Training Package
TP 32/23

Recent (Year 2022) Safety Incidents in the Gases Industry in Asia

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Recent (2022) Safety Incidents in the Gases Industry in Asia

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Agenda

- Incident cases
  - Product Transportation including Loading/Unloading
  - Handling of Cylinders
  - Process Safety
  - Occupational Safety/Maintenance Work/Construction related
- Learning from the incidents
- AIGA references related to the incidents

Incidents in Product Transportation Including Loading & Unloading

Event # 1

High Severity Product Vehicle Accident

Consequences: *Rollover with damage to ISO Tanker*

What Happened:

This incident happened at 10 30 am on a day when a bulk ISO tanker with LAR was taking a sharp U-turn at an intersection and rolled over. The road was dry when the rollover happened. There were no injuries sustained from this event. The ISO Tank was damaged but there was no leakage of products. The vehicle speed was **15 km/hr** when the driver made the U-turn. The vehicle was fitted with ESC and ABS.

Driver did not follow designated route. This was not the first time. Driver made the U-turn at a junction where there is no U-turn traffic sign.

Lessons Learned:

- Stop before making a U turn
- Reduce driving speed accordingly when making a U-turn with ISO tankers (normally having a high Centre of Gravity).
- Fleet management to do periodic checks to identify illegal or unsafe driving.

Event # 1 Pictures

Event # 2

LOX Tanker Rear-ending by a 3rd Party Truck

Consequences: *Equipment **d**amage*

What happened:

LOX tanker driver stopped on road shoulder because he started to feel sleepy. After washing his face, he immediately returned to the cabin. While he was sitting in the cabin and was about to move forward, the LOX tanker suddenly got hit by another truck from the back. There were no injuries sustained from this event.
The ISO Tank valve box received significant damage but there was no leakage of products.

Lessons learned:

- To always set up breakdown triangle / cone at a sufficient distance behind stationary vehicle to warn other road users.
- To establish the criteria and educate drivers on how to determine whether a location is safe for stopping.

Event # 2 Pictures

LOX Tanker after the incident

3rd Party Truck after the incident

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Event # 3

Product Vehicle Accident – Driver Distraction

Consequences: *Equipment damage*

What Happened:

At about 09:30hrs on a day, a bulk tanker finished product unloading at the customer's site. The driver departed from the unloading location and approached the customer site intersection access road. While passing the intersection, the driver checked his mobile device for the next loading schedule. He was also aware that there was a small truck in front, making a left turn. At this point, the bulk tanker was still moving forward and the right-hand side of the bumper bar collided with the small truck on the right.

Lessons Learned:

- Avoid distraction while driving – use of mobile is strictly prohibited
- Apply safe driving skills

Event #3

Pictures

Event # 4

High Severity Product Vehicle Accident

Consequences: *Single Vehicle Roll Over/ minor product release*

What happened:

A contract driver operating a fully loaded LOX vehicle was involved in a single vehicle rollover on a winter day at around 8:45 am. The driver changed from the slow-driving lane to the fast-driving lane (two driving lanes in each direction) to overtake a passenger car which was in front of the contractor vehicle. While overtaking, the driver lost control of the vehicle. As a result, the vehicle jack-knifed, and the trailer disconnected then from the tractor and rolled over. The vehicle was fitted with Roll Stability System(RSS).

The driver received a hairline fracture on his spine. There was minor product release and significant damages on the tractor and trailer.

Lessons learned:

- Conduct refresher driver defensive driving and roll over training to all drivers.
- Measure the driver training effectiveness with road test.
- Conduct routine job safety observation and in cab footage review to rectify any unsafe behaviors.

Event # 4

Pictures

Event # 5

Wheel Detachment From Trailer

Consequences: *High Severity Potential Event*

What Happened:

A driver completed pre-trip inspection process with no defect raised, and then started his journey. Approximately an hour later in the evening, the driver noticed on the right-side mirror that the wheel at front right trailer axle detached and rolled out from trailer. The driver immediately pulled over on the road shoulder, he found out the wheels at position no.13th and 14th disappeared, so he notified to supervisor. There was no third party involved.

Lessons Learned:

- Review and ensure suitable model of air impact wrench is available
- Conduct random observation of maintenance workshop
- Establish verification process on post maintenance inspections

Event # 5 Pictures

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Event # 6

Product Vehicle Accident Involving 3rd Party Bicycle

Consequences: *3rd party injury*

What happened:

At around 12:59 pm, a road tanker crossed a single solid line to overtake a bicycle while delivering LIN. In the process of overtaking and also in order to avoid the oncoming vehicle, the driver adjusted the tanker back to the original lane when the rear of the trailer hit the bicycle rider, causing the rider to fall down and get injured.

Lessons learned:

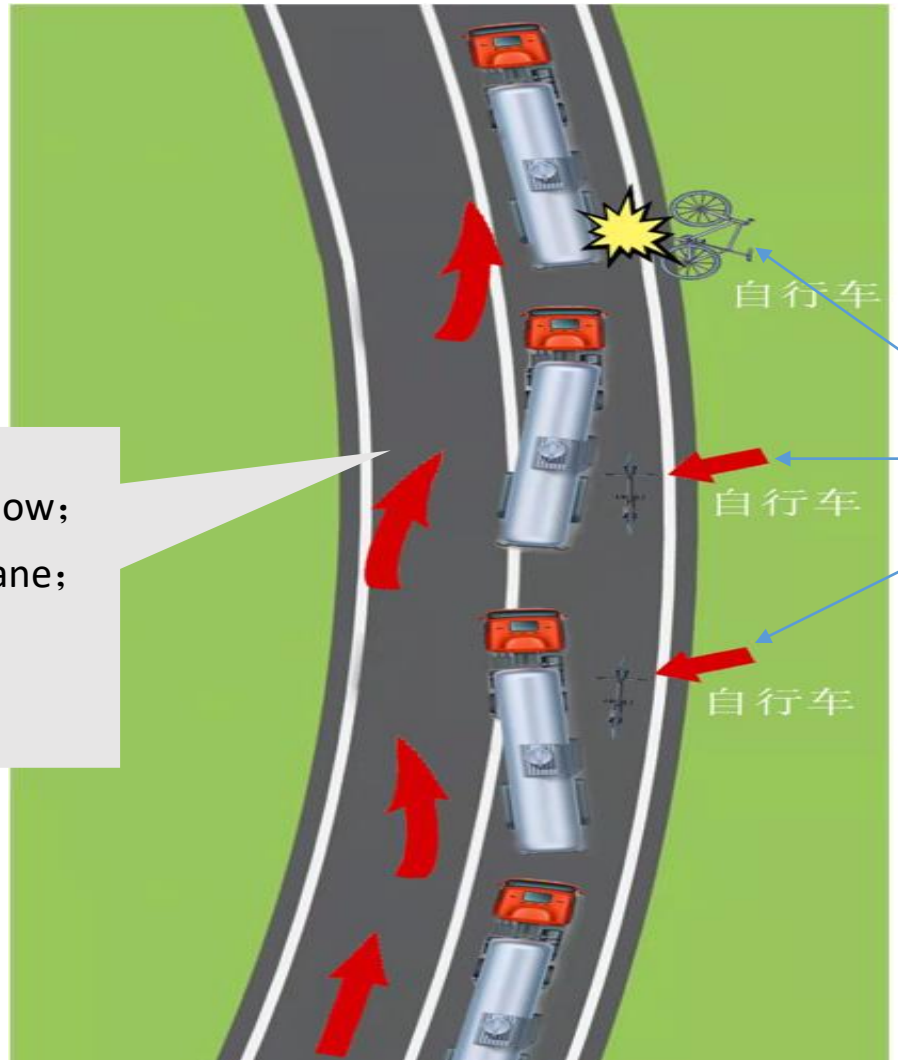
Be aware of the specific risks associated with two wheelers and other non-motor vehicle riders:

- Never take the to non-motor vehicle movement for granted；
- Remember they can easily lose control and hit the truck
- Do not trust your mirrors because a non-motor vehicle can be hidden in your blind spot；
- Never cut in too closely after overtaking a non-motor vehicle；
- Be courteous – signal your intentions well in advance – Make sure they see you；
- Avoid a non-motor vehicle on side by side of your vehicles because it can overtake and be in front of you any time；

Event # 6

Pictures

- Urban roads, large traffic flow；
- No dedicated non-motor lane；
- Speed 32km/h， the limit 40km/h



Event # 7

High Severity Product Vehicle Accident

Consequences: *Tractor Jack Knife*

What happened:

A road tanker was returning via expressway to base after delivering LOX. It was raining heavily when the incident happened at around 6 55 pm. A car droving in the same direction was on the overtaking lane. Though the vehicle was fitted with roll stability system but due to excessive speed and improper driving on the wet road, the car drifted out of control to the right lane and collided with the road tanker on the slow lane on the left side. This led to jack knife of the road tanker and also some damage to the car body.

