BAM
Bundesanstalt für Materialforschung und -prüfung

Sicherheit in Technik und Chemie

HYDROGEN - SAFETY OF ENERGY CARRIERS

Competence centre H_2Safety@BAM

We build trust in hydrogen technologies.

www.bam.de

The person

- Chemist
- Employed at BAM since 1998
- Chair of the Competence Centre H_2SAFETY@BAM
- Head of the „Safety of Energy Carriers" Division
- Spokesperson of Cluster IV "Safety, Acceptance and Sustainable Market Introduction" of the German Hydrogen Research Network

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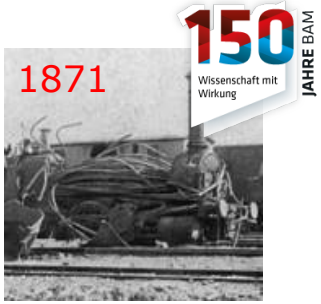
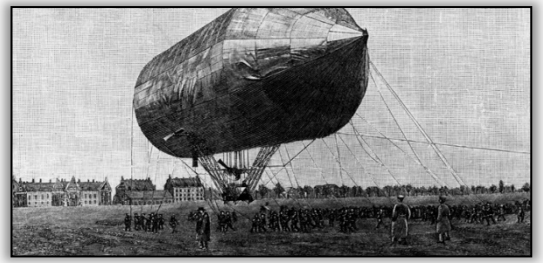
Safety in Technology and Chemistry

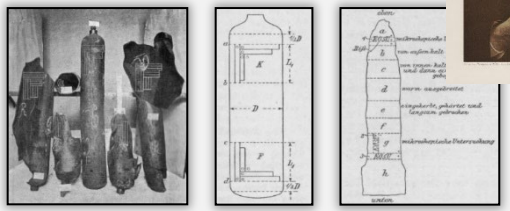
BAM is a senior scientific and technical Federal institute with responsibility to Federal Ministry for Economic Affairs and Climate Action

Federal Ministry
for Economic Affairs
and Climate Action

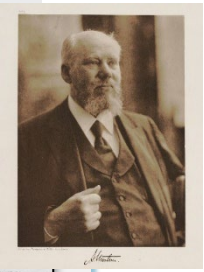




Berlin-Tempelhof 25.05.1894



A. Martens, Journal of the Association of German Engineers, 40 (1896), No. 26, pp. 717 – 723 in German



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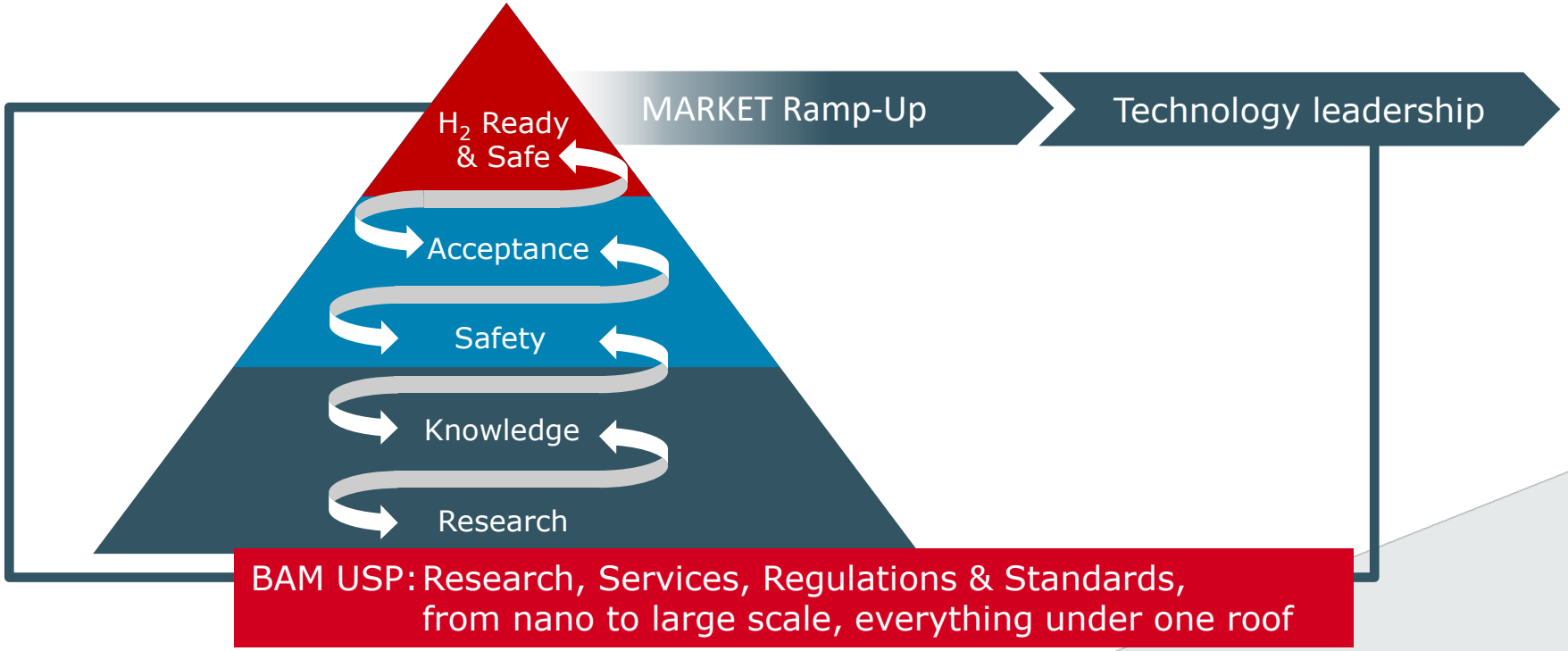
Our contribution to the national and European hydrogen strategy



