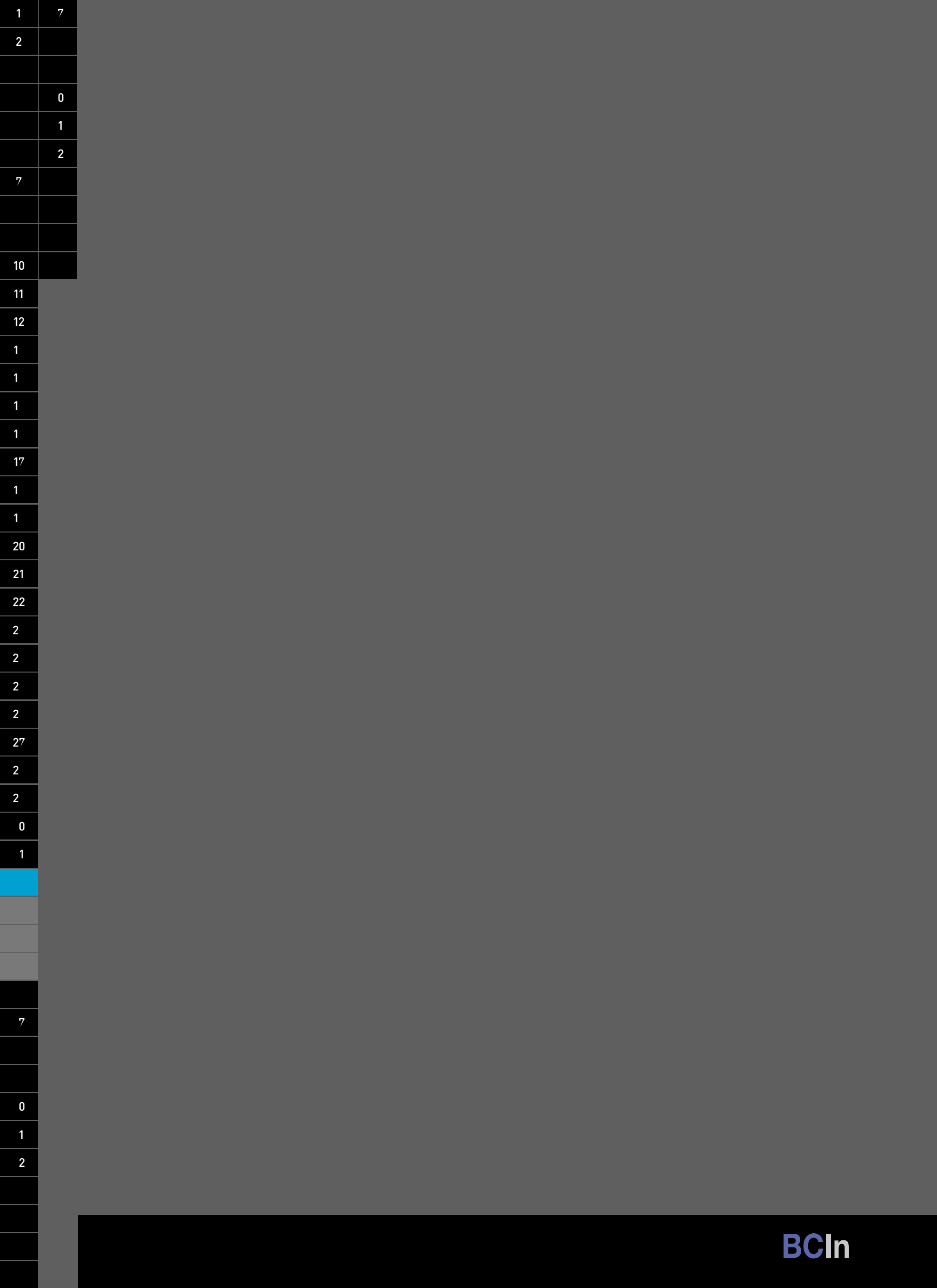

BCIn

- Improper handling hazardous materials:
  - Flammables
  - Combustibles
  - Toxins
  - Corrosives
  - Explosives (or substances capable of exploding)
  - Poor utilisation or lack of proper PPE
  - Poor utilisation or lack of proper RPE

These issues occur over and over again. But why are we seeing repeat "violations" involving issues that we know to be problematic? Is it:

- a competence issue?
- a personnel issue?
- an individual/organisational issue?
- attitudinal in nature?
- behavioural in nature?
- related to risk?
- an ownership problem?
- a lack of commitment issue?
- a normalisation issue?
- a matter of beliefs?

It is believed that the intersection of all of these issues in aggregate constitute "the culture", or in this case, safety culture. Safety culture is important because management systems and their associated policies and procedures depend upon the actions of individuals and groups for their successful implementation.

