Validity of available risk-based models for hydrogen technologies

Green Hydrogen Webinars

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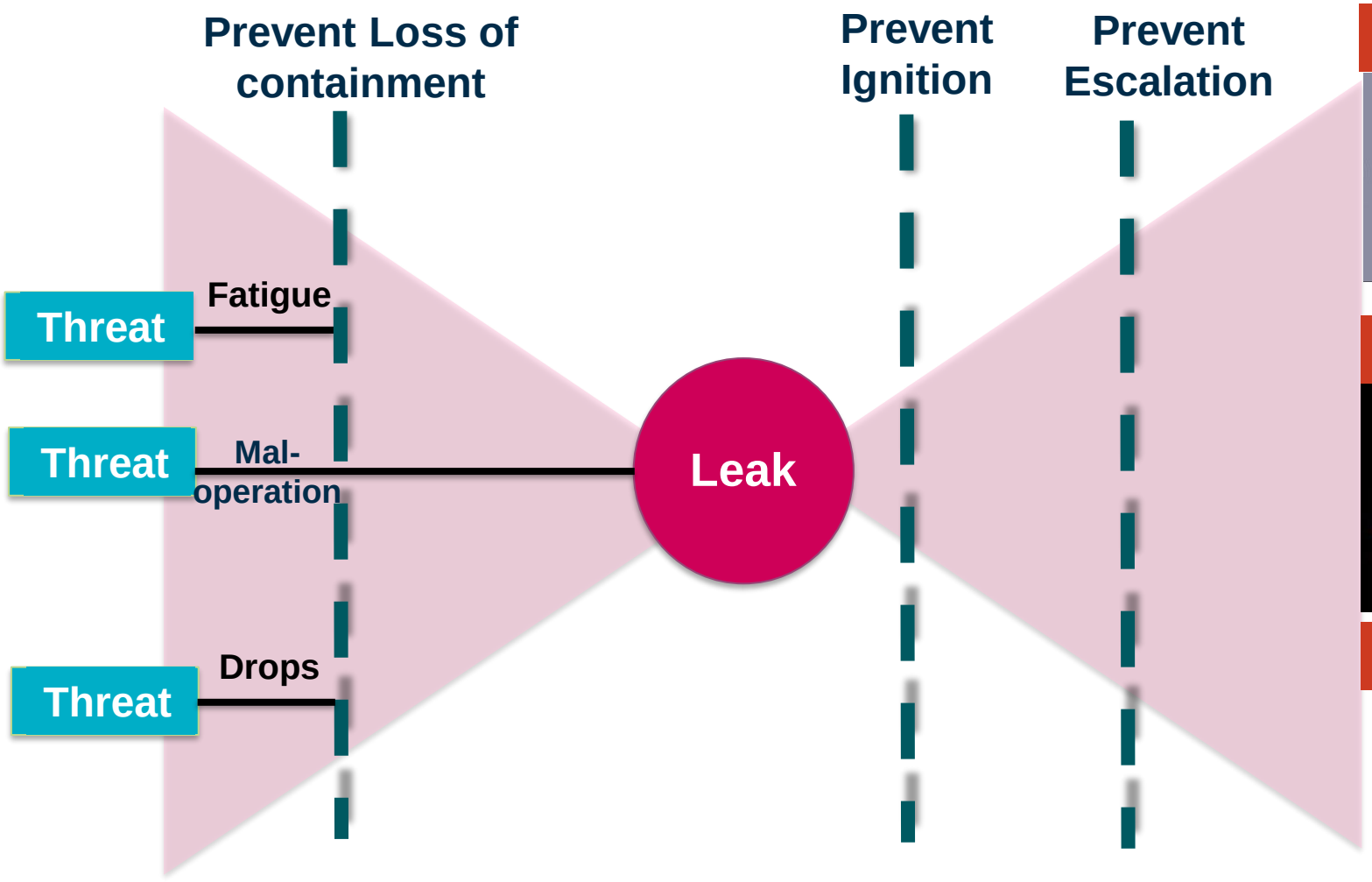
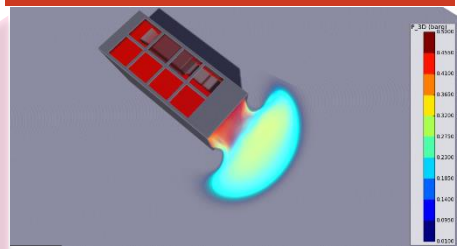
What kind of risk based models for hydrogen technologies do we have?

Are the available models valid to use for hydrogen?

