



# SAFETY STANDARDS AND NORMS FOR GREEN HYDROGEN/GREEN AMMONIA/GREEN METHANOL

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- **H<sub>2</sub> Production**
  - Technical assessments
  - Certifications of origin
  - Green Hydrogen
- **Grid Operators**
  - IT security
  - Operational monitoring and surveillance
- **Industrial H<sub>2</sub> Users**
  - Material testing
  - H<sub>2</sub> readiness
- **H<sub>2</sub> in Mobility**
  - Homologation of H<sub>2</sub>-powered vehicles
  - Range calculations
- ...

***Founded 1869***  
***German/EU Notified Body for***  
***Inspection, Testing, Certification &***  
***safety***

***in industry***  
***Core sectors Oil and Gas, Nuclear,***  
***Renewable, Chemical Fertiliser, Steel,***  
***Mobility,***



*Derived from 150 years of experience  
Driven by passion for true sustainability & safety  
Focused on value creation for generations*

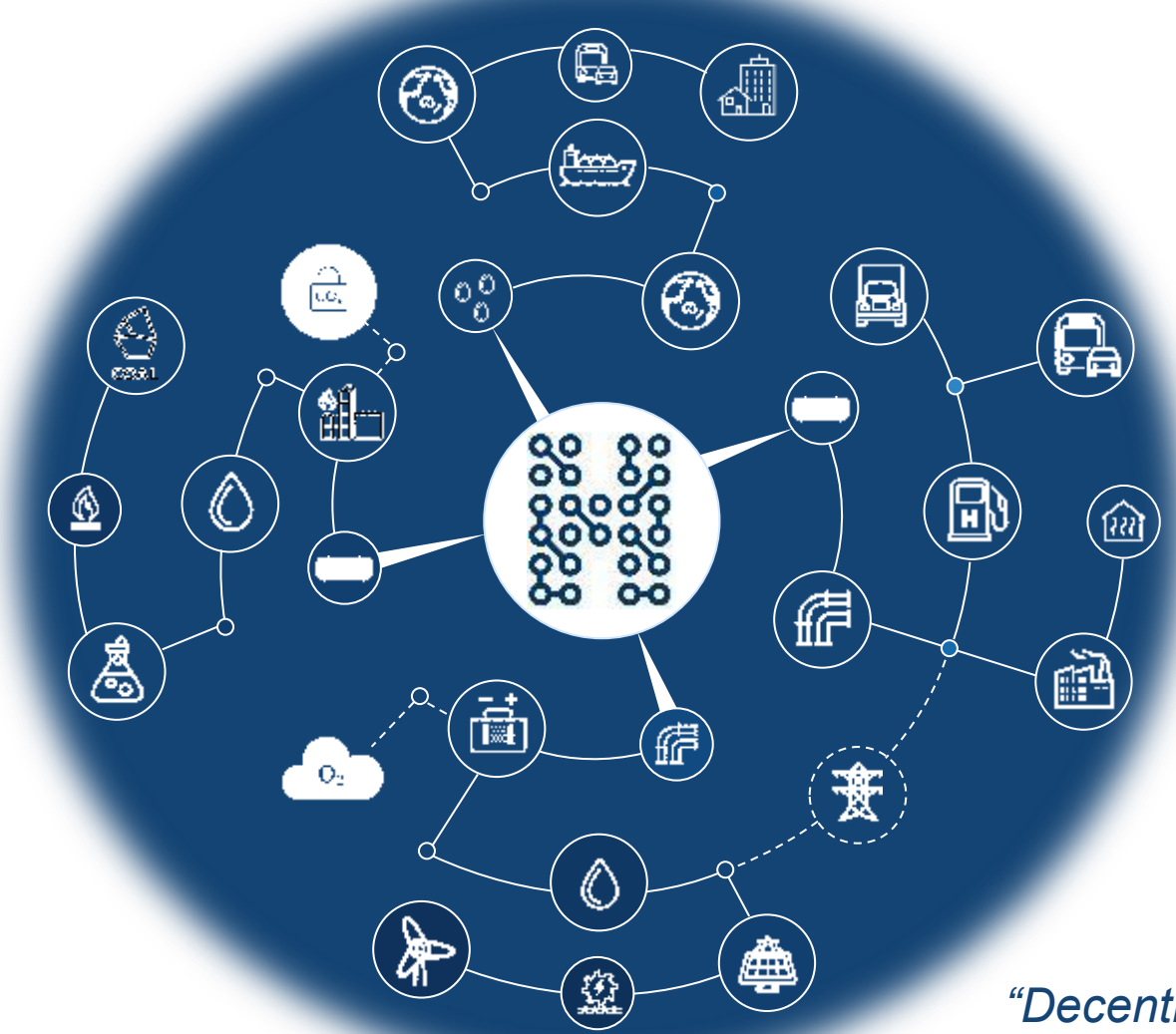
**Business platform  
for hydrogen  
knowledge exchange**

