





Keeping Safety Grounded in the Hydrogen Take-off

Revisiting Risk in Pig Launching and Receiving Operations

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Agenda

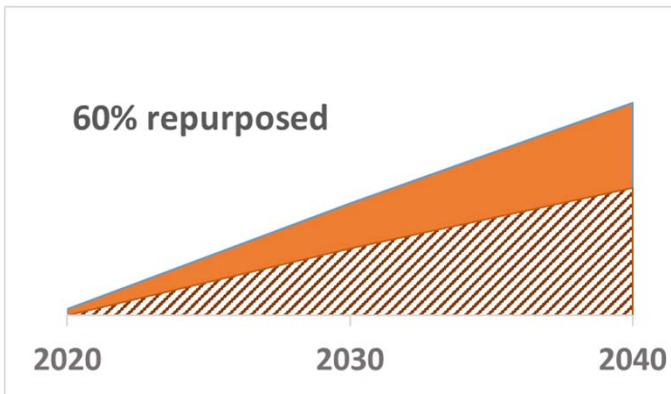
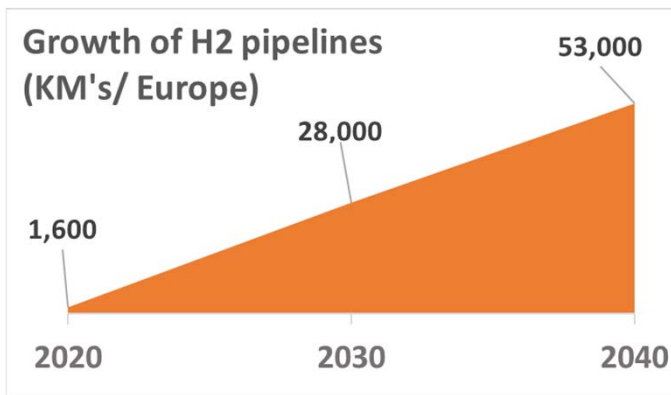


- Introduction: the significance of hydrogen
- When, why & how will a hydrogen transporting pipeline be pigged?
- How can the **elevated** operational risks posed by hydrogen be mitigated?
- Conclusions

The significance of hydrogen



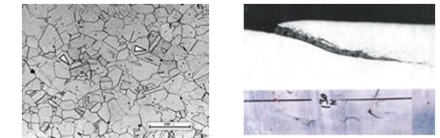
ROADMAP



Pig Launch and Receive operations

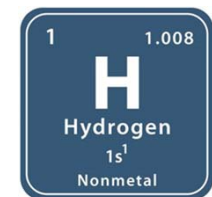


HYDROGEN



- Integrity threats
- Material selection
- Production processes

Hydrogen vs Methane?



Hydrogen properties



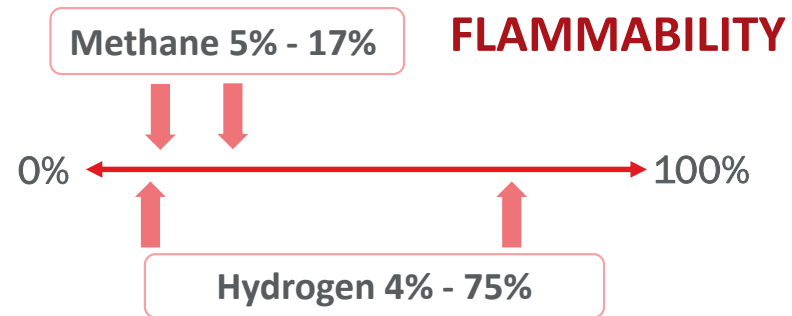
“Highly flammable...easily ignited, tendency for autoignition, heats up when reduced in pressure.”

“One of the most difficult gases to prevent from leaking”

“Difficulty in seeing flame, does not support breathing”

“unique corrosion mechanisms”

EIGA (2004)



Methane: 0.25 mJ



IGNITION

Hydrogen: 0.017 mJ

MOLECULE SIZE

- Lighter than air
- Leaks
- Integrity
- Low density

When, why & how to pig?



