
Texas City Incident

Human Factor Aspects

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Incident Summary

- Occurred during start-up of the isomerisation unit after a month's shut-down.
- Highly flammable gasoline components released from a blowdown drum after a tower overflow.
- 15 fatalities in or near office trailers located close to the blowdown drum.
- 170 injured and estimated \$1.5 billion damage.
- 43 000 residents told to stay indoors during incident.

Incident Summary

- Investigation Report by the U.S. Chemical Safety and Hazard Investigation Board
- Key Issues:
 - **Safety Culture**
 - Regulatory Oversight
 - Process Safety
 - **Human Factors**

Process Overview

- Isomerisation (ISOM) unit – boost octane level in unleaded petrol. Accident in raffinate splitter section.
- Raffinate (mixture of liquid hydrocarbons) fed into tower.
- The splitter (or raffinate) tower – 170 foot distillation column.
- Split the raffinate into light (40%) or heavy (60%) components.
- Light components sent to next portion of unit; heavy components to storage.

Incident Overview

- Raffinate splitter shut down 21st Feb 2005 for scheduled maintenance.
- Normal workforce 1600, with additional 800 contractors (sited in temporary trailers).
- ISOM operators: 12-hour shifts every day from Feb 21st to March 23rd start-up.
- No time to complete repairs of level indicator, level sight glass and a pressure control valve before start-up.

Incident Overview

- No time to complete safety checks of alarms and instruments on March 22nd. Signed off by supervisor on paperwork.
- The start-up was begun on March 22nd, aborted and then restarted on March 23rd during the night-shift.
- Two supervisors in the day. The experienced supervisor was called away to a family emergency. The second supervisor was preoccupied with other unit.