Lessons learned:

- From the video footage, effect of aquaplaning was clearly noticed when the tires loose contact to the road. This leads to lose the control of the vehicle.
- Drivers to be careful and drive much slowly in heavy rainy day

Event # 7 Pictures

Event # 8

High Severity Product Vehicle Accident

Consequences: *Road tanker Jack knife and equipment damage*

What happened:

On a lightly raining day (slippery road surface) at around 7 pm a road tanker was turning to the parking lot of service area by the ramp of the expressway. But the driver was chose a wrong way to enter the car parking area. When the driver noticed the limited height sign ahead, he applied a sharp brake. A jack knife of road tanker followed. It caused damage to the right side of the tractor, rupture of the fuel tank and urea pot. The truck was fitted with Roll Stability Systems (RSS).

Lessons learned:

- All drivers need to slow down in advance according to Defensive Driving Training requirements when turning to the ramp.
- Reduce speed when driving under bad weather or road conditions.
- To have a program to identify high-risk behavior of drivers and ensure correction

Event # 8

Pictures

Event # 9

Road Tanker Wheel Presses Against the Foot of a Pedestrian

Consequences: *3rd Party Lost Time Injury*

What happened:

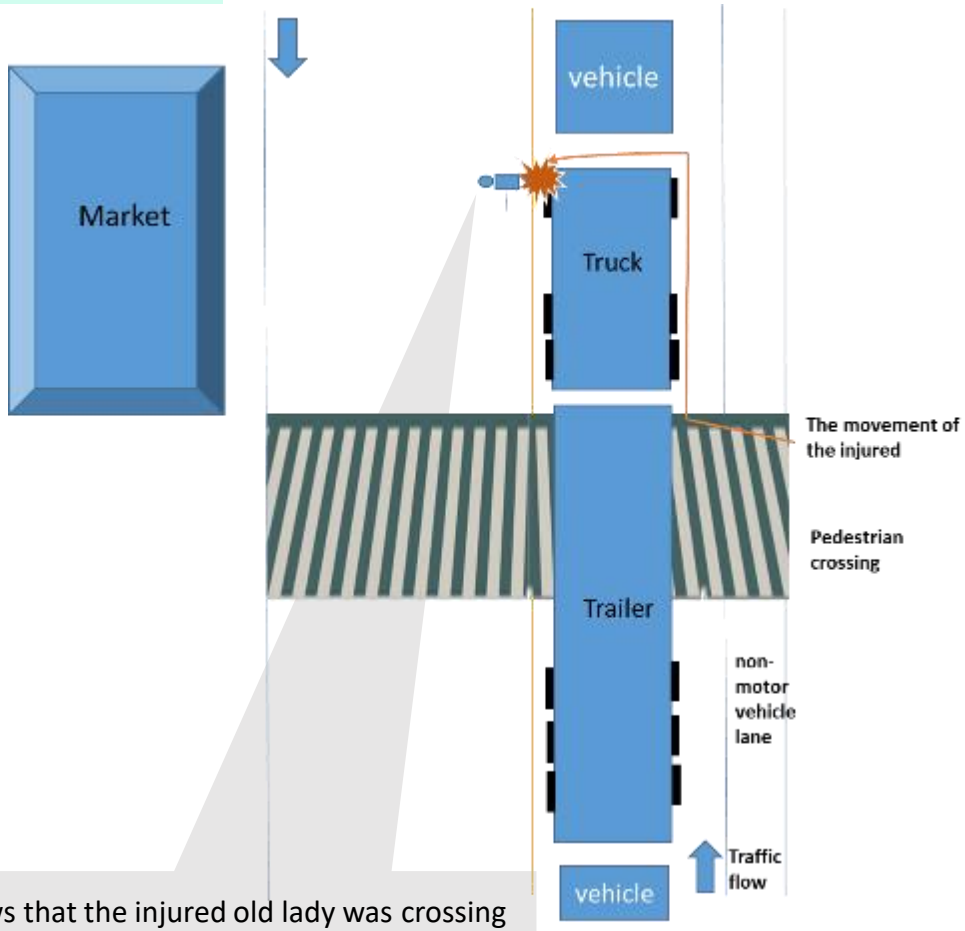
At around 11:00 am, a road tanker was passing a zebra crossing, when it stopped and waited because of the traffic jam in front. The tanker started again but stopped because the car in front also stopped for allowing a pedestrian in front crossing the road. At this time, the front of the tanker was occupying the zebra crossing. As the tanker started to move, the front left wheel pressed against the feet of an old lady crossing the road.

Lessons learned:

- Make sure the risk assessed was performed for distribution route.
- Specific and clear measures have been formulated for the risk points in the unavoidable high-risk road sections.
- Be sure, there is an annual training program for defensive driving for active drivers, which should be systematic and complete；
- Be sure for the new drivers, whether complete driver training and a certain length of internship assessment are carried out；

Event # 9

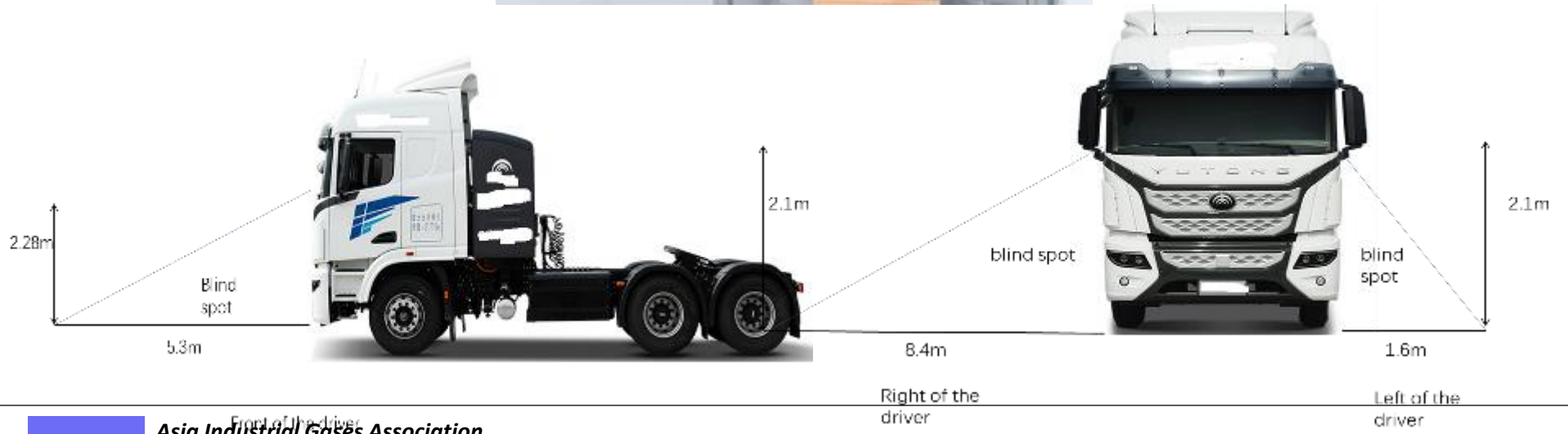
Pictures



Traffic monitoring shows that the injured old lady was crossing the road from the right side of the road tanker, then she was walking along with the trailer and the truck as the red line shows. At last, she reached left front wheel of the truck (below the reflector) when the incident happened.

