Learning from creeping changes

Presenter

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Objectives

- Understand Creeping changes
- Lead process safety metrics
- Case 1 and Case 2
- What happened
- Circumstances
- Leading metrics associated with the case
- Conclusions

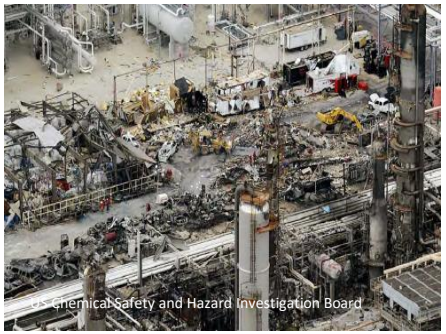
Past events

Nimrod XV230

Kings Cross

Costa Concordia

SHELL Moerdijk



Texas City Refinery

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What are creeping changes?

Accumulation of minor changes which often are ignored or accepted as the new norm, but which over time can add up to a big change and ultimately lead to a major incident.

(Source: Development of a Creeping Change HAZID Methodology Richard J. Goff and Justin Holroyd, Health and Safety Laboratory, Buxton, SK17 9JN, UK. Hazards 27)

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Frog in boiling water

Theory

No industrial sites are static, changes made to the original design or changes

- due to ageing and
- degradation of equipment over time,
- together with organizational changes.
- “normalization of deviance” fits into this category, accepting deviations from the norm.

The main aspects

- Physical degradation, physical changes in plant and equipment
- Organizational changes (ownership)
- Altering from the original design.
- New or modified processes.
- Loss of skills and knowledge brought about by staff changes.
- Changes in the culture of the company.

Why is it difficult to identify?

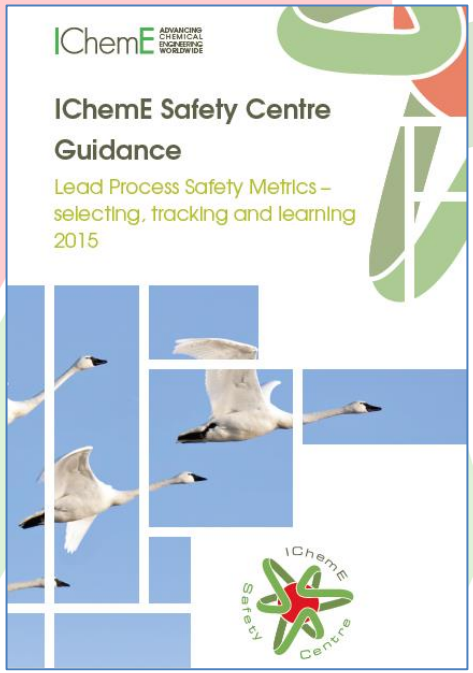
- Creeping changes remain unchecked because these changes are

1. Small
2. Unplanned
3. Gradual, therefore not noticed

and leads to

4. Normalisation of deviance

Lead process safety metrics



Lead process safety metrics – selecting, tracking and learning, ISC, 2015
bit.ly/ISCPubs

Lead process safety metrics

Elements	Metrics
Knowledge and competence	Conformance with Process Safety related role competency requirement
Engineering and design	Deviations to safety critical elements (SCE) Short term deviation to SCE Open management of change on SCEs Demand on SCE Barriers failing on demand
Systems and procedures	SCE Inspections Performed Versus Planned Barriers fail on test Damage to primary containment detected on test/inspection SCE maintenance deferrals (approved corrective maintenance deferrals following risk assessment) Temporary operating procedures (TOPs) open Permit to work checks performed to plan Permit to work non-conformance Number of process safety related emergency response drills to plan
Assurance	Number of process safety related audits to plan Number of non-conformances found in process safety audits
Human factors	Compliance with critical procedures by observation Critical alarms per operator hour (EEMUA, 1999) Standing alarms (EEMUA, 1999)
Culture	Open process safety items Number of process safety interactions that occur

Case 1 - Oil refinery FCCU

What happened

- The Fluidised Catalytic Cracker Unit was shut down following a power distribution failure and was being restarted after an 11-day shutdown.
- During start-up a significant leak of hydrocarbons was discovered. Vapour cloud formed and ignited resulting in a serious fire. Workers escaped before the blast, nobody got injured in the incident.