**Consulting,  
Engineering & Training  
for the Hydrogen Economy**

**Partner to  
like-minded businesses  
to broaden impact**

**Hydrohub an initiative of TUV Nord Group Companies**

# HYDROGEN – A CENTRAL BUILDING BLOCK FOR NEW ENERGY SYSTEMS



*“Decentralized,  
cross-sector & sustainable.”*



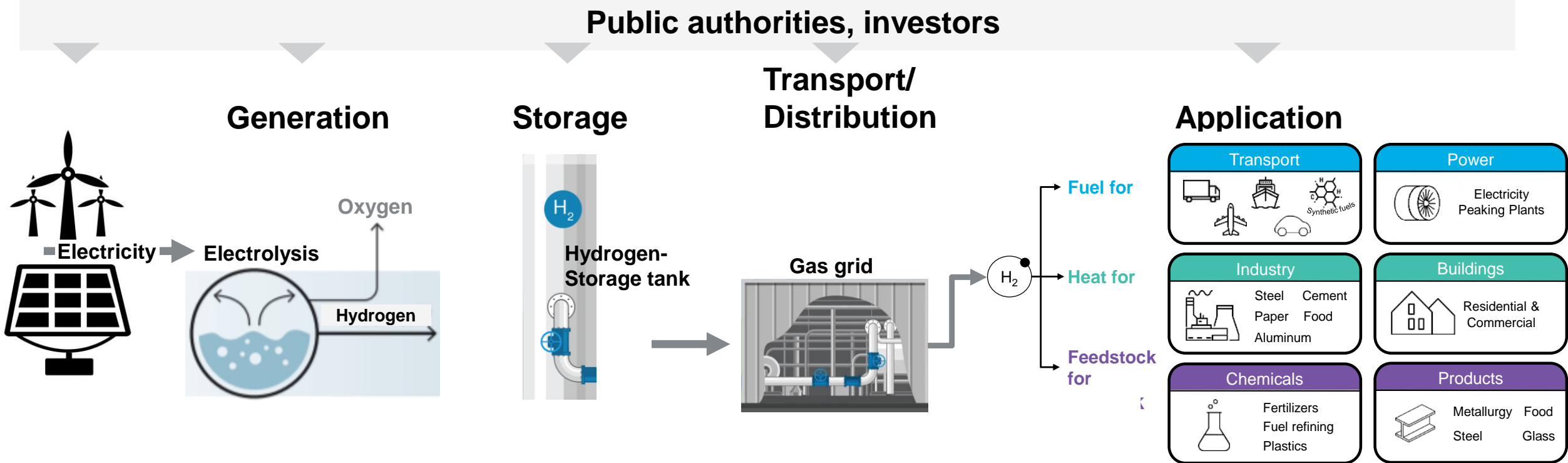
# WHAT?

## NEW TECHNOLOGIES / TECHNOLOGY SHIFT

Global overview on activities towards H<sub>2</sub> strategies

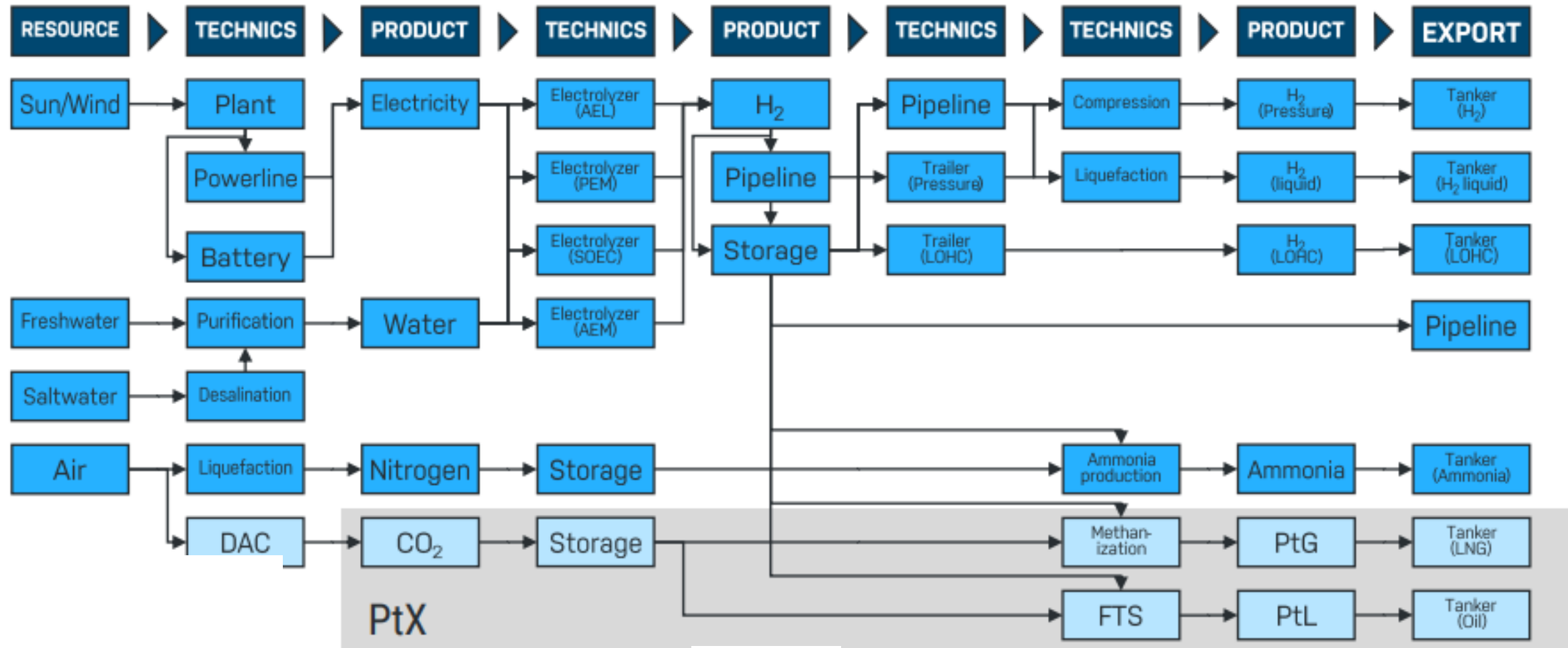


# HYDROGEN SUPPLY CHAIN

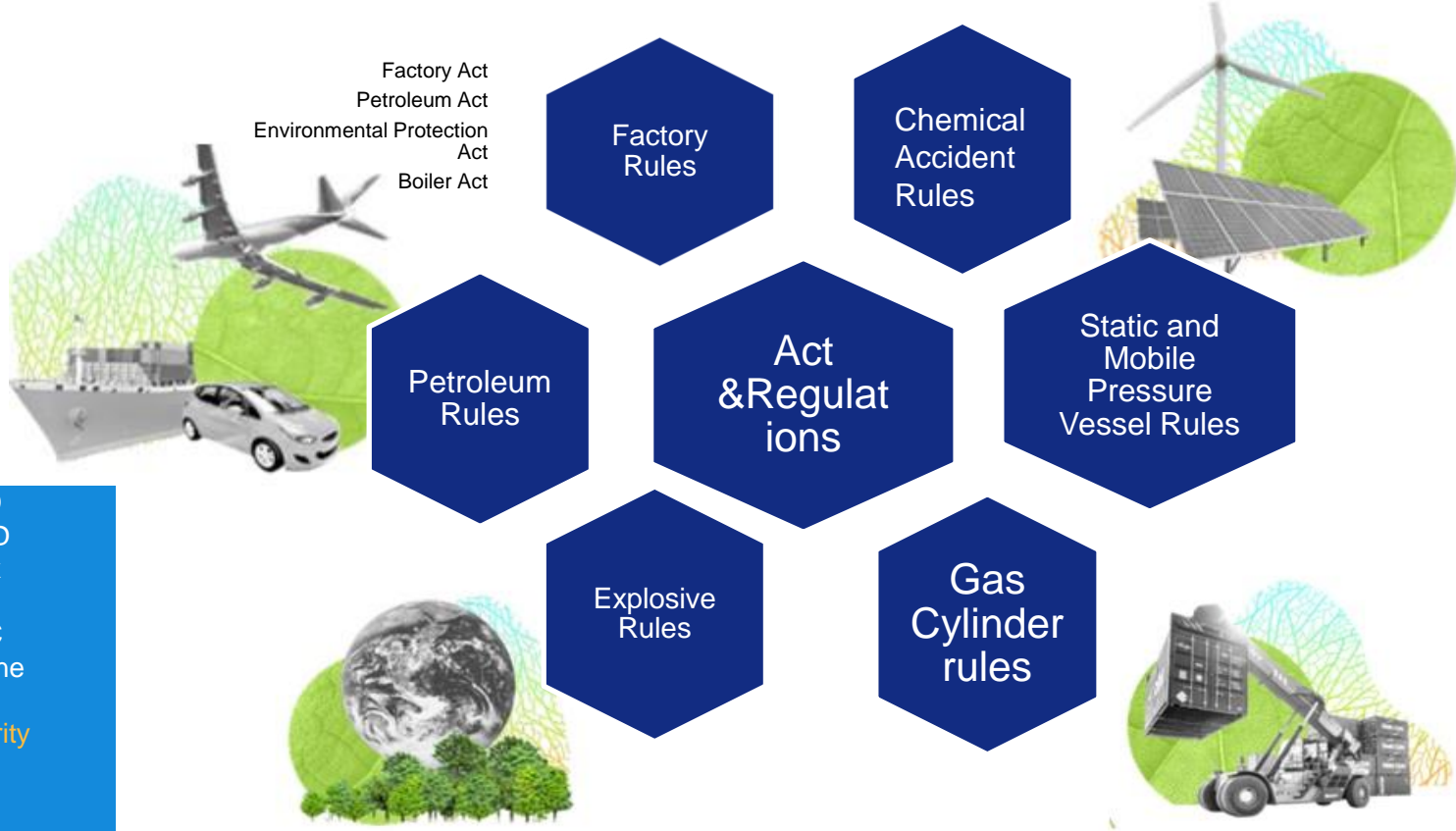


# HYDROGEN AS A PATH TO CLIMATE NEUTRALITY

## Hydrogen value chain



# REGULATORY FRAMEWORK



- 2014/68/EU-PED
- 2014/29/EU-TPED
- 2014/34/EU-Atex
- 2014/35/EU-LVD
- 2014/30/EU EMC
- 2006/42/EC Machine
- 200/14/EC Noise
- NIS2 – Cyber security

Government  
National authorities  
Notified Body  
Inspection Body  
Owner/Operator  
Safety



# WHAT DOES THE LAW SAY ABOUT RISK ASSESSMENT?

Whether you're an employer or you work on your own, different countries law states that you need to carry out and conduct risk assessment practices to identify foreseeable risks in your business, and take action to prevent or minimize these risks.

General legal requirements: The 1999 [Management of Health and Safety at Work Regulations](#) (MHSWR) for UK outline that employers must:

- Assess risks to self, employees, and any other people who have contact with the workplace or work processes
- Review any assessment over time to address any changes
- In the case of organizations with five or more employees, keep a record of risk assessment findings, and identify people who are considered especially at risk

Additional laws: Depending on the nature of your work, you may also need to know about regulations that address specific hazards in UK, for example:

- [Control of Substances Hazardous to Health \(COSHH\) regulations](#)
- [Display Screen Equipment \(DSE\) Regulations](#)
- [The Control of Vibration at Work Regulations](#)

# INDIAN REQUIREMENTS FOR HAZARDOUS MATERIALS RISK ASSESSMENT AND SAFETY STUDIES

Following are the Indian requirements for carrying out Risk assessments and other studies of Hazardous Materials Which include H2, Methanol & Ammonia

- **As per MSIHC rule SCHEDULE -8 See Rule 10(1)],** Information To Be Furnished In A Safety Report which includes inputs on Risk assessment quantitative as well as Qualitative techniques.
- Off-site emergency plan prepared under **Rule 14 of the MSHIC** (Manufacture, Storage and Import of Hazardous Chemicals);
- The **Chemical Accidents Rules, 1996, Rules** On Emergency Planning, Preparedness And Response For Chemical Accidents.
- The Audit is carried out as per the requirement under **IS 14489** and the various Legislative requirements such as the **Factories Act, 1948 and the state Factories Rules**, Environment (Protection) Act, 1986.

# ESSENTIAL SAFETY REQUIREMENT FOR GREEN H<sub>2</sub>, AMMONIA & METHANOL

Every Hazardous Material handling and transportation system must be designed, constructed and operated in such a way that the additional risk to people, property and the environment is kept within acceptable limits.

There are different type of Risk assessment and management techniques or studies to be carried for controlling/eliminating and managing different type of risk in all Green Hydrogen, Ammonia and Methanol systems. Following are the some of the process safety Studies that need to be carried out for such system:

- For Hazard Identification: HAZID, HAZOP, What-If analysis, Checklist based hazard identification, HIRA, FMEA etc.
- For Evaluation of risk from the different hazardous Scenarios in system: QRA, Consequence analysis, FERA, Blast Overpressure study, Dispersion Analysis, etc.
- Risk controlling or management studies : HAC, Electrostatic Hazard Assessments, Safety Audits, Process Safety Reviews, MIERA, F&G Mapping, etc.

In addition to above there are various type of process safety studies that can be carried out for control and elimination of specific hazards identified during hazard identification stage.

# ESSENTIAL SAFETY REQUIREMENT FOR GREEN H2, AMMONIA & METHANOL

SRL	Facility	HAZID	HAZOP	FMEA	SIL Classification/ Verification	FERA	QRA	Vent Dispersion	RAM	Hazardous Area Classification	Passive Fireproofing	F&G Mapping	Bowtie Analysis & SCE Identification
1	Green Hydrogen Plant	Y	Y	Y*	Y	Y	Y	Y	Y	Y	N	Y	Y
2	Green Ammonia Plant	Y	Y	Y*	Y	Y	Y	Y	Y	Y	Y	Y	Y
3	Green Methanol Plant	Y	Y	Y*	Y	Y	Y	Y	Y	Y	Y	Y	Y

