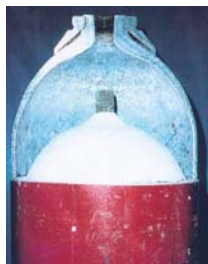


ACETYLENE GAS SAFETY SEMINAR 2009



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Asia Industrial Gases
Association



Council of Labor Affairs
Executive Yuan



Taiwan High Pressure
Gas Industrial Association

SAHTECH 財團法人
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Acetylene Incidents

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Acetylene Incidents

What can we learn?

– What have we forgotten?

Acetylene is unlike any other gas

In the past, we maintained the safety of the process by:

- ◆ **Strict engineering rules**
- ◆ **Tried & tested operational procedures**
- ◆ **Skilled staff highly supervised by experienced managers**

What has changed?

- ◆ Acetylene declining in importance
- ◆ Retirement of the “old generation”
- ◆ Competent engineers in short supply
- ◆ Manpower reduced
- ◆ Less direct supervision of the workforce
- ◆ Changes made to plant & processes without full understanding of the consequences

Incidents have happened

- ◆ The following incidents have happened in recent years in the global gas business
- ◆ From several companies - names and locations have been omitted
- ◆ All of them were preventable
- ◆ Nothing new was discovered from the investigations!

Incident **No.1** - Acetylene Fire

WHAT HAPPENED

- On 10.03.08, fillers were venting acetylene cylinders to atmosphere, not using the vent manifold, when an ignition occurred
- The fire quickly spread to other acetylene cylinders in the area
- The fillers unsuccessfully attempted to extinguish the fire
- The flammable filling operations were shut down and the facility evacuated
- The local fire department was called and extinguished the fire

CONSEQUENCES

- Minimal damage to the building in the area that the venting occurred
- One employee received a 1st degree burn to his face, a strained leg muscle and minor lacerations to the leg. He was treated and released from the local hospital
- Loss of 406 cylinders - \$35000(USD)
- Lost Revenue \$62000(USD)
- Actual or Potential Litigation / Prosecution Matters

Acetylene Fire - Damage



Building damaged



Cylinders damaged in fire

KEY FINDINGS (FROM CAUSAL TREE)

IMMEDIATE CAUSES

- ✓ **Flammable Atmosphere was created by acetylene cylinders venting directly to atmosphere**
- ✓ **Ignition Source not determined**
- ✓ **Employees attempted to fight fire exposing themselves to excessive heat**

KEY FINDINGS (FROM CAUSAL TREE)

- continued

UNDERLYING CAUSES

- ✓ **There was a backlog of cylinders to be vented as a result of an increase in reject rate in the 2 weeks prior to the incident that was not identified**
- ✓ **Site Emergency Action Plan instructs employees to fight small fires if possible but does not define small**
- ✓ **No fire protection system covered the area**

