Health and Safety
Executive

Ageing plant:
some HSE experience
from other sectors

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UKOPA/13/018

What will this presentation cover?

- What's been going on in other high hazard sectors regulated by HSE:
  - Offshore oil & gas on the UK Continental Shelf (UKCS), regulated by OSD
  - Onshore chemicals sector, principally COMAH sites, regulated by HID CI
- Plus a couple of specific examples that illustrate some weaknesses in the management of ageing plant & wider risk control systems for major hazards

What is Ageing Plant?

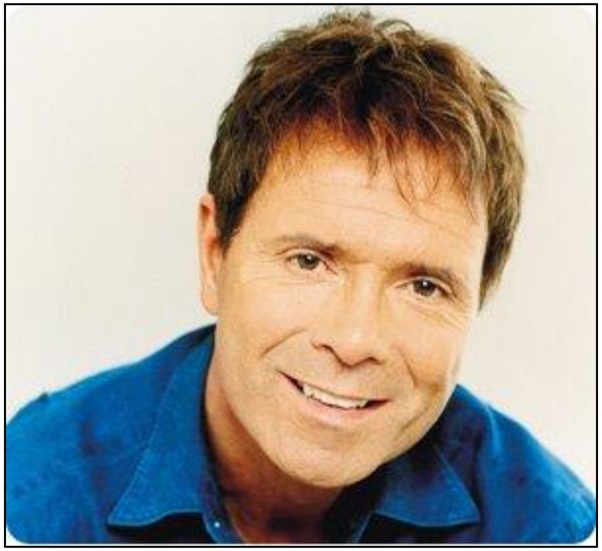
- HSE Research Report 509 'Plant ageing: Management of equipment containing hazardous fluids or pressure':
  - *"Overall, ageing plant is plant which is, or may be, no longer considered fully fit for purpose due to deterioration or obsolescence in its integrity or functional performance. 'Ageing' is not directly related to chronological age."*

Source: HSE

More on ageing from RR509…

'Ageing is not about how old your equipment is; it is about its condition, & how that is changing over time'

Keith Richards Born 1943



Cliff Richard Born 1940

How significant an issue is it?

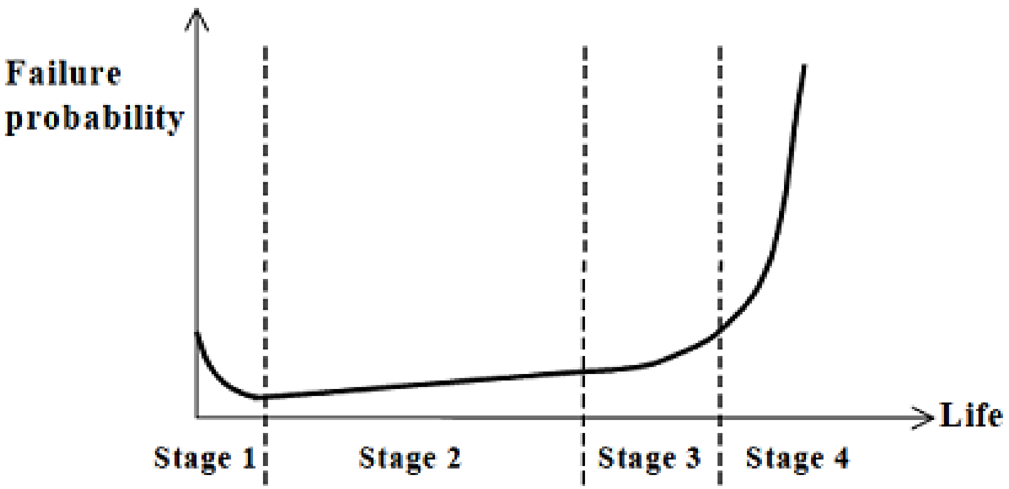
- HSE onshore ageing plant programme findings:
  - c. 60% of major accidents related to technical integrity
  - ageing contributed to 50% of these
- EU Major Accident Reporting System (MARS) database – c. 28% of reported MA losses of containment due to ageing

