# OFFSHORE EXPLOSION SAFETY TIMELINE (NORTH SEA)


TOWARDS A SAFE AND SUSTAINABLE OPERATIONAL ENVIRONMENT

## 1988

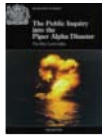
### THE ACCIDENT – PIPER A

A major leak of gas condensate resulted in an explosion on the production deck, subsequently followed by a number of smaller explosions leading to large oil fires that spread rapidly to other areas of the platform. The rupture of the gas risers (pipelines) from neighbouring installations produced further explosions and fireballs, eventually resulting in the structural collapse of the platform into the sea leading to a loss of 167 lives.


## 1991-95

### THE AFTERMATH (UK OFFSHORE)

- Cullen inquiry report – 106 recommendations to offshore safety procedures
- Health & Safety Executive (HSE) Offshore Safety Division established (1991)
- ALARP introduced (reduce risk to "As Low As Reasonably Practicable")
- Offshore Safety Act (1992) – QRA incorporated in UK legislation
- HSE Hydrocarbon Release Database – reporting of leaks
- Offshore Installations (Safety Case) Regulations (1992)
- Offshore Installations Prevention of Fire and Explosion and Emergency Response (PFEER) (1995)




## 1994-97

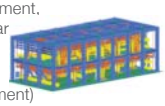
### EXPLOSION RESEARCH

- Research programs initiated:
  - Large scale experiments "Blast and Fire Engg. for Topside Structures (BFETS)"
  - Explosion model benchmark ing (10-15 models)
- Much higher pressures seen in tests than expected (by O&G industry & authorities), ca. 4-5 barg
- Deluge could help reduce pressures
- Explosion Phenomena too complex for "simple" models – these cannot be used
- Advanced models based on Computational Fluid Dynamics (CFD) are required


## 1997

### EXPLOSION RESEARCH (POST 1997)

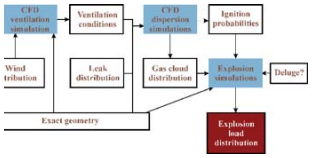
- HSE Phase 3A experiments with several configurations (confinement, congestion, ignition location var
- Lessons learned:
  - Deluge very effective (but depends on confinement)
  - Ignition location very important
  - Very high pressures possible (>10 barg), but short duration
- Question from Norway Petroleum Authorities to ALL operators (1998): How do YOU plan to incorporate findings in your risk studies?
- High pressures ("worst case") impossible to design for ==> Probabilistic explosion QRA methodology developed



## 1998-2001

### NORWAY: IMPROVED EXPLOSION QRA APPROACH

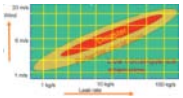
- Initiative from operators
  - Several safety consultants developed approaches for probabilistic QRA
  - Time dependent ignition model developed
- Phase 3B large-scale project
  - Included experiments to validate probabilistic QRA approach
  - Large-scale dispersion & delayed ignition, partial fills




## 2001

### NORSOK Z013 STANDARD

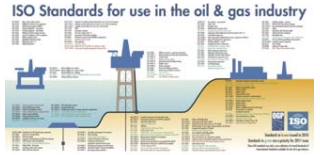
- Procedure for Probabilistic Explosion QRA
- Validated CFD tools (such as FLACS) to be used for ventilation, dispersion and explosion
- 9 leak sizes (rates) + varying wind speeds + and direction (wind/leak)
- Equivalent cloud size approach
- Time dependent ignition intensity model
- Several ignition and gas cloud locations
- Transparency – no black box approaches
- Large number of scenarios considered – less likely to miss scenarios important for risk
- Benchmarked for real platforms to develop consistent methodology across suppliers



## 2002

### PROBABILISTIC EXPLOSION QRA – OFFSHORE SAFETY

- Concept used all across the North Sea (UK/Norway) and now increasingly globally
- Norwegian offshore regulations based on adoption of such approach
- Probabilistic approach adopted in ISO standard 19901-3 on Topside Structures
- Requirements in ISO standard ISO 13702 on mitigation of fires and explosions points to the use of CFD




## CURRENT STATE OF AFFAIRS

- 1980s – several large explosion accidents
- 1990-2000 – number of explosions significantly reduced, but still several releases
- Programs to reduce hydrocarbon releases
  - Inspection, toolkit, detailed statistics
  - Targets for reduction of releases
  - Asset integrity
- No "ignitions" in the Norwegian sector for the last 20+ years
- EU safety directive ratified (2013)
- Number of releases (and hence potential accident scenarios) continue to reduce