Training Package

TP 25/20

Recent (1Q & 2Q of 2019) Accidents/Incidents in the Gases Industry in Asia

No 2 Venture Drive, #22-28 Vision Exchange, Singapore 608526
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Recent (1Q & 2Q of 2019) Accidents/Incidents in the Gases Industry in Asia

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Introduction

At the regular Safety Advisory Group (SAG) meetings, members exchange information on accidents/incidents that have occurred . Accident/Incident details discussed at the SAG remain confidential.

The SAG has decided to share the more notable accidents/incidents on a regular basis with the national associations and member companies via the Training Package publications.

These slides contain the summaries, pictures and other relevant information to highlight the root causes and lessons to be learned.

Further Information:

These Training Packages are posted only on the Members Page and are meant for distribution among Members only.

While the best effort is made to provide sufficient information on the accidents/incidents, please contact the SAG (through the Secretary General) if you need further clarifications.

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Agenda

- **Incident Cases**
  - Transportation including Loading/Unloading
  - Working Injuries/Occupational Safety
  - Process Safety
  - Maintenance Work/Construction
- **Learning from the Incidents**
- **AIGA standards related to the incidents**

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Accidents/Incidents in Product Transportation including Loading & Unloading

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Event #1

High Severity Product Vehicle Accident

Consequences: *Roll Over with LTI*

What happened:

A LIN tanker rolled-over on the connecting curve of a city loop road and an expressway without involvement of any third party. The helper suffered a rib fracture and pulmonary contusion caused by the safety belt, and the driver suffered from a skin cuts/bruises plus soft tissue injury on his left elbow. The incident happened in the morning at around 10 am.

Major Cause(s):

- High speed in the curve: ~ 70 km/h
- Careless driving

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Event #1 Pictures

Event #2

High Severity Product Vehicle Incident

Consequences: *Roll Over with equipment damage*

What happened:

A contractor' truck carrying LOX was on the way to make a delivery. After turning a right hand curve road, the driver noticed a cyclist on the soft road shoulder; moving on the same direction. All of a sudden the cyclist swerved into the main lane in front of the contractor' truck. To prevent an accident, the contractor' driver moved to the right and tried to get back to the left lane. In this course of action the driver lost control and the truck rolled over. The driver was wearing seat belt, sustained minor injury and was treated with first aid. The truck cabin, tank, vaporizer and fleet chassis were damaged. Some product venting was required due to pressure rise.

Major Cause(s):

- Driver did not observe and anticipate ahead while driving
- Driver did not adjust the speed to suit the road conditions

Event #3 Pictures

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Event #4

High Severity Product Vehicle Incident

***Consequences*:** *3rd party driver LTI and vehicle damage*

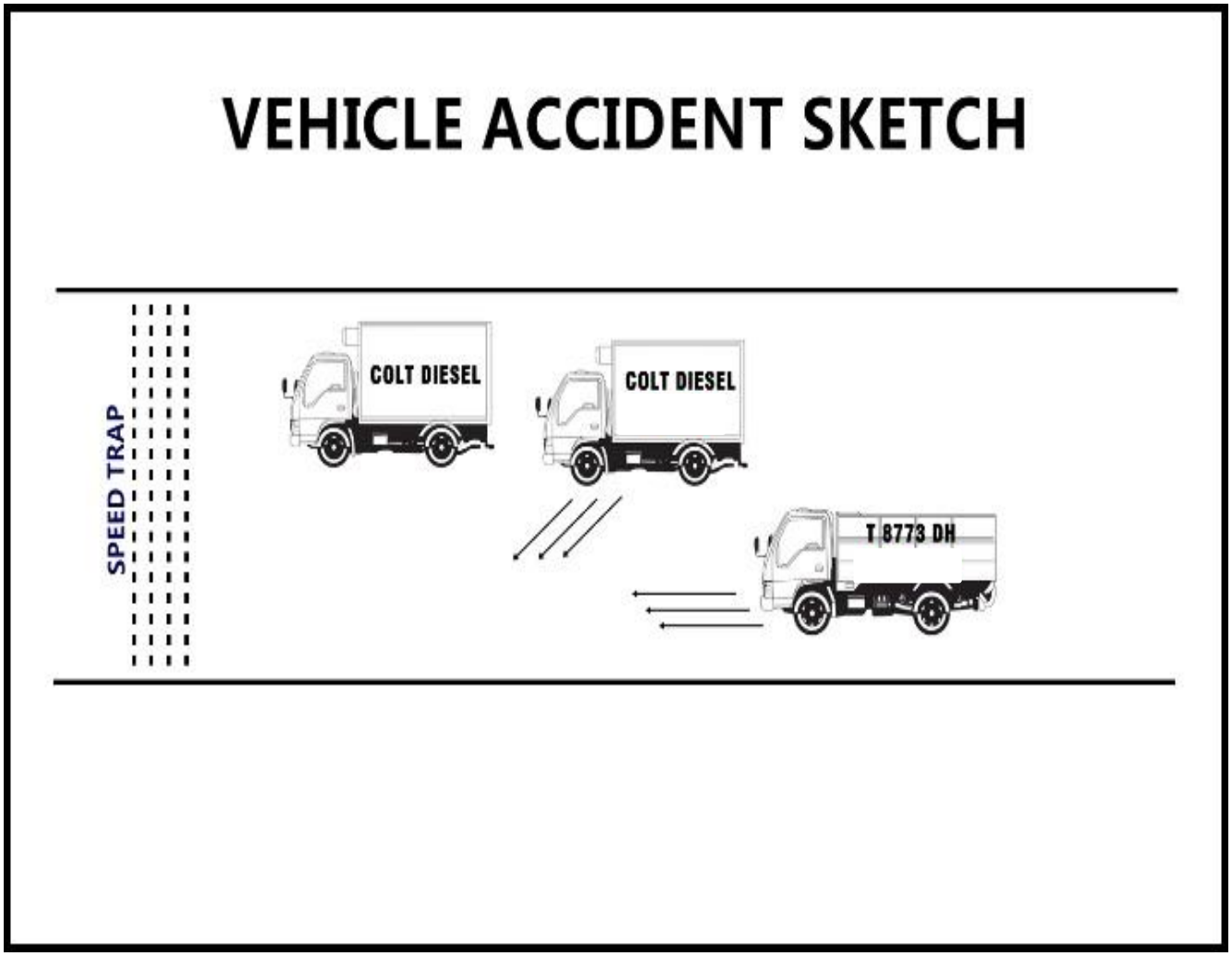
What happened:

A cylinder truck crashed at the rear of a box truck after the box truck attempted to avoid a collision with another vehicle ahead by overtaking the cylinder truck while the other vehicle made forceful braking to pass a speed trap. Unfortunately, this effort failed because of inadequate space between cylinder truck and other vehicle. The cylinder truck speed was 30 Km/hr and the other truck around 50Km/hr when the incident happened. The third party driver received lost time injury, however the cylinder truck driver and co-driver had seatbelts and received no injury.

Major Cause(s):

- Cylinder truck driver not following defensive driving
- No ABS for the truck

Event #4 Pictures



Event #5

High Severity Product Vehicle Incident

Consequences: *Rollover*

What happened:

On way back after the delivery of Lox, a product vehicle driver arrived at a busy road where he intended to move to the left lane, but the traffic condition did not permit him to do so. As soon as he found an opportunity to switch lane, he tried to accelerate his speed to overtake a 10-wheel lorry which had occupied the left lane. At the same time, a car (on the right lane) braked in front of the driver and the driver naturally reacted by doing the same. In order to avoid collision, he steered the vehicle off the car, travelling at a speed of 50km/hr prior to the incident and the wet road made him lose balance, resulting in a rollover.

Major Cause(s):

- Wrong overtaking procedure followed by the driver on a wet road
- Did not maintain enough space cushion from the car in front of him
- Driver was travelling at a high speed (50km/hr) on a busy road in bad weather
- The product vehicle was not installed with ABS, EBS or RSS

Event #5 Pictures

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Event #6

High Severity Product Vehicle Accident

Consequences: *Lost Time Injuries to drivers*

What happened:

When returning to the depot, a LCO2 tanker hit the right side of an oncoming truck. Due to the impact, the tractor cabin was badly damaged but no product loss. The driver sustained head & right eyebrow injury and a fractured right wrist. There was no injury recorded for the 3rd party driver. The 3rd party driver contacted the emergency service and transferred the driver to the nearby hospital. Later the doctor refer him to another hospital for further treatment .

Major Cause(s):

- Driver was found to be fatigued and had a micro sleep – cumulative fatigue
- Driver did not apply brakes prior to the collision(GPS speed report)

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Event #6 Pictures

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Event #7

High Severity Product Vehicle Accident

Consequences: *3rd Party Two-wheeler rider fatality*

What happened:

An empty LAR tanker driven by contractors‘ driver, returning from a customer after delivery met with the incident. The video footage indicated that a motorcyclist (with 2 pillion riders) coming from the opposite direction to the tanker and was trying to pass by another motorcyclist who stopped on the side of the road, got unbalanced and contacted the tanker. One lady pillion rider got fatally injured. The motorcycle driver, 2nd pillion rider & two seat-belted contractor’ drivers of the tanker escaped without injuries. There was no damage to tanker nor any product loss.

Major Cause(s):

- At risk behavior by the tanker driver
- 3rd party motorcyclist displayed unsafe and non-defensive driving

Event #7 Pictures

- 21’ double lane road without median
- Slow moving overloaded tractor trailer obstructing visibility
- Driver tried to overtake the tractor trailer
- Two wheeler with 2 pillion riders from opposite side tried overtaking another stationed two wheeler
- Two wheeler riders were without helmets

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Event #8

High Severity Product Vehicle Accidents

Consequences: *Lost Time Injury of 3rd party motorcycle rider*

What happened:

A LIN Tanker was on its way returning from a customer site to depot. At a curved section of the road, the tanker overtook a motorcycle and accidentally grazed onto it. The LIN Tanker driver was unaware of it until the police contacted on duty scheduler, based on eye-witnesses information. The motorcycle rider and his pillion suffered injuries (fractures). The male victim suffered 4 fractures on right rib bones and shoulder/collar bone. The female victim suffered 2 fractures on left wrist and hand.

Major Cause(s):

- Driver did not follow Defensive Driving. Overtook the motorcycle even though he did not have a clear view of sight.

Event #8 Pictures

Event #9

Preventable Vehicle Accident

Consequences: *Tube Trailer disconnection from tractor*

What happened:

Driver prepared to send the H2 TT for treatment. Driver hooked trailer to the tractor head, came down from the prime mover and connected the sussie hose and electrical line. He later wind up the landing leg. Upon completed, the driver drove away from the parking lot. While making a 90 degree turn, the trailer was disconnected from the tractor head. There was no injury and product loss.

Major Cause(s):

- Driver did not follow the correct trailer hooking procedure.
- Driver did not perform the tug test to ensure the lock jaw secured the king pin
- Driver did not check on the lock jaw and king pin position.

Event #9 Pictures

Event #10

Hose whip Incident

Consequences*: *Driver Lost Time Injury

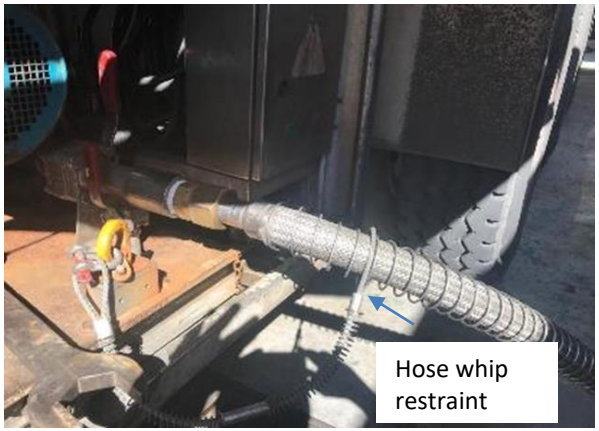
What happened:

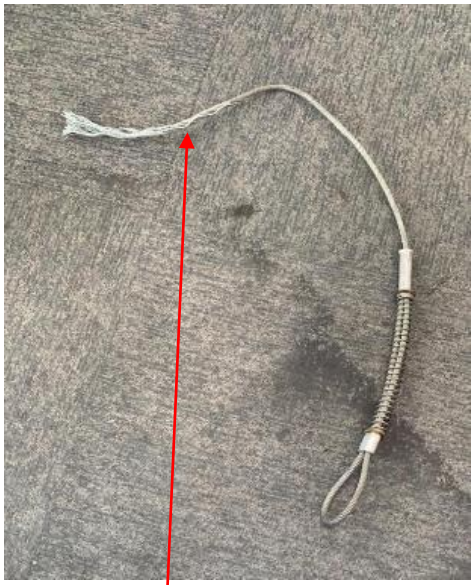
A contractor driver started the loading LCO2 into a road tanker at a plant site. After few minutes, he noticed leak from filling hose at the road tanker end. The hose got disconnected while he was checking the hose coupling for tightness. The anchor point of anti whip restraint (installed to prevent hose-whip) dislodged simultaneously causing hose whip that hit the driver's right foot and back. He managed to contact the plant personnel to shut off the auto valve. The driver was sent to hospital for medical treatment. There was no damages to the road-tanker.

Major Cause(s):

- Driver tried to stop the leak at connection point while hose was pressurized and tanker filling in progress - Failure to adopt safe procedure.
- The restraint failed prematurely, the clamp crimping the cable gave way - Inadequate design & engineering review of current anti-whip system.

Event #10 Pictures





The end of the loop which was shroud on the hose neck at the tanker side gave away from the cable crimper.

The cross section of the crimper and the location of the cable edge position in the crimper

Working Injuries/Occupational Safety

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Event #11

Working Injury in Manual Handling of Dewar

Consequences **:** *Lost Time Injury*

What happened:

A LIN TAXI driver was pushing a loaded dewar (weight: 270Kg) into a customer's lab where he tried to lift both front wheels to over an 8 cm high step. The support (left) leg slipped forward on wet floor with little frost from the dewar body and the dewar leaned to his body. He was forced to sit down slowly with the dewar while his both hands held the top rung upwards to avoid dewar strike his body. The helper tried to pull the dewar up but failed while the middle rung of the dewar rested on the top beside of left leg tibia. Driver felt pain on his left knee but continued his last drop for the day. Later on, he was sent to hospital when X-ray showed a tiny crack on driver's left lateral condyle. After further diagnose, driver received surgery as recommended by the doctor.

Major Cause(s):

- Uneven pathway at customer site (8 cm high step)
- Inappropriate frame design for the Dewar (high Center of Gravity, narrow base with small wheels)
- The person was not provided proper training before being assigning the task

Event #11 Pictures

8 cm elevation

Dewar Total weight: 270 kg (loaded)

Note: Pictures for illustration only

Event #12

Working Injury in Manual Handling of Cylinders

Consequences*: *Recordable Injury to cylinder handler

What happened:

An attendant attempted to transfer 18 cylinders from a pallet to another pallet when he confirmed that a number of cylinders visually had slipped out of vertical position before he loosened the ratchet. Some of the cylinders slipped, when a single cylinder fell against his waist area. After an hour of continuing with work, the attendant started experiencing pain. He was immediately taken to local clinic where an X-ray and confirmed that the lower back and waist was not fractured. The doctor gave him pain killer, and no other medical treatment was suggested. He returned to plant from the clinic and continued on light duties.

Major Cause(s):

- Pallet grating near pin tail damaged due to pallet grating hit by 'pintle' on truck whilst loaded in other depot.
- Improper movement during cylinder transfer - attendant trapped in between loose pallets and unable to escape.
- Difference in the designs for the 'pin tail' for the pallet and the truck.

Event #12 Pictures

Cylinders fell on attendant

Event #13

Working Injury in Manual Handling of Liquid Dewar

***Consequences**: Recordable Injury*

What happened:

The driver and escort of a truck was collecting an empty dewar at a customer site. When they collected empty dewar and the cart was elevated by tailboard, the escort who stood on the truck chassis noticed the cart was about to slip away from the tailboard. He stepped on the platform and wanted to stop the cart slipping. At this moment, his left foot was slipped back to trap into the gap between of tailboard and chassis, and was pinched by tailboard even though the driver immediately stopped the elevating tailboard. The escort was immediately taken to a hospital where he was diagnosed for a fracture on left foot and was treated with plaster. The escort came back depot next working day with light duty task assigned.

Major Cause(s):

- Unsafe act by the escort - stepped on the platform during tail lift and intended to stop the cart slipping.
- The cylinder cart was not secured.

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Event #13 Pictures

Cart was not secured, started to slip during tailboard evaluating

The escort's right foot stepped on the tailboard to try to stop the cart slipping

The escort's left foot slipped back to trap into the gap between tailboard and chassis, and was pinched by tailboard

Event #14

Working Injury: Finger pinched by Sliding Door

Consequences: *Lost Time Injury to employee*

What happened:

After unloading the cylinders from his truck, an employee tried to close the roll-up door (sliding rear door) by pulling it down. The door was not fully closed with first try. So he pushed the door down by foot instead of hand. At the same time, he unconsciously placed his fingers on the gap between the sliding door plates. He got his right fingers (3rd and 4th fingers) stuck between door plate as soon as the door is closed completely. He was transferred to the hospital and had a surgery.