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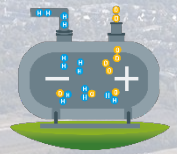
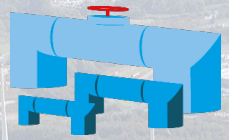
Safety Issues along the Hydrogen Value Chain

Production



- Scale-Up
- Consequences of Cross-Over
- Materials degradation
- Protection areas
- Safety guidelines

Transport



- Materials compatibility
- Explosion protection
- Consequences of failure
- Gas quality influences

Storage

- Operation-dependent safety assessments
- Structural health monitoring
- Life time assessment
- Isolating materials for cryogenic storage
- Advanced storage technologies

Use

- Proof of safety concepts
- Leak monitoring
- Hydrogen quality
- Digital quality infrastructure
- Consequences of failures & safety measures
- Tribology and Lubricants

Acceptance | **Education and Training** | **Regulation, Codes and Standards**

Test Site for Technical Safety (BAM TTS)

The "Hydrogen Safety" test area offers unique testing possibilities

- Modern infrastructure and equipment
- Testing under extreme conditions on a real scale

1. H_2 Test Area (H_2TA): 100 MPa infrastructure, LH_2, Impact test facilities, Pipeline test facility
2. Real Lab „Hydrogen Refuelling Station"
3. Test house pressure vessels (completion: 08/2024)
4. Fire test stands and high-speed impact test facility
5. Free-jet testing and constructive explosion protection

Hydrogen Safety – State of the Art

- R&D on safety issues using hydrogen or on hydrogen systems are already going on for decades
- Hydrogen systems can be as safe as systems based on conventional energy carriers
  - » assuming the specific properties of hydrogen and the hydrogen system are properly addressed
- Safety must be considered from the beginning of technology development
- Gap analysis required ("Not to reinvent the wheel!")

Hydrogen Safety – State of the Art

- Identified Knowledge Gaps (Extract from the „Recommendations German Hydrogen Research Network“ (published 03/2022); 1.500 Experts from economy and science; Recommendations handed out to German government)
  - Material properties and compatibilities (Selection of suitable materials for entire life time of a technology)
  - Safety of LH_2 (as it might play an important role for energy transport and distribution)
  - Leak detection and monitoring (R&D of area- and volume-based detection of hydrogen releases and mixing behavior; sensor networks; Digitalization and AI)
  - Protection concepts (Guidelines for specific measures, e.g. releases; definition of protection areas; …)
  - Knowledge transfer (Education, Training, Regulation, Codes and Standards)

Promoting Young Talent and continuous Education

- Cooperation with the University of Birmingham - BAM lectures on hydrogen safety within the Joint European Summer School
- Capacity building at University of Namibia (Participation to Master Graduate School)
- BAM Academy for educating and training of young scientists and experts
- BAM and BTU Cottbus joint graduate programme "TrustWorthy Hydrogen" for the promotion of PhD Students

Joint European Summer School
on Fuel Cell, Electrolyser and Battery Technologies

UNIVERSITY OF BIRMINGHAM

Brandenburgische Technische Universität Cottbus - Senftenberg

UNAM
UNIVERSITY OF NAMIBIA

Project: Safety related research in the field of LH_2 storage and transport applications

Part 1: BLEVE Tests

Part 2: RPT Tests

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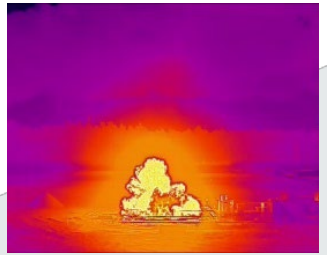

High energy impact testing on gas cylinders
up to 25kJ@70MPa

construction of the impact test bench with internal pressure (modular drop apparatus)

implementation of a splinter protection (patenting of modular anti-splinter elements)

implementation of a gas filling unit for filling with hydrogen (patented gas weighing unit)

Hydrogen Safety – Conclusions

- Hydrogen safety is not a barrier to the introduction of the energy carrier or technologies
- Safe handling of hydrogen has been the subject of intensive research for years → gaps need to be identified and closed
- Experience and knowledge must be used from many different areas, e.g., from the chemical industry or the area of nuclear safety
- Hydrogen systems can be as safe as systems based on conventional energy carriers
- Dissemination of knowledge, competence and safety culture to all stakeholders in the technological value chain:
  - » design, manufacturing, assembly, operation, maintenance, decommissioning, first responders, training, education, etc.


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