drain. Items to discuss include: Additional water lances at pressure → Secure basement in case of glass leak → Protect equipment → Containment walls should be in place → Protect furnace support → Ensure that drain water is from an uninterrupted source → Discuss what happens when/if plant or outside fire department arrives ie whom reports to whom and where should water be directed.

9. Situational Assessment (2nd Event):
   a. Root Cause: Glass leakage between the cover tile and the sidewall block.
   b. Contributing Factors:
      i. Large water volumes applied on the previous day may have caused contraction of the cover tile, creating a thin glass path between the cover tile and sidewall block.
      ii. Vibration on the previous day due to the jackhammer and cleanup process may have caused a separation between the cover tile and sidewall block.
      iii. Removal and replacement of the bricks within the trough during the second setup may have allowed for a loosening of the securing force between the trough lining and the cover tile.
   c. Corrective Actions:

i. New Standard Operating Procedure for when a cover tile and trough experience a major upset: Clear the receiver → Mine the glass from the trough → Assess damage → If damage done to splits, replace → If splits are replaced, inspect the cover tile and if any movement is noted, remove, clean and replace → If no movement is noted, wedge the cover tile in tightly using splits, steel work and caulk around any exposed edges → To replace cover tile, drill into the sidewall block about 3", freeze the glass, and while holding a water lance against the glass, cool the cover tile and remove.

10. Reported by:

Kari Evely (Hotwork Safety Coordinator) 9-24-14
Printed Name, Signature & Date

11. Reviewed By:

Larry Drake (Hotwork Operations Manager) 9-24-14
Printed Name, Signature & Date

Ryan Nelson (Hotwork Glass Industry Manager) 9-24-14
Printed Name, Signature & Date

12. Attachments: (Facility Report/Photographs/Medical report)

a. Crew Notes
   i. Report written by our Mark Randle at the O-I Penrith site
   ii. Report written by our Jason Tomkins on 7/25/14
b. Photos

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Date-July 17th 2014

Incident Report-Drain at OI Penrith Australia July 2014

On July 15th it was planned to drain the glass from furnace SP1, the drain equipment supplied by Hotwork has been set up during the three days prior (12th, 13th & 14th)

On the morning of the 15th the Hotwork crew of Mark Randle (Hotwork Team leader), Jason Tomkins, Robert Ward, Christopher Barker, David Cobane and Kitirat Kaenthao arrived at site at 6am to prepare for a 7am drain start, the following bullet points describe the events that proceeded:-

- 6am start OI pumps to supply water to the Hotwork drainpipe.
- At 7am after agreeing with OI that both Hotwork and OI where ready for the drain to commence Hotwork proceeded to start the drain.
- The safety shut off ball was pulled back to allow access to the 'drain hole' Mark Randle was down in the hole are with a oxy acetylene cutting torch to heat the 'cold glass' in the hole to allow the drain to start.
- After a period of 5 minutes noticed that the class had started to bulge out and stopped the heating with the torch
- The glass then started to flow from the hole
- The cold ball of glass from the hole stuck to the cover tile and when Jason Tomkins tried to insert the ball the 'gob' of cold glass restricted the insertion of the ball
- At this point the hot glass flowed over the top of the ball at a very quick rate.
- Jason Tomkins tried to jack the ball into the hole but the amount of 'hot' glass coming down the Hotwork trough and into the Hotwork receiving hopper was too much for the water to carry and subsequently the Hotwork drain pipe blocked, with the drain pipe blocked and the water still flowing the glass that was flowing into the receiver started to 'erupt' out similar to a volcano shoots lava into the air.
- A communication was made to stop the water to the Hotwork drain pipe in order to stop this glass flying into the air, the stopping of the water for miscommunication reasons took approximately 8~10 minutes, during this time it was nearly impossible to get to the drain area safely.
- Hotwork personnel directed water lances and fire hoses in an attempt to stem the flow of glass.
- After a sustained period of time (approx. 1.5hrs) it was decided to stop the fire hose and lance water, let the hole heat up and then attempt to insert the ball into the hole,

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after several attempts by both Mark Randle and Jason Tomkins the ball was successfully inserted into the hole sufficiently to stop the glass flow.