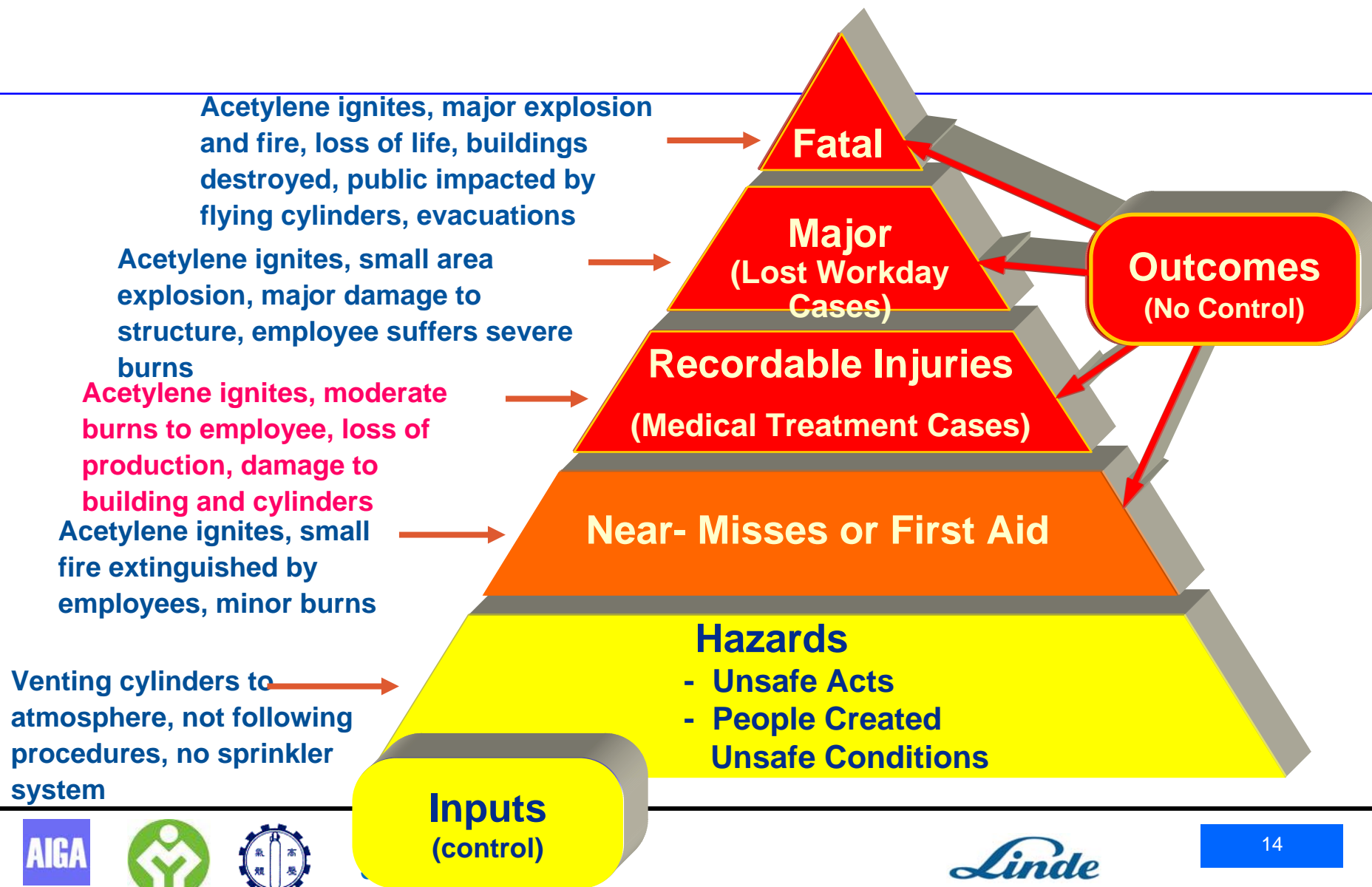
KEY FINDINGS (FROM CAUSAL TREE)

- continued

BEHAVIOURAL FACTORS:

- **Employees vented cylinders to atmosphere in violation of Company policy**
- **Employees attempted to control fire instead of following emergency fire protocol**

THE HAZARD TRIANGLE



Incident **No. 2**: Cylinder Fire & Explosion

Incident Description:

- Three DA cylinders were kept inside a steel cubicle located in the middle of a railway workshop.
- The customer's employees noticed smoke and fire in the cubicle and withdrew to a safe distance.
- The fire continued for about 20 minutes, at which point some employees approached the cubicle.
- One person knocked one of the cylinders over on to the ground and it exploded, killing him.
- Five men suffered burn injuries and two of them later died in the hospital.

