



Health and Safety
Executive

The Explosion and Fire at the Conoco Humber Refinery – 16th April 2001

HSE Investigation and the Lessons Learned

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- The Refinery
- Incident
- HSE Investigation
- Lessons to be Learned



Conoco Humber Refinery, Immingham

- Designed & constructed mid 1960s
- Fully on line 1970
- Key product specialised coke for aluminium & steel production
- Various expansions to current 12 m tpa capacity
- Full range of integrated process units inc. FCCU, HFA, HDS etc.
- Total of 750 employed + up to 525 others
- Normal daytime on-site population 800

Saturate Gas Plant (SGP)

- Commissioned 1981 to improve gas recovery
- In house process design
- Separates light liquids by fractionation into gasoline, butane, propane
- 3 columns in series, with intermediate reflux drums
 - W413 de-ethaniser, 28 barg
 - W414 stabiliser, 10 barg
 - W415 propane/butane splitter, 17 barg
- Throughput 12,000 bpsd

Incident

- 14.20 hrs Easter Monday 2001
- Plant running normally, no recent upsets
- Sudden release from de-ethaniser column overheads line (P4363)
- 12m above ground, northern end of SGP
- 0.7 m downstream of water injection point
- Upstream of X452 heat exchanger
- Dispersed into adjacent plant by 7.2 ms^{-1} northerly wind

SGP - Fire

- Explosion led to fire in SGP and surrounding areas
- Fire fuelled by other releases arising from blast damage
- Various ‘fireball’ events due to hot failures of large diameter lines
- Fire continued for over 3 hours
- Manual isolation of all failed lines eventually eliminated fuel
- Total release 180 tonnes of gas/liquid

Damage On Site

- SGP widespread major damage - write off
- Coker closed blow down system significant damage
- Minor damage to adjacent units
- Minor structural damage to many buildings including main admin. block, stores
- Site wide damage to glazing - canteens, offices
- Site wide damage to cladding, lagging - led to asbestos contamination
- Central control room blastproof - no damage

Damage On Site



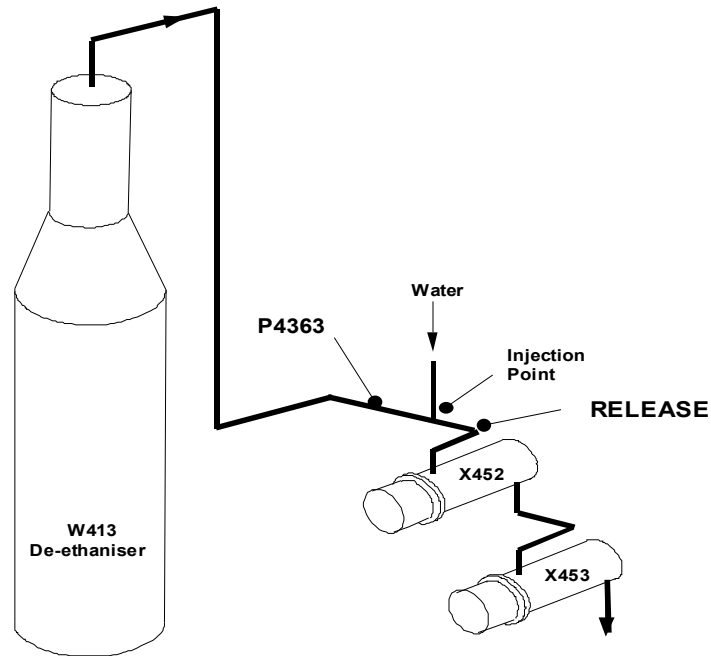
Damage Off Site

- Property damage up to 1500m distance
- 370 separate damage reports received from local businesses and homeowners
- Mainly glazing and minor structural effects
- Adjacent Lindsey Oil Refinery some building damage but none to plant
- Damaged reputation and trust

Injuries

- 1 '3 day' injury - employee in locker room cut by flying glass
- Various minor cuts & bruises
- No off significant off-site injuries
- Only 185 persons on site due to Bank Holiday
- Most operators indoors preparing for shift changeover
- Nearest occupied building 175m (150 -200mb OP), some structural damage but no collapse
- Optimum timing for injury limitation