- The water lances remained switched on and pointed at the drain area for a period of approximately 1 hour to allow the are to sufficiently cool to allow the clean up to start.

Report written by Mark Randle at OI Penrith site

Diary Of Events That Took Place (by: Jason Tomkins)

- Set up of Hotwork equipment 12th-13th-14th July 2014
- 15th July planned drain start at 7am
- 14th July 2014 at 1pm the furnace sidewall was drilled through by the Hotwork technicians, the water cooled drill was left spinning and cooling the drilled hole for approx. 30 mins, upon removal of the water cooled drill the excessively hot glass spurted out the remaining core from the sidewall and proceeded to follow through the hole, the Hotwork safety water cooled shut off ball was inserted into the hole, and the glass flow was shut off and made safe.
- The glass temperatures were hotter than normal operating conditions at the tapping point
- The glass viscosity was higher than normal operating conditions at the tapping point, this was evident by the remaining core being "spat" out of the sidewall block, and that the internal glass could not be frozen enough after 30 mins of water cooling to remove the drill, clean the hole, insert a ceramic plug, and seal the hole as per Hotworks normal procedures.
- We allowed the ball to cool the front face of the glass down, and added cooling water to the top of the ball in an attempt to freeze it enough to chip back enough cold glass and insert a ceramic plug.
- The above was deemed to difficult, and un-safe as the glass temperature behind the ball was too hot to try and attempt to do this, as the furnace electrodes had been isolated for drilling, the plant was requesting to turn them back on for production, we collectively as a group discussed the situation, and did not feel 100% comfortable with the plant re-isolating the electrodes incase of any earth leakage through the molten glass, and the Hotwork safety shut off ball, so we decided that we would wait and place a refractory brick between the hole face and safety ball to eliminate any possible current leakage.
- This was done successfully and the trough was patched with high temperature mortar, and the hot board was cut to suit, and preparations were done ready for the drain to begin, the electrodes were re-energized and a plant electrician tested the safety ball and steel work surrounding the drain to make sure it was safe from any earth leakage, it was deemed that the supporting steel drill frame could be an obstruction path so it was cut and removed for safety purposes from the tapping point, this was completed and we left site at approx. 3pm that day.
- Steel support frame removed for safety reasons, we also had a steel base stand constructed, as the height of the ball was greater than the furnace platform level, this allows easy access to the safety ball to adjust it if required in an emergency.
- As you can see the drop height between the trough and receiver was only approx. 6" in height, we had discussed prior with the plant about dropping this draining hole location, and putting in a banana piece to lower the elevation, the plant did not want to do this and accepted that the height and elevation was acceptable.
- There are always elements of risk and danger associated with such a close drop height form the trough to the receiver.
- Tuesday morning the 15th of July 2014 all Hotwork crew members were on site at the plants request of 6am, the nightshift crew completed their plant inductions, and proceeded to the tapping site, the plant had removed the furnace batch chargers, and were draining the forehearths and working end before we could start the glass drain, there was one dedicated front end loader driver that was busy in the basement and until he was free we could not start, meanwhile we all got our safety gear on, had 2 lances prepared, and discussed between ourselves as a group who would be responsible for what part during the opening of the hole. The boilermakers were on standby with equipment to assist on either lancing the hole if required, or providing heating via a gas torch. ***Hotwork had discussed prior with the plant and boiler makers that a clear line of communication was required at all times between, the person at the API pit watching the levels and checking on the pump status, a person at the 2nd booster pump to monitor its operational activities, and a 3rd person at the hotwork tapping site to communicate with us directly if we needed any of the pumps to be shut down in an emergency, all of these people required radio communication between them.***