The well-proven risk management principles apply also for the hydrogen industry…



Consequence



Explosions

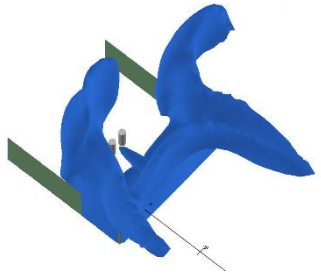
Small amount of H2 may generate significant blast loads

Consequence

High momentum jet fire

Leaks of pressurized H_2 is prone to ignition

Consequence



Gas leaks

NB! Momentum of leak push gas along surface before rising!

…but even more important to avoid leaks due to more difficult to control ignition

QRA as basis for standards

For standard equipment and events, safety distances can be prescribed by national regulations, and/or may be determined through quantitative risk assessment of a generic design. For any given fuelling station, one may also conduct a quantitative risk assessment, which can be used to understand the risks and the effects of station-specific mitigations; the result of the analysis may result in a recalculation of the safety distance to result in station-specific safety distances. If the safety distance is too large, additional mitigation or prevention measures should be considered and the safety distances may be re-calculated using a quantitative analysis.

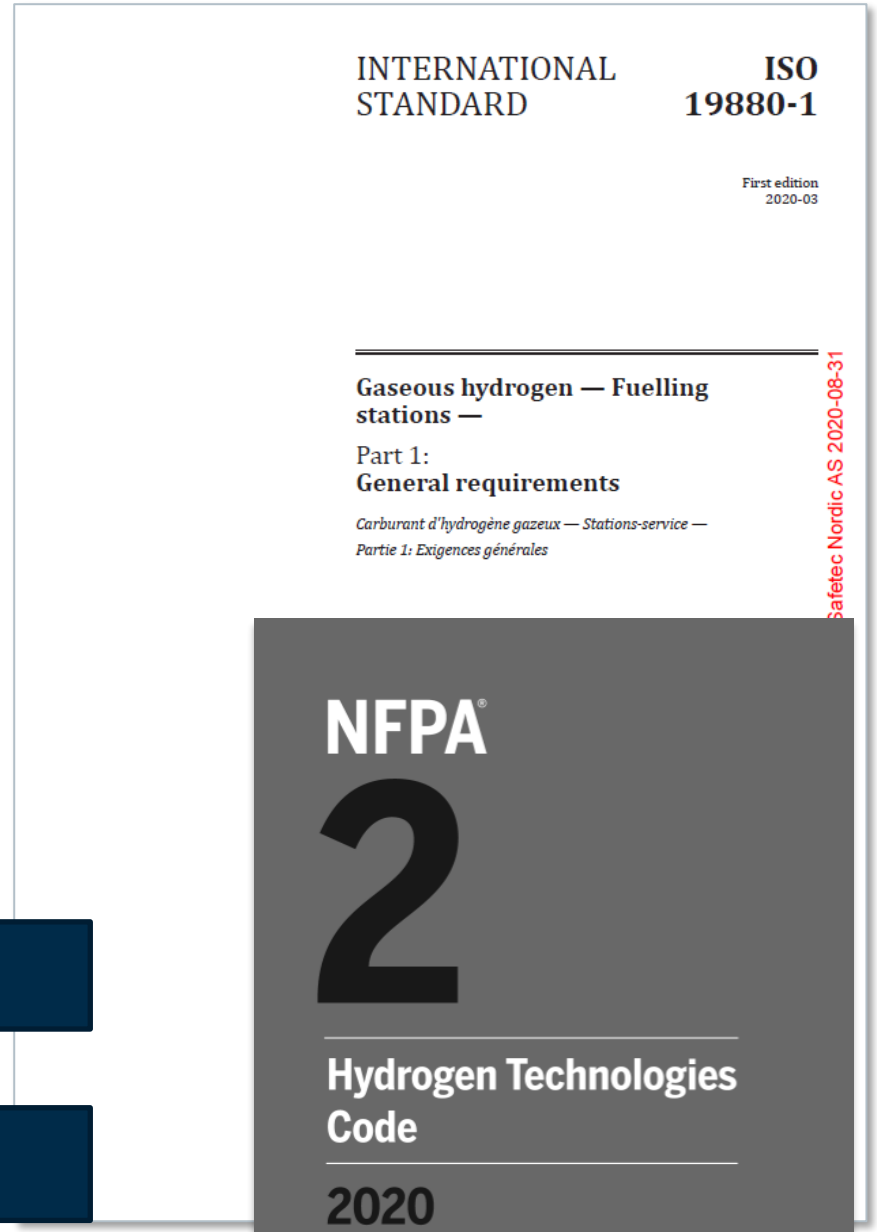
NOTE 2 The benefit of conducting quantitative analysis is that it generates safety distances that are specific to the fuelling station/site that is analysed.

NOTE 3 The quantitative analysis is used to demonstrate that the fuelling station does not pose unacceptable risk to specific targets, taking into account the design and mitigation features of the actual installation. Acceptable quantitative techniques include quantitