



MODULE 2

WORKSHEET 2: HYDROGEN TRANSPORTATION RISK ASSESSMENT

The Objective

The objective of this worksheet is to enhance your abilities in identifying, evaluating, and managing the risks related to hydrogen transport, while also familiarizing you with essential safety standards and procedures.

Introduction

The transportation of hydrogen, whether in compressed or liquid form, entails particular risks that require thorough analysis and mitigation. Inadequate procedures or mistakes can result in significant incidents.

Primary threats in hydrogen transportation:

- **High flammability and explosiveness of hydrogen:** Hydrogen possesses a broad spectrum of explosive concentrations in air (ranging from 4% to 75%) and requires minimal ignition energy.
- **High pressure:** In the case of compressed hydrogen, damage to the tank may result in a rapid release of gas and the generation of a shock wave.
- **Low temperatures (for LH2):** The spillage of liquid hydrogen can result in frostbite and may also embrittle materials with which it comes into contact.
- **Boil-off phenomenon (for LH2):** The loss of hydrogen due to evaporation, resulting in economic losses and heightening the risk of flammable atmospheres in inadequately ventilated spaces.
- **Invisibility of the Hydrogen Flame:** The hydrogen flame is devoid of color and nearly imperceptible in daylight, rendering the fire challenging to identify.

Key transportation standards and regulations:

- **ADR (European Agreement concerning the International Carriage of Dangerous Goods by Road):** Establishes regulations for the classification, packaging, labeling, documentation, and technical specifications for vehicles and drivers engaged in the transportation of dangerous goods by road. For hydrogen, the stipulations regarding pressurized tanks and emergency protocols are essential.
- **IMDG Code (International Maritime Dangerous Goods Code):** The International Maritime Dangerous Goods Code provides comprehensive guidelines for vessels transporting LH2 and hydrogen carriers, such as ammonia.

Risk mitigation strategies:

- **Safe design:** Utilization of suitable materials, safety mechanisms (overpressure valves, leak detection systems, shut-off systems), and ventilation.
- **Personnel training:** Drivers and staff engaged in transshipment must receive adequate training regarding the properties of hydrogen, emergency protocols, and the utilization of protective equipment.
- **Operating Procedures:** Formulation and rigorous compliance with standardized protocols for loading, unloading, transportation, and lay-up.
- **Emergency planning:** Establishing action plans to address potential leaks, fires, or accidents, which encompass procedures for evacuation and notification of emergency services.
- **Monitoring:** Ongoing assessment of pressure, temperature, and hydrogen concentration.

Task

Scenario: You are tasked with overseeing the logistics of transporting hydrogen from a substantial electrolyzer situated on the Baltic coast to a steel mill located 500 km inland. The mill necessitates 10 tons of compressed hydrogen each month. Given the geographical considerations, both road transport (utilizing pressurized tankers) and rail transport are under evaluation.

Your responsibilities:

1. Identify the primary risks associated with the road and rail transport of compressed hydrogen in this scenario.
2. Compare these risks, specifying which are more substantial for each method.
3. Propose a minimum of three specific risk mitigation measures or procedures for each of the selected transportation methods, totaling at least six.
4. Specify the applicable standards and regulations (ADR/IMDG) in this instance and explain their significance.

Practical Advice for Participants

- Think pragmatically: Assess the potential issues that may arise during transport and evaluate the actual consequences.
- Specific measures: Rather than relying on generalities, outline precise actions that can be implemented (e.g., "training" is broad, while "training in the operation of safety valves and emergency procedures" is specific).
- Comparison of methods: Emphasize the distinctions in risks and countermeasures between road and rail transport. Rail facilitates the movement of larger volumes but introduces unique challenges (e.g., train length, risk of derailment).
- The Role of Regulation: Comprehending the significance of standards (ADR, IMDG) is essential for ensuring safe and legal transportation. Reflect on how they contribute to risk mitigation.
- A comprehensive perspective: Assess risk at each phase – from loading, through transportation, to unloading.

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