    1. Mark was to be the person to open up the hole

2. Jason was to be the person to control the ball
3. Chris and David were to be on standby by with lances ready
4. Tong and Rob were to assist as required

- The above action plan was thoroughly discussed a collective group prior to opening up the hole
- I pulled back the ball and it was clear that the front face of the glass was slightly cool and required warming to make it run, Mark used a oxy and acetylene torch to warm up the hole and glass, after about 5 mins the cold glass was starting to bulge from the hole, before Mark had time to bore out the hole with a 2x2 the glass started flowing like liquid, I inserted the ball as far as I could, tightened the middle jack screw and started to jack in the ball using the handle, the ball was not moving in like it should have been to stem the flow, I could see the hot glass flowing very quickly over the top of the ball, and also I could see that the ball was not in the hole 100%, the flow of glass was so hot and liquefied that it started to fill up the receiver at a rapid pace to a point that the internal first section of straight pipe became blocked immediately, once this happened which was within 1-2 minutes of the glass flowing from the hole, the glass started to back up from the receiver and shoot out in all directions, all of those in the vicinity of the tapping point had to step back for safety reasons, as per the below picture we were in the direct firing line of the molten spray.
- At this point the drain had got out of our immediate control, and was spewing out molten glass over the trough, receiver, and below grating into the basement, we immediately instructed the pumps to be shut down but it took a while for this message to relay back to the appropriate personnel down stairs in the basement, and for both pumps to be shut down took a further 5 mins or so, meanwhile we as a crew inserted our 2 lances into the trough to try and stem the flow, and the plant was busy trying to locate additional water hoses and equipment to assist in trying to control the situation, the plant safety glass run cabinet that has additional safety spray hoses and lances were not connected together with water and air, so there was no additional assistance in controlling the situation at hand.
- The pumps were then shut down and we could get closer to the tapping point to try and control the situation, the plant had assembled some additional small fire hoses that we grabbed and used to try and stem the flow from the trough and receiver, but at this point the glass was flowing rapidly into the basement downstairs, we all were on the front line with all available water and fire hoses fighting through a dangerous situation filled with hot glass and steam, the area was very congested from the start but we all did what we could given the circumstances, at this point the fire brigade appeared but left us to try and fight this on our own, there was a large gathering of people behind us mainly plant personnel observing the situation, a few voices were raised as we fought the situation because of many different people wanting to try and assist in controlling the area, it was quickly discussed between Hotwork and O-I that we needed to stem the flow at the source of the hole if we had any chance of now stopping this flowing molten glass, we decided that we would try and stop fighting the situation with water to control the steam and let us observe the trough situation to get to the shut off ball and do some kind of assessment, we did this a couple of times but every time we shut down the water the glass started spurting out at us from the trough, we kept trying to cool down the glass flow so we could get back control and close the ball, and eventually myself and Mark just like the rest of the crew but our bodies on the line to get to the jack through the steam and heat to try and wind it in through and crust of bubbling hot and cold glass, we managed to do this after several attempts and slow the glass down with the ball and gain back control of the situation.
- Total time lapsed was approx. 2-3 hrs. during the above
- After all has settled we discussed with the plant to abort the drain for that day, clean up the area, check the cover tile for damage, and asses what was required, we changed out the damaged and blocked pipes, receiver, and cleaned up the glass around the area, and the trough to asses the damage to the tile.
- Both Hotwork and O-I assessed the trough and cover tile for damage, we all agreed that the tile looked ok enough to re-use, but we would replace all of the trough bricks as we had to use a jack hammer to clean it.
- The area was cleaned, new bricks installed in the trough, and the tapping point deemed fit and safe for tapping again the following day, we had a meeting with the plant to discuss the safety aspects of re-

tapping, and availability of water hoses, plant back up, and an action plan if this was to occur again, and all parties were agreed with the plans we had in place.