Purpose Built

- Pre-H₂: Cleaning, drying
- In H₂ service: monitor



Mechanical/ Cleaning Pigs

Repurposed: Pre-hydrogen

- Cleaning (liquids or wet gas)
- Evaluate integrity threats, missing records
- Valve assessment & repair



Inline Isolation Tools

Repurposed: In H₂ service

- Corrosion
- Contamination

In H₂ service pig modifications



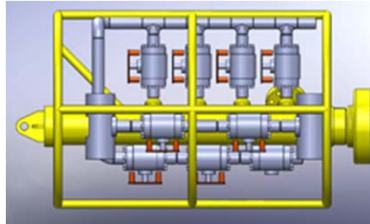
Inline Inspection (ILI) Pigs

How is a pipeline pigged?

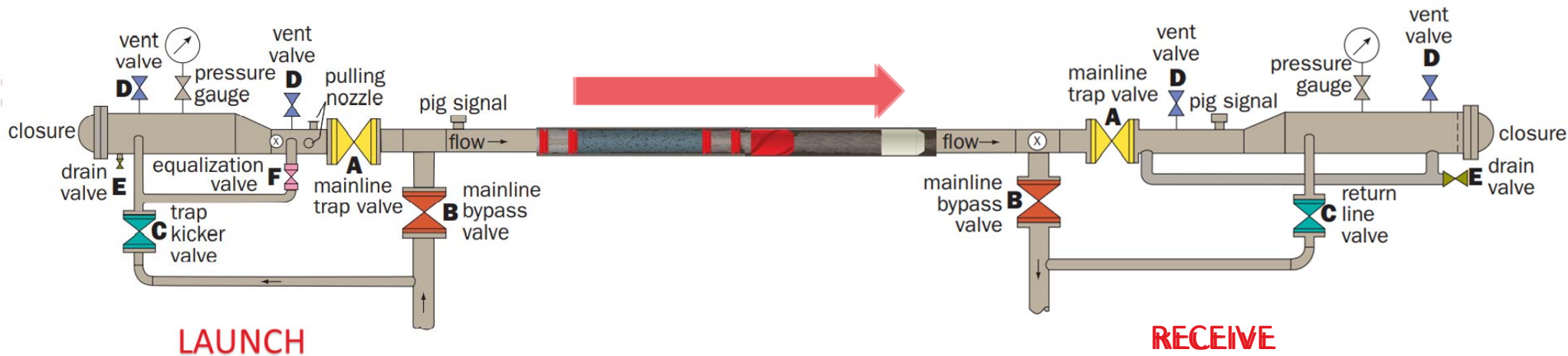


Launchers & Receivers “Traps”

- Design options
- Specific vs multipurpose



- Suitable equipment, competent personnel, robust procedures: prevent incidents
- Valves must be opened & closed in correct sequence to avoid system damage & shutdown



RISKS & MITIGATION WITH HYDROGEN IN THE PIPELINE

LAUNCHING AND RECEIVING PIGS

Worksite design, procedures & people



Mitigation by design



Ventilation

- Outdoors ideal, mitigate if enclosed
- Dilute leaks to 25% of LEL ... 1% by volume air (ASME B31.12)



Eliminate sources of ignition

- Electrical safety : lighting, equipment (ATEX)
- Spark potential: earthing temp/permanent plant, ground cover



Operational Considerations

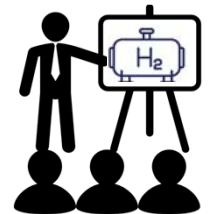
Venting pathways, neighbouring activities & SIMOPS
Site security & signage

Procedures & People

Written Plan
(B31.12)



Training &
Communication



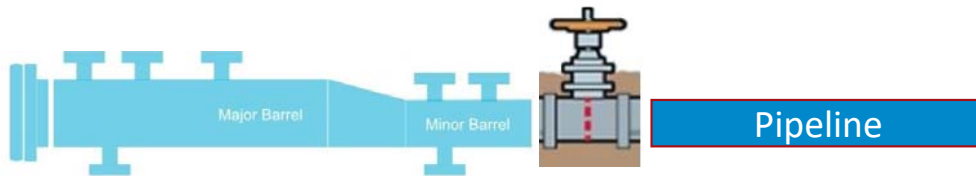
Onsite Controls



Verified isolations



- Effective isolation barriers
- Critical valves: fit for purpose & not bypassing
- Hydrogen propensity to find leak paths
- Single vs double isolations (ASME B31.12)



Repurposed Pipelines for H2 (EIGA)

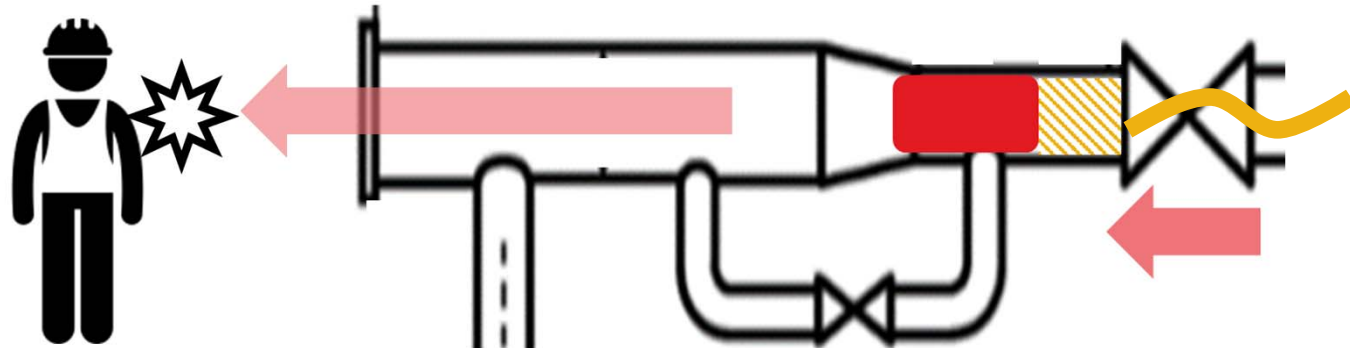
- Valves refurbished, refaced & tested
- Flanged joints replaced with welded
- Inline Isolation Pigs / Hot tapping

Temporary equipment

- Leak test all joints, verified procedure

CASE STUDY

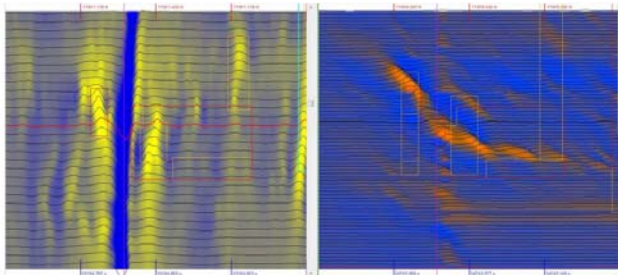
- US D.O.I. (GOM) 2008
- Valve bypassing
- Pig ejected backwards
- Strikes operator



Controlling pig velocity



Function



- Gas vs liquids
- Speed excursions
- ILI data
- Tool damage
- Cleaning action

Safety



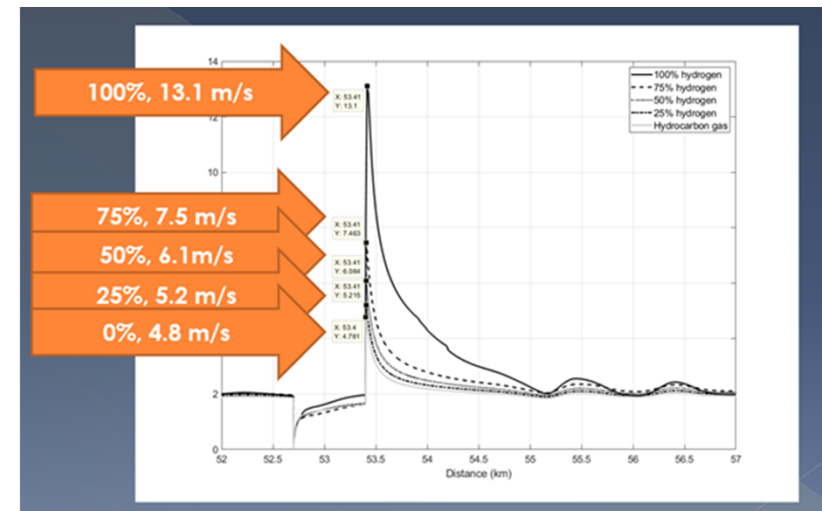
- High velocity pigs
- Damage to pipeline
- Risk to personnel
- **Case studies***

*National Energy Board, Canada (2007)

*Institute of Chemical Engineers (2006)

Impact of hydrogen

- Modelling study (Pipeline Research Ltd)
- Speed excursions are exacerbated
- Low density effects



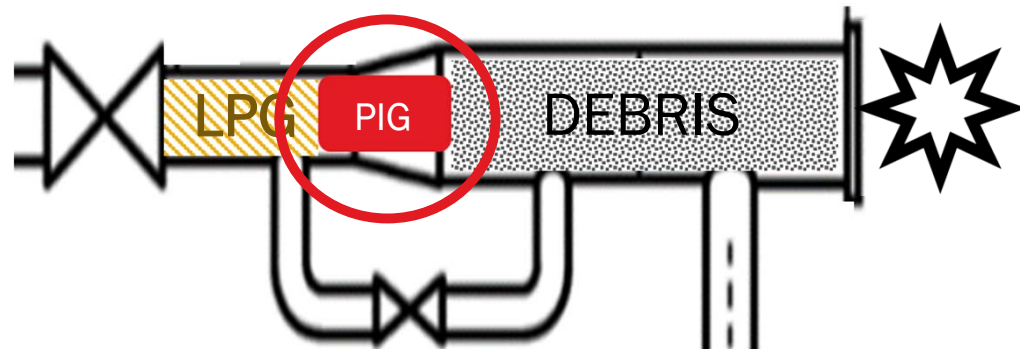
- Calorific value and operating pressure
- Mitigation measures

Operational sources of ignition and pressure



Large volumes of debris can be present in the receiver

CASE STUDY : Fatal incident/LPG pipeline Indian Oil Industry Safety Directorate (2016)

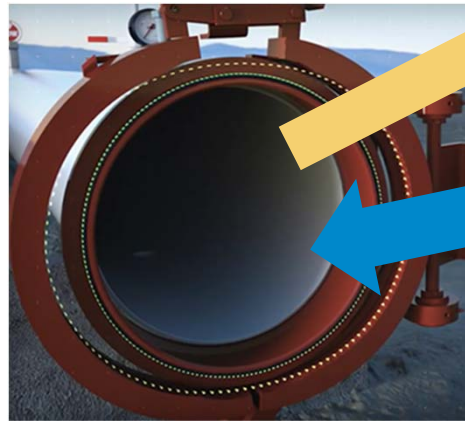


- Threat for repurposed or blended lines
- Black powder corrosion byproducts
- **Pyrophoric debris & hydrogen**
- Verified isolations, depressurization & inerting
- Competent personnel, procedures & equipment

Inerting & venting



- Purging traps with inert gas
- Critical step to safeguard operational teams
- Preventing or removing volatile gas mixtures
- H₂ exacerbates risk



H₂ lighter than air

Heavier air will sink into open chambers

Explosive limits will quickly be achieved

SAFE VENTING & FLARING

- Extending venting pathways
- Recompression, ignition risk if vented to atmosphere, flaring is preferred
- Flaring hazards, air ingress, positive pressure
- Temporary pigging sites, NRV, spark arrestor