Major Cause(s):

- Unsafe act: wrong method of closing door

Event #14 Pictures

Gap between door plate

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Event #15

Occupational Safety Incident: Slip-Trip-Fall

***Consequences**: Lost Time Injury to driver*

What happened:

A MB driver completed unloading, when he was placing filling hose back to truck, he lost balance and fell due to stepped by construction trash pile with full occupied hands (copper hammer in right and filling hose in left) at that time, and his right chest hit on the tip protruding pedal of bike. He reported supervisor immediately and continuously finished rest of the work even he felt slight pain. Driver went to see a doctor. An X-Ray identified a minor fracture on the 7th rib.

Major Cause(s):

- Loss the balance due to foot stepping on unstable debris with both hands occupied by hammer and loading hose.
- Normalize the deviations, working on the poor housekeeping area as usual.
- Loading access way was block by garbage pile.

Event #15 Pictures

Event #16

Occupational Safety: Right Thumb Pinched

Consequences*: *Recordable Injury

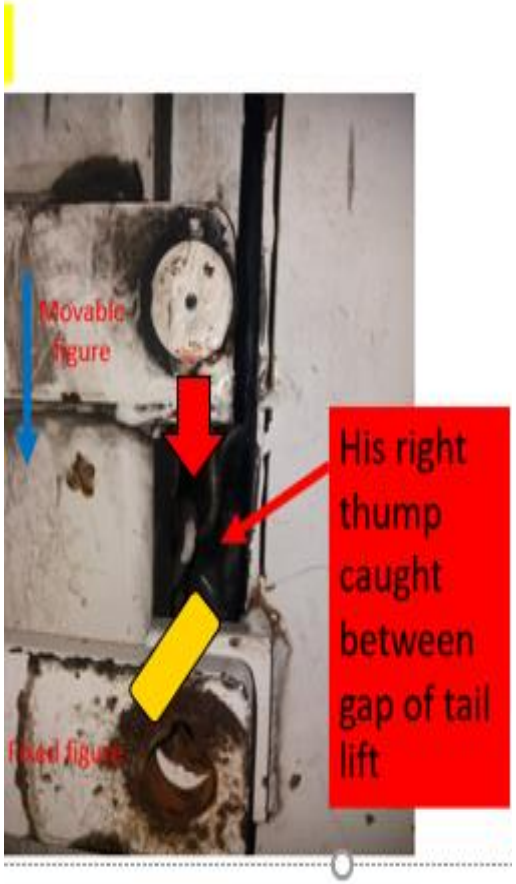
What happened:

A contractor store man disregarded the driver's instruction to wait and proceeded to operate the tail lift by himself in order to step up to the truck to scan cylinder barcodes. As he used his left hand to operate the lift gate, his right thumb was pinched with the moving lift gate. He was not wearing any gloves. Consequentially he was admitted to hospital where he had surgery to stitch his right joint and tendon and released from hospital to perform light duty work.

Major Cause(s):

- Not using a PPE: Lack of hazard awareness and hazard evaluation
- Failure to follow instruction from the driver to wait
- Lack of preventive maintenance for the tail lift

Event #16 Pictures



Right thumb joint and tendon injury

Process Safety Events

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Event #17

Process Safety Event

Consequences: Near Miss

What happened:

A contract sorter detected acetylene smell coming out from an ISO container while performing un-stuffing of cylinders. Special precautions were taken by the sorter during the opening of the container door. Acetylene Cylinders were found in in horizontal position inside the ISO container.

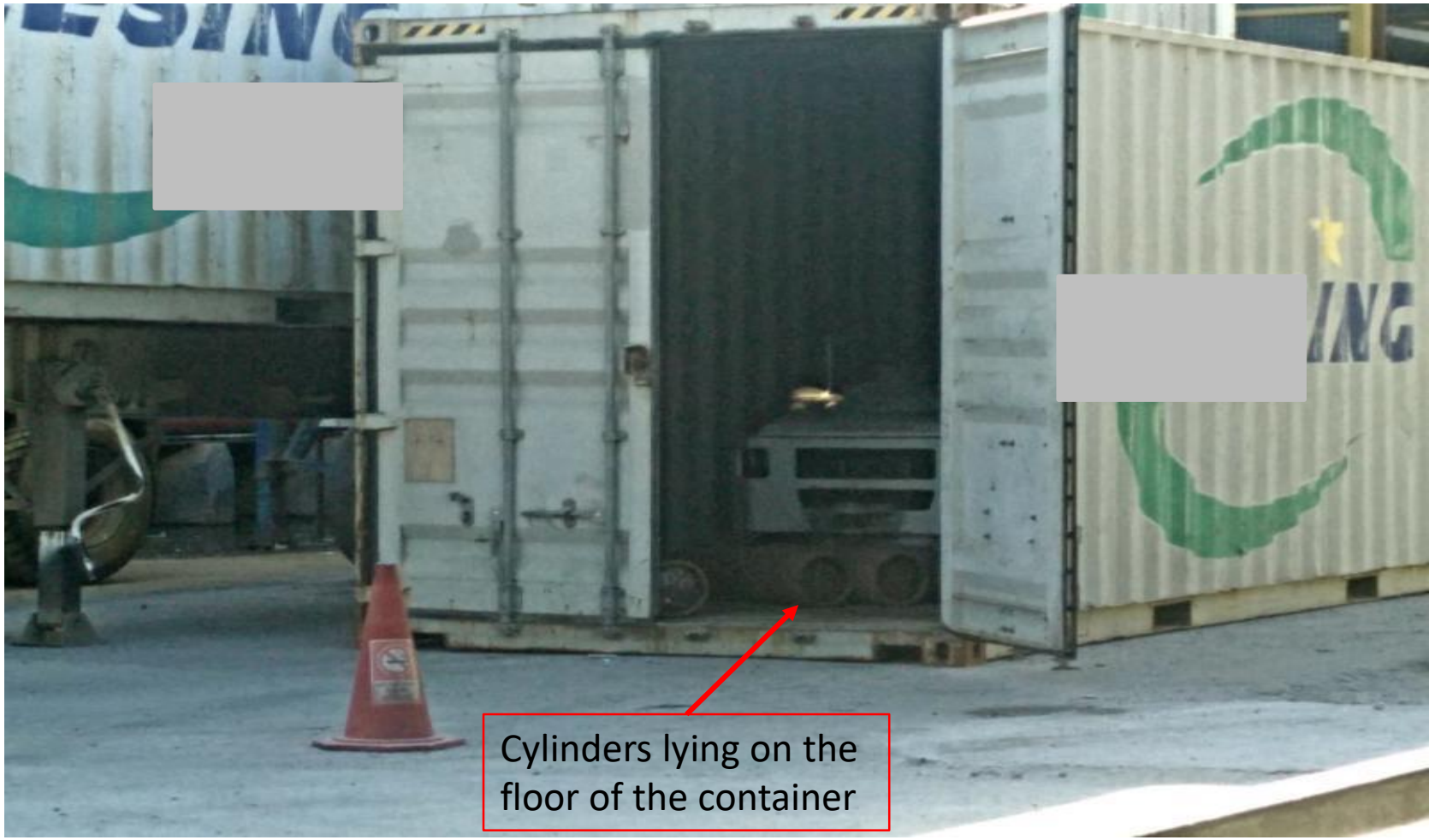
The container was ventilated and subsequently the cylinders were removed safely. 3 cylinders found to be leaking at valve.