\* - Especially applicable for Electrolyser package, Can be part of RAM Study

## WHICH IS MORE HAZARDOUS?

- If we compare Hydrogen, Methanol and Ammonia, Hydrogen Gas is the most hazardous one due to its sensitivity towards the ignition source (, it needs lowest energy for the ignition i.e. 0.02 mJ as compare to ammonia and Methanol).
- Also the flammability range of the Hydrogen is wide ranging from 4% to 75%, hence in case of any leakages from the system it will form an flammable/ explosive atmosphere easily.
- Following are some of the flammability properties comparison among H2, ammonia and Methanol:

Properties of Material	Hydrogen	Ammonia	Methanol
Flash Point	Can get ignition at any temperature	132 Deg C	10 Deg C
MIE (Minimum ignition Energy) required for Ignition	0.02 mJ	NA	0.14 mJ
Flammability Range	4% to 75 %	Not Flammable	5.5% to 44 %
Auto Ignition Temp	550 Deg C	651 Deg C	455 Deg C

# DIFFERENT STANDARDS APPLICABLE FOR HYDROGEN HANDLING, STORAGE AND TRANSPORT:

- **NFPA-2: Hydrogen Technologies Code** -This code provides fundamental safeguards for the generation, installation, storage, piping, use, and handling of hydrogen in compressed gas (GH<sub>2</sub>) form or cryogenic liquid (LH<sub>2</sub>) form.
- **NFPA-70: National Electrical Code®** - Adopted in all 50 states, NFPA 70, National Electrical Code (NEC) is the benchmark for safe electrical design, installation, and inspection to protect people and property from electrical hazards, these can be used for selection of the electrical fittings in hydrogen handing areas.
- **NREL 60948: Hydrogen Technologies Safety Guide**
- **29CFR1910 H: OSHA 29 CFR 1910 sub part H** specifies general safety and health standards that apply to Hazardous materials.
- **29CFR1910.119: OSHA 29 CFR 1910.119** - Process safety management of highly hazardous chemicals
- **49CFR: The Code of Federal Regulations (CFR)**, These regulations govern the transportation of hazardous materials (hazmat) in interstate, intrastate, and foreign commerce.
- **CGA H-5: CGA's H-5 Publication Guides Safe Design, Installation, and Use of Bulk Hydrogen Supply Systems**

# GENERAL SAFETY RECOMMENDATIONS FOR H2 SYSTEM

- Being highly sensitive towards the ignition source, it is important to eliminate all types of ignition sources like mechanical spark, electrostatic sparks, electrical, open flames etc. from the system where there is possibility of possible hydrogen flammable atmosphere.
- Hydrogen venting is also critical where it is used for the reactions. The venting has to be done in a controlled manner ( N2 or steam purging methods can be adopted to reduce risk involved in H2 venting)
- Being an Highly explosive gas, adequate blast wall constructions to be done in the areas where hydrogen is stored. To minimise the impact of the overpressure on the nearby structures, storage quantity has to be bare minimum (Inherantly safe design).
- Adequate type of IIC rated electrical fittings to be used in Hydrogen areas.
- Most of the Hydrogenation reactions are exothermic in nature hence adequately designed overpressure venting system ( Rupture disc and Pressure safety valves) need to be provided on the reactors.
- Right placement of gas leak detection system
- Adequate earthing system should be there in order to avoid the electrostatic discharges from the metal plant items.
- Operators involved in the hydrogen handling operation need to have clothing and footwear to avoid the electrostatic discharges from their personal PPEs .

