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PARTNER IN COMPLIANCE

Influence of Situational Awareness on Process Safety

Why, What & How

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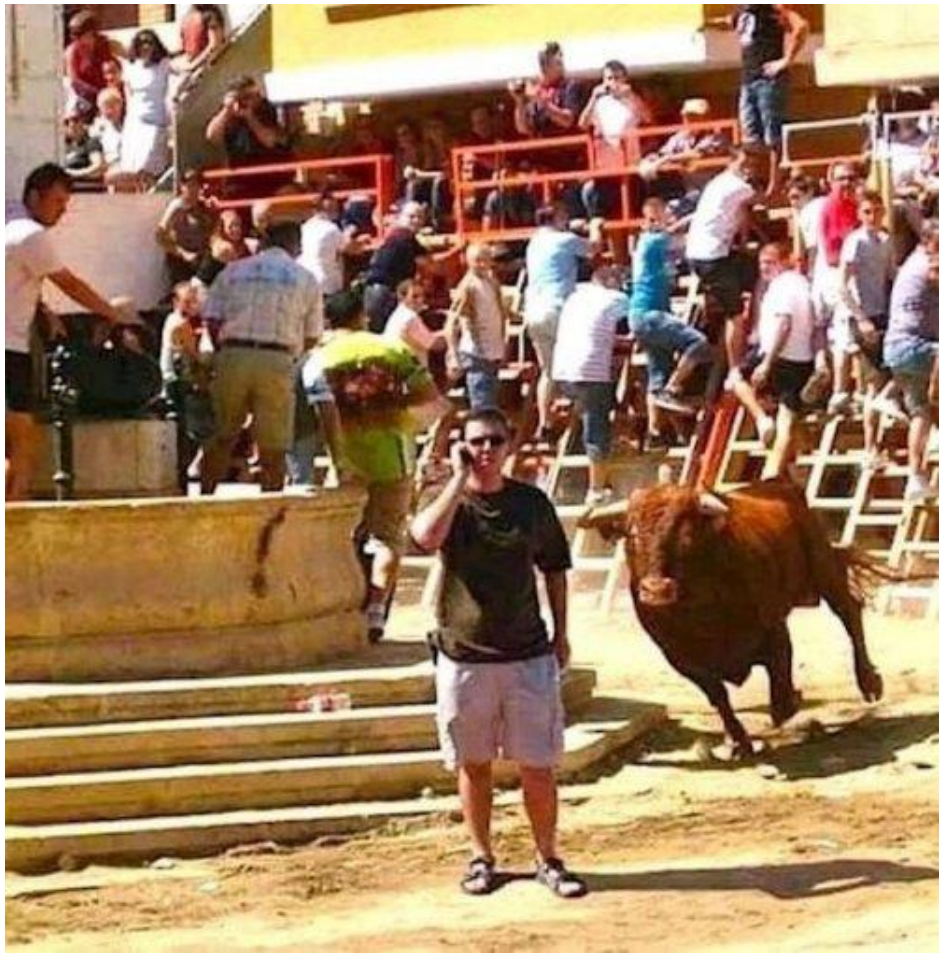
- Material & Corrosion R&D
- Refinery/Chemicals Operations
- Global Operating Integrity implementation (Up & Downstream)
- Operational Excellence Advisor
- Operations Assurance

First: Situational Awareness

What we think Situational Awareness is

Why is it important in the Energy Industry?

How can we optimize Situational Awareness?



What is Situational Awareness?

US Navy defines it as:

1. “The degree of accuracy by which one's perception of his/her current environment mirrors reality”.

In Aviation:

1. “The aware attention to the external reality, and more importantly, the accurate interpretation of events, conditions and phenomena”
2. “An ongoing process of the continuous assessment and accurate interpretation of reality”

How does Situational Awareness influence process safety?