Initial investigation indicated that the cylinders may have leaked during road transportation.

Major Cause(s):

- Not properly securing the cylinders/ Lack of supervision during loading of cylinders inside the container

Event #17 Pictures



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Event #18

Wrong Hydrostatic Test Pressure

Consequences: *Potential cylinder rupture*

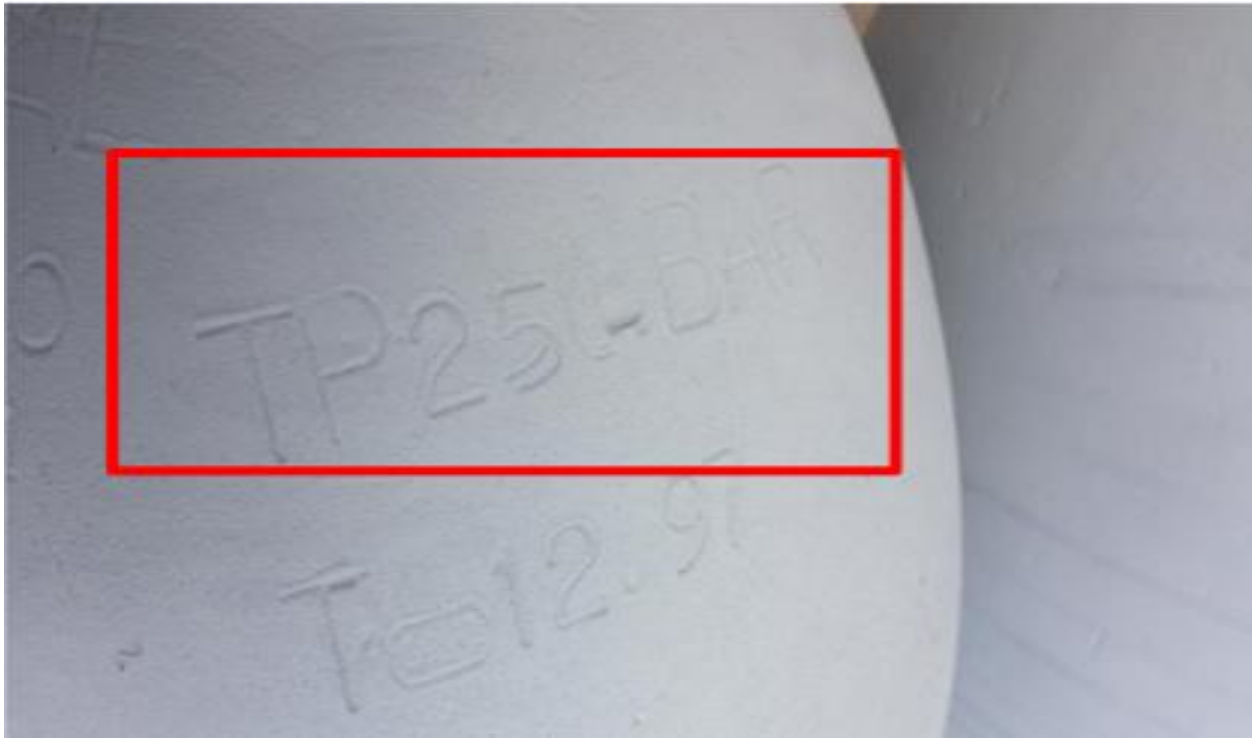
What happened:

A hydrogen trailer consisting of 24 tubes went through hydrostatic test at 333 bar on December 2018. It was later discovered that 7 tubes has Test Pressure 250 bar stamped on the tube. The 17 other tubes have Test Pressure of 330 bar stamped on the tube. So, 7 tubes have been tested beyond their designed Test Pressure.

Major Cause(s):

- Professional Engineer based on last 2 test record and proceed to certify test at 333 bar.

Event #18 Pictures



Event #19

Loss of Containment - Cylinder

Consequences: Process Safety Event with injury potential

What happened:

An operator was filling a customer owned CO2 cylinder and noticed that the valve was leaking. The operator aborted the filling and set aside the cylinder without cap and without strapping it. While setting up another cylinder, the cylinder that he had put aside was continuously leaking and fell to the ground due to high pressure. The valve broke, releases vapor cloud and the cylinder shoot forward. There was no injury to the operator.

Major Cause(s):

- Lack of Operational Discipline - Did not cap and strap the cylinder

Event #19 Pictures

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Event #20

Process Safety Event

Consequences: LOPC with Lost Time Injury

What happened:

An operator was wearing only safety hardhat was performing settled pressure check on a batch of 40L oxygen cylinder (filling pressure 120 bar) at a customer site when the testing gauge (250 bar MAWP) suddenly ruptured. As a result, the broken pieces of gauge glass cover hit his face. He was immediately sent to the hospital for emergency treatment. Diagnosis showed that the operator's face and nose bridge were injured and foreign body entered his left eye.

Major Cause(s):

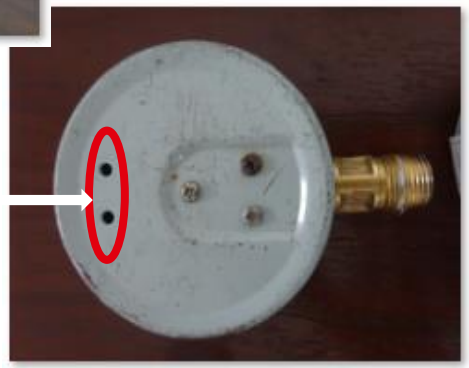
- Oil was found in ruptured copper spring ring inside pressure gauge - High pressure oxygen contact with oil caused the gauge ruptured.
- Non oxygen compatible gauge used, No mark for "Oxygen Service" or "Use no oil"
- Oxygen service gauges and non-oxygen service gauges were stored at same area.
- No pressure leakage hole in this pressure gauge
- Settle pressure check SOP not available at site and operator did not wear safety glasses

Event #20 Pictures

Damaged Gauge

Oil can be detected under UV-light in the internal of blasted pressure gauge

Two 4mm-diameter small hole in the back of pressure gauge, can not effectively release pressure



Event #21

Process Safety Event

***Consequences**: Recordable injury*

What happened:

A permit to work was issued for removing a leaking cryogenic valve after isolating related valves. Two mechanic were removing the leaking valve but the system line still had residual pressure. Due to the residual pressure parts of the valve flew apart hitting both mechanic's face (they were wearing safety glasses). After administering first aid they were sent to hospital for further treatment where both received stitches.

Major Cause(s):

- Residual pressure in downstream side from liquid and incompletely released pressure.
- Continue work permit approval even found pressure was passing from valves.
- Incomplete qualification program for operator and isolation knowledge of mechanic.

Event #21 Pictures

Event #22

Process Safety Event

***Consequences**: Recordable injury with fatality potential*

What happened:

Three contractors was attending to small leakage of heat tracing pipe of S1201B pulverized coal fill filter in running gasification facility. The contractor (A) was disposing leakage point at the scaffolding work platform, the other two contractors (B&C) did preparatory work far away, the contractor (A) exposed CO2 environment short time when the S1201B pulverized coal fill filter released pressure normal operation nearby.

The contractor (A) felt uncomfortable and left working platform with the contractors' (B&C) help, he was sent to local hospital for oxygen therapy about 1 hour then came back to work after confirming with no other injury or illness.

Major Cause(s):

- The contractors working at a gas venting area during normal operating.
- Inadequate risk identification during SWP issuing.
- Inadequate hazardous area management ,lack of proper hazard warning and control for potential hazardous area.

Event #22 Pictures

A: S1201B release of G4
- DN 1000cm
- atmosphere pressure after 5.0Mpa orifice
- DN of orifice
- 99.4% CO2 and 0.6% CO

B: scaffolding working platform for contractor
- scaffolding was erected on June 21
- acceptance inspected by safety inspector
- total 7.2m height with 4 layers

Contractor (A) worked on scaffolding platform

Contractor (B&C) stood on the 16 F inside of handrail

Event #23

Ex boiler feed water exchanger piping puncture

Consequences*: *Process Safety Event

What happened:

Water droplets were observed at 8m from the ground at the outlet of boiler feed water exchanger piping of a steam methane reformer. A puncture of 1 ½ inches in size was found at the elbow of the piping. Further investigation indicated that carbon steel was used on the piping instead of stainless steel by the plant provider.

Major Cause(s):

- Designer inadvertently picked carbon steel material pipe class while routing the line
- Missing verification in engineering checking and fabrication & skid checkout.

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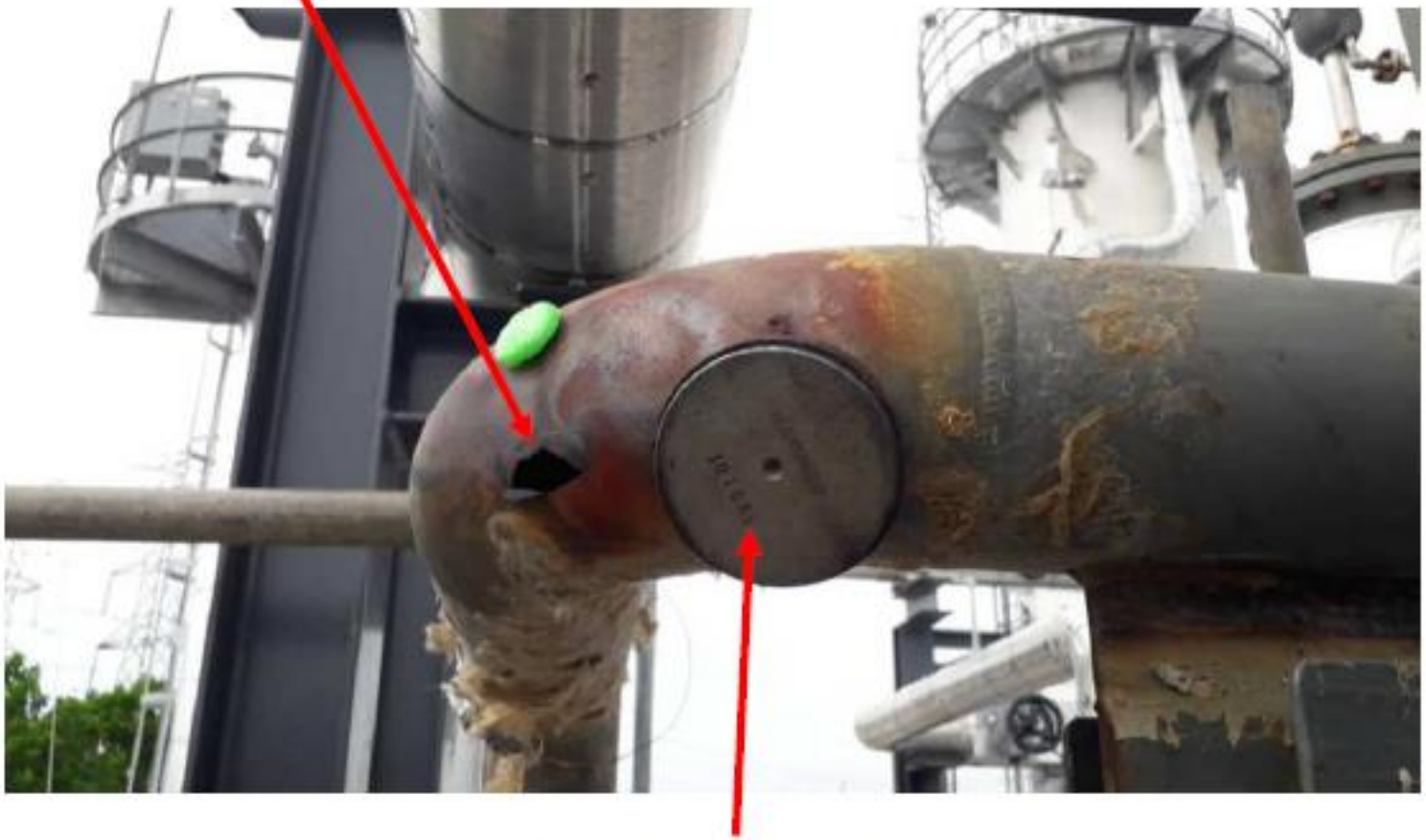
Event #23 Pictures

Approximately 1.5 inches size puncture hole at elbow



Piping material test with magnet, proof that it's carbon steel instead of Stainless Steel

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Maintenance and Construction

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Event #24

Construction Safety Event

Consequences*: *Crane topple during unloading, no injuries

What happened:

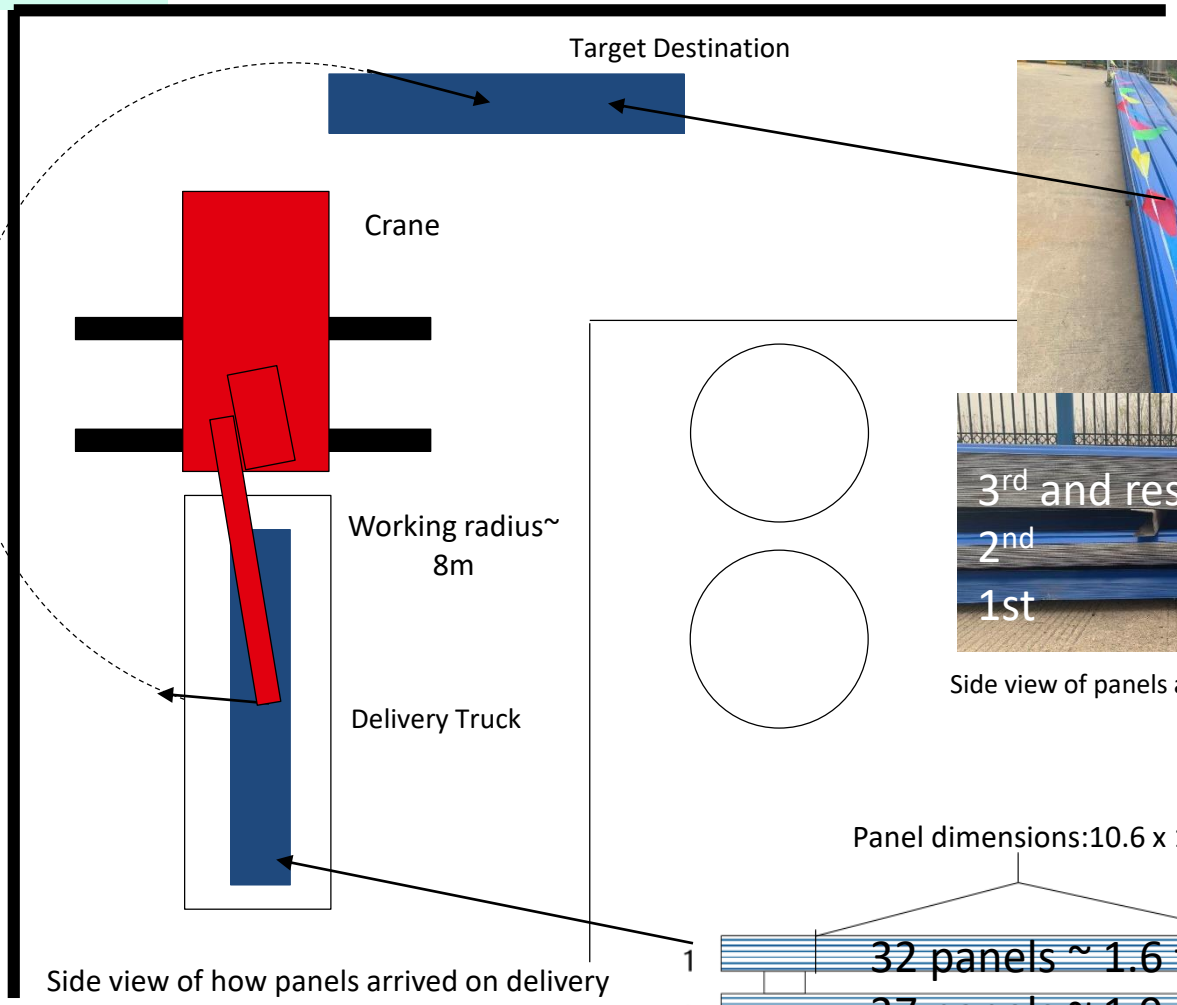
A supporting certificate of lifting (lifting plan) as part of a PTW had been completed prior to the lift, and a maximum weight of 2 Ts for each bundle had been estimated (based on 50 kg per panel) and recorded on the certificate. The first lift from the truck was a batch of 32 panels in a bundle (~1.6 te), the second bundle had 37 panels (~1.9 te). The first two lifts were completed. For the third lift, 48 panels were in the bundle (~2.4 te), and the crane toppled. The boom extension had been set to 17.4 m and working radius was ~8 m when lift began to topple. From loading chart, the safe loading weight at these parameters is only ~1.7 te