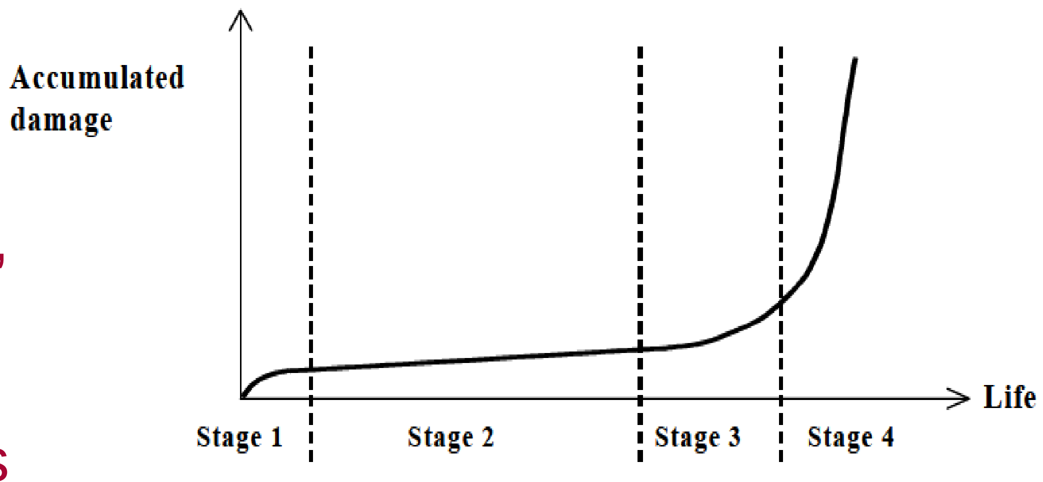
Current situation offshore

- Business/UK PLC interest in producing north sea oil & gas for longer than originally anticipated
- 50% of fixed platforms on the UKCS have exceeded their original design life
- Approx. 25% of pipelines have exceeded original design life, may be > 50% within 10 years
- Life extension is a significant & ongoing issue

Ageing and Life Extension Offshore

- Life extension of offshore installations and pipelines raises issues relating to asset integrity that go beyond traditional practice in the offshore sector
- Need also be aware of non-physical and organisational contributory factors, e.g. obsolescence, loss of corporate memory, change management, operator interface changes





Clearest evidence of ageing when

- Frequent or recurring defects/failures, increasing trends of unplanned maintenance/repair work/breakdowns
- Signs of ageing e.g. cracking, corrosion, creep and increasing corrosion rates
- Reduction in pipeline Safe Operating Limits or temporary isolation or down-rating due to deterioration or discovery of defects
- Enforced increase in frequency of inspection and testing regimes for pipeline systems or associated equipment and protective devices
- Reduced reliability and standard in performance e.g. increases in seat leakage and travel time for RESDVs

Offshore life extension: reassuring signs

- Relevant degradation processes understood
- Accurate knowledge of both pipeline condition and its predicted response in the aged condition
- Effective strategy to deal with increasing risk of failure - deterioration is predicted, detected and assessed as far as it's possible to do so
- Suitable inspection techniques and engineering analysis methods used
- Appropriate balance achieved between engineering analysis and inspection

Offshore life extension: worrying signs

- Gaps in management interfaces e.g. between operators
- Gaps in maintenance/corrosion management routines
- Equipment missing from asset register/maintenance management system
- Records/findings from inspections not reviewed for lessons, trends etc
- Testing/inspection frequencies not reviewed in the light of findings
- Inadequate recording/use of performance data for pipeline integrity (i.e. SPIs for integrity management)

In the background – KP3 (2004-07)

- OSD's KP3 programme examined the maintenance of safety critical elements at nearly 100 offshore installations (about 40% of total number). Key findings:
  - infrastructure condition poor in over half of installations inspected
  - problems surrounding assessment of deferrals, backlog clearance and corrective maintenance
  - major hazard risk control measures poorly understood
  - underlying issues included leadership/KPIs, competence, corporate memory/learning and planning

HSE Offshore Division KP4 programme

- Aim:
  - To ensure that the risks to asset integrity associated with ageing and life extension are controlled effectively
- Objectives:
  - To raise awareness of the need for specific consideration of ageing issues
  - To consider individual duty holder approaches to the management of ageing and life extension
  - To identify shortcomings & enforce an appropriate programme of remedial action
  - To develop a common industry approach to the management of ageing installations to ensure the safe operation of all offshore installations on the UKCS

KP4 Pilot Study

- 3 duty holders
- Topics within scope:
  - generic management
  - structural integrity
  - fire & explosion
  - corrosion
  - mechanical systems integrity
- Set of standard questions for each topic area – 'templates'

KP4 Pilot Study – key findings

- Ageing not considered explicitly in connection with life extension
- Varied approach between dutyholders and topics, asset maintenance not always a high priority
- Commercial pressures influential on AIM
- Reliance on contractors/independent competent persons
- Dutyholder engagement by HSE needed to:
  - raise awareness of Offshore Information Sheet 4/2009 & other guidance/information on HSE website
  - support an industry forum on ageing issues
- Conclusion: Need for a full KP4 programme