In important factor in process safety incidents: “Perception Versus Reality”

- Incoming information versus expectations
- View on the situation (observations) / interpretation
- Assumptions & biases
- Normalising the abnormal

Herald of Free Enterprise (1987)

Piper Alpha (1988)

Milford Haven (1994)

Longford (1998)

Texas City (2005)

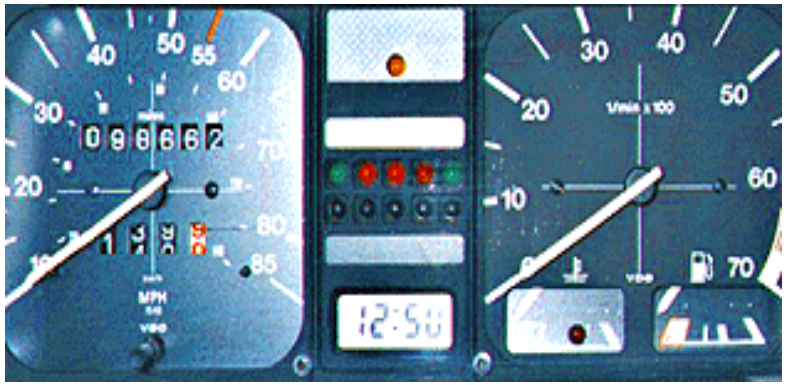
BP Macondo (2010)

Situational Awareness – test (1)

Is the situation as you expect it to be ?

Situational Awareness – test (2)

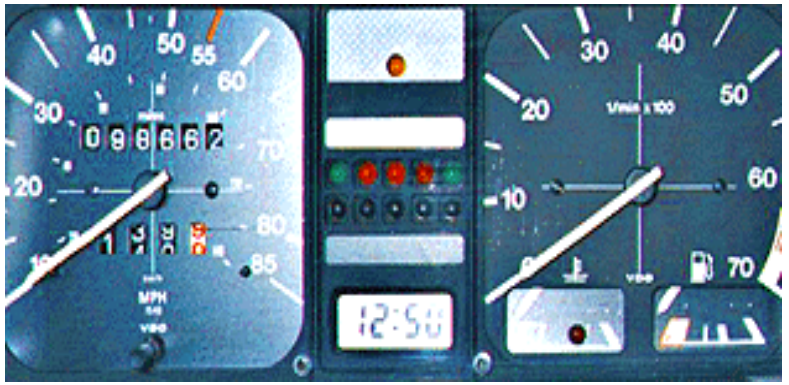
Is the situation as you expect it to be ?



Situational Awareness – test (3)

Is the situation as you expect it to be ?

