

***2nd International Conference on Hydrogen
Safety
San Sebastian, September 11-13, 2007***

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Centre for Hydrogen Safety and Codes & Standards™

Risk Management and Hydrogen Safety
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Concept of Risk

Defining Risk – Risk as a qualitative (social) construct:

- ✓ The word 'risk' derives from the early Italian *risicare*, which means 'to dare'. In this sense, *risk is a choice rather than a fate*. (Bernstein, 1996, p.8)
- ✓ Risk may be defined as a systematic way of dealing with hazards and insecurities and *introduced by modernization itself*. (Beck, 1992, p.21)
- ✓ Risks evolve along with societal progress. *...if there were no tomorrow there would be no risk*. (Bernstein, 1996, p.15)
- ✓ Several arguments have been put forward by social scientists that quantitative determinations of risk are inadequate in portraying the influence of social factors. The Royal Society (1992) argued that *"risk is socially constructed."*
- ✓ Klinke and Renn (2001) incorporate human influence and values into their definition: *"Risk refers to the possibility that human actions or events lead to consequences that affect aspects of what humans value."*
- ✓ Risk is all in the *mind*. (Adams, 2005)
- ✓ Risk perception is a *response to uncertainty*. (Eiser, 2004, p.32)

Concept of Risk

Defining Risk – Risk as a quantitative (technical) construct:

- ✓ During the Renaissance risk became an area of serious study leading to Pascal and Fermet's discovery of the *theory of probability*.
- ✓ From its early beginnings where problems of chance associated with gambling consumed the efforts of early mathematicians *risk has evolved* into a tool for organising, interpreting and analysing information to *make decisions about the future*
- ✓ The ability to apply *mathematical principles* to defining risks has enabled the development of methodologies geared towards their identification and management. These methodologies are based on the notion that *risk is a function of the magnitude and the probability of harm*

Technical vs Social:

- ✓ This two dimensional construction of risk is deemed to be too narrow by social scientists as people have a *multi-dimensional* concept of risk. A purely technical assessment of risk does not address adequately the social characteristics inherent in risk and is therefore not an adequate basis for policy-making (Kasperson, et al., 2000). *Merging quantitative risk measurements with the social dimensions of risk* is exercising the minds of policymakers and others engaged in the risk debate

Is Risk Perception Part of Risk?

Canadian National Standard Q-850 Risk Management: Guidelines for Decision-Makers

“Risk involves *three* key issues:

- ✓ The *frequency* of the loss, that is, how often the loss may occur;
- ✓ The *consequences* of the loss, that is, how large might the loss be; and
- ✓ The *perception* of the loss, that is, *how a potential risk is viewed* by affected stakeholders in terms of its effect on their needs, issues, and concerns.

Because there is a need to understand how a potential loss might affect and be perceived by the various stakeholders, *it is insufficient, and indeed can be quite misleading, for the decision-maker to consider risk solely in terms of probability and consequence.*”

Is This True Representation of Risk?

Example of “Hindenburg”:



“My only answer to him is Hindenburg” – Robin Williams’s comment on Arnold Schwarzenegger’s hydrogen initiative in California (Jay Leno show, June 2006)

- ✓ 70 years after, “Hindenburg” still remains a key driver of public risk perception of hydrogen despite explicit proof by Dr. Addison Bain that hydrogen is not “responsible” for this disaster

Question: Does this mean that if people **THINK** hydrogen is risky, it **IS** risky?

Risk Perception

“Societal risk perception is influenced by several factors of which the role of the **media** is a prominent example. Poor public understanding of risk is compounded by **sensationalist news reporting**, which can reinforce inaccurate perceptions. This, in turn, **influences** the climate of public debate and, hence, **government responses**. “