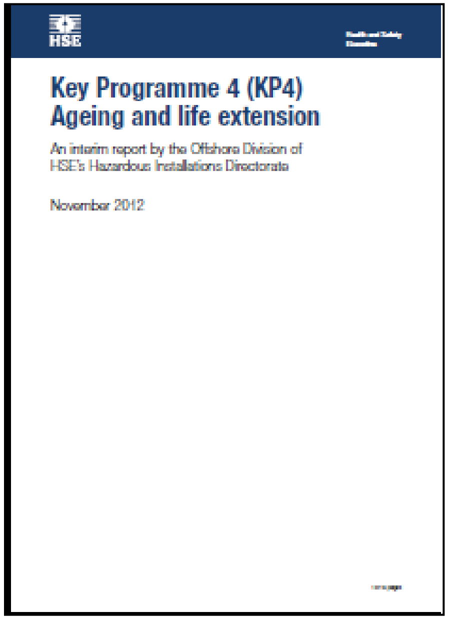
Progress with KP4

- Launched in July 2010
- Industry has reacted well:
  - most dutyholders engaging positively with HSE
  - many have undertaken independent reviews of integrity management practices
  - evidence of senior management buy-in
  - Oil & Gas UK co-ordinating production of guidance
- Still much to do to ensure that installations' long-term plans anticipate and manage the effects of equipment and infrastructure degradation

KP4 INTERIM REPORT

http://www.hse.gov.uk/offshore/ageing/kp4-interim-report.pdf

- Published on 6 November 2012
- Interim Report Structure
  - Industry strengths
  - Industry good practices
  - Additional focus require
- KP4 continues, running to December 2013



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Key Programme 4 (KP4)
Ageing and life extension

An interim report by the Offshore Division of HSE's Hazardous Installations Directorate

November 2012

Ageing plant onshore & COMAH

- COMAH Competent Authority Strategic Management Group (CASMG) tasked to set priorities, offer clear guidance on priority topics and monitor progress
- Priorities identified using intelligence from investigations, accident/DO stats etc
- CASMG identified ageing plant as strategic priority & developed intervention programme to address it
- Ageing plant operational delivery guide produced in 2010, implementation is a priority in the CA workplan
- Also HSE Research Report RR823 '*Managing ageing plant - A summary guide*' – complements RR509

Ageing Plant Strategic Programme

- Commenced June 2010
- Covers control & instrumentation aspects as well as mechanical engineering
- 4 main elements:
  - publication of new guidance by CA
  - intelligence gathering via questionnaire survey
  - inspection programme targeted according to site priority (determined by intrinsic hazard & past performance) and survey findings
  - where previous relevant inspections done, gap analysis carried out to target future inspections

APSP progress 2011/12: ME team

- Completed Intervention Plan visits with APSP Content: 236
- Sites at which AP topics were addressed: 192
- Total sites for which APSP performance data is now held: 246
- Formal enforcement on ageing plant issues:
  - 25 Improvement Notices
  - 2 Prohibition Notices

  (significant proportion of total HSE enforcement action taken on COMAH sites)

