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Standardization Roadmap for Hydrogen Technologies

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Standardization Roadmap for Hydrogen Technologies

- participating organizations

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik	Deutscher Verein des Gas- und Wasserfaches e. V. (DVGW)	Verein für die Normung und Weiterentwicklung des Bahnwesens e. V. (NWB)	Verband der Automobil-industrie e. V. (VDA)	Verein Deutscher Ingenieure e. V. (VDI)	Verband Deutscher Maschinen- und Anlagenbau e. V. (VDMA)
DKE (German Commission for Electrical, Electronic and Information Technologies)	German Technical and Scientific Association of the Gas and Water Sector (DVGW)	Association for the Standardization and Further Development of the Railway System (NWB)	German Association of the Automotive Industry (VDA)	Association of German Engineers (VDI)	German Mechanical and Plant Engineering Association (VDMA)

Standardization Roadmap for Hydrogen Technologies

- Aims / Motivation

  - Framework conditions for the ramp-up of the hydrogen industry

  - Creation of a reliable and congruent set of rules

  - Groundbreaking guidelines for technologies, infrastructures, and quality standards

  - Status quo of the inventory and needs analysis of standards and technical regulatory documents

Standardization Roadmap for Hydrogen Technologies

- Organisation
  - 39 working groups with about 600 experts
  - Subject areas
    - Infrastructure
    - Application
    - Quality Infrastructure
    - Training, Certification and Safety

- ⇒ about 850 exisiting standards and technical regulations were listed
- ⇒ about 180 needs and recommendations for action for technical regulation were identified

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- Participation in the following working groups
  - Infrastructure
    - WG 2.2.1 stationary and mobile pressure vessels — **No cryogenics !**
    - WG 2.2.4 Liquefaction
  - Applications
    - WG 3.4.1 Filling systems — **No cryogenics !**
    - WG 3.4.3 Rail vehicles — **No cryogenics !**
    - WG 3.4.5 Aviation — **No cryogenics !**

Most working groups did not deal with cryogenics, so LH_2 or requirements were assigned to other units as cross-cutting topics.

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- Many areas concerning LH_2 are covered by existing standards.
  - e.g.
    - Cryogenic standards
    - European Pressure Equipment Directive
    - European directives on explosion protection (ATEX)
    - ….

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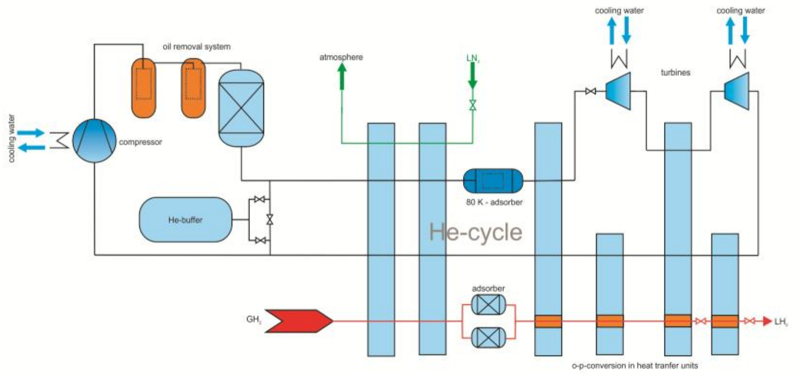
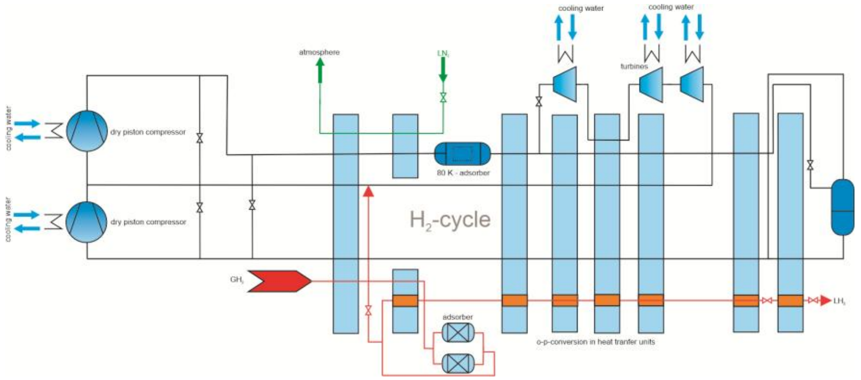
- Additional identified needs
  - Standard for the design and operating time of cryogenic adsorbers to avoid an ignitable mixture