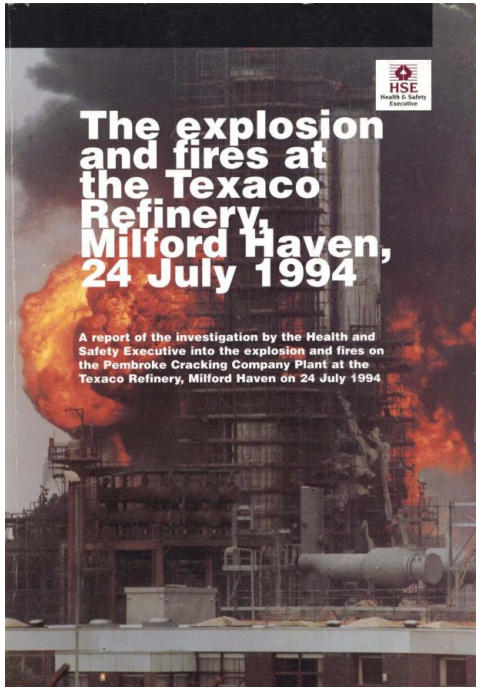
Tachometer Speed



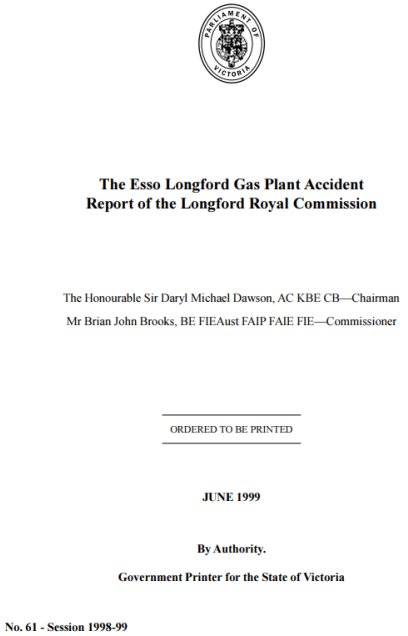
Speed Tachometer

Three examples in more detail

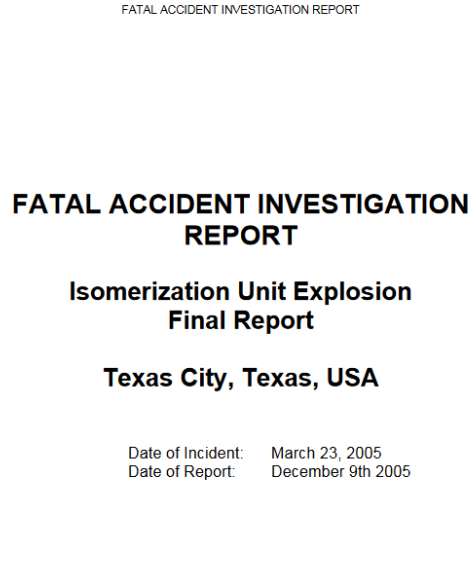
There are numerous examples of process safety incidents where (lack off) situational awareness played an important role, below three examples we'll discuss in more detail:



Milford Haven (UK)



Longford (Australia)



Texas City (USA)

Example: Milford Haven (1)

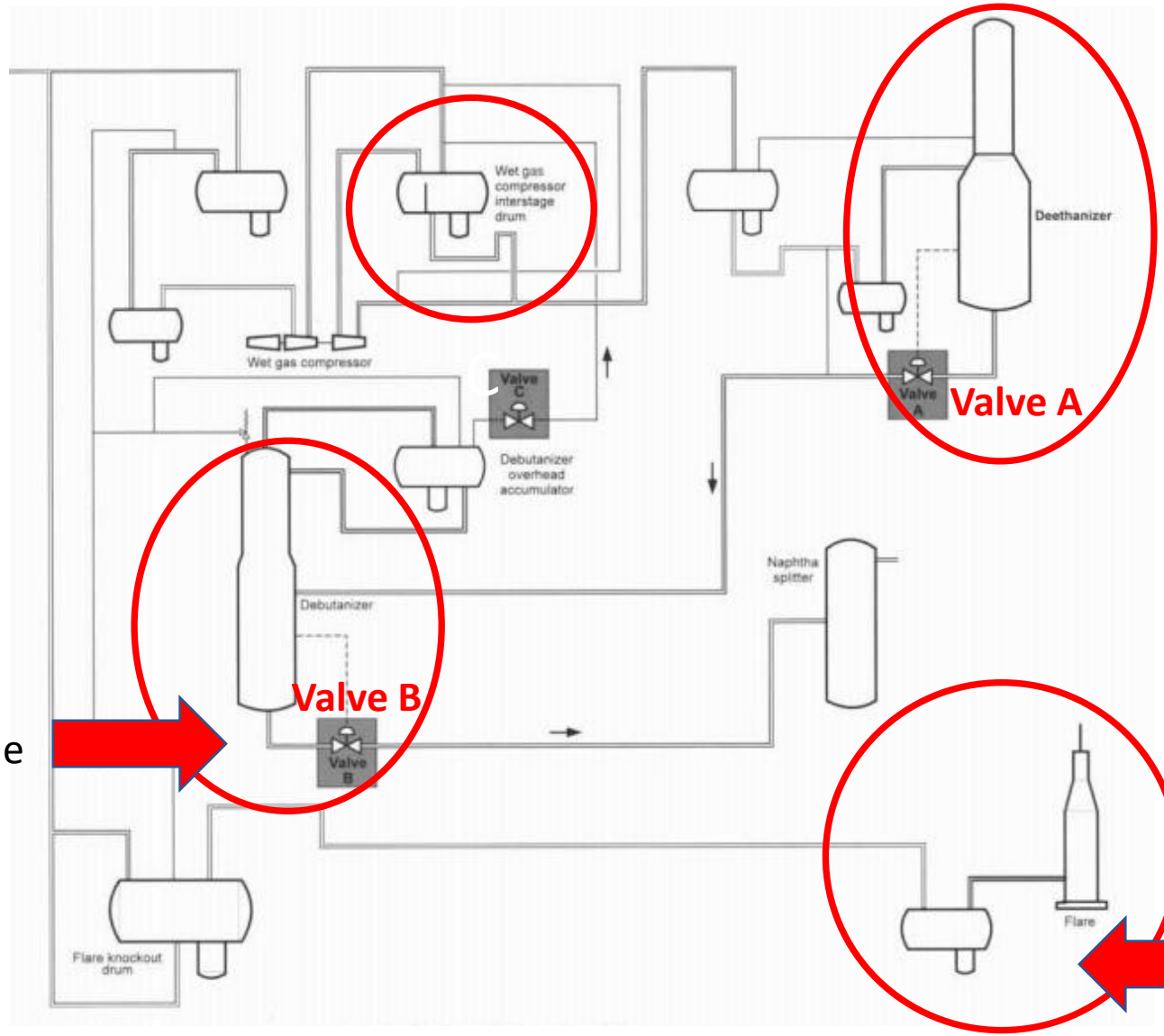
In 1994 an explosion and large fire developed in the Texaco Milford Haven refinery due to the rupture of a large flare line.

- The start of the events; a lightening storm that affected a large part of the refinery;
- All units went down except the Catalytic Cracker (CC);
- Problems with the flow into the de-ethaniser (of the CC) initiated a series of actions during which large quantities of liquid were dumped into the flare system;
- Due to a plant change the flare vessel could not be emptied at a high enough rate to cope with the inflow of liquid;
- A rupture in a flare line led to the release of 20 tonnes of flammable hydrocarbons. The drifting cloud of vapour and droplets found a source of ignition 110 meter from the rupture point;
- It took about two and a half days to extinguish the fire;
- 26 people were injured on site, off site damage was limited, some house in Milford Haven had glass damage. There was considerable damage on the site.

Example: Milford Haven (2)

Various repeated actions to drain hydrocarbons

Valve B which closed and never opened again (but shown “open” on the DCS screen



The low level in the de-ethanizer which caused valve A to close

The increasing level in the KO drum which was not noticed resulting in liquid carry-over into the flare line

Example: Milford Haven (3)

- Operators were focused on fixing the problem;
- They were overloaded with alarms and other information;
- The true position of Valve B was not noticed;
- Actions were repeated without considering why the problems were not solved;
- Operators did not realise that you could not dump unlimited quantities of liquid into the flare system;
- The increasing Flare KO level was not noticed;
- Operators were unaware of the weakness of the flare system (corroded and not designed for liquid).

Example: Longford (1)

In 1998 an vapour cloud deflagration and a subsequent large fire developed in the Esso Longford Gas Plant due to the rupture of a heat exchanger:
The plant was operated a too high throughput to meet production targets. Various process parameters were operated beyond normal values;

- Due to a too high level in a condensate absorber condensate entered the rich oil stream, the lean oil pump tripped.
- The lean oil heat exchanger cooled down from the normal 60-230 °C range to -48 °C. Ice was formed on the equipment and flanges became misaligned due to thermal stress, leaks developed;
- 4 hours were spent on the re-start of the lean oil pump to thaw the ice and restart the process, finally they managed to restart the pump;
- Lean oil of 230 °C entered the cold exchanger, which failed due to cold embrittlement;
- A vapour cloud of 10 tons of hydrocarbons developed which was ignited by a furnace. The cloud deflagrated and a fierce jet fire developed which lasted for two days.
- As a consequence the whole complex was shutdown;
- Two people were killed and eight were seriously injured. The state of Victoria 2 weeks was without natural gas and Esso faced claims of around $1 billion;
- A Royal Commission concluded that operators were not to be blamed.

Example: Longford (2)

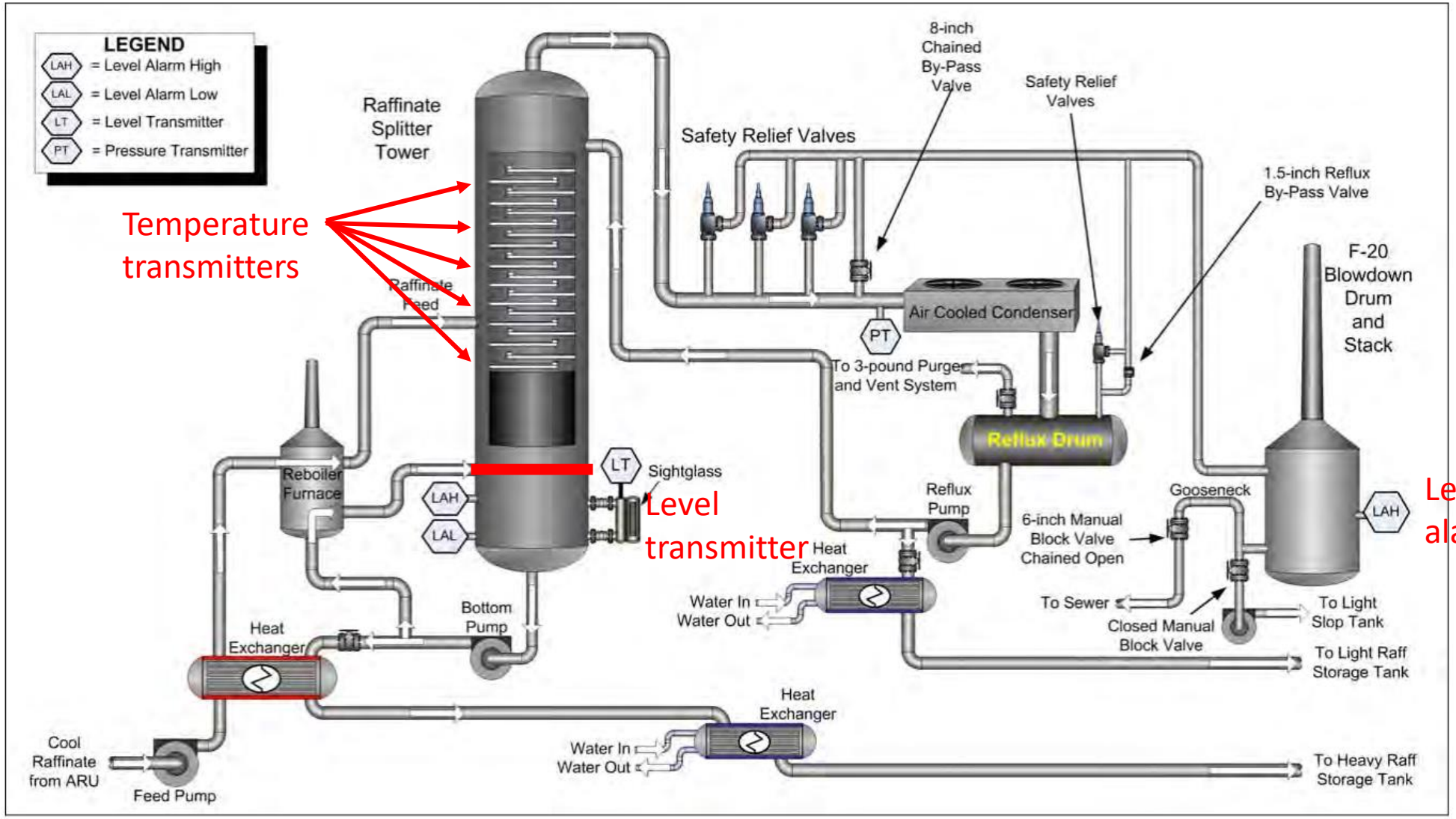
- Running the beyond the design limits was considered normal to meet the gas demand;
- No HAZOP done (due to resource concerns) - "if it ain't broken, don't fix it - it ran fine for 30 years"
- Operators were focused on fixing the problem;
- They were overloaded with alarms and other information;
- In the control room operators were not aware of the dangerous situation outside;
- Actions were repeated by different shifts due to a poor handover;
- Operators were not aware of the safety consequences of the developing situation (lack of knowledge).