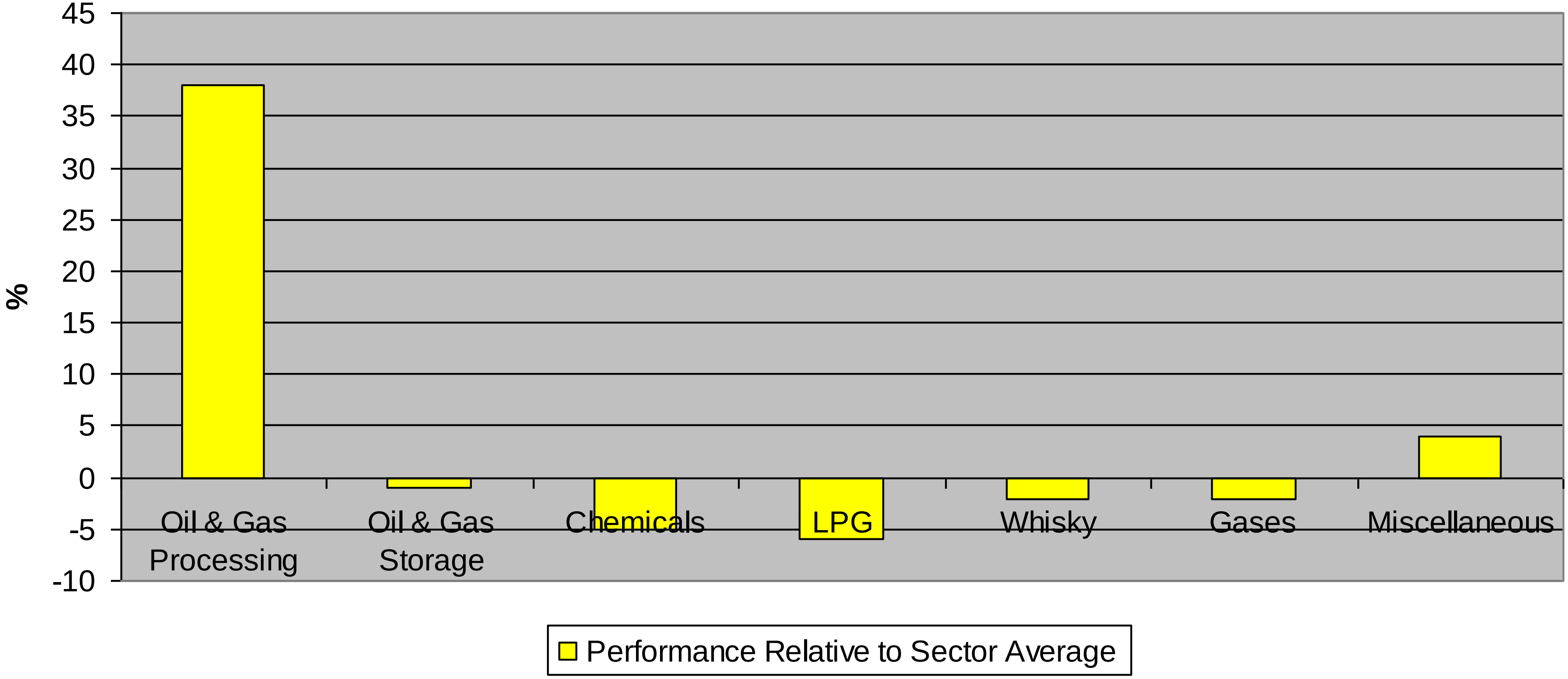
Use of 3rd parties, PSSR & COMAH

- Sites utilising 3rd parties providers for integrity management services appear to perform less well
- COMAH/PSSR confusion known to be a problem
- Dutyholders may not be intelligent customers & assume PSSR compliance meets COMAH duties
- PSSR WSE only considers stored energy hazards:
  - doesn't consider toxicity of release
  - doesn't consider flammability of release
  - buried pipework can be a particular problem
- HSE working with SAFed and EEMUA to draw up new guidance on inspection management

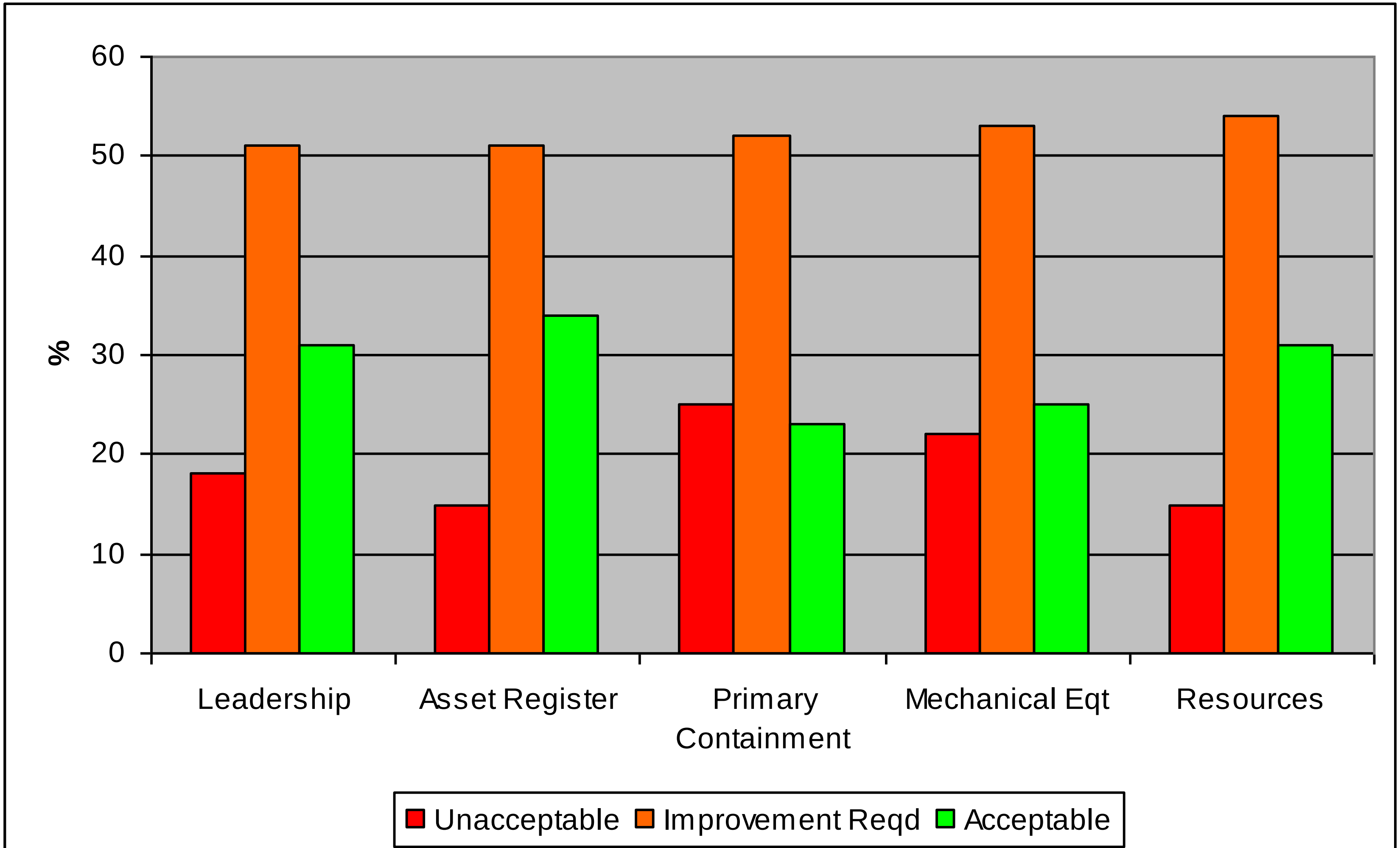
Buried pipework

ICL Plastics - LPG leak ignited. 9 dead, 33 injured.

APSP ME findings to 31/3/12

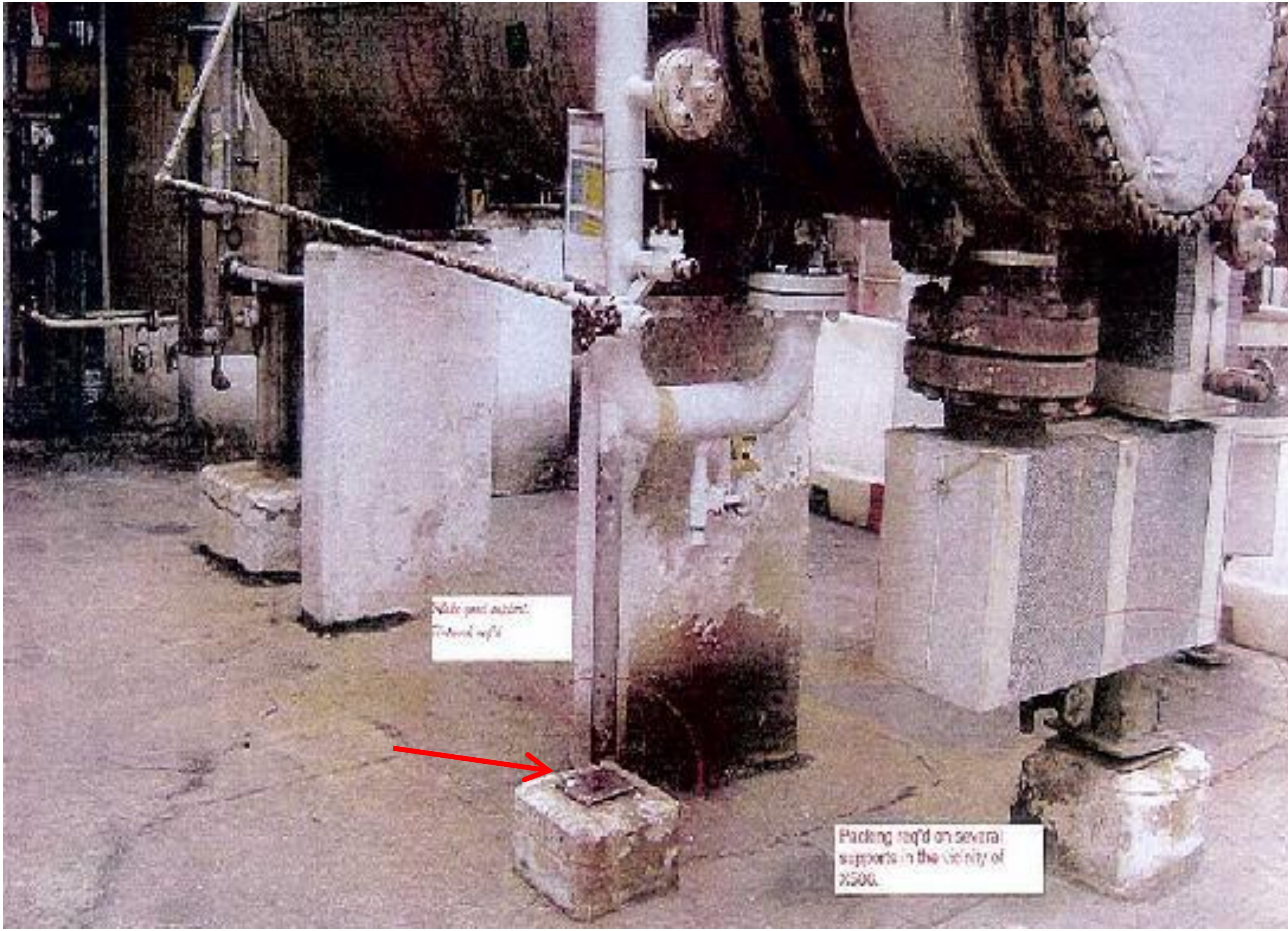


APSP ME findings to 31/3/12 (2)



Helen's experience on COMAH sites

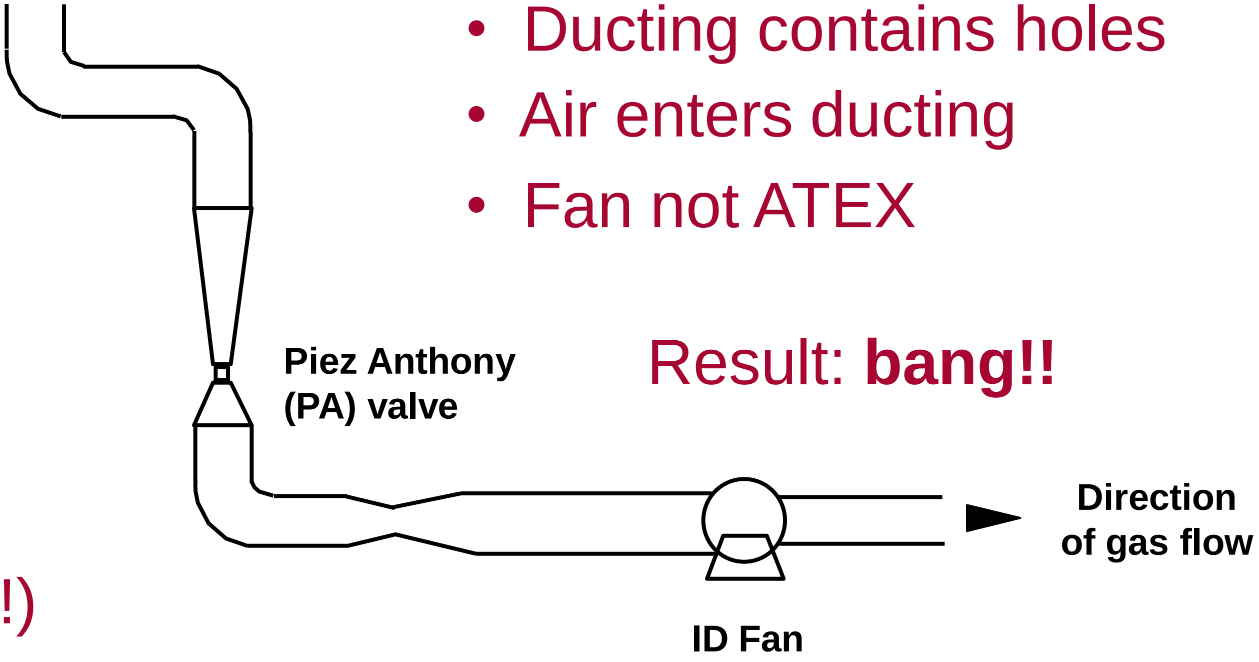
- Ageing tends to cause latent defects in plant
- Process/plant still works after a fashion BUT there are clues that all is not well
- Slow progress of ageing effects means clues can be overlooked & working around snags become a new 'baseline' for normality
- It's not just the hardware - wider management systems failures always play a part
- Apparently sophisticated sites can have significant problems


Packing req'd on several supports in the vicinity of X500.

Example – explosion in ducting

Ducting contains flammable gas at slight +ve pressure during normal operation but process issues caused slight -ve pressure to develop between fan & PA valve