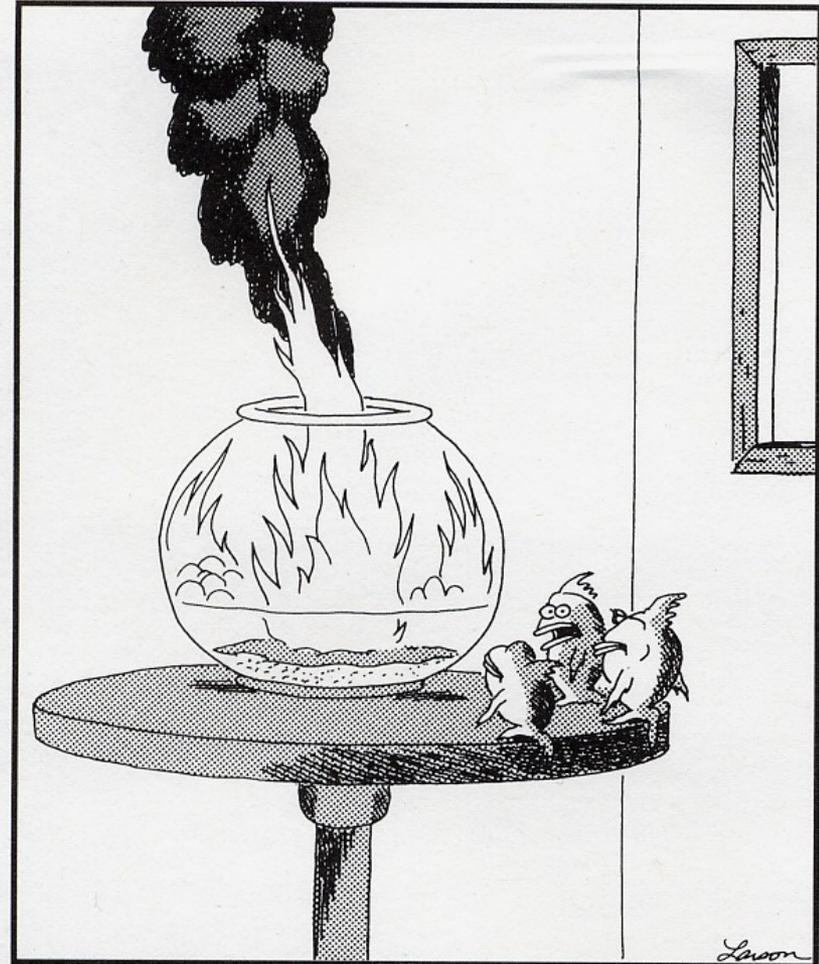
RSA Risk Commission

<http://www.rsa.org.uk/acrobat/RiskoverviewSept04rev1SW.pdf>



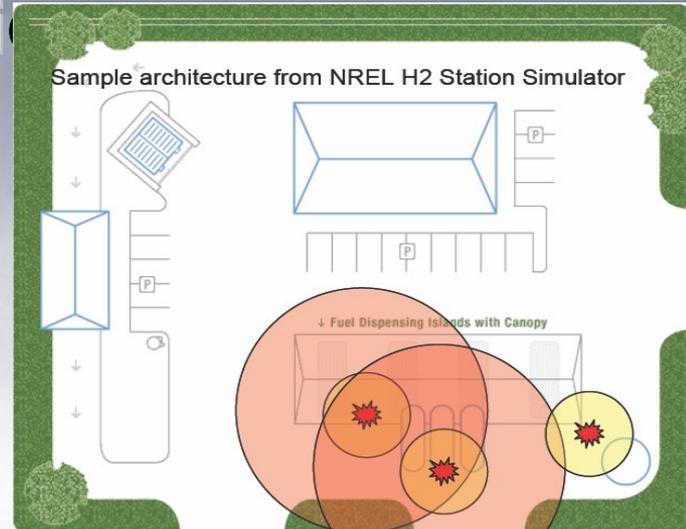
Comparative Risk Assessment

As society has become more complex, the ability of the public to assess and deal with comparative risks has diminished.