Circumstances

- Failure of a tee-piece connection at the base of the debutaniser column which found a source of ignition nearby.
- The tee-piece connection originally installed in the 1950's was correctly specified but incorrectly fitted, and then hidden by lagging.
- The plant drawings were not update to reflect the change.

Circumstances

- Series of modifications to the unit since 1986
- Pipework at the base of the column and a valve removed
- Inadequate support for the remaining pipework and the tee-piece connection
- Between 1996 and 1998 unit not operate consistently
- Increase in the number of start-up/shutdown cycles
- Subsequent incidents/cyclic stresses/vibration.

Circumstances

- 11 weeks preceding the incident in 2000, 19 start-up attempts only 7 successful
- Safety report – not reflecting to current condition
- Incidents with vibration of the transfer line two years prior to the explosion not reported or investigated
- Construction of new facility – contracting and further subcontracting out
  - Lack of supervision
  - Lack of following procedures.

Useful metrics

Compliance with safety critical procedures by observation

- Critical procedures, such as start-up procedures should be correctly followed.
- In this case, an incident occurred in 1999 during a prolonged start-up on the FCCU. It resulted in an ignition of a torch oil vapour cloud.
- Contrary to plant operating instructions, the torch oil was admitted to the regenerator when the unit was at too low a temperature.

Useful metrics

Open management of change on Safety Critical Elements

- Modifications of the plant, particularly the removal of a valve on the pipework, at the base of the column which supported the pipework and the tee-piece connection.

Number of non-conformances found in process safety audits

- The safety report failed to reflect the reality of the condition of the FCCU. The 1997/98 revision concluded that “hardware and software controls in place on the FCCU are adequate to prevent the occurrence of a major accident”.

Useful metrics

Metrics related to culture

- Incidents with vibration of the transfer line had occurred over the two years prior to the explosion.
- These events were not reported or investigated which resulted in changes that went unnoticed.
- The company reviewed the FCCU to find out why it did not operate properly but the findings were never implemented or communicated properly.

Case 2 The Herald of Free Enterprise

What happened

- The Herald of Free Enterprise took the lives of 193 when it sank off the port of Zeebrugge, Belgium on 6 March in 1987.

- While leaving the harbour of Zeebrugge en route for Dover water entered the hold and car decks via the open bow door.

Circumstances

- The ferry did not have bulkheads within the car decks; faster load
- When water entered the ship it moved to one side of the deck and became unstable.
- Parliament act requiring divided hull but lobbying resulted in it being repealed.

Circumstances

- Assistant bosun not at his station to close doors.
- The Bosun was on the main deck but did not consider it his duty to close the doors.
- Doors not visible from bridge (standing orders required Captain to assume vessel in all respects ready for sea if no report to contrary).

Circumstances

- First ferries had had so-called visor doors. The door design was changed to a clam type.
- Sailing with open loading doors an identified issue. Captains asked for indicator lights to be installed but their requests had been ignored by the management.

Circumstances

- The holding company had only owned the company for a few months before the accident.
- Carrying of excessive numbers of passengers; 10-20% more than the loading limit. More passengers carried than life-saving equipment supplied.
- Three crews and five sets of officers were employed; no consistency in the duties.

Leading metrics associated with the case

Conformance with Process Safety related role competency requirements

- Personnel were overworked.
- They could not implement work activities due to lack of procedures.

Leading metrics associated with the case

Engineering and design issue

- A high number of failures upon demand indicates an engineering design issue or the need for improvement in the effectiveness of the inspection and maintenance of the barrier or determine if the demand frequency matches the design of the protection loop.
- The lack of divided hulls is a lack of barrier in place.

Leading metrics associated with the case

Open MoC on Safety Critical Elements

- The change in the design of the visor doors should have required an MoC process.

Failure of primary containment on inspection/ barriers failing on test

- The same metric could be applied considering the several occasion's ships had left harbour with their doors open and several captains had asked for indicator lights to be installed.

What can you do? ISC Safety Lore

- ISC Safety Lore
- Issue No. 5 on creeping changes
- Podcast

The ISC believes that leadership across six key functional elements is vital to achieve good process safety outcomes. These elements are:

- systems & procedures
- engineering & design
- assurance
- knowledge & competence
- human factors
- culture

In the *What can I do* section below you can see how each of these elements plays a part.

http://bit.ly/ISCResour

What can you do?
Managers

What can you do? MoC

- Changes in management or ownership can have large consequential hazards.
- Incidents often occur after some change in the system. Make sure that changes as a result of adoption of new or altered processes, loss of skills and new knowledge brought into the operation go through MoC.
- Every system and its environment change over time. Apply strategies to adapt to changing environment, changing in the safety management system.

What can you do? Design

- Ensure audits address changing behaviour to check that the process is carried out as designed.
- There can be significant difference between the designed and the built system. If an incident scenario is not considered in the design phase but that scenario is possible, then it needs to be incorporated into the leading metrics programme.

What can you do? Detect

- Signs of change are difficult to detect. Implementing a system and structured process for identifying them, detecting how the process should operate and what the current status is.
- Implement leading metrics in the risk management programme and responsibilities assigned for checking the metrics and following them up in case problems are found.
- Action plan to ensure that leading metrics exist and they indicate when and how they will be checked and have an action associated with them. Periodically review and update the list of leading metrics.

What can you do? Incidents

- Ensure that change is detected and even small changes to the system are documented in the incident investigation reports instead of simply focusing on proximal events.
- In case of an incident, check if leading metrics are in place and why they failed to identify the problem to prevent the incident, or, if they did, why effective action was not taken.
- Make sure that near miss events are identified and investigated as they can be precursors of a major incident. Pay attention to cumulative causes that help to identify dramatic changes that may have been overlooked.

What can you do? Costs

- Make sure that cost cuts do not impact safety and they do not threaten plant integrity.
- Make sure that process knowledge is maintained and transferred.

What can you do?
Supervisors
Process Safety Engineers

What can you do?

- Make sure you record trending of the leading metrics, ensure that the process functions as it is intended based on the original design.
- Ensure that you document all changes, particularly safety critical ones and near misses immediately and these records are incorporated in the plant operating procedures.
- Have up-to-date plant layout drawings and maps to follow up changes and keep record of the original design layouts.

What can you do?

- Starting up a process unit results in significant changes on the pipework and vessels as they are brought up to the required operating conditions from ambient. Be aware that increasing the frequency of start-ups results in fluctuations in conditions and increased cyclic stresses on mechanical systems.
- Pay attention to the signs of normalisation of deviance where operators might alter from the original procedures, to make sure that safe operation is in place.
- Report and investigate all cases of violations, unauthorised changes and workarounds in the system.

What can you do?
Operators

What can you do?

- Make sure that you follow the operating, maintenance and emergency procedures and do not deviate from them.
- Report any damage or irregular event immediately to the supervisor.
- If the procedures cannot be followed, report the situation to your supervisor for investigation and resolution.

Conclusions

- Subtle but gradual changes to the system can contribute to accidents.
- Lead metrics are helpful tools to monitor processes and changes with.
- Appropriate knowledge and understanding of what we want to achieve and why.
- Leadership - make relevant stakeholders aware of their own responsibility.
- With the necessary care and vigorous monitoring of the system, these changes can be captured in time to prevent a major incident.
- Follow the creeping change hazards identification (CCHAZID) methodology provided by the Energy Institute

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