It is the product of the individual/group values, attitudes, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety programs. A more succinct definition has been suggested: "Safety culture is how the organisation behaves when no one is watching."

Human beings take shortcuts for a variety of reasons and may do so without unacceptable consequences. Over time this can result in normalisation of deviance and lead to a poor safety culture, for example:

- little or no safety planning;
- no balance between safety and profitability;
- lack of training;
- no reporting of hazards;
- general lack of awareness of consequences of actions which could lead to a catastrophic disaster;
- inevitable consequences of actions led to catastrophic disaster;
- no commitment from workforce;
- feedback loop is not closed after an accident;
- management blames individuals for an accident.

Manny stated that we have to stop behaving like an ostrich, sticking our heads in the sand and believing it will improve if we do nothing. We need to start talking, start doing and by believing together we can move toward zero fatalities.

Safety incidents

The key safety related papers were:

Fire due to oil tank rupture

A power outage tripped the ammonia plant and 30 minutes later the syngas compressor oil tank exploded. They had all the components needed for an explosion in the tank. Oil vapour likely containing hydrogen degassed from oil to a limited extent ignited as oxygen enriched ambient air entered the oil tank. The missing pressure switch trip on the nitrogen compressor and the leaking end lid contributed to the incident. It is very unlikely to identify such a scenario through a HAZOP, where double jeopardy isn't usually considered. All unwanted incidents, like a nitrogen compressor not stopping when it should, must have two independent technical barriers. In this case the water mist system limited the damage. Another fact is that during the 30 minutes between the plant trip by the power outage and the fire, the control room operator got 900 alarms from the DCS.

Process gas cooler (PGC) tubesheet thermal disintegration

This paper highlighted the complexity of designing and operating a process gas cooler. The fibre materials used (high SiO_2 content) were not resistant to the reducing gas atmosphere and started to dissolve over time, opening gaps. The inliner of the central bypass was restricted in axial movement and pushed the refractory away from the tubesheet. The gap between the ferrules and the tubesheet holes was not closed with resistant material and allowed the gas to flow through.

The learnings were as follows:

- Damage along the tubesheet (gas side) cannot be detected during regular inspections without having the refractory removed.
- If the gas bypasses the refractory it may cause overheating of the metal shell, leading to coking and material loss. Also, the risk of high temperature hydrogen attack arises.

Manny Ehrlich, CSB Board Member, 2014-2019

- Fitness for service analysis can determine whether a PGC with a damaged tubesheet is further usable.
- During equipment design an exchange of all operating parameters including start-up and shutdown conditions is extremely important as design parameters are easily compromised during those operational stages.
- During manufacturing and repair a high focus must be put on refractory design and execution as well as details regarding ferrule tolerances and the bypass in liner.

HP scrubber undetected carbamate corrosion

In February 2018, a leak was noticed in the spherical dome part of a HP scrubber in a urea plant. The plant was stopped immediately to attend to the leak. Upon opening of the HP scrubber sphere, it became clear that severe corrosion had occurred on the liners. The liner was covered with a huge amount of corrosive products and many cracks were observed which resulted in leaks.

The severe corrosion of the pressure bearing part of the sphere was due to the fact that the liner leakage preceding this corrosion could not be noticed as leak detection holes got plugged. This demonstrates the importance of a reliable and robust leak detection system. Nowadays the technology licensor recommends using a state of the art leak detection system, which is based on continuous forced air flow fed to an ammonia analyser (so-called pressurise system), which can be connected to the DCS system.

The leakage in the liner occurred due to so-called strain induced intergranular corrosion (SIIC). This was the result of condensation of reactor off gases in combination with plastic deformation of the 316L UG liner.

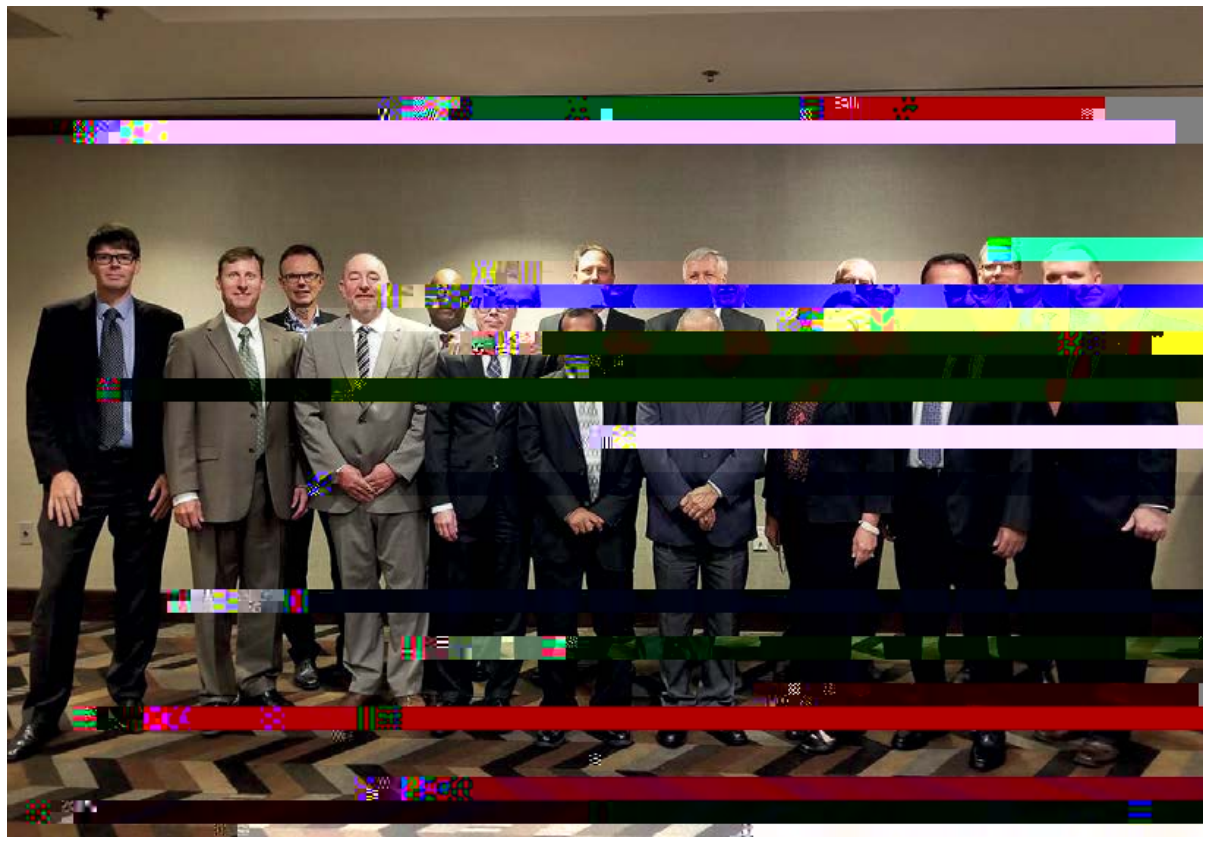
The plastic deformation was mainly the result of bending the liner plates during manufacturing. However frequent temperature and pressure cycles may play a role as well.

Condensation of the hot reactor off gases cannot be avoided completely in the HP scrubber sphere, despite the presence of a steam tracing. Plastic deformation of the 316L UG liner material cannot be completely avoided either.

Due to the liner leak, ammonia-carbamate started to corrode the carbon-steel pressure shell. Besides wall thinning, hydrogen induced cracks (HIC) were also developed in the carbon-steel. Unfortunately, the selected steel (20MnMoNi45 DIN 17201) for the HP Scrubber sphere is prone to this failure mode (HIC) due to the high strength properties. Corrosion of the carbon-steel pressure retaining part should be avoided always. This is managed by having a reliable leak detection system in place. Furthermore, the risk of hydrogen induced cracking can be reduced by applying so-called low strength steels instead of high strength steels.

Damage of combustion air ducting

Severe damage to the parent material



F : *John Brightling (Johnson Matthey), Taylor Archer (Clariant), Michal Warzes (Yara), John Mason (Nutrien), Venkat Pattabathula (Incitec Pivot), AK Singh (IFFCO), Dorothy Shaffer (Baker Risk), Ahmed Esmael Rahimi (QAFCO), Eugene Britton (CF Industries)*

B : *Klaus Noelker (ThyssenKrupp Industrial Solutions), Ian Welch (Nutrien), Scott Rodrigue (CF Industries), Robert Collins (KBR), Neal Barkley (Coffeyville Resources Nitrogen), Harris Duisters (OCI Fertilizers), Svend Erik Nielsen from Haldor Topsoe was missing in the image.*

As part of the plant upgrade activities, the synthesis loop boiler feed water exchanger of Ammonia Unit II was replaced in February 2012 due to its tube plugging history. The elevation of the inlet nozzle of the new BFW exchanger was higher than the previous one. To accommodate the change in inlet nozzle elevation of the old BFW exchanger, a pipe spool piece of 1.3-m (4-ft) length was inserted into the vertical leg of piping from a new exchanger installed in 1993 plant revamp at the exit of old BFW exchanger.

The fire incident happened due to localised cracking/rupture at the weld joint of this inserted spool piece which was carrying synthesis gas at a temperature of 285°C (545°F) and pressure of 179.5 bar (2603.5 psig). The incident took place on 5th November 2017 at 10:08 am and the fire was controlled within 15 minutes. The plant was operating normally prior to this incident.

The fire caused damage to the equipment, pipelines, instrument and electrical cables, insulation etc. in the vicinity, which were assessed and restored. The plant operations were fully normalised by 30th November 2017.

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