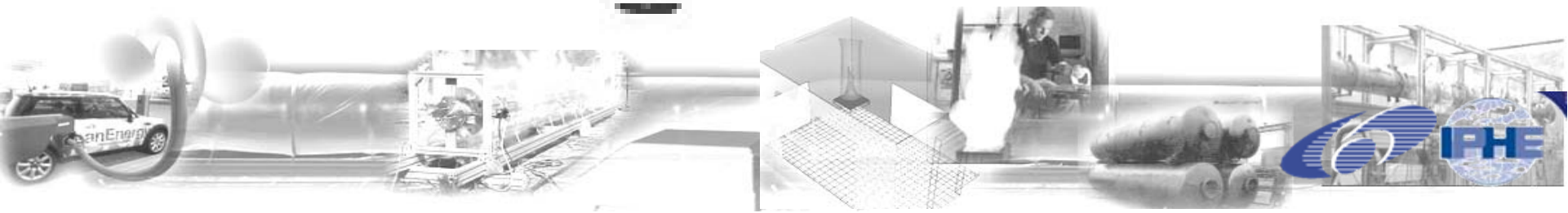


How to avoid...



THE BLACK SWAN



H2 Safety Research Needs



Releases

- Impinging and **wall attached jets** and jet fires with the associated heat transfer to set conditions for safe blowdown
- Properties and behaviour of cold hydrogen from liquid releases Evaluate the effects of various **LH2 spill** quantities, spill-and-surrounding configurations, atmospheric conditions, ignition energy, and ignition time delays on resultant blast hazards.
- Further the understanding of **ignition** phenomena to allow suitable modelling - Perform systematic studies of the ignition energy of potential ignition sources in order to classify practical ignition sources as weak or strong initiators



H2 Safety Research Needs

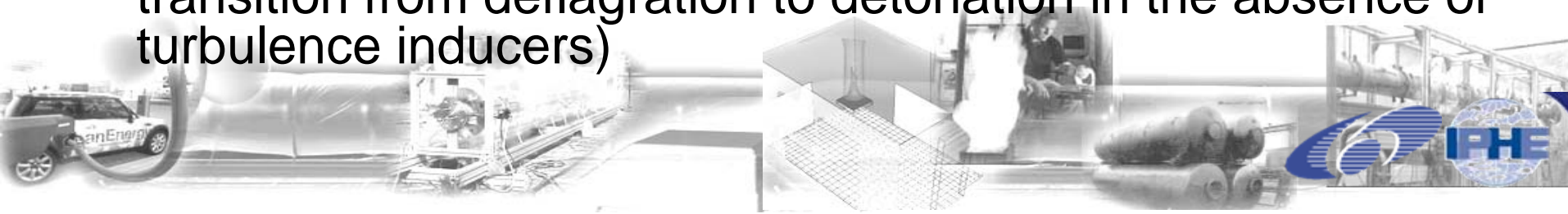


Fires

- Assess thermal radiation effects and the **effects of water vapor / droplet absorption**
- Evaluate existing **fire control techniques**: dry chemicals, foams, etc. as found useful in controlling LNG fires

Explosions

- **Transitional combustion phenomena** in realistic conditions (low temperatures, congestion, non-uniform mixtures...) and the impact on mitigation measures, for example flame acceleration and deflagration-detonation-transition in the presence of water sprays
- Experimentally verify **detonation in open air** detonable clouds. (Evaluate strong initiator and the possibility of transition from deflagration to detonation in the absence of turbulence inducers)



H2 Safety Research Needs



Mitigation

- Establish appropriate flame-arrester criteria and design/develop reliable flame-arresters

Tools

- Develop further appropriate safety engineering methodology like a reference quantitative risk assessment methodology and apply it to garage, tunnel scenarios etc
- Development of a reliable reference simulation tool for combustion open to the research community

Performance based standards

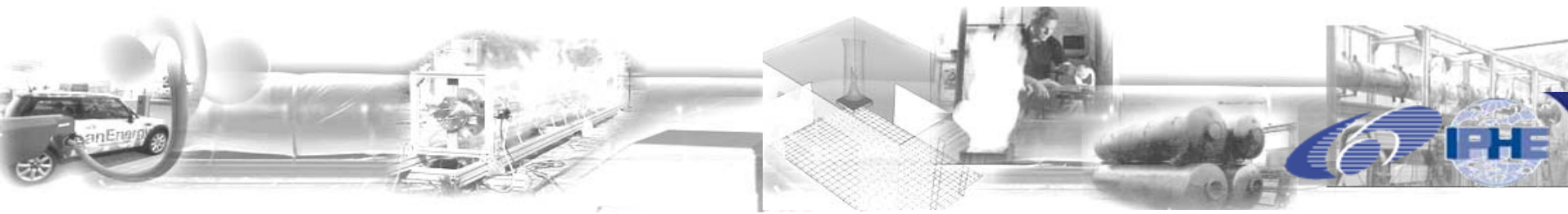
- Formulation of requirements for permitting the use of hydrogen vehicles in confined spaces
- Release strategies related to accidental scenarios, i.e. scientifically grounded requirements to location of and operational parameters for pressure relief devices



„Extreme Topics“



- Electrostatic properties of H₂ at all relevant physical domains
- Detonation arrestors
- Shock absorbing materials
- and



Provocation



So that we can help to introduce
the
„Safest Fuel Ever“