Event # 9

Pictures



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Event # 10

High Severity Product Vehicle Accident

Consequences: *Vehicle damage*

What happened:

At around 1345hr on a day, a driver was assigned to deliver the Liquid Nitrogen to a customer. On way to the customer site, a pick-up truck that was in front of the LN2 tanker performed an emergency braking. The tanker driver did not get enough time to stop in time. As a result, the LIN tanker crashed into the back of the pick-up truck and was damaged. No injury was sustained arising from the accident.

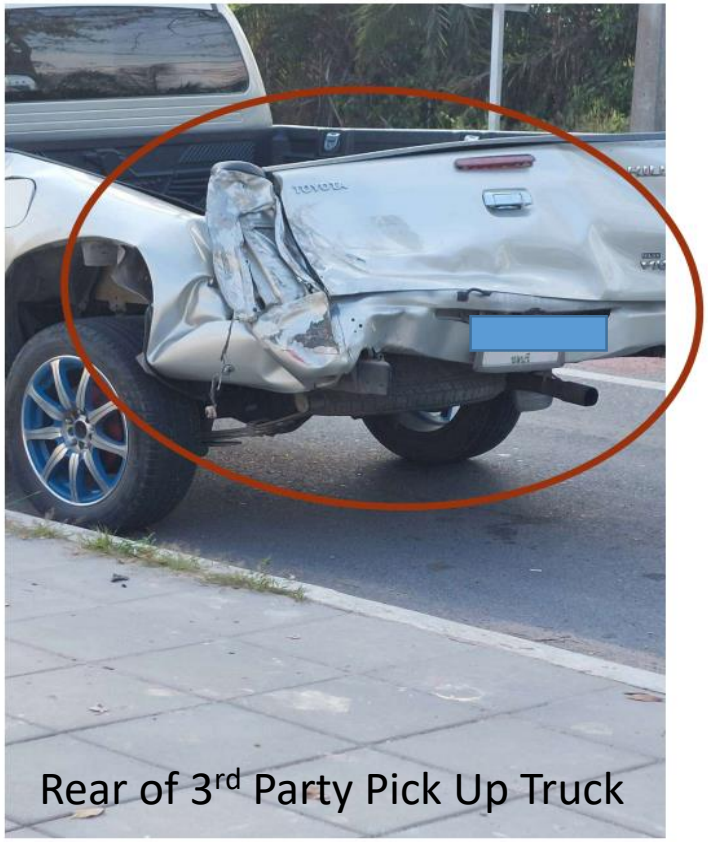
Lessons learned:

- Supervisor to review the principles of safe distancing with training.
- Reviewed and emphasized the principle of keeping a safe distancing from the front vehicle by using the 4 seconds rule.

Event # 10 **Pictures**

The damage of this incident

Front of LN2 Tanker



Rear of 3rd Party Pick Up Truck

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Event # 11

Product Vehicle Accident

Consequences: *Damage to Tractor and 3rd Party Vehicle*

What happened:

At 16:00hr, a Tractor was returning back to the production facility after product delivery. A red car in front of the tractor slowed down and signaled to turn left. The tractor driver in his effort to avoid collision with the car, tried to maneuver to the right. However a tanker carrying flammable goods was passing then and caused collision with the tractor. Left rear outer tire of the flammable tanker was hit by the tractor head causing the tire to burst while the front right bumper and fender of tractor head were damaged. No person reported injured in the accident.

Lessons learned:

- Driver did not use defensive driving technique
- Reinforce defensive driving training for the driver.

Event #11 Pictures

Tractor Front Fender and Bumper

Tractor tyre skid mark

Damage to 3rd party Flammable Liquid Tanker and Tyre

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Event # 12

Product Vehicle Accident

Consequences: *Rollover of an ISO Tanker*

What happened:

An ISO tank carrying LCO2 crashed against a road side prayer house building on left side of straight road after travelling 700Km of distance. The incident happened at around 7 40 am. This crash caused damage to the driver cabin and rollover of the ISO Tank. There was no injuries to anyone.

The speed of ISO truck was around 40 km/h just before the accident.

Lessons learned:

- Skill up the driver discipline and awareness by giving training on defensive driving continuously.
- Consider to install advanced safety features to reduce accident risk.
- To focus on fatigue management

Event # 12 Pictures

Process Safety Incidents

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Event # 01

Malfunction of PSVs

Consequences: *Potential Serious Safety Event*

What Happened:

The Operations and Maintenance Team was performing calibration for two PSVs during a shutdown. The set pressure of the PSVs was 25 barg. However, both PSVs did not pop when pressure was increased until 25.5 barg. After further investigations, rust was found inside the both PSVs what did not allow the PSVs to pop.

Lessons Learned:

- Maintenance not executed in accordance to the maintenance plan. PSVs not calibrated for 8 years (to be done once 5 years as per the maintenance plan)
- Improper design of outlet venting vaporizer. Moisture getting trapped in the line as outlet venting line design will not stop moisture entering from piping outlet.

Event # 01 Pictures

Event # 02

Liquid Oxygen Leak from Tanker Outlet Valve

Consequences: *Potential Fire and Explosion*

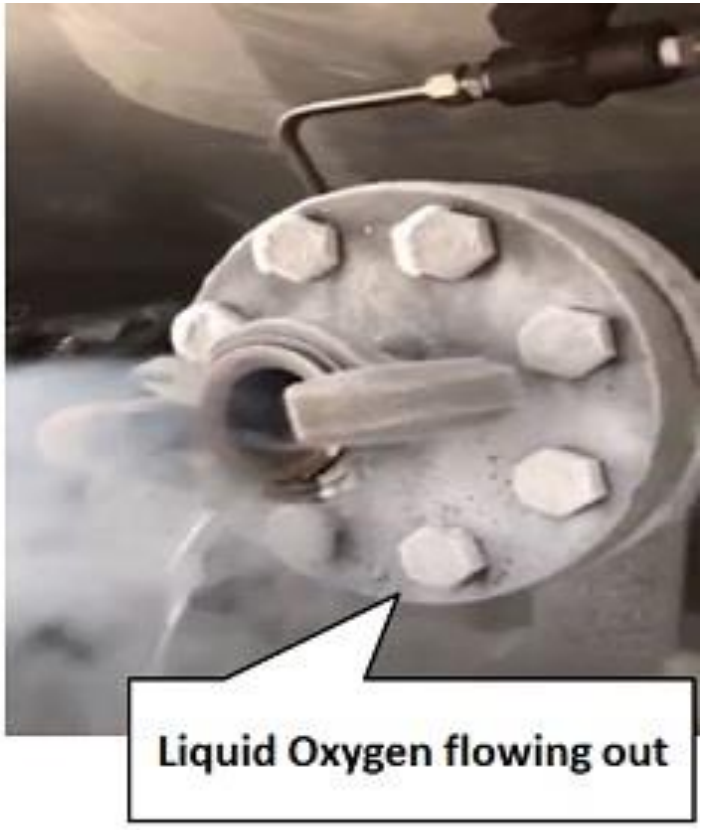
What Happened:

After topping up a Cryogenic storage tank at customer site, a liquid leakage and icing was seen at the outlet. The driver used water to defrost and depressurize the tanker and managed to tighten the outlet valve to stop the liquid from leaking. Minor gas leakage was still coming out from the outlet. After the next tank top up, liquid oxygen was flowing out of the outlet. Driver depressurized and decant to shut the outlet valve. Minor gas leakage was still observed. The tanker was subsequently sent back to site for investigation.

Lessons Learned:

- Ensure drivers are trained to handle leakage of all products which they are handling.
- Improve management of N+1 tanker qualification.

Event # 02 Pictures



Event # 03

Bursting of Flammable Gas Scrubber

Consequences: *Potential Exposure to Toxic Materials for Plant Personnel*

What Happened:

An operator was performing line purging as part of preparation activities for filling reactive mixture gases, where filling line pressure was held at around 150 bar.