Example: Texas City (1)

In 2005 an explosion and a subsequent large fire developed in the BP Texas City refinery during the start-up of isomerization unit (ISOM) due to the overfilling of the raffinate splitter:
The isomerization unit was started up after a maintenance shutdown;

- The start-up was initiated by filling the raffinate splitter with liquid;
- Open maintenance orders on defect equipment were ignored;
- The level indicator had a range of only 3 meter, beyond that the level could be displayed as a drop in the level;
- An additional high-level alarm at 2.5 meter was not noticed or didn't work;
- The supervisor was not on site during the critical start-up phase;
- Once the operator sensed that the level could be far higher than expected the corrective action (draining the column) increased the temperature of the incoming fluid;
- Vapour bubbles caused a discharge of liquid and vapour into the overhead relief system, this resulted in a geyser of hydrocarbons from a vent stack;
- This resulted in an explosion triggered by a spark from a running car engine;
- 15 people were killed and 170 were injured by the explosion;
- The incident triggered a series of investigations and resulted in changes in various rules and regulations

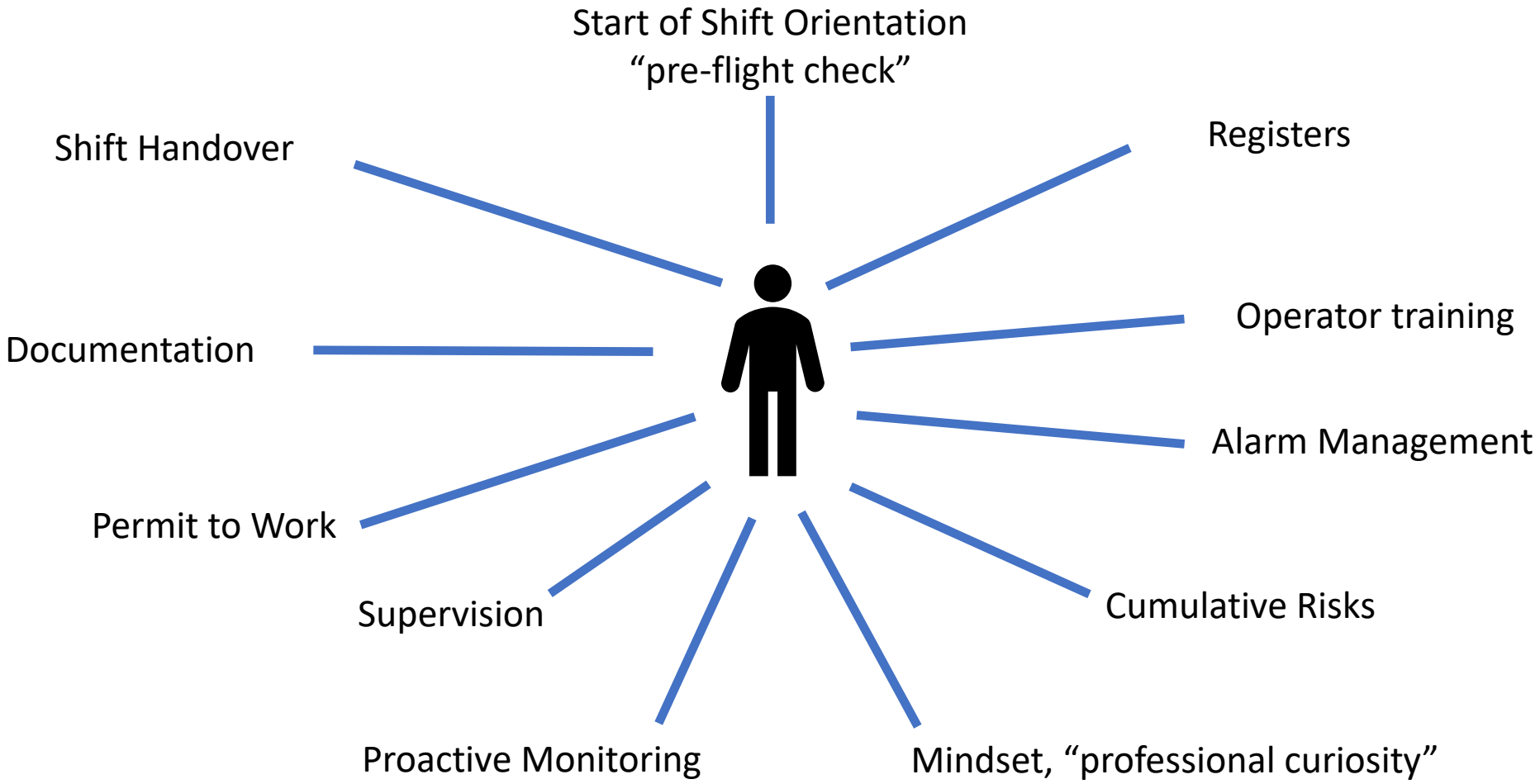
Example: Texas City (2)