Cylinder Fire & Explosion - Damage



Steel Cubicle

Lessons Learnt

- **Hot acetylene cylinders can spontaneously explode. Do not approach, move or knock them.**
- **People who handle acetylene cylinders must be fully informed of and understand hot cylinder procedures.**

Incident **No.3** - Transporting Cylinders in Enclosed Cab

- A fitter with a work van left a DA cylinder on the back seat of Toyota dual cab over the week end.
- Acetylene cylinder valve was not fully closed and a leak occurred.
- Acetylene accumulated in the van.
- On Monday morning, as soon as the fitter opened the door, a large explosion took place.
- Ignition may have been caused by either:
 - internal light circulatory
 - automatic door control
 - mobile phone which was on the front seat
 - lighting a cigarette. The fitter was a smoker.

Cab badly damaged



Transporting Cylinders in Enclosed Cab - Consequences & Lessons learnt

Consequences

- The fitter has damage to his ear drums & injuries on the face.
- The cab was badly damaged

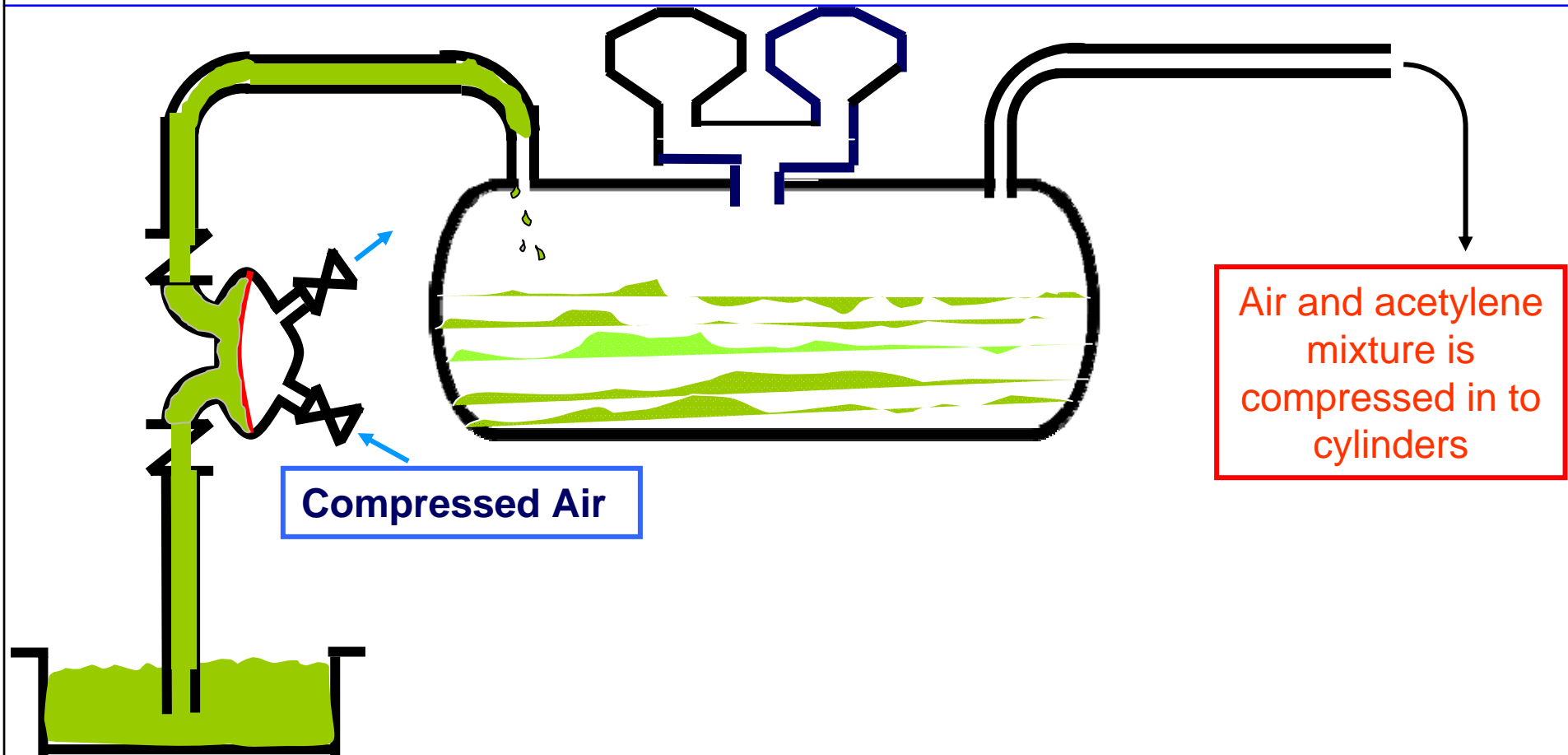
Lessons learnt :