Nitrogen case study

- OSHA (U.S) 2012
- N₂ purging
- Over-pressurisation

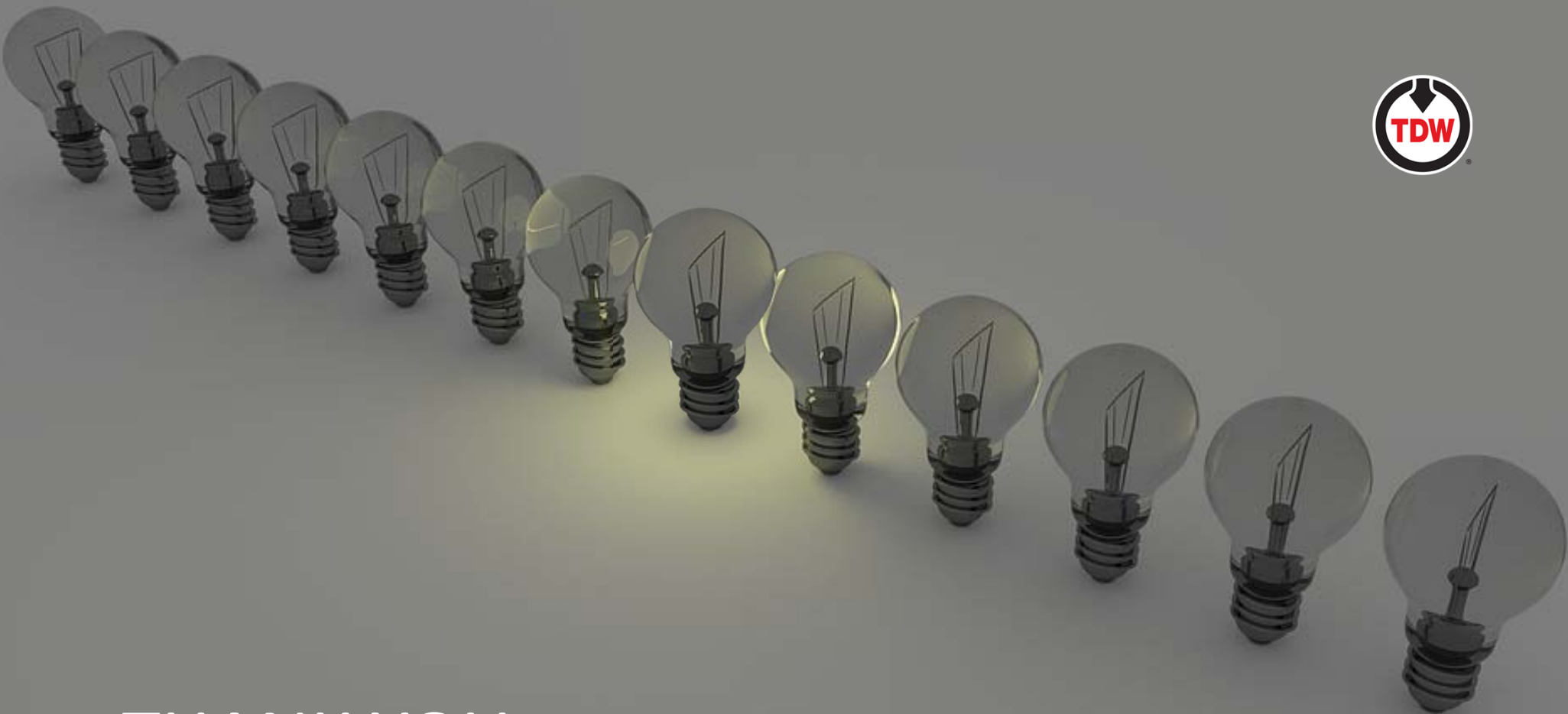
Conclusions



- Hydrogen: valuable medium contributing to net zero
- Will become commonplace in gas pipeline networks
- Poses challenges to infrastructure & industry is responding
- Escalation of risk associated with launching & receiving pigs
- Challenges need to be mitigated & communicated

Goals

- Collective aspiration: transition to hydrogen without critical incidents
- Safeguard frontline workers & communities
- Knowledge sharing, collaboration & vigilance



THANK YOU... QUESTIONS