The operator started to open valve slowly. When the pressure reached 10 bar, he heard loud sounds coming from the scrubber cabinet, and the pressure in the filling line dropped to 0 bar.

After checking, the Operator found that the flammable gas scrubber had burst. There was chemical release into the environment around the scrubber.

Lessons Learned:

- Written processes need to be established for all work activities, with subsequent training and qualification provided to relevant personnel.
- Staff needs to be trained and aware of the hazards involved in their work.

Event # 03 Pictures

Before

After

Event # 04

HP Argon Pump Safety Valve Release

Consequences: *Product Release(LOPC)*

What Happened:

The safety valve of a High Pressure Argon pump had to open several times as the pressure switch did not auto stop the pump at set point. To stop the pump, the filling station operator had to press the emergency pump stop button at the filling station area.

The filling station staff then informed the Maintenance Team about the situation. After investigations, the Pressure Switch was eventually replaced as it was found that the high pressure value set lever was broken.

Lessons Learned:

- Maintenance Strategy of equipment essential for safe and reliable operations needs to be established.
- To establish periodic visual inspections as a minimum for equipment with no periodic maintenance planned.

Event # 04 Pictures

New Pressure Switch

Old Pressure Switch

Event # 05

Truck Pulled Away with Fill Hose Connected

Consequences: *Near Miss Process Safety Event/Equipment Damage*

What Happened:

At around 13:44hr a contractor driver had completed the product loading of a 3rd party ISO tank at the ASU. At this point, the filling hose was still connected to the ISO tank. It was believed that the driver had forgotten to disconnect it despite he have relieved the hose pressure and walked to the weighbridge office. After he got the paper-work, he walked back to the loading bay. The driver removed the red flag, wheel choke, climbed up the tractor and drove-off, which resulted in the tanker pulling the hose away. The filling hose was tensioned and still connected at both ends. The driver noticed the situation and immediately stopped the tanker. Unfortunately, the ISO CGA connection point was bent 90deg and the extended 1 ½" hose was damaged. There was no injury or product loss.

Lessons Learned:

- Be Aware of Your Surroundings - Check and ensure the truck is free from any connection
- Enforce ignition key control for all 3rd party trucks
- Install the break away coupling on the fill line

Event # 05 Pictures

Bent filling port

Hose being pulled

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Event # 06

Nitrogen Pipeline Punctured by Utility Provider

Consequences: *LOPC/Temporary disruption in gas supply to Customer*

What Happened:

At 2.10 am, a 3rd party utility contractor was conducting Horizontal Directional Drilling along a public area. As the main ream was inserted and pulled, they noticed machine's heavy movement and realized that underground nitrogen pipeline had been punctured.

The nitrogen gas supply was isolated and approximately 2 meters length of nitrogen pipeline was damaged.

Lessons Learned:

- Establish clear protocol on communication to utility contractors before any excavation works to occur near any gas pipeline.

Event # 06

Pictures

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Event # 07

N2 Gas Release From Valve Pit

Consequences: *LOPC/Temporary disruption in gas supply to Customer*

What happened:

At 10.30am nitrogen gas leaked at valve pit located outside the customer's site. Team immediately reached site and barricaded the area to prevent personnel to access this area. The leak was noticed from a 4" spare valve inside the pit. The failed valve was removed and replaced with the blind flange, supply to customer was resumed at by the evening on the same day.

Lessons learned:

- Review existing checklist to make it simple and easy to use at field.
- Train personnel on use of valve pits inspection and maintenance checklist.
- Modify/replace pit covers to prevent rain water ingress and improve water proofing
- Inspect all other valve pits to ensure correct bolt specs for carbon steel valve, corrosion and water leaks and take corrective actions
- Reinstate the cathodic protection at valve pit
- Review lessons learnt with Engineering team for revising existing practices for underground pipeline installation for future

Event #07 Pictures

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Event # 08

Perlite Leak from Cold Box Casing Wall

Consequences: *LOPC/Near Miss event*

What happened:

Around 1030am, a technician was performing weekly inspection of cold box when he found some perlite was released from corroded surface of a cold box top wall at 66 meters elevation. Approximately 2kg of perlite was released.

Lessons learned:

- Implementation of routine surface thickness measurement and high-quality painting program for process equipment and piping to prevent localized corrosion based on environmental conditions

Event # 08 Pictures

Corroded Casing

Cold box interior

Event # 09

Incident During Preparation of Calibration Gas Cylinder

Consequences: *Flash Fire with Lost Time Injury to Operator*

What happened:

At about 15:03 pm, an employee was preparing calibration gas cylinder (8L aluminum cylinder) for heating and evacuation at outside (pretreatment steps before filling the steel cylinder). During the process, the operator connected the empty cylinder in the pallet with manifold for pretreatment. When opening the valves one by one for inspection, a flash explosion occurred what caused burns to the operator's legs and required hospitalization.

Lessons learned:

- Reasonable classification and placement requirements for returning cylinders；
- For the replacement treatment of gas cylinders (i.e. heating, evacuation and replacement), the remaining gas of gas cylinders must be confirmed to have been discharged before connecting to the treatment system；
- Gas cylinders marked as combustible shall not be treated with cylinders of other gas types

Event # 09

Pictures

After verification, the cylinder containing CH4 Bal gas is the diluted gas cylinder for the plant's own use. The cylinder body has no label and is mixed in the storage area where the returned cylinders to be processed. (The cylinder was not in the CTMS system)

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Event # 10

Nitrogen Regulator Rupture

***Consequences**: LOPC with Lost Time Injury to Technician*

What happened:

Around 13:00hrs, an E&I technician was setting up the regulator assembly at the Compander area with a nitrogen cylinder. After the preparation works were completed, he proceeded to test the setup by opening the cylinder valve. When doing so, the regulator ruptured causing a piece of foreign material to be embedded into his left forearm with a puncture wound. Immediately, he made his way back to control room and reported the incident to supervisor. Local team applied first aid and sent him to hospital for treatment using personal vehicle.

Lessons learned:

- MOC to be raised for new work process
- WRA must be detailed to cover the entire scope of the process
- SWP Issuer and Receiver must communicate the detailed steps of the work activity

Event # 10 Pictures



Incorrectly rated pressure regulator

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Event # 11

Accidental Opening of SCBA Cylinder Valve

***Consequences**: Lost Time Injury*

What happened:

A plant engineer moved the analyzer box in the storage cabinet. In the meantime, the SCBA cylinder box got pulled out too. The full cylinder slid out onto the ground and the valve was opened accidentally causing cylinder pressure to release. Cylinder flew and hit the engineer's left inner thigh. He immediately reported to Plant/EH&S/Maintenance Managers and was sent to the hospital for treatment.

Lessons learned:

- Store SCBA cylinders vertically and in secured condition
- Install valve cap/plug on the valve outlets

Event # 11

Pictures

Accidents/Incidents in Handling of Cylinders and Portable Liquid Containers

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Event #01

Incident in Loading of a PLC

Consequences: *Driver Recordable Injury*

What Happened:

A driver was trying to load a dewar over the side of lift gate on the ground; not straight back as there was not enough space around truck's lift gate. The vehicle was parked too close to dewar loading area. The dewar, which was moving over the side of lift gate, tilted to the left side where another dewar stood. As the dewar tilted, the driver's left hand was holding the moving dewar's handle when his left little finger was pinched between the moving dewar and the standing dewar's handles.

Driver received first aid and continued his normal duty. When he visited the hospital two days later, he received disinfection to the wound, dressing and prescribed medication of antibiotics.