# DESIGN AND CONSTRUCTION CODES FOR HYDROGEN

Mode of storage/transport	Form	Acceptable Codes	Regulatory Auth	Aspects
Static Vessel	Gas	IS 2825; ASME Section VIII Division 1 or Division 2, PD5500, AD:2000, EN 13445-3	NOBO/National Auth.	Design /Manufacturing/Installation/operation
Static Cryogenic Vessel	Liquid -253C	ASME Section VIII Division 1 EN 13458, AD2000, EN 13445	NOBONONOBO/National Auth.	
Gas Cylinders	Gas	ISO: 9809, IS 7285, ISO 11119-1	NOBO/National Auth.	Risk Assessment
Transport Cryogenic Tank	Liquid -253C	ASME Section VIII Division 1 EN 13530/AD2000, ISO 21029-1, EN 13445	NOBO/National Auth.	
Pipeline	Gas	API 31.12/31.3	NOBO/National Auth.	Blended NG



# DIFFERENT STANDARDS APPLICABLE FOR AMMONIA HANDLING, STORAGE AND TRANSPORT:

- **ANSI K61 / CGA 2.1 – 2014:** American National Standard Safety Requirement for the Storage and Handling of Anhydrous Ammonia
- **ANSI/IIAR 2-2008:** American National Standard for Equipment, Design and Installation of Closed-Circuit Ammonia Mechanical Refrigerating System
- **OSHA - 29 CFR 1910.111:** Storage and handling of anhydrous ammonia.
- **US-OSHA 29 CFR 1910.119:** Process Safety Management of Highly Hazardous Chemicals Standard
- **US-Dept. of Transportation 49 CFR Parts 171-180:** Transportation of Hazardous Materials
- **EN 60079:** Explosive atmospheres. Electrical installations inspection and maintenance
- **EN 378:** Refrigerating systems and heat pumps. Safety and environmental requirements. Basic requirements, definitions, classification and selection criteria
- **IS 4544 (2000), ICS 71.060;13.300:** Ammonia - Code of Safety
- **IS 660 (1963):** Safety code for mechanical refrigeration

**Note: In addition to the above mentioned standards there are various country specific standards are also available and applicable for the hydrogen system and Risk management of such hazardous system**

# DESIGN AND CONSTRUCTION CODES FOR AMMONIA

Mode of storage/transport	Form	Acceptable Codes	Regulatory Auth	Aspects
Double wall Storage Tank	Liquid	API 620, Annexure R	NOBO/National Auth.	
Transport Tank	Liquid	IS 2825; ASME Section VIII Division 1 or Division 2, PD5500, AD:2000, EN 13445	NOBO/National Auth.	
Pipeline	Liquid	API31.4/API 31.8	NOBO/National Auth.	

# DIFFERENT STANDARDS APPLICABLE FOR METHANOL HANDLING, STORAGE AND TRANSPORT:

- **NFPA-70: National Electrical Code®** - Adopted in all 50 states, NFPA 70, National Electrical Code (NEC) is the benchmark for safe electrical design, installation, and inspection to protect people and property from electrical hazards, these can be used for selection of the electrical fittings in methanol handling areas.
- **29CFR1910 H:** OSHA 29 CFR 1910 sub part H specifies general safety and health standards that apply to Hazardous materials.
- **29CFR1910.119:** OSHA 29 CFR 1910.119 - Process safety management of highly hazardous chemicals
- **49CFR:** The Code of Federal Regulations (**CFR**), These regulations govern the transportation of hazardous materials (hazmat) in interstate, intrastate, and foreign commerce.
- **NFPA 77:** Recommended Practice on Static Electricity, This recommended practice offers guidance on identifying, evaluating, and controlling static electric hazards for purposes of preventing fires and explosions.
  
- **Note:** In addition to the above mentioned standards there are various country specific standards are also available and applicable for the Methanol system and Risk management of such hazardous system

# DESIGN AND CONSTRUCTION CODES FOR METHANOL

Mode of storage/transport	Form	Acceptable Codes	Regulatory Auth	Aspects
Storage Tank	Liquid	API 650, IS 7444	NOBO/National Auth.	
Transport Tank	Liquid	IS 2825; ASME Section VIII Division 1 or Division 2, PD5500, AD:2000, EN 13445	NOBO/National Auth.	
Pipeline	Liquid	API 31.4	NOBO/National Auth.	

# Many thanks for your attention!



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