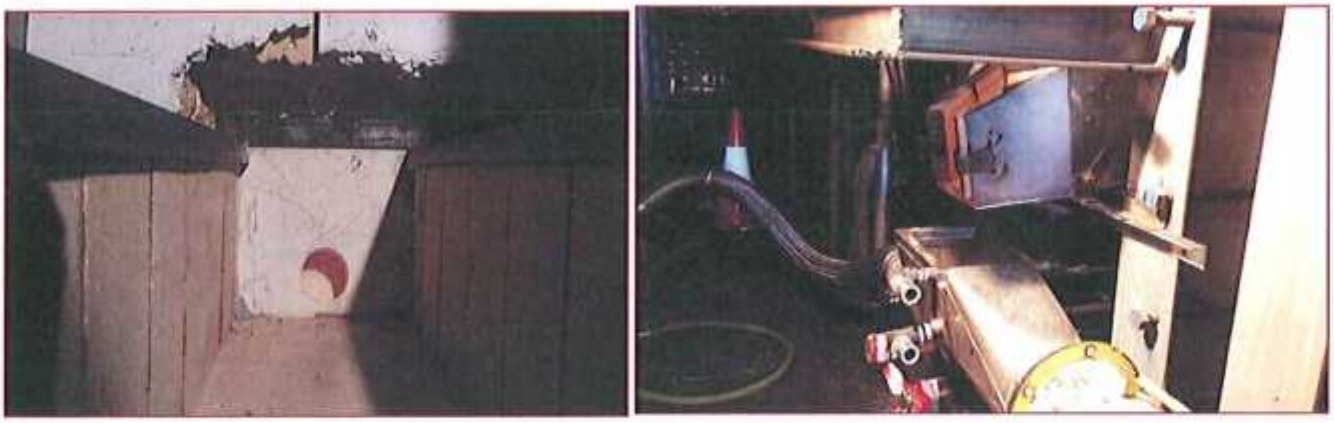
- Wednesday the 16th at 6:30am all crew was on site ready for tapping, the action plan was as is below, and a repeat of what we had structured for the first drain attempt.

    1. Mark was to be the person to open up the hole
    2. Jason was to be the person to control the ball
    3. Chris and David were to be on standby by with lances ready
    4. Tong and Rob were to assist as required

- Before we opened up the hole we had a safety meeting with the plant in the furnace control room to discuss and confirm that the plans we had all agreed upon were fit for measure, and " what are we going to do differently today " this was raised by Steve Town and all parties discussed the measures in place.
- At approx. 7:30am I pulled back the ball from the hole, and Mark was handed the torch to start to warm the glass up, after about 5 mins the colder glass started to bulge slightly from the hole, David came in and cooled the face down of the bulge, and Mark chipped away the front face so it was flat and flush with the hole, he then warmed up the front face again with the torch, as the cold glass started to bulge again he grabbed it with the tongs and made sure that it was pulled away safely from the hole as the hot glass came through the hole, I moved the ball into the hole and locked it into position to control the flow of glass into the trough, all went as smooth as it would of done normally, and we had controlled glass flowing into the trough and receiver at approx. 5-8 tons per hour, the glass was very hot and running almost like liquid still, even though the electrodes had been off all night from the plant, the glass optical temps from the flow coming out were recorded at 1340 deg c at the start of the drain, as we were night shift we hung around until 8:30 or so and then left the plant, so I can comment on what happened after that point.

# Set up Pictures

Sidewall insulation removal – cover tile installation into the trough – lining of the trough and installation



Drilled cover tile and alignment with the water-cooled receiver at the designated tapping point and location

Drilling of the furnace sidewall – set up of the safety ball – hole drilled and a safety brick in front of the hole

Supporting steel drill frame removed giving an obstruction free pathway to the tapping point and location

Drop height

Water cooled shut off ball in place.

## Post Incident

Glass leaked into basement

Assessment made to shut off glass on second day

Sidewall with cover tile removed