Lessons Learned:

- Follow dewar loading/unloading procedures
- Park vehicle at the designated location
- Ensure sufficient space for dewar handling

Event # 01 Pictures

Event # 02

Incident While Moving a Cylinder Cart

Consequences: *Driver Recordable Injury*

What happened:

At about 13:30hrs, a driver was assisting the escort to collect empty cylinders from the customer site. They used a cylinder cart to move two empty cylinders down a slope. The driver held onto the railing with his left hand to control the speed of descend. However, it gradually accelerated on its way down. There was a steel sheet (5mm thick) at the end of the slope. When they reached the bottom of the slope and passing over the steel sheet on the ground, the right front hard nylon wheels hit the raised steel plate first, and the left side cylinder jumped up and slide out of the cylinder cart base. The cylinder valve guard hit the driver's right hand that was holding onto the cylinder cart handle. Driver went to the hospital for examination and was diagnosed with a fracture at the end of the right middle finger and ring finger. He returned from the hospital after the treatment and continued to do light duty.

Lessons learned:

- Control the speed of descend.
- Cylinder cart had one securing chain. Recommend to install additional securing chain at the middle section.
- Hard nylon wheels vibrate the cylinder cart when moving on uneven surfaces. Recommend to replace with pneumatic wheels.

Event # 02

Pictures

Event # 03

Worker Safety Incident in Cylinder Handling

***Consequences**: Recordable Injury*

What happened:

A truck assistant was standing on the truck tray bed to load loose cylinders. He used his left hand to operate the remote control to lift the tail lift, with is right hand resting on the loose cylinders. While lifting, the tail lift stalled. The truck assistant continue to press the remote to raise the tail lift. By doing so, the lifting hydraulic force caused too much pressure on the cable and caused the weld joint to fail, resulting in the tail lift dropping down.

During the drop, the cylinders on the tail lift shook and the assistant's finger was wedged between two cylinders. The assistant was wearing full PPE, including gloves.

The truck assistant was taken to the hospital, where the doctor applied 10 stitches to his crushed finger and prescribed him with some medication. He reported back to work on the next working day.

Lessons learned:

- Implement securing mechanism on the tail lift for cylinders.
- Job Hazard Analysis has to consider all tasks related to the job.

Event # 03

Pictures

Event # 04

Incident While Moving a Full Ammonia(NH3) Cylinder

Consequences: *Recordable Injury*

What happened:

At 10:20AM, while a driver was moving a full 102-liter Ammonia cylinder(total weight 100Kg) to the customer warehouse. He lost control of the cylinder and tried to catch the falling cylinder. His left hand's middle finger was caught between the steel door and the falling cylinder. He was taken to a nearby hospital and received surgery on the fractured finger. There was no product release.

Lessons learned:

- Update manual handling training program and conduct refresh training
- Develop a plan to conduct customer site's safety assessment regarding safe access, loading/unloading, and moving to/from the storage area.
- Educate customers to make safe loading /unloading area and pathway.
- Do not try to catch a falling cylinder

Event # 04 Pictures

The road width is 1.2M and 6M long, a slope of about 10 degrees downward.

The middle finger was pinched between the cylinder and steel door.

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Event # 05

Lifting Incident- Hook Failure

Consequences: *Near Miss Fall Incident*

What happened:

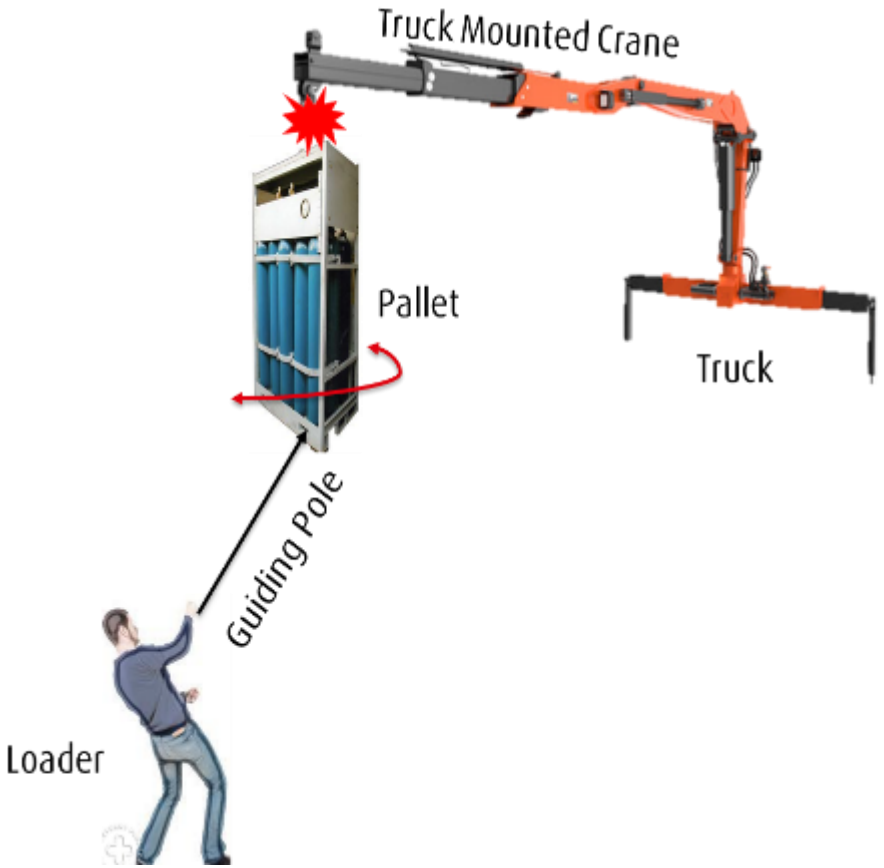
During unloading of a Manifolded Cylinder Pallet (MCP) using a crane, mounted on vehicle, the MCP fell from height (approx. 5') due to failure of hook attached to the parcel with crane. Hook holding MCP gave way from swiveled joint.
There was no injury nor damage to any vehicle part.

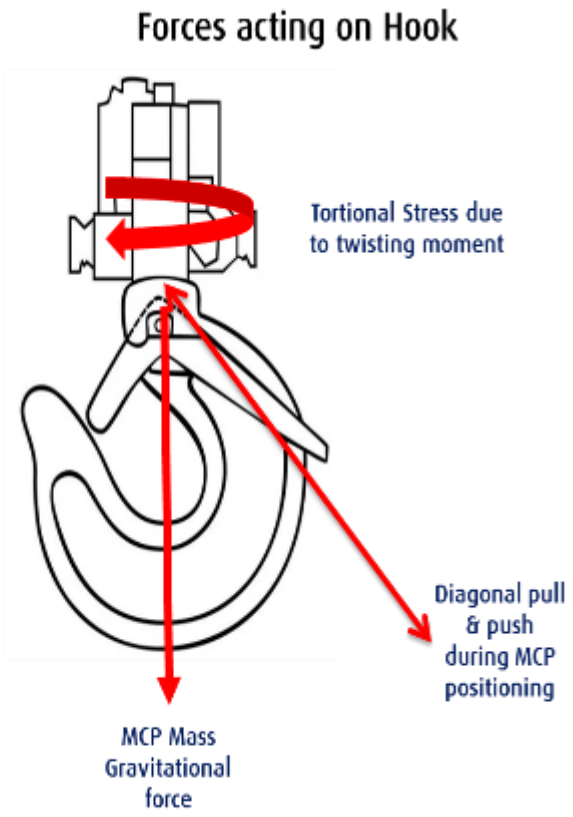
Lessons learned:

- Conduct crane handling safety review, identify and implement appropriate controls in work instructions
- Conduct routine job safety observations
- Review and standardize manifold layout e.g., linear vs cascade storage, safe distances between MCPs etc.,
- Implement controls to ensure critical safety commodity such as crane & its components purchases are monitored- vendor qualification, periodic evaluation and product certification

Event # 05

Pictures





Event # 06

Customer Injury When Picking Up a LIN Dewar

***Consequences**: Lost Time Injury*

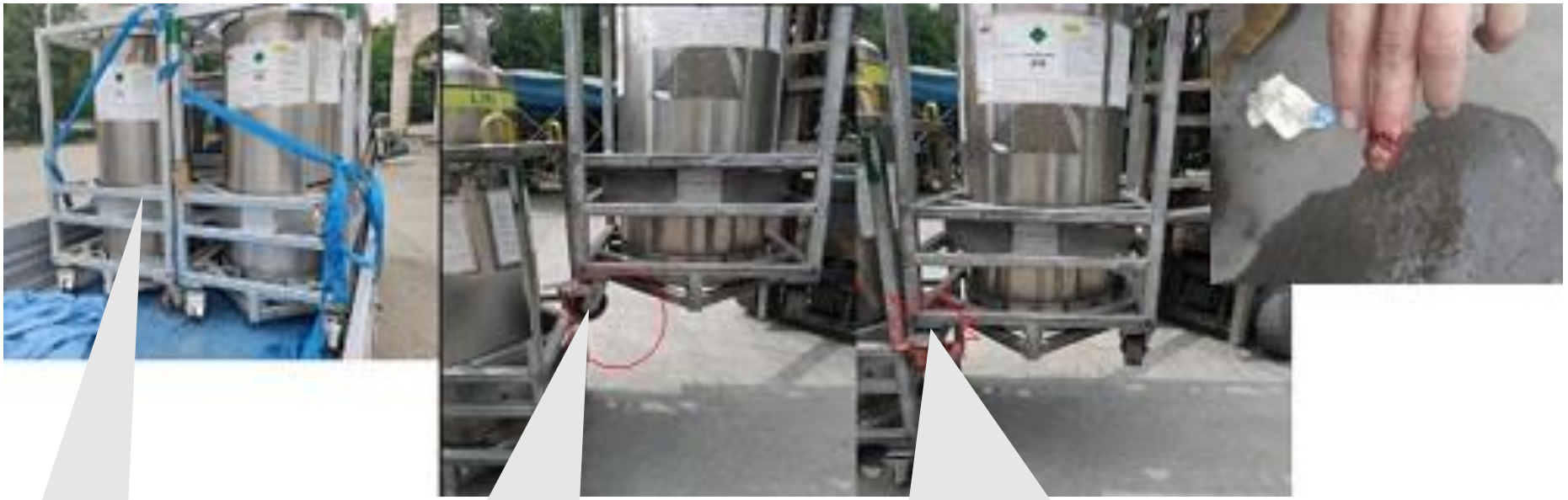
What happened:

A customer was picking up the LIN dewar at a cylinder gas filling site when the operator was forking the second dewar onto the customer's truck. The customer wanted to adjust the dewar's wheel but plant operator failed to notice that. The frame of the dewar pinched the finger of the customer which resulted in a fracture on tip of his left middle finger.

Lessons learned:

- Be sure to conduct the safety training of the driver/customer before entrance.
- Gate inspection for the vehicle before entrance.
- Be sure there were risk analysis and corresponding SOP regarding the cylinder unloading/handling involvement of customer and their selected vehicle

Event # 06 Pictures



The customer pick up two 196L LIN Dewars with non dangerous goods vehicle；

the vehicle is too narrow, the two frames should stay as close as possible, so the customer adjusted the wheel of the frame while the second dewar was loading onto the truck.

the two frames pinched the left hand of the customer.

Occupational Safety, Maintenance & Construction Work Related Incidents

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Event # 01

Incident During Cylinder Maintenance

Consequences: *Lost Time Injury to Technician*

What happened:

A cylinder maintenance technician was stenciling hydrotest date on the cylinder that passed the hydrostatic test. The Cylinder Maintenance Technician uses metal stencil marker and a mallet. When the mallet struck the metal stencil, a shrapnel from the mallet went astray and hit the right side below chest/abdomen of Cylinder Maintenance Technician, causing to bleed heavily. Another Cylinder Maintenance Technician administered first aid to stop the bleeding. Then rushed to the nearest hospital and based on the x-ray result, a tiny fragment from the mallet was pierce into his chest/abdomen. He was admitted to the hospital to remove the fragments by a surgeon.

Lessons learned:

- To wear thick body cover(apron) when doing the activity
- To reduce discomfort on the use of PPE, implement administrative controls such as work-rest method and use of electric fans to provide additional ventilation.

Event # 01 Pictures

SHRAPNEL/ TINY FRAGMENT FROM HAMMER THAT HIT AND ENTERS THE AFFECT PART OF BODY

Event # 02

Trucking Incident Inside Warehouse

Consequences: *Lost Time Injury to Helper*

What happened:

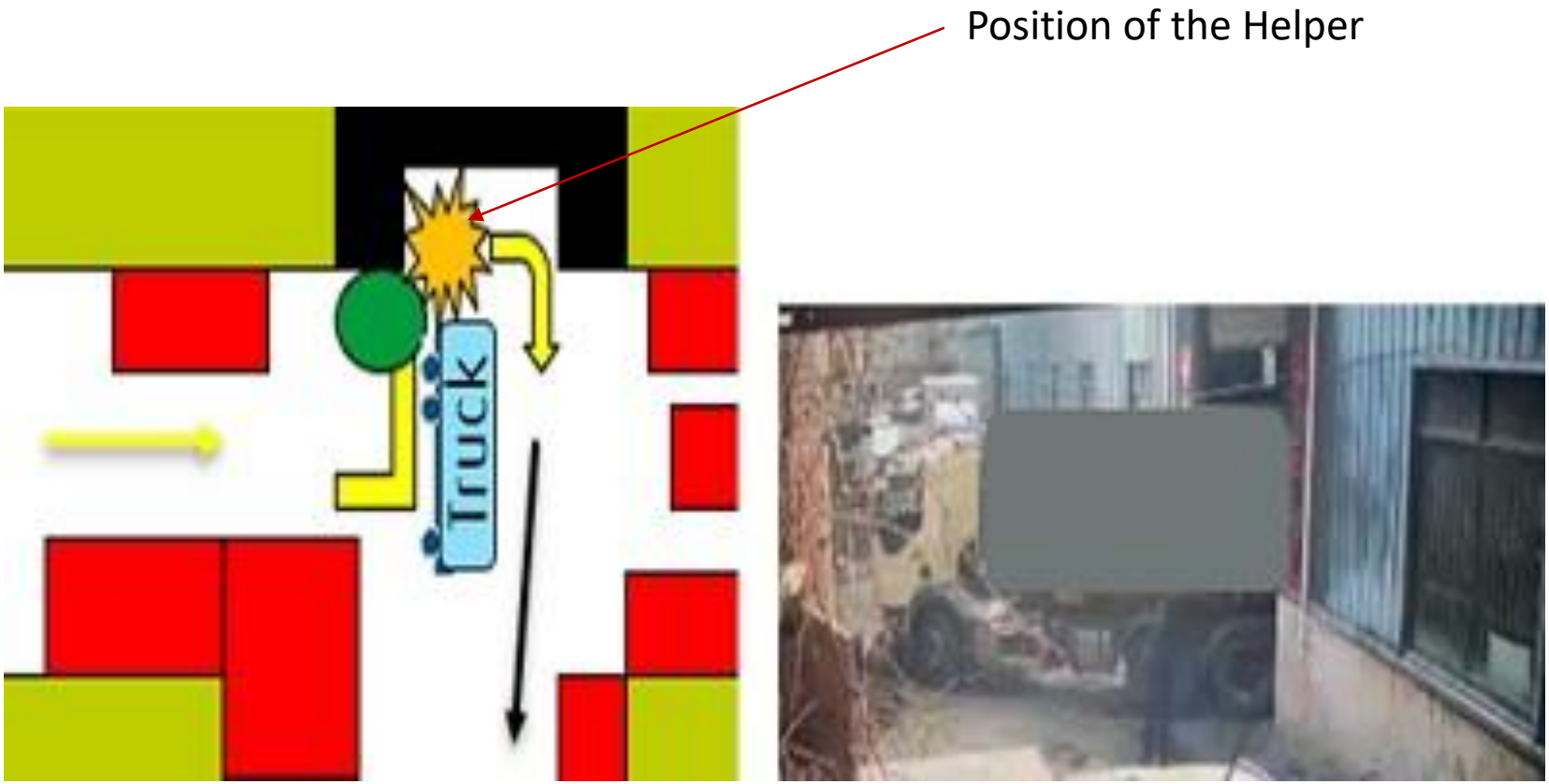
A product vehicle was maneuvering within a warehousing complex using an opened warehouse entrance to avoid parked cars in order to position for product fill at tank. The vehicle had stopped momentarily outside the warehouse door, when the helper moved to the rear of the vehicle to attempt to move a metal bucket. At that moment, the driver engaged the clutch to shift gear and the vehicle moved back 20-30 cm, and the helper's right forearm got caught between the vehicle and the workshop pillar. As a result, the helper received an avulsion fracture of right olecranon and underwent surgery to address bruising on his forearm tendon.