Example: Texas City (3)

- Operators did not fill the column according to their own start-up procedure;
- Because the liquid level exceeded the range of the level instrument it was impossible to determine the real level;
- The next shift continued feeding liquid into the column due to a poor handover/logbook entry;
- There was no simple display to determine the mass balance of the column;
- Finally due to an increasing pressure in the column operators sensed something was not right;
- The mitigating actions worsened the situation;
- Operators were unaware of the (quickly) rising level in the blow-out drum

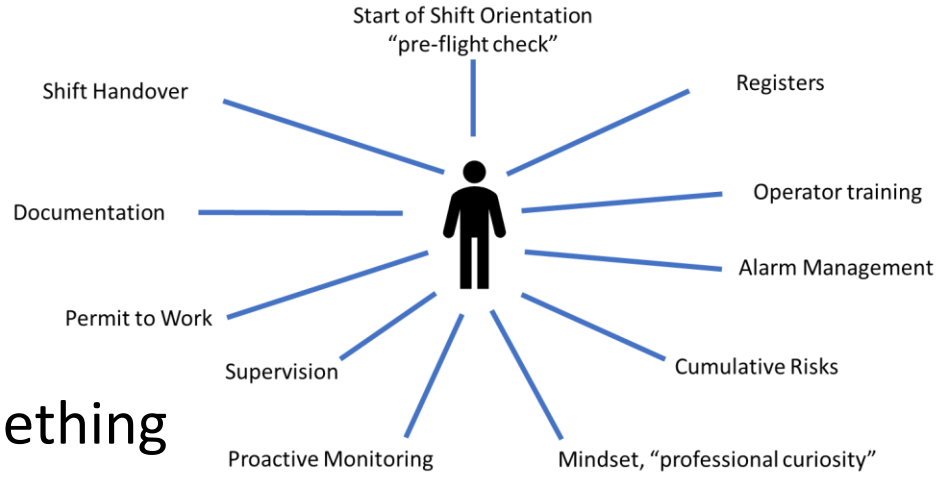
Situational Awareness - How



Situational Awareness – How it supports Process Safety

Several things can raise the level of situational awareness:

- A good shift report of status and actions taken is a sound basis for the next shift;
- A quality 1-1 two-way handover will enhance this further;
- A first orientation on status and ongoing activities will confirm assumptions and verification of handover information;
- Additional tools and systems should provide correct information on status and process information;
- In addition to all that, a critical mindset is key; if something appears wrong there must be something wrong;
- Supervision should ask critical questions about status, ongoing activities and possible corrective actions



Concluding remarks

- Poor situational awareness is an important factor and may contribute to process safety incidents;
- There is no “silver bullet” to increase the level of situational awareness, all items discussed will make their contribution;

- It cannot be resolved by an IT solution, though some may help;
- Simple tools can help; registers, check lists, structured operator routines etc.
- Thorough training on process will help to detect abnormal situations in an early stage;
- A a critical mindset and supervision will add to the desired “sharpness” to detect early signs of developing trouble and take corrective actions.

ANY QUESTIONS?

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