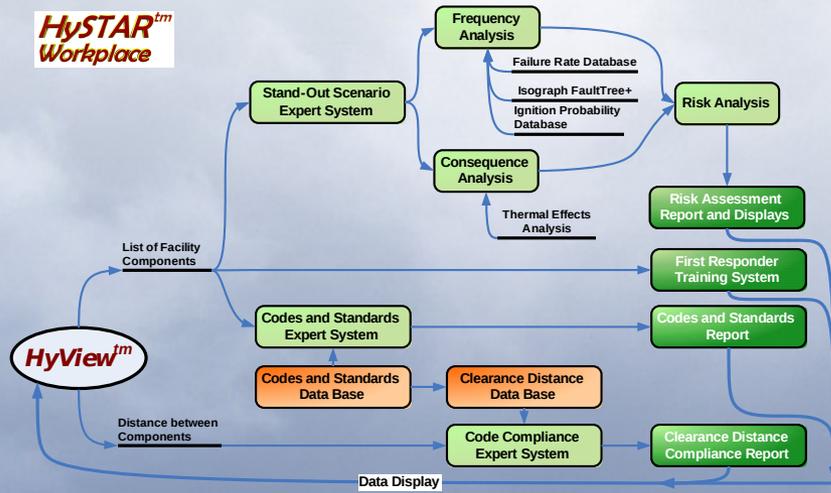
“Well, thank God we all made it out in time. ...
'Course, now we're equally screwed.”

Risk Communication and Education



Hydrogen Safety, Training and Risk Workplace

Thursday, August 31, 2006



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Permitting Process	Pathway to Retail			Retail Hydrogen Station		
	Case Studies			Case Studies		
Planning and Zoning	Addition to Existing Station			Stand Alone Station		
Application for Permit	Gasoline	CNG	H2	On-site Production	H2 Delivery	
Site Plan	Diezel			Elect. SMR	ATR	LH2
Buildings	{ Process Flowchart }					CGH2
Equipment	{ Level of Detail }					Storage
Operation						Underground (LH2) At-grade Canopy Top (CGH)
Construction	Inspection	{ Timetable }				Compression
Operation, Maintenance						Dispensing
Codes and Standards						
{ IFC 2209 }						
{ NFPA 52 }						
{ Etc. }						

Perception of Safety or Risk?

- ❑ Definition:
- ✓ Safety is freedom from unacceptable risk (ISO/IEC Guide 51:1999)
- ❑ This effectively means that:
- ✓ Risk is the technical (quantitative) measure of safety
- ✓ Society accepts the fact that there is neither absolute (i.e., 100%) safety nor zero risk
- ✓ Society, de facto, establishes acceptable levels of risk or **risk acceptance criteria**
- ❑ Hence, safety not risk is a **moving target** because:
- ✓ Safety depends on acceptable level of risk, which (level) is subject to public perception or political / regulatory decisions, i.e. **social factors**
- ✓ Risk criteria affect only the level of acceptable risk (i.e. **safety**), but **NOT** the **risk value** itself
- ✓ Safety cannot be calculated while risk can
- ❑ Conclusion:
- ✓ It appears that **'safety' is a social construct** rather than 'risk'
- ✓ Thus, **perception is a component of 'safety'**, not 'risk'

Risk Criteria

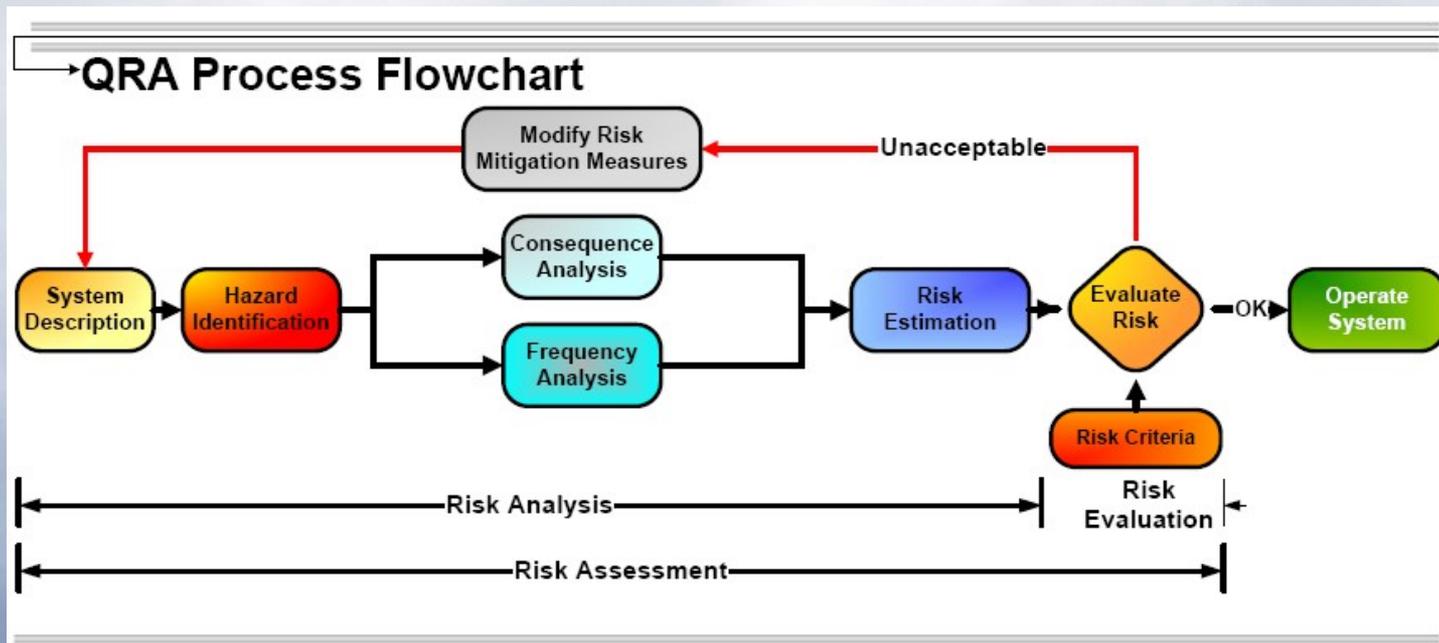
- ❑ Definition:
 - ✓ Risk criteria – terms of reference by which the significance of risk is assessed
- ❑ Establishment of risk criteria is a key element in risk management decision making:
 - ✓ Individual risk reflects the frequency that an average person located permanently at a certain location is harmed
 - ✓ Societal risk reflects the relationship between the frequency and the number of people harmed
- ❑ Options for selection of risk criteria:
 - ✓ Specify that the risk from hydrogen accidents be some fraction of the total risk to individuals from all unintentional injuries, or
 - ✓ Utilize just the individual fatality and injury risk associated with only fires and explosions
 - ✓ Specify that the risk associated with hydrogen refuelling stations be at par with the risk associated with gasoline or CNG stations

Risk Criteria and RCS Process

- The need to comply with risk acceptance criteria suggests that:
 - ✓ Any product must have a ***basic design*** that satisfies risk acceptance criteria and thus ensures minimum acceptable level of safety under intended operating conditions
 - ✓ ***Methods and tools*** are required to measure and verify product compliance with acceptable levels of risk
 - ✓ ***Codes and standards*** that identify minimum design, performance and installation requirements as well as regulations that guide permitting and approval processes have to reflect those risk acceptance criteria in order to become ***risk-informed***

Concept of Risk Management

Risk management – coordinated activities to direct and control an organization with regard to risk. Risk management generally includes risk assessment, risk treatment, risk acceptance and risk communication. ISO / IEC Guide 73: 2002



Risk Based Safety Management

Risk based safety management vs Consequence

based safety management:

Consequence based approach:

- *Worst conceivable events* at an installation handling hazardous materials should not have consequences *outside certain boundaries*

Risk based approach:

- *Residual risk* should be analysed both with respect to the *frequencies and probabilities* and the *nature* of hazard

- Opportunity for further *risk mitigation*

- Very *unlikely* events may, but not necessarily will, be *tolerated*

Conclusions

Safety and Risk:

- ✓ Safety is a social construct and a moving target – depends on risk criteria
- ✓ Risk is a technical construct – can be precisely calculated

Risk Perception:

- ✓ Should it be re-qualified as *Safety Perception*?
- ✓ Role of the media is crucial in forming perceptions

Risk Criteria:

- ✓ Terms of reference determining the significance of risk and its acceptable level – critical for establishing safety requirements
- ✓ RCS, to ensure optimal safety, need to take risk acceptance criteria into account, i.e. be risk-informed

Risk Based Safety Management:

- ✓ With the established risk criteria, risk based approach allows to determine maximum allowable level of leak frequencies and eliminate large (catastrophic) leaks from consideration of safety distances – crucial for siting of hydrogen infrastructure
- ✓ **THE ONE WHO CONTROLS FREQUENCIES CONTROLS RISK!**