Lessons learned:

- Training with focus on maneuvering/reversing for drivers (get out & look, no uncontrolled rolls, don't drive if the helper is not visible etc.)
- Reversing training for helpers, do's and don't (don't walk in blind spots, have always eye contact with the driver, never closer than 2 meters to the vehicle, clear communication rules/ hand signs

Event # 02

Pictures



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Event # 03

Slip, Trip & Fall Incident

Consequences: *Recordable Injury*

What Happened:

During product delivery at a customer site at 10 30 am in the morning, a driver was stepping down from an operating box pedal when his right foot stepped on the filling hose. As a result, he sprained his right ankle and had a fracture of the skeleton on his right foot.

Lessons Learned:

- Clearly define the placement of hoses on site to be safe and reasonable.
- Strengthen on job observation, focusing on improving the implementation of three-point contact
- Review with the delivery personnel how to get on and off the vehicle correctly , up and down the pedals.

Event # 03 **Pictures**

Event # 04

Incident Involving Lifting of a Cold Box

***Consequences**: Lost Time Injury*

What happened:

At around 7:30 pm, during shifting and positioning of cold box by using two mobile cranes with a capacity 45 MT and 80 MT, one of the Helper's (Injured Person) right-hand thumb was suddenly stuck in the gap between the Coldbox and one of the 4 resting stools. As a result, upper portion of the thumb got separated.

Lessons learned:

- Team must verify the declaration of competency of the Crane crews including signalman
- Ensure effective implementation harmonized PTW system including Lifting plan & method statement.
- Pre-job discussion (job specific hazard)must be conducted with all workmen involved in the job and documented.
- Establish proper communication system between all personnel involved in lifting
- Install suitable handle to adjust the stool.

Event # 04 Pictures

80 MT Crane

45 MT Crane

Position of the Helper (IP)

Event # 05

Worker Safety – Cryogenic Burn

***Consequences**: Recordable Injury*

What happened:

At around 07:30hrs, a bulk tanker driver informed the mechanic that the top fill valve cannot be fully closed. Mechanic arrived offsite to examine the defect. He consulted the senior mechanic, who advised him to replace the top fill valve topwork. Around 10:00hrs, mechanic vented down the tank pressure to 0 psi but there was still some vapour/liquid coming out from the bleed valve. While he was repairing the valve, liquid splashed onto his left hand and caused cryogenic burn. Fleet Supervisor and senior mechanic accompanied the mechanic to the hospital.

Lessons learned:

- Do not contact with cryogenic liquid even when wearing protective gloves
- Do not rush
- Follow safe work procedures

Event # 05 Pictures

Event # 06

Workers Safety in Maintenance Work

***Consequences**: Lost Time Injury*

What happened:

At around 16:40hrs, our operator stood on a ladder and used two adjustable wrenches to disassemble the joint of the analyser's sampling tube. Due to the tightness of the joint, the operator did not disassemble it with force the first time. The joint suddenly came loose on the second attempt, and the handle of the adjustable wrench in the operator's left hand hit him in the nose. The injured person took X-rays and CT scans at the hospital and confirmed the fracture of the nasal bone. Had surgery and being hospitalized due to nasal bone fractured.

Lessons learned:

- Keep clear from the Line of Fire while handling hand tools
- Limiting excessive force and overreach while working on ladder
- Select proper tool and apply proper technique when handling hand tools

Event # 06 Pictures

Event # 07

Work Place Injury on a GOX Compressor

***Consequences**: Recordable Injury*

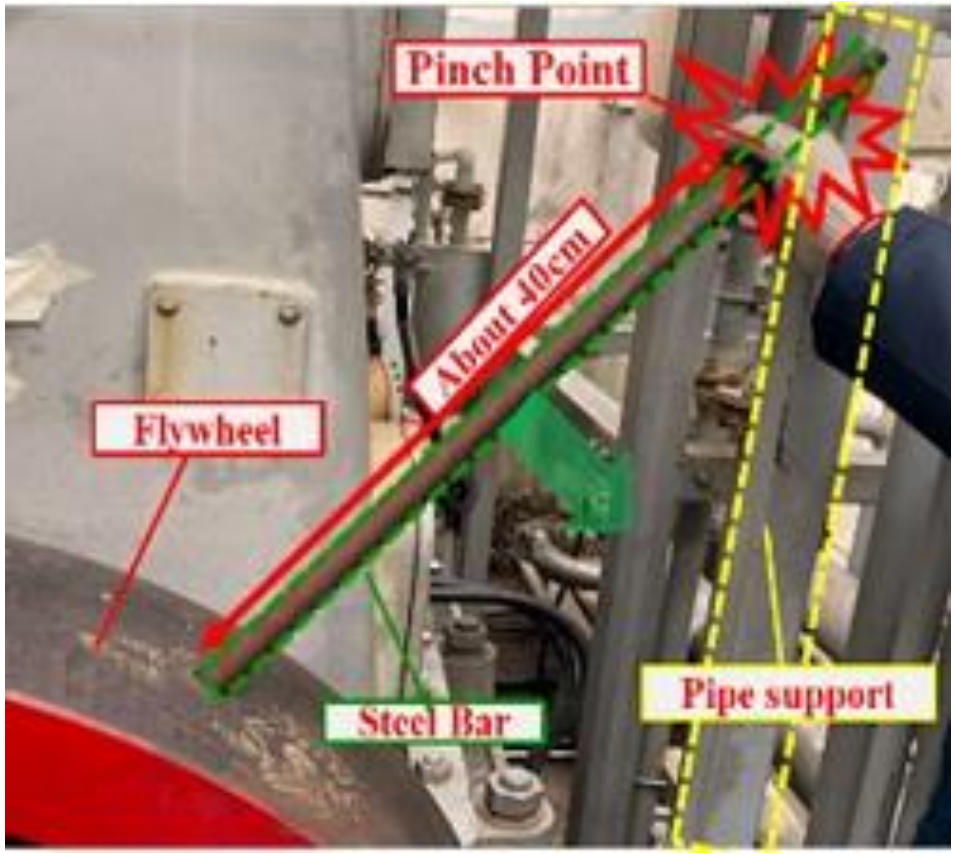
What happened:

Two contractors were working on barring & free-turning the GOX compressor's 47" flywheel, in order to check alignment (crankshaft axial clearance). On one side of the flywheel, by using both hands, Contractor "A" started pulling down the steel bar inserted to the barring hole at the top of the flywheel. On the other side, Contractor "B" was pushing up the flywheel by using both hands. Soon after the flywheel started turning, Contractor "A" tried to pull out the steel bar from the flywheel, but the back of his right hand was pinched between steel bar and pipe support before he retracted his hand. After pinched, the back of his right hand became bruised and swollen slightly. The injured person went to the hospital with the supervisor. There was no bone fracture through the X-ray. However, the injured person received prescribed medicine and splint for fast recovery.

Lessons learned:

- Be aware of pinch point hazard
- Stay out of the Line of Fire
- Do not rush

Event # 07 Pictures



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Event # 08

Slip, Trip and Fall Incident

***Consequences**: Recordable Injury*

What happened:

A technician was moving to install the H2 trailer jack stand during Hydrogen ISO tube trailer changing out work. Technician slipped with H2 trailer jack stand in front of H2 tube trailer on slippery ground spot where there was some remaining snow even though site team did snow housekeeping activities. When he slipped and fell together with H2 trailer jack stand, upper top rounded flat metal of the jack stand hit technician's right eyebrow resulting skin cut about 3cm injury. The employee went to hospital with supervisor and received 8 stitches medical treatment and returned home on the same date of incident.

