Ageing of hazardous installations

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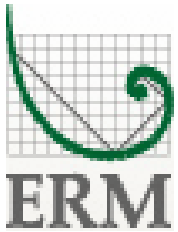
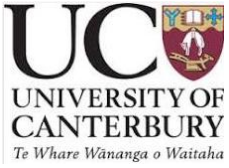
What is the IChemE Safety Centre?
Current Operating and Industry Partners



Current supporting partners and collaborators



What is ageing?

"AGEING IS NOT ABOUT HOW OLD YOUR EQUIPMENT IS; IT'S ABOUT WHAT

YOU KNOW ABOUT ITS CONDITION, AND HOW THAT'S CHANGING OVER TIME"

(Plant ageing RR509 HSE, UK 2006)

Aspects of ageing

Ageing is a multi-aspect phenomenon

- Equipment
- Memory/expertise
- Procedures/technology

The challenge

From the day of their construction:

- Older facilities see significant developments and changes in engineering, policy and regulations, and in the overall socio-economic conditions under which they operate.
- Introduction of legislative frameworks, the development of new safety standards and new operating procedures following new discoveries in science and engineering - need for an upgrade in many of the facilities.

Equipment – physical ageing

- Modifications/ Change of use
- Obsolescence
- Degradation – fiberglass and concrete, too
- Wear and tear
- Control systems manual/electromechanical
- Electrical and electronic systems
- Safety systems; standard and provision
- Retrospective HAZOP; procedural fixes
- Corrosion under insulation

People

- Fluctuation
- Loss of corporate memory
- Change in role
- Retirement – loss of continuity
- Reorganisation
- Transfer of knowledge
- Lack of knowledgeable expertise from suppliers
- Third party workers
- Perception that knowledge can be bought in

Procedures

- Documents
- Operating procedures
- Standards
- Loss of records for inspection and maintenance
- Failure to update map/drawings/contact list
- Change in ownership/reorganisation
- Loss of documentation about design
- Operating procedures obsolete

Common issues

- The engagement of third party personnel – insufficient knowledge
- Missing or incomplete documentation on the design, operation and history of the facility
- Loss of knowledge about the design and operation of the plant
- Inappropriate design of the equipment (premature ageing)
- Inadequate inspection plans
- Inspection body reduces frequency of inspections
- Lack of Hazard identification/risk assessment

How to measure - 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

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Engineering & design

- Deviations to SCE
- Short term deviation to SCE
- Open management of change on SCE
- Demand on SCE
- Barriers failing on demand

Engineering & design ageing

- Corrosion
- Erosion
- Obsolescence
- Fatigue
- Worn equipment

Systems & procedures

- SCE inspections performed verses planned
- Barriers fail on test
- Damage to primary containment detected on test/inspection
- SCE maintenance deferrals
- Temporary operating procedures
- Permit to work checks performed to plan
- Permit to work non conformance
- Number of process safety related emergency response drills to plan

Systems & procedures- ageing

- SCE fit for purpose
- Obsolescent emergency response plan and operating procedures in place
- Inspection programme is not updated
- Switch from analogue to digital

Assurance

- Number of process safety related audits to plan
- Number of non conformances found in process safety audits

Assurance - ageing

- Audits should address aspects related to ageing
- Follow-up after audit and implementation of findings
- Monitoring sign of ageing
- Record data

Human factors

- Compliance with critical procedures by observation
- Critical alarms per operator hour
- Standing alarms

Human factors - ageing

- People can age
- Lack of transfer of knowledge

Culture

- Open process safety items
- Number of process safety interactions that occur

Culture - ageing

- Process knowledge is maintained and transferred
- Keeping records of installation specifications

ISC Safety Lore

- Case studies
- Key learning points
- „What can I do” session
- An mp3 podcast of all Lores

https://www.icheme.org/knowledge/safety-centre/resources/safety-lore/
https://soundcloud.com/user-182199992/talking-safety-lore-dec-2018

Case study - corrosion

- A pipe in the crude distillation unit ruptured, releasing flammable hydrocarbon process fluid.
- The flammable liquid partially vaporized into a large vapor cloud engulfing nineteen employees.
- After two minutes the flammable portion of the vapor cloud ignited.
- All of the employees escaped, narrowly avoiding serious injury.

Key learning points

- Poor operating procedures in regard to mechanical integrity.
- Operator overlooked:
  - Pipe wall thinning due to sulphidation corrosion
  - Over a period of 35 years, the piping component lost 90% of original wall thickness near the rupture.
- A team of experts on site in sulphidation corrosion but not involved in decision making within the unit affected.
- Lack of hazard identification.
- Inherently safer design – material selection.
- Ineffective inspection.

Challenges

- Plant integrity – recognition of ageing assets.
- Maintenance – inspections and testing needs to adapt to the equipment; changes in age and condition are constant Leadership – auditing, monitoring, prioritising.
- Competence – skills, knowledge and expertise relevant are present and taken into consideration.
- Identification of SCE and have them documented.
- Resources – knowledge is transferred and maintained.
- MoC – change of ownership and other changes.
- Being an intelligent customer – third party workers.
- Hazard identification and risk assessment – understanding degradation methods and address in.
- Design – archive of old plant layouts, maps, documents and parameter settings.

Strategies

Replacement strategy and assessing remaining life

- Understanding the base line conditions/performance
- E.g.: function, availability & reliability
- Check if historical data is available about degradation rate
- Involvement of experts on the related field.
- Understanding maintenance records data – what do they tell us?
- Setting priority in measuring performance – not same rigour to address everything.
- Consider audience – CEO look for data to support financial decisions; operations managers look for data to support replacement strategy.

Questions

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