Source of Release



Source of Release



Source of Release



HSE Investigation – Vapour Cloud Explosion

Modelling of release and dispersion

- Pipe failure equivalent to full bore release, 45° downwards, release rate 133 kg/s, reducing to 71 kg/s after 30s.
- Max. flammable cloud size (10k m³) after 15s, began contracting after 40s, max length 175m, max width 80m at 75m dist (CFD model).
- Congested volume ~5k m³, 500kg, max o/p 0.5bar.
- Ignition 12-32s after release at fired furnace (65m)

HSE Investigation – Vapour Cloud Explosion

- Alternative wind speeds & directions modelled – 3 m/s (same direction) & 3/7 m/s at 90°.
- In all cases max distance of flammable envelope reduced
- With 3 m/s crosswind max. volume increases to 15k m³
- No other permanent ignition source within any 'alternative' flammable gas cloud
- Concluded that outcome could not have been significantly worse – no risk of significant impact on HF Akylation unit.

HSE Investigation – Cause of Release

- Catastrophic rupture of 6” diameter overhead pipe (P4363)
- Pipe failed at elbow 67cm downstream of water injection point
- Mild steel pipe, original thickness 7.1mm, reduced to min. 0.3mm, significant area <1mm.

HSE Investigation – Cause of Release

- Degradation due to corrosion-erosion
- Various potential corrosive agents present – ammonia, chloride, hydrogen sulphide
- Injected water sweeping round pipe bend constantly removing passive film of corrosion products – no dispersion device.

HSE Investigation – Cause of Release



Conclusions and Key Lessons

Management of pipe work inspection

- No effective system in place for SGP pipe work inspection
 - **Refinery inspection systems focused on equipment**
 - **Pipe work systems not in line with industry good practice**
 - **Knowledge and experience from other plants not applied**

Conclusions and Key Lessons

- Insufficient condition data obtained to verify integrity and inform future inspection
 - Introduction of RBI requires comprehensive condition data, large backlog of data not entered into database
 - Default RBI assessment would have led to P4363 inspection but failure occurred first

Key lesson; High hazard pipe work requires inspection to industry good practice standard informed by adequate condition data

Conclusions and Key Lessons

Management of change

- Installation of P4363 water injection not subject to MoC review
 - **'Quick-fix' solution to fouling problem**
 - **No consideration of suitability of location, need for dispersion device or corrosion potential**

Conclusions and Key Lessons

- Use of injection point not monitored or controlled
 - Changed between continuous and intermittent by operation staff
 - Information on use not provided to other departments

Key lesson: Effective MoC systems are needed for plant & process changes to prevent un-assessed 'quick-fix' modifications.

Conclusions and Key Lessons

Management of corrosion

- Arrangements not sufficiently thorough or systematic
- Action on specific alert about injection point corrosion problems undermined by inadequate knowledge of status and mode of operation

Conclusions and Key Lessons

- Resource provided for reviews and monitoring but not sustained

Key lesson; Refinery corrosion management requires systems and resources to ensure that relevant information and knowledge is identified and acted on and that relevant processes are monitored and reviewed

Conclusions and Key Lessons

Communication

- Inadequate communication of the 'status' and usage of P4363 water injection point, both within the operations department itself and also with other departments (notably inspection), resulted in its exclusion from subsequent assessment.

Conclusions and Key Lessons

- Information from the limited inspections carried out on P4363 in 1994 was not adequately recorded or communicated, resulting in the recommended further inspections not being carried out.

Key lesson; Accurate recording and effective sharing of information and data relevant to plant corrosion is essential for major accident prevention.

Learning Points for HSE

Focus on pipe work integrity

- Importance shown by this and other incident investigations
- HSE HID UK Refineries Pipework Integrity Project, 2002/03 – findings detailed in SPC/Tech/Gen/33
- Project extended to to other major hazard chemical sites for 2005/06.

HSE Actions

- Safety alert to industry via web site, once immediate cause confirmed, on need for effective pipe work inspection systems with particular reference to injection points
- Improvement Notice to implement adequate pipework inspection regime.
- Prosecution HSW S2 & 3 (COMAH Reg4 charge not pursued). Guilty pleas, fine 2 X £400k, with £218k costs. June 2005.
- Publish incident report on web site late 2005.



Any Questions?