Lessons learned:

- Remove ice and snow on the ground thoroughly
- Wear safety shoes with anti-slip aids

Event # 08 Pictures

Event # 09

Slip. Trip and Fall Incident

***Consequences**: Lost Time Injury*

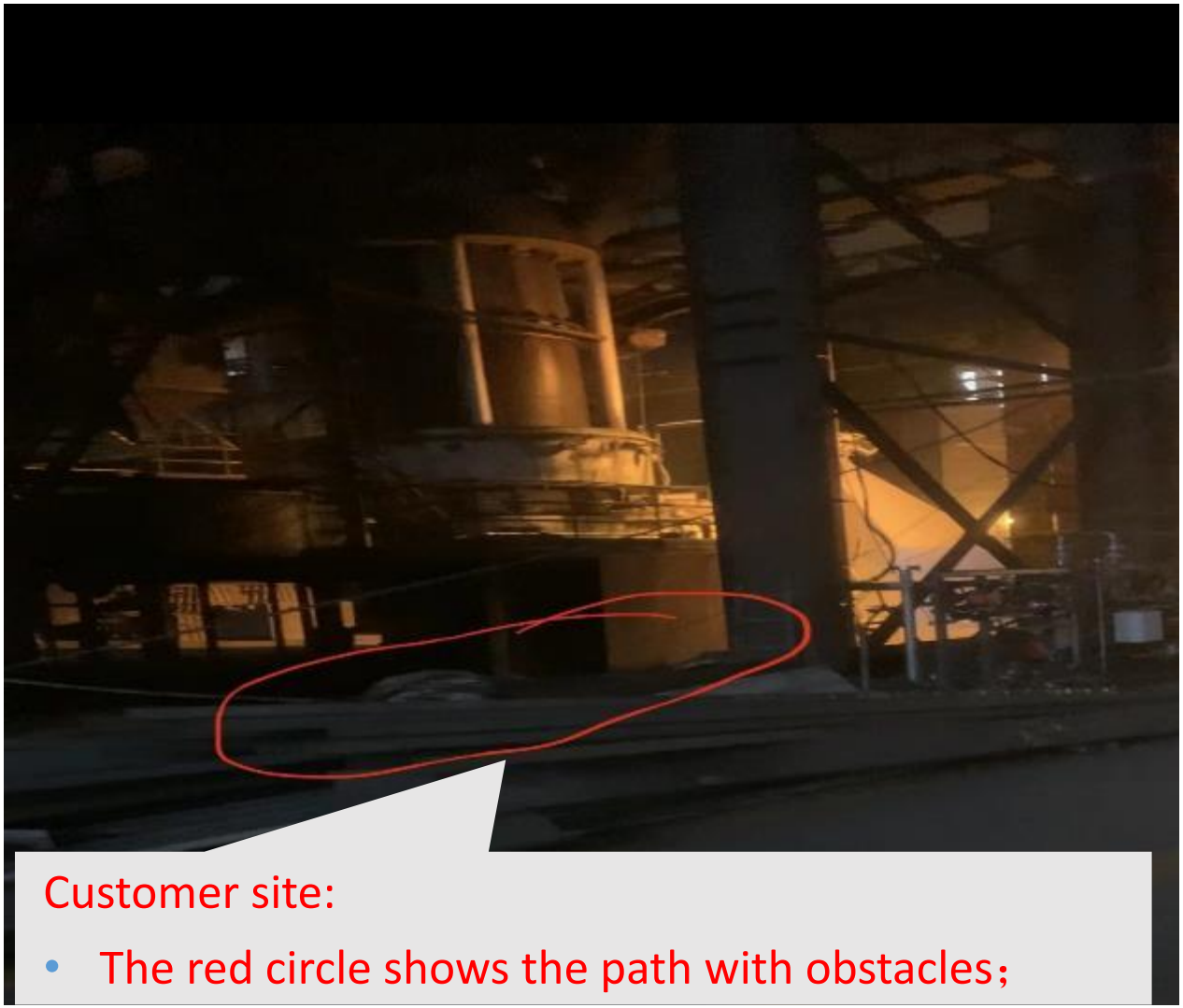
What happened:

A industrial gas company employee was testing the oxygen-rich combustion equipment at a customer site. During the testing, it was necessary to go back and forth between the valve set and the PLC cabinet, but some stumbling block was piled up on the poorly lit walking path. The employee was tripped by a hanging cable while crossing the stumbling block, result in fracture of his right knee patella.

Lessons learned:

- Take time to prepare the risk assessment of customer site prior to visit or starting an activity
- Do not take or continue the work if you do not feel safe
- Always demonstrate safe behavior

Event # 09 Pictures



Customer site:

- The red circle shows the path with obstacles；

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Event # 10

Slip, Trip and Fall Incident

***Consequences**: Lost Time Injury*

What happened:

A driver who missed his step and fell to the ground as he got out of the cabin. his back and the back of his head hit the ground. Two days later the driver began to feel unwell and was sent to hospital for inspecting.

The diagnosis was that he got epidural hemorrhage of his right frontal and some fracture of his right frontal bone fracture and bilateral parietal bone.

Lessons learned:

- Re-training Basic Safety Awareness regarding Prevention of Slips, Trips and Falls.
- Through video surveillance, regular spot check whether the up-down of the cabin behavior meets the requirements

Event # 10

Pictures

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Lessons learned from the safety events(1)

★ Transportation safety

- Continue reinforcing Driver **Awareness of Fatigue and Distraction**
- Periodic monitoring of **In cab camera** output is important in preparation to Driver coaching / feedback sessions
- Constantly remind Drivers about **Defensive Driving Skill areas**– Speed management, adapting to road conditions, pre planning, rolling the eyes, etc.
- Revisit your **Vehicle inspection programs** – tyres, wheels, periodic maintenance verification, any mobile equipment like lift gates / cranes on vehicles, etc.

★ Handling of Cylinders and PLCs

- Discuss about the importance of **Human Factors** in manual handling
- Communicate clear **roles and responsibilities** to the teams with training
- Following **Safe Practices** is critical
- Never stand in the **'line of fire'**
- Conduct **Crane handling** safety review and training prior to work

Lessons learned from the safety events(2)

★ Process Safety

- **Operating Procedures**: Follow procedures; Stop and ask questions
- Ensure **MOCs, Risk Assessments and Hazard Reviews** are done consistently for all changes or new processes or systems
- **Permit to Work/LOTO:** Discuss whether these are implemented per standards
- Ensure proper **inspection of vendor supplied equipment** before installation at project site

★ Occupational Safety, Maintenance Work and Construction

- **Employee Training and Safety Orientation:** Critical for carrying out any hazardous work
- **Avoid Unsafe act :** Follow correct **procedure** and use of **PPEs**
- **Good Housekeeping** keeps everyone safe
- **Being mindful and attentive** on task is important
- Always use **3 point contact**
- Be aware of **hazards at Customer Premises and carry out risk assessment** before visits or taking up activities

List of Useful AIGA documents for incident prevention

- ❑ AIGA SP 01 & 02: Safety Poster on ‘Driver Fatigue’
- ❑ AIGA SP 03 & 04: Safety Poster on ‘Driving Distraction’
- ❑ AIGA SP 11: Safety Poster on ‘Safe Transport of Cylinders and PLCs’
- ❑ AIGA SP 17: Safe Handling of PLCs
- ❑ AIGA SB 11: Human Behaviour in Transport Safety Operations
- ❑ AIGA SB 12: Transportation Safety, Challenges and Improvement Strategy
- ❑ AIGA SB 27: Vehicle Specification and Maintenance
- ❑ AIGA 008: Safety Training for Employees
- ❑AIGA 011: Work Permit System
- ❑ AIGA 015: Safety Management of Contractors
- ❑AIGA 041: Defensive Driving
- ❑AIGA 066: Selection of Personnel Protective Equipment
- ❑ AIGA 099: Process Safety Management Framework
- ❑AIGA 119: Overview of Fleet Safety Technology and Vehicle Specification

Thank you

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