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- Additional identified needs
  - Procedure for filling a tank with liquid hydrogen
    - e.g.
      - Status recording
        - Manufacturer specifications (volume, max. pressure, interfaces, max. ΔT for cooling down and warm up, …)
        - Actual condition (pressure, temperature, liquid level, …)
      - Determination of the operating modes for preparing for filling the tank
        - Cleaning the tank by flushing and evacuating
        - Controlled cool down
        - …
      - Preparation and implementation of the selected operating modes
        - …

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- Additional identified needs
  - Standardization of cryogenic couplings as interfaces between filling systems and the application
    - DIN EN 13371: couplings for cryogenic service
      - Only a basic description
    - Standards with specified dimensions are necessary

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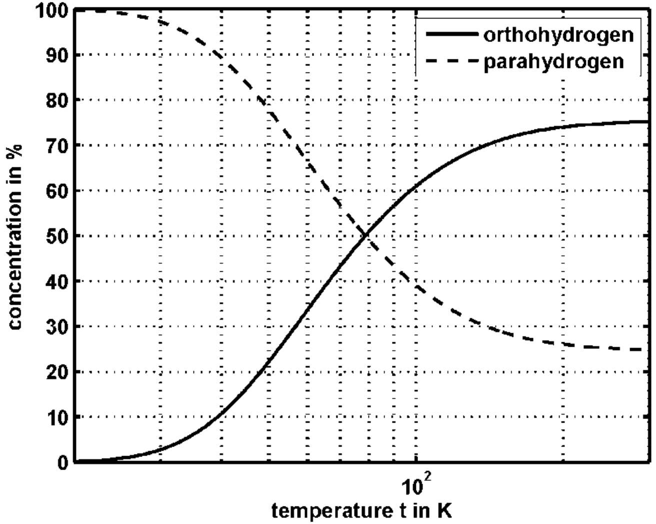
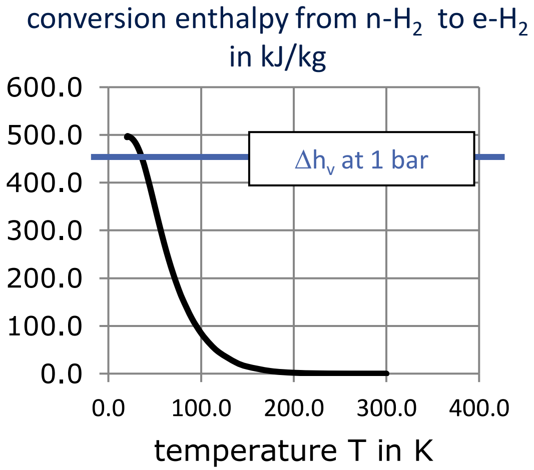
- Additional identified needs
  - Standardization of the para content of liquefied hydrogen as a quality feature for long-term storage



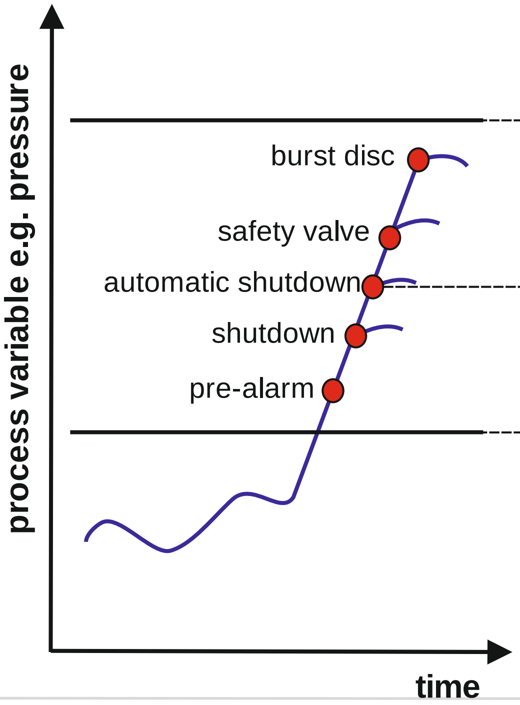


n-H_2 liquefied:
slow spontaneous reaction
→ lot of energy released
→ up to 67 % extra evaporation
→ slow spontaneous conversion
$t_{1/2} \approx 3.65$ d

Safety of cryostats

- Design pressure of cryostat

non intended operation	**non permitted fault range**
intended operation	permitted fault range
	acceptance region



	damage control levels
burst disc; safety valve	protection level
hard wired pressure switch; SPS	monitoring level
controller	operational level

Example: Vacuum break LH_2-cryostat

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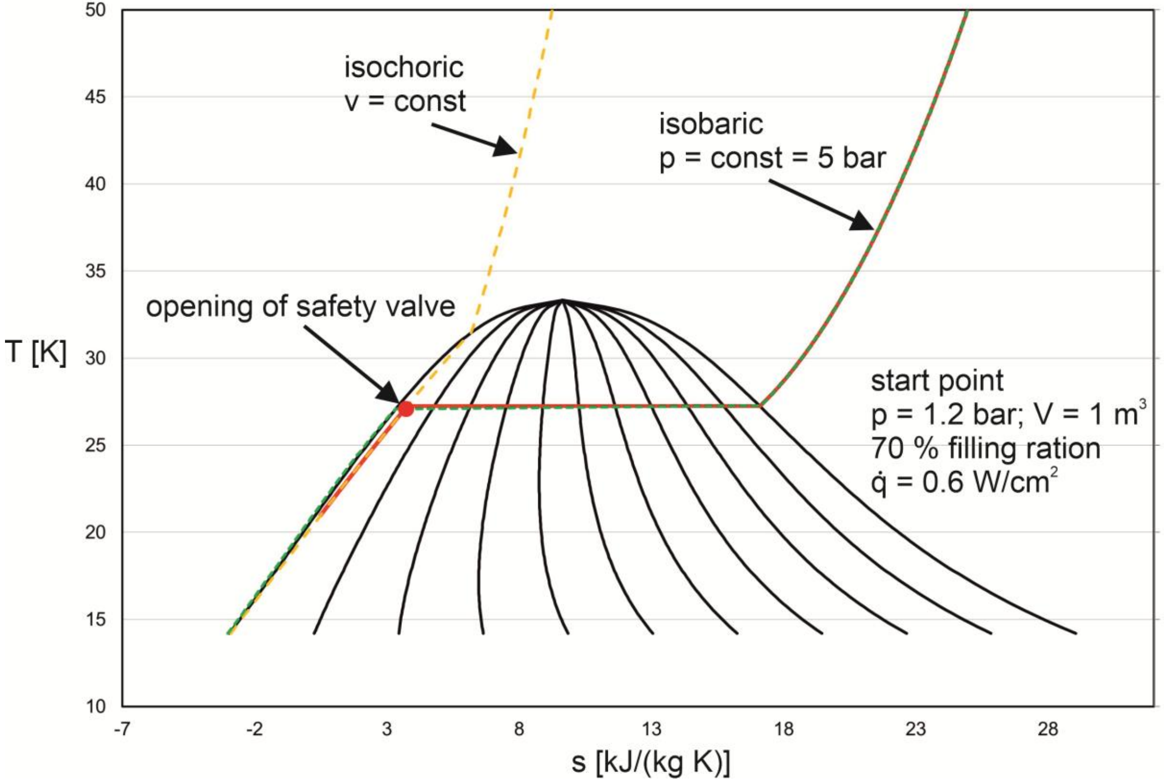

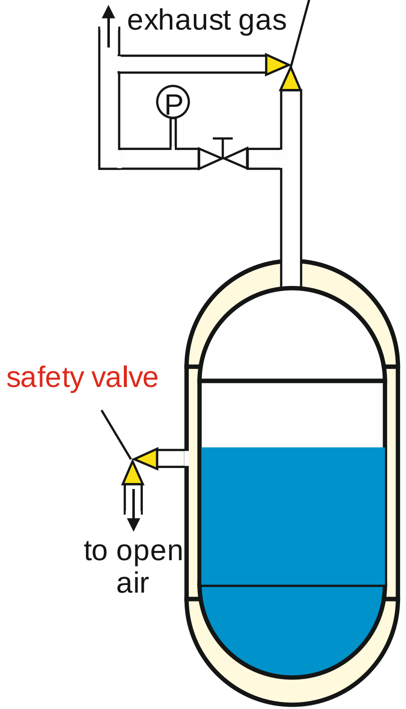

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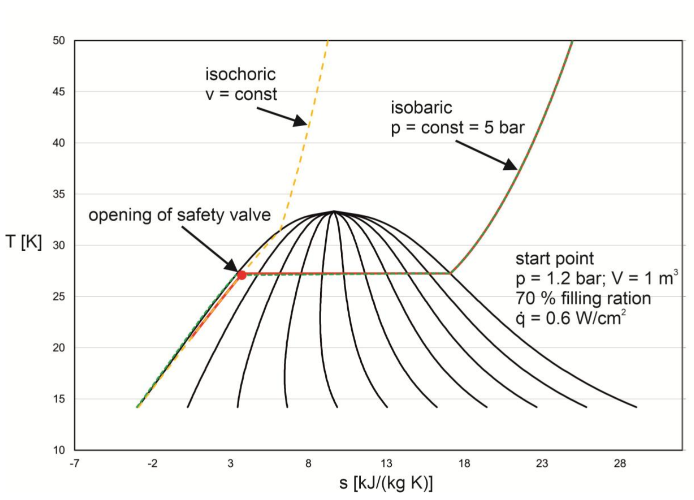
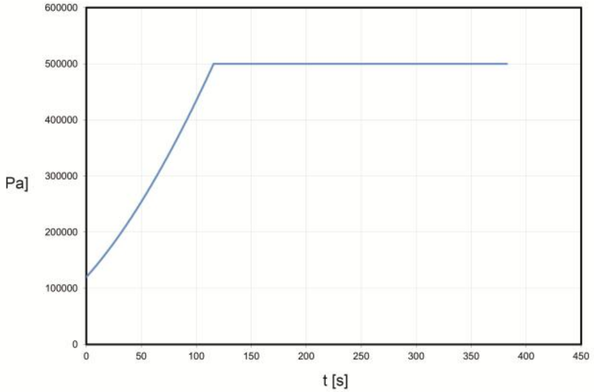
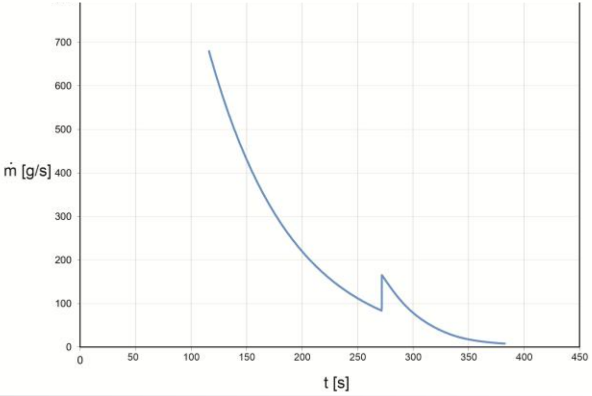
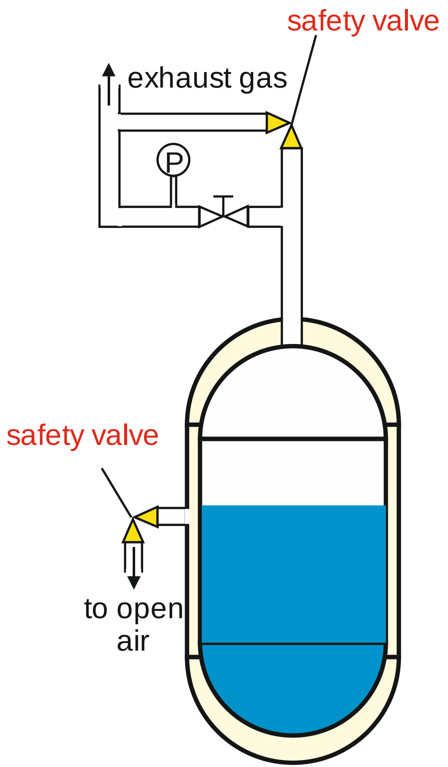


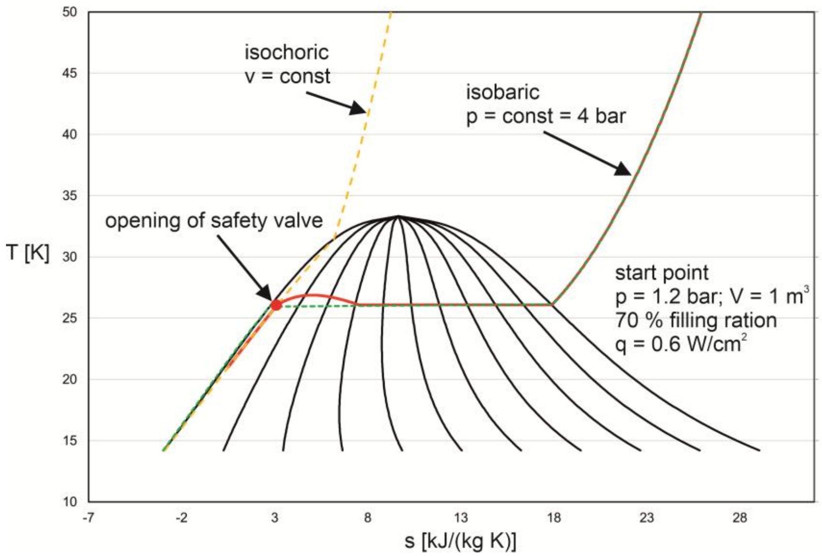


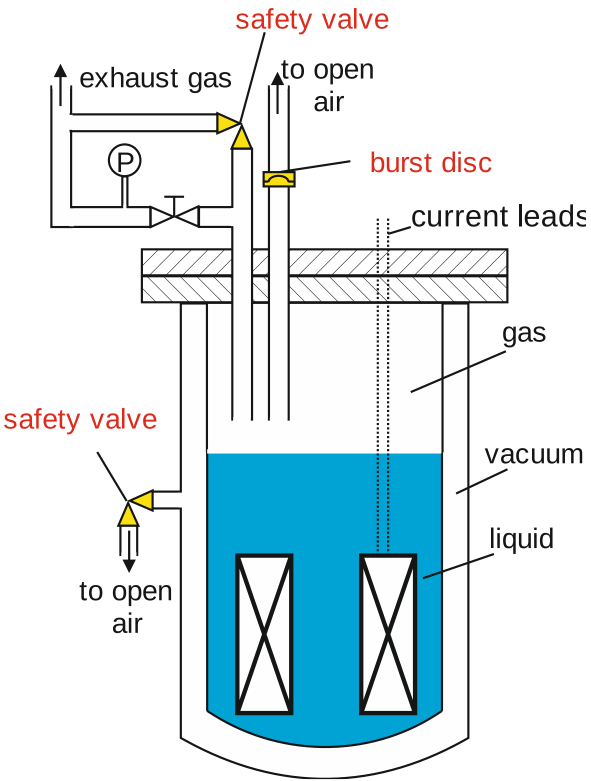




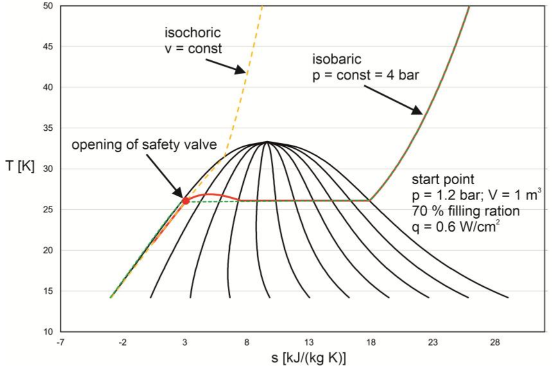
Combination safety valve and burst disc

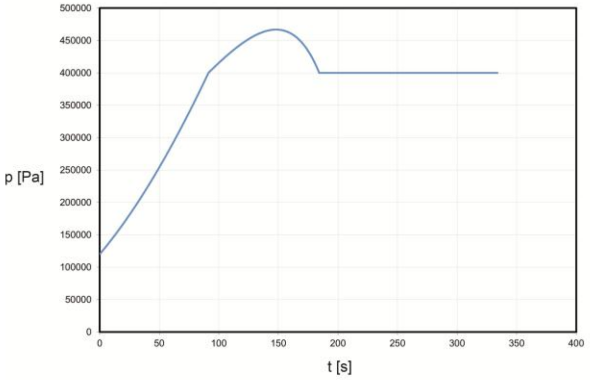
- Established good practice in helium cryostats is to use a combination of safety valve and rupture disc for safety

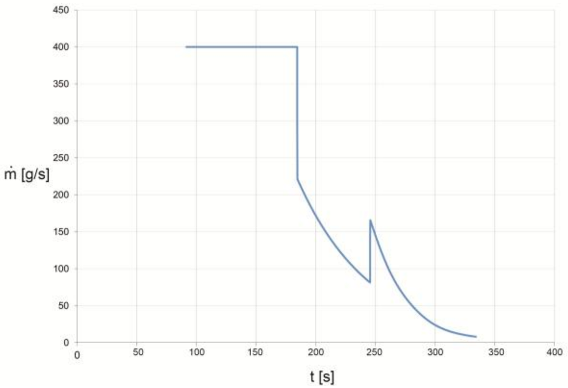


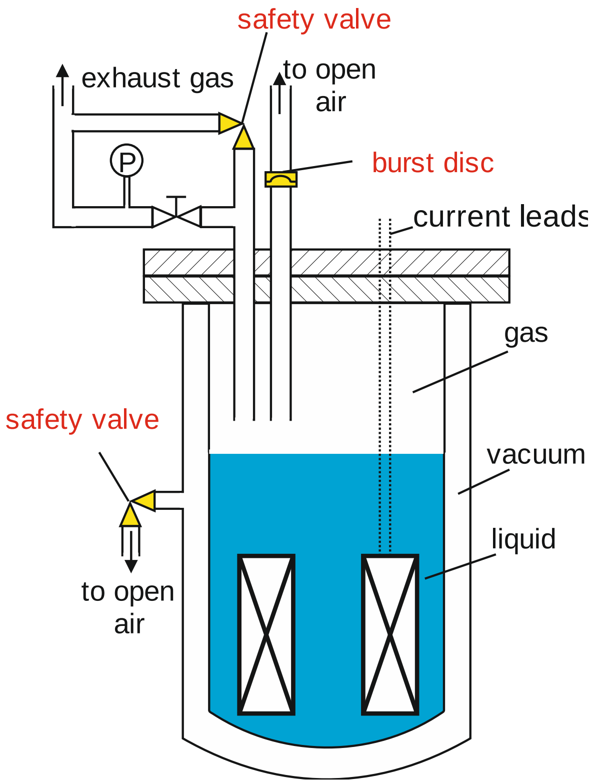


Combination safety valve and burst disc





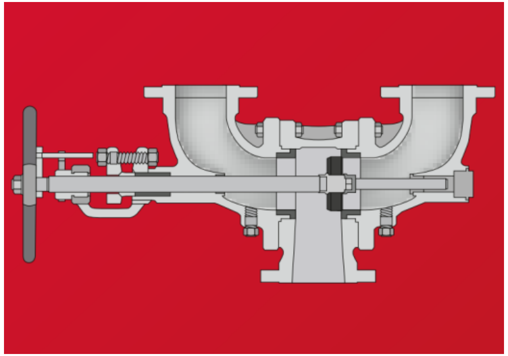




- Burst disc p_{max} = 5 bar not broken
- smaller mass flow allows smaller diameter lines to the safety valve and thus smaller safety valves
- Smaller diameter pipes to the safety valve mean smaller heat loads

Problem with burst disc

- After the rupture disc opens and the hydrogen flows out, air enters the cold cryostat.
  - ⇒ Condensation of the air with oxygen enrichment
  - ⇒ Formation of an ignitable mixture
- possible solution: shuttle valve



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Thank you for your Attention!