- Ducting contains holes
- Air enters ducting
- Fan not ATEX



Result: **bang!!**

(Greatly simplified schematic!)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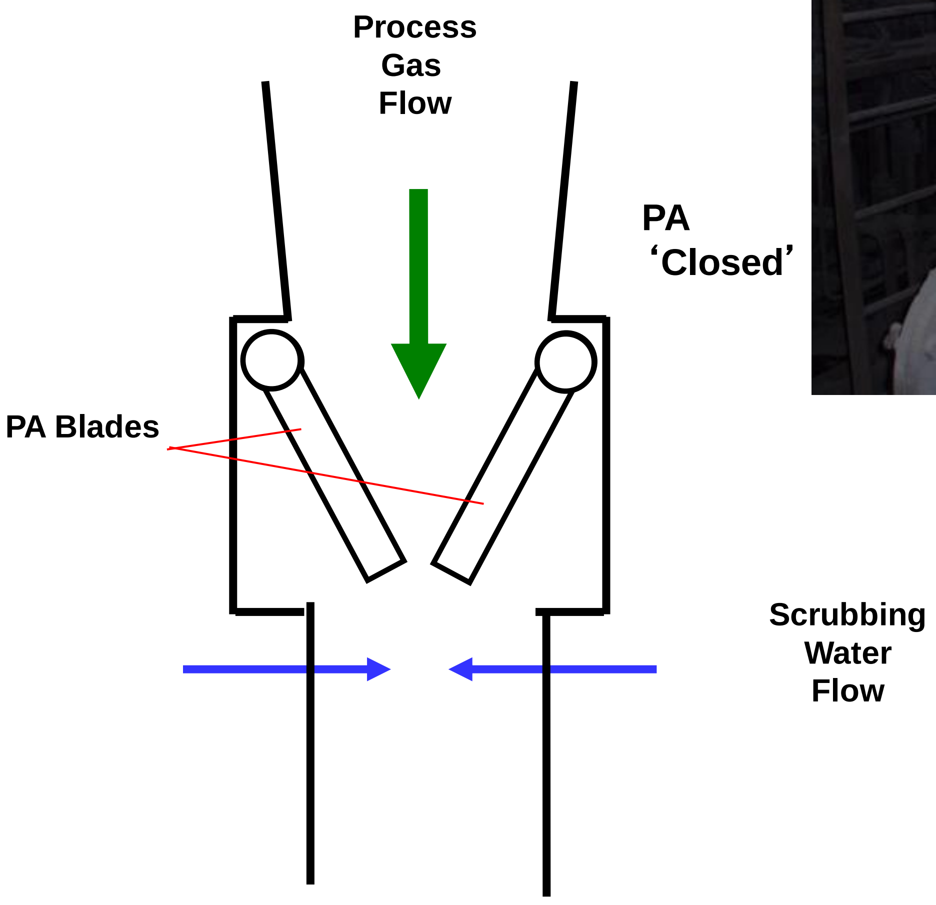
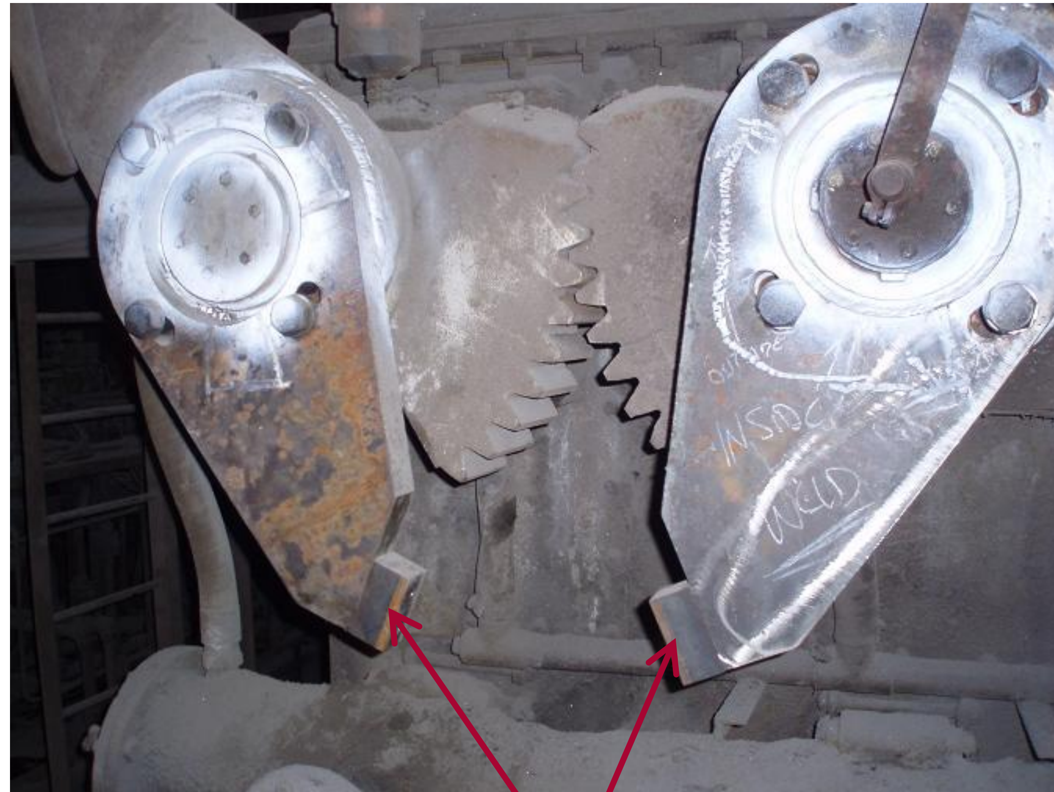
Ageing plant issues