- Never store cylinders in an enclosed vehicle or area

Incident **No.4**: Cylinders filled with air

- An air driven diaphragm pump on the generator water system failed, resulting in the ingress of air
- The air got filled into several racks of DA cylinders resulting in a mixture of 80/20% acetylene/air
 - ✓ Some of the cylinders were dispatched to customers

Air Acetylene Mixture



Lessons learnt

- **Management of change procedures**
 - Experience of local engineering & management staff
 - Incorrect design of pump selected
 - HAZOP and risk assessment
 - Review of design by competent persons
- **Staff knowledge of plant, processes and operations**
 - Diagnostic skills
 - Acetylene purity testing

Similar incidents?

- **Compressed air line used to remove sludge blockage in water pipe**
- **Compressor started up after maintenance with suction pipe not connected**
 - Combined with failure of low pressure suction switch on compressor
- **Failure to purge plant after maintenance**
- **Nitrogen purge connection by-passing**
 - Adiabatic compression of N_2 & C_2H_2 can cause a decomposition




Incident **No. 5**: Acetylene explosion

- ◆ Acetylene cylinders were vented to atmosphere in the yard
- ◆ A postman parked his van close by
- ◆ Upon returning, the postman got into the van & started the engine, igniting the gas cloud
- ◆ Large explosion





Lessons learnt

-  **Never vent DA cylinders to atmosphere**
-  **Acetylene from a cylinder contains acetone – the mixture is heavier than air**
-  **This type of incident has happened many times in the past**

Incident **No.6** - Gasholder Explosion

- Broken support bracket on gasholder dome required repairing
- Plant shut down, system purged with nitrogen for 4 days
- Permit-to-Work issued after testing for acetylene in the gasholder
- Welding started - there was an instant explosion
- The gasholder dome shot up into the air
- The welder fell from his ladder - not hurt





Lessons learnt

- **Pellistor* sensors require the presence of air and acetylene to function**
 - ✓ they cannot detect acetylene in nitrogen
- **Acetylene dissolves in water in gasholders**
 - ✓ it may be released if the temperature rises or the pressure drops

*A **pellistor** is a solid-state device used to detect gases which are either combustible or which have a significant difference in thermal conductivity to that of air. The word "pellistor" is a combination of pellet and resistor.

Where else has this happened?

- Acetylene released from water in underground drains resulting in an explosion
- Acetylene released from carbide lime slurry in a tanker which used a vacuum pump for loading resulting in an explosion in the pump housing
- Acetylene released from freshly filled (recycled) water in the generator body after generator cleaning causing an explosion when the first charge of carbide was dropped into the hopper

Summary - what can we do?

- Follow the AIGA Doc 22/05 - Code of practice: Acetylene
- Always follow Management of Change procedures – refer to AIGA Doc 010/04
- HAZOP study all designs and changes
- Perform risk assessments for all acetylene operations and processes
- Train all staff and assess competency

Summary - what can we do?

- Periodically audit all systems, operations and engineering to ensure compliance
- Managers must get out of their offices
- Be aware at all times of the specific hazards associated with acetylene
 - ✓ ignition
 - ✓ deflagration
 - ✓ detonation

Acetylene Safety

Please look after the safety of yourself, your colleagues and your customers

Thank you