Major Cause(s):

- The safe working load of the crane was exceeded by the Operator at the 3rd lift
- Crane operator admitted he didn't sufficiently reduce working radius before rotating boom.
- Lack of attention to critical detail / lifting management inadequacy by Supervisor
- Inadequate design - The crane had no limiter / alarm warning for approach to unsafe loading

Event #24 Pictures

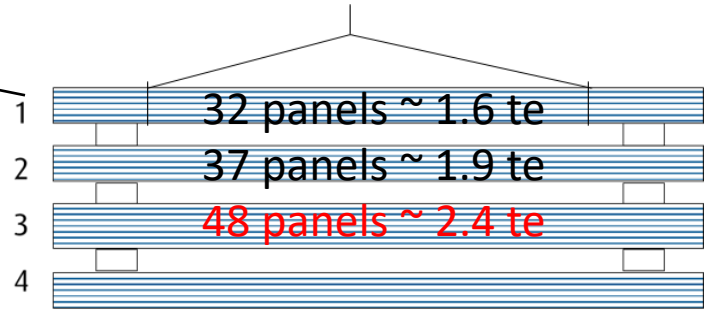
Crane topple position



Side view of panels after unloading

Side view of how panels arrived on delivery truck as four bundles – not so easy to notice difference:

Panel dimensions:10.6 x 1.0 x 0.006m



Event #25

Finger pinched by compressor wheel

***Consequences**: Lost Time Injury of employee*

What happened:

A mechanical engineer was performing a turning for compressor wheel by hand (manual barring).His glove got stuck between belt and the small pulley and he did not pull his hand out in time, which leads to the finger being stuck between belt and the small pulley. His right ring finger-end was fractured.

During the turning, the engineer wore PPE, the power of compressor was shut off and lock-out, the safe work permit was issued.

Major Cause(s):

- The person did not anticipate the risk
- Finger crush injury risk was not identified when issuing work permit

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Event #25 Pictures

Gloves worn during the incident

Lessons learned from the safety events

★ Transportation safety

- Driver **Fatigue Awareness** programs are critical for transport safety
- Driver Defensive Driving **refresher** training is essential
- **Around Two Wheelers**: Attention to high speed, separation distance and caution while overtaking
- Use of seat belts is a **life ‘saver’**
- **Installing** ABS, EBS, RSS etc help prevent roll overs

★ Process Safety

- **Operating Procedures**: Not following or gaps in procedures
- **Engineering and Field Reviews of Changes**: Not involving competent people and insufficient or lack of field verification
- **Permit to Work:** Insufficient supervision and not having competent people
- **Oxygen Compatibility**: Importance of correct design, procedures, materials etc
- **PPEs**: Non compliance

Lessons learned from the safety events

★ Work Injuries/Occupational Safety

- **Designs:** Gaps not identified
- **Operational Discipline and Site Management Accountability**: Ensure
- **Employee Training:** Lack of properly trained personnel not to carry out hazardous work
- **Unsafe act** and not following correct procedure
- Use of proper **PPEs**

★ Maintenance and Construction

- **Permit to Work**: Not carrying complete Risk Assessment and not identifying the Hazards before issuing HWP
- **Unsafe Act** by Operators and **gap** in supervision
- **Lift Review for Cranes**: Competent people and field reviews

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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 SB 12/18: Transportation Safety, Challenges and Improvement Strategy
- ❑AIGA 039/16: Road Transport Emergency Preparedness
- ❑ AIGA 041/10: Defensive Driving
- ❑ AIGA 040/15: Good practice guide for loading & unloading of cryo liquid tankers
- ❑ AIGA 008/10: Safety Training for Employees
- ❑ AIGA 066/18: Selection of Personnel Protective Equipment
- ❑AIGA 011/04: Work Permit System
- ❑ AIGA 015/15: Safety Management of Contractors
- ❑ AIGA SB 05/10: Recent cases of asphyxiation in confined spaces in Asia
- ❑ AIGA 008/18: Hazards of Oxygen Deficient Atmosphere
- ❑ AIGA 099/18: Process Safety Management Framework

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Thank you

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