- Old, degraded & leaky ductwork, subsequent inspection revealed numerous holes/defects – wholesale replacement necessary
- Not a pressure system requiring statutory examination under PSSR
- No set frequency for inspection
- Some areas tortuous to access & inspect properly
- Inspection & maintenance fell off the radar, condition of ductwork allowed to deteriorate

Other non-physical factors

- Management of change failure – original PA valve had stops preventing full closure but it had been replaced, the new valve did not have these & could move to 100% closed meaning fan could pull -ve pressure on ducting
- Risk assessment failure – explosion linked to air ingress into ducting not identified as credible scenario during hazard analysis, therefore condition of ducting & presence of stops on PA valve not flagged as safety critical





These stops were missing!

What were the underlying failures? (2)

- Monitoring failures -
  - process parameters routinely strayed close to safe limits but this didn' t trigger any action
  - evidence that ignitions/overpressures had occurred on other parts of system, were they investigated? Were any lessons learned?
- Competency failure? Automatic PA control system response slow but manual override disabled some safety features, nobody flagged this as an issue, manual operation became custom & practice

What were the underlying failures? (3)

- Human/organisational factors –
  - alarms would sound during normal operation
  - 'make do and mend' mentality
  - 'driving the plant' was sign of a skilled operator
  - management scrutiny/oversight lacking
- SPIs could have been set e.g. for excursions beyond certain process parameters or use of manual overrides
- SPI for maintenance/inspection backlog obvious but would not have picked up ductwork condition & PA valve defect

Example 2 – leak of very toxic gases

- Process involves passing a nasty mixture of gases through bed of raw material
- DO - leak of gases from manifold beneath bed
- Pinhole leak caused LOC from manifold, reportable DO involving release of significant quantity of T^+ COMAH substance
- Manifold less than 18 months old – how can this be 'ageing plant'?
- Turned out to be a real can of worms…
- Illustrates many potential weaknesses in management of ageing assets

Leak of T^+ gases

- Manifold on harsh duty & known to deteriorate rapidly in normal use, planned replacement occurs after about 18 months in operation
- Within scope of PSSR & identified as COMAH safety critical
- Subject to inspection/NDT according to WSE
- Inspections/NDT were carried out
- Manifold still ran to failure
- What went wrong?

T^+ gas leak - immediate cause

- Process had been unstable, plant unreliable
- Unusually large number of shut down/start up cycles
- Cold start took some components of gas mixture through their dew point
- Gas stream then contained liquid droplets
- Caused erosion at localised points within manifold
- Rate of thinning of affected areas greatly accelerated
- Eventually pinhole created in manifold & LOC resulted

Contributory factors

- Inspection/NDT done by specialist contractors
- Their reports showed manifold had reached/gone beyond minimum allowable thickness in places
- Reports passed to site engineer:
  - backlog of work
  - recent organisational changes poorly managed
- Inspection frequency increased but nobody made the call to halt production (silo working)
- Senior site managers apparently unaware of situation
- Post-DO: vulnerable pipework made from Inconel alloy

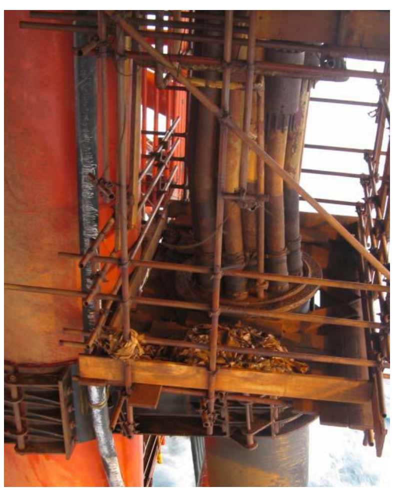
A few of the lessons learned

- Needs to be coherent asset integrity management system with roles & responsibilities fully documented/understood
- Process conditions that have implications for asset ageing need to be understood, documented and monitored
- Mechanism needed to ensure details of such conditions communicated between production & engineering
- Clear retirement criteria needed for critical plant
- ‘Post mortems’ of retired plant to validate assumptions that underlie inspection schemes/intervals etc
- Set SPIs – ensure senior managers aware of process instability, inspection backlogs unexpected deterioration etc

Final Thought (courtesy of Mr Souden)

"Integrity without knowledge is weak and useless, and knowledge without integrity is dangerous and dreadful."

—-- Samuel Johnson



Source: HSE

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