Risk management strategy for hydrogen economy projects

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Presentation overview

• Understanding the regulatory framework
  • Who is the Regulator?
  • Important pieces of legislation

• Hazards of hydrogen

• Developing a risk management strategy

• Practical approaches to risk reduction

• Sources of advice and guidance
Regulation of workplaces etc

- Industrial premises, factories, hospitals, schools, universities, LA premises: HSE
- Commercial/retail: LAs
- Domestic (fuel gases): HSE
- Road vehicles: VOSA/DfT
- Ships/boats: M&CGA/DfT
Some important legislation

- Dangerous substances and explosive atmospheres regulations 2002 (DSEAR)
- Gas safety (installation & use) regs 1998 (GSIUR)
- Gas appliances (safety) regs 1995 (GASR)
- Planning (hazardous substances) regs 1992
- Control of Major Accident Hazards (COMAH) Regs
- Health & Safety at Work etc Act 1974
Legislatively important quantities

- Planning (hazardous substances) regs 1992
  >2 t hydrogen  c24 000 sm³

- COMAH (lower tier)
  5 – 49 t hydrogen

- COMAH (top tier)
  >50 t hydrogen
Gas safety (installation & use) regs 1998

- Hydrogen only covered in domestic premises
- Those carrying out work must be CORGI registered
- Appliances defined (heating, lighting, cooking etc)
- Equipment must be suitable
DSEAR

• The overarching legislation for flammable substances

• Doesn’t apply to GASR (GAD) gas appliances

• Doesn’t apply to ship/boats or vehicles

• Doesn’t apply in mines or quarries

• Applies to FCs where electricity is the primary output
What does DSEAR require you to do?

• Assess and control the risks from dangerous substances

• Eliminate or reduce the risk from dangerous substances so far as is reasonably practicable

Remember also

ALARP
Notable hazards of Hydrogen

- Very wide flammable range
- Very low ignition energy
- Possibility of detonation
- Invisible flame
- Low viscosity
- Extremely diffusive
- Embrittlement of metals
Very wide flammable range

• Hydrogen is flammable in air from 4% to 75% v/v
• The range is much wider than for other fuels:
  - Methane: 4% to 15%
  - Propane: 2% to 10%
  - Butane: 2% to 8%
  - Petrol: 1% to 8%
• Hydrogen burns with an almost invisible flame
Very low ignition energy

- Hydrogen/air mixtures ignite extremely easily
- At stoichiometric ratios only 0.02 mJ required

  compare methane 0.30 mJ
  petrol 0.25 mJ

- Almost any spark may cause ignition
- Mobile phones are a potential ignition source
Practical approaches to risk management
Risk management strategy

• Recognise, understand and prioritize the hazards

• Identify those scenarios that generate the big risks

• Demonstrate you have a plan to manage the risks

• Show your plan follows a suitable hierarchy

• Don’t forget the boring, old fashioned risks!
DSEAR risk control hierarchy

• Substitute

• Control the risk
  • Reduce inventory
  • Avoid/control releases
  • Prevent flammable atmospheres forming
  • Avoid ignition sources

• Mitigate the risk
  • Reduce the number of people at risk
  • Provide explosion relief, suppression or containment
Reducing the risk from hydrogen

- Replace hydrogen with a lower hazard material
- Reduce the inventory
- Avoid the formation of flammable mixtures
- Avoid sources of ignition
- Ensure the security of the installation
- Suppress the explosion or mitigate its effects
Avoiding flammable mixtures

• Containment

• Location

• Ventilation
Containment

- Design and construct to an appropriate code
- Use suitable materials
- Minimise the number of joints
- Use welded or brazed joints when practicable
- Minimise the use of threaded or flanged joints
- Avoid compression joints
- Leak test in an appropriate manner
Location

- Locate H$_2$ storage/handling equipment outside
- Beware of ceilings, covers, canopies and roofs
Let the buoyancy of $H_2$ work for you
Ventilation

• Estimate maximum foreseeable leak rate
• Provide adequate high and low level ventilation
• Use CFD for complex ventilation requirements
Avoiding sources of ignition

• Carry out a hazardous area classification
• Try to locate electrics in non-hazardous zones
• Use appropriate electrics in hazardous zones
• Control hot work, smoking, mobile phones etc
• Use bonding, earthing and anti-static clothing
• Consider protection against lightning
Security and access control

- Provisions should be appropriate to location
- Perception of Regulator likely to exceed true risk
- “Precautionary principle” expectation likely
Explosion mitigation

• Relief
• Containment
• Suppression
Information and guidance

- HSG 243; Fuel cells, understand the hazards, control the risks
- European Industrial Gases Assoc. (IGC Doc 15/96)
- NASA (Safety std for hydrogen & hydrogen systems)
- ISO/DPAS 15916: Safety of hydrogen systems
- NFPA 50A: Standard for gaseous hydrogen systems
- ATEX (supply) Regs; SI192,1996
- DSEAR ACOPs
- BS EN 60079 Electrical app. for explosive gas atms
That’s all folks!
Acknowledgements

• Jem Sullivan: hydrogen man cartoon
• Fuel Cells Canada: selected images