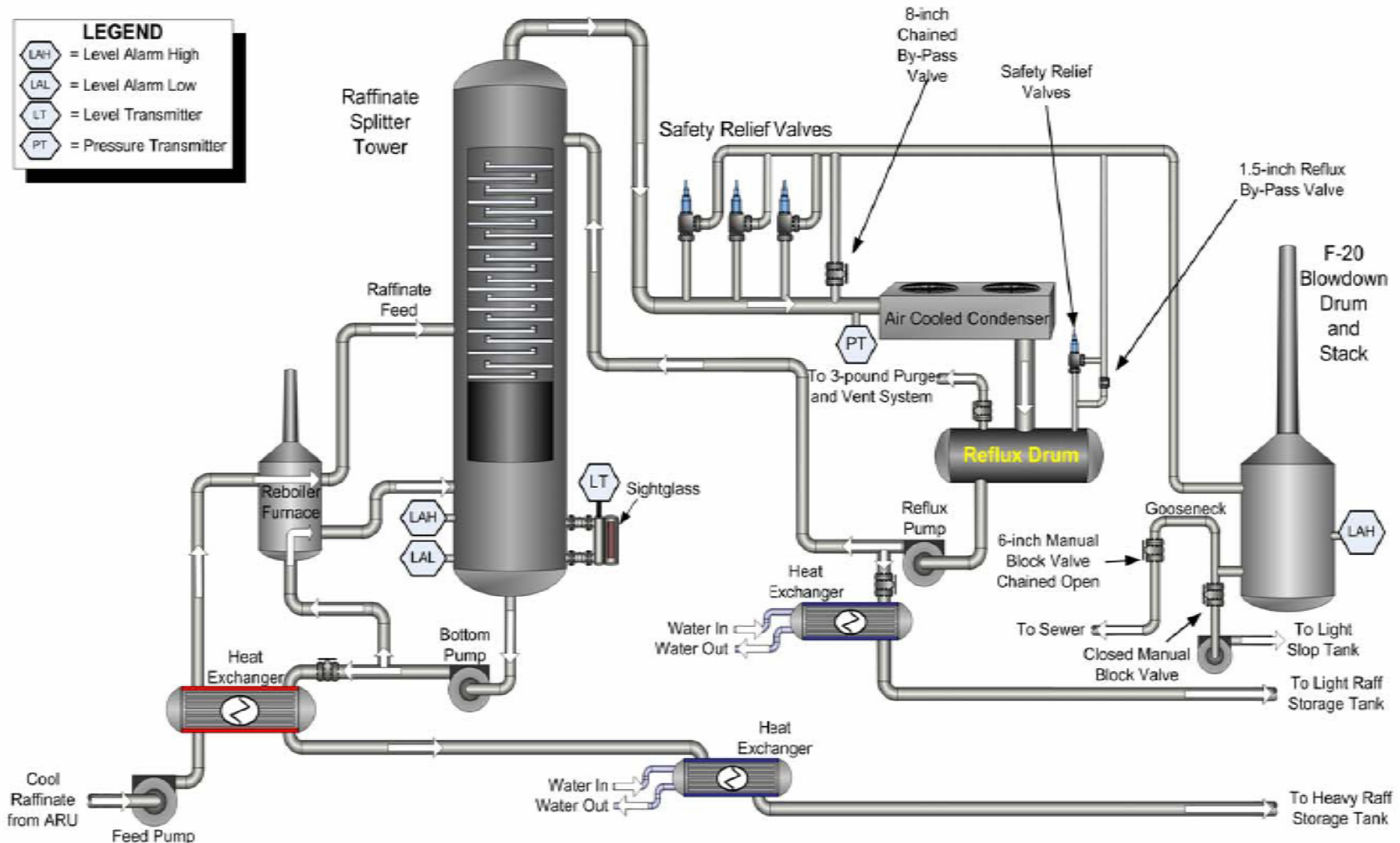
Texas City Video

- Six minute video.
- Illustrates the sequence of events leading to the overflowing of the raffinate splitter tower.
- A number of human factors influencing events are apparent.
- Which human factors issues are illustrated in the video? (Job, Organisation, Individual Factors)

Raffinate Section of the ISOM

LEGEND

LAH	= Level Alarm High
LAL	= Level Alarm Low
LT	= Level Transmitter
PT	= Pressure Transmitter



Human Factors Summary

“Individuals do not plan to make mistakes; they do what makes sense to them at the time”

Why did the individuals take the actions that they did?

Human Factors Summary

1. Procedures were not followed.
2. Ineffective communication during start-up.
3. Instrumentation gave misleading information.
4. Operator fatigue.
5. Understaffing and lack of supervision.
6. Ineffective Training.
7. Poorly designed control board display.
8. Poor safety culture.

Procedures not followed

“The work environment encouraged procedural deviations.”

Procedures did not reflect actual practice:

- In a majority of the start-ups the tower filled above the range of the level indicator.
- There were swings in level in the majority of the start-ups. Accepted as normal, had to run raff discharge valve in manual to overcome these.
- Tower pressure alarm set-points were frequently exceeded. Procedure didn't address this at all.

Procedures not followed

- BP allowed supervisors and operators to alter, edit and remove procedural steps without MOC analysis.
- The start-up procedure lacked sufficient instructions for the Board Operator on start-up
 - especially for the unusual circumstance of aborting the start-up
 - a rigorous pre start-up safety review had not been carried out.
- Time pressure caused the supervisor to bypass safety checks on March 22nd and yet sign off the start-up procedure to say they had been checked.

Procedures not followed

- Problems during start-up were so common that operators believed that they had to deviate from the written standard procedures in order to start the unit efficiently.
- “Necessary violations” – when departing from the procedure is necessary to get the job done.

Ineffective Communication

- Confusion around whether the light or heavy raffinate tanks were full.
 - day board operator believed he was instructed not to send heavy raff to storage and closed the tower level control valve,
 - outside operators believed they were instructed not to send light raff to storage and diverted light raff to the heavy raff line.

Ineffective Communication

- The condition of the equipment was not communicated across shifts.
 - Day board operator thought only the tower had been filled with raffinate, and was unaware that the ancillary equipment (e.g. piping) had also been filled with raffinate.
- **“ISOM: Brought in some raff to unit, to pack raff with.”**
- BP had no shift communication policy and did not enforce formal shift turnover, or require logbook/procedural records to facilitate communication

Instrumentation Misleading

- The sight glass on the tower was dirty and unreadable.
- The redundant high level alarm on the splitter tower failed to sound.
- The level indicator that was available was miscalibrated and gave the operators false readings that suggested the liquid level in the tower was declining.
- There was no other indication of level available to the operators.

Instrumentation Misleading



Figure S- 3. LT-5100 cabinet showing calibration set for 0.8 specific gravity

Operator Fatigue

- Day Board Operator had worked 29 days successively on 12 hour shifts. Lost 1.5 hours sleep per day. Estimated sleep debt of 43.5 hours (nearly one weeks sleep).
- Night Lead Operator had worked 33 days.
- Acute sleep loss and sleep debt.
- Baker Report - average rate of overtime at Texas City was 27%, with several employees exceeding 68%. Excessive, likely to compromise safety, and symptomatic of understaffing.
- CSB concluded that fatigue was a likely contributing factor to the incident.
- BP had no corporate or site-specific fatigue prevention policy or maximum shift work regulations.

Operator Fatigue

- The Board Operator did not recognise that feed was entering the tower but not being removed, or that the tower was overflowing.
- Multiple pressure spikes in the hours preceding the incident. The operators focused on reducing pressure rather than questioning why the pressure spikes were occurring.
- Rigidity in thinking; difficulty to respond to changing circumstances; takes longer to reason correctly.
- ‘Cognitive fixation’– ignoring information that doesn’t agree with diagnosis.

Supervisor & Operator Understaffing

- No supervisor or operator with experience on the isom. unit assisting with start-up.
- Only one board operator present. Past BP hazard review recommended two during start-ups.
- 1999 – 25% budget cut target – control room consolidation – additional workload added in 2003 to the one operator.

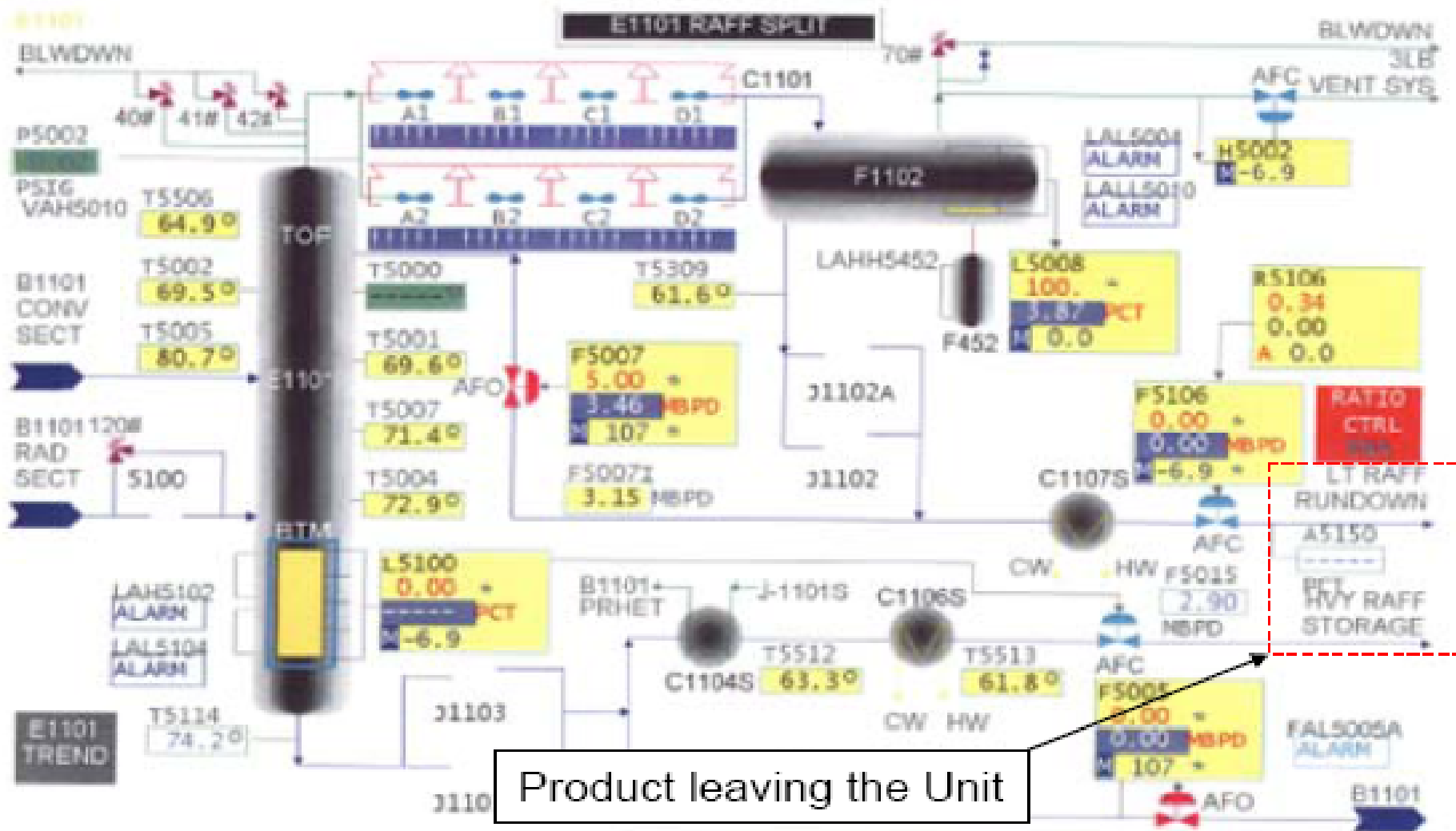
Operator Training Ineffective

- No effective training for abnormal situation management.
 - simulators unavailable.
 - hazards of unit start-up, material-balance calculations, managing tower over-fill scenarios not adequately covered.
- No effective verification methods of operator competency.
- 1998 – 2004 training staff cut from 28 to 8, move to computer-based training, halving of training budget. CSB found this was driven by cost savings.

Poor Control Board Design

- The display lacked an adequate indication of the liquid level in the tower (and did not calculate the material balance of the system).
- Two different screens used to display liquid in and out of the unit.
- Displayed portions of the unit in discrete detailed sections— no screen providing a complete overview of the process.

Poor Control Board Design



Product leaving the Unit

Safety Culture

“The product of individual and 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 management”

“The way we do things around here”

Safety Culture

- CSB found that the BP Board of Directors provided no effective oversight of the company's safety culture and major accident prevention programs.
- Poorly managed corporate mergers, leadership and organizational changes.
- Process safety performance impaired by cost-cutting, failure to invest, and production pressure from BP Group executive members

Safety Culture

- Focus on personal safety and work behaviours as a measure of safety performance.
- CSB noted that despite 23 deaths in the 30 years prior to this incident and many hazardous material releases, BP did not take effective steps to stem the growing risk of a catastrophic event.

Safety Culture

- CSB found that BP Texas City lacked a “reporting and learning culture.”
- Personnel were not encouraged to report safety problems, and some feared retaliation for doing so.
- Internal audits and studies repeatedly revealed safety problems at Texas City, but little was done to remedy them.
- Deficiencies in BP’s mechanical integrity program resulted in the “run to failure” of process equipment.

References

- Link from HSE Human Factors internet pages to the BP Report, CSB Report and Baker Report on Texas City:

<http://www.hse.gov.uk/humanfactors/topics/texascity.htm>

- “To say accidents are due to human failing is like saying falls are due to gravity. It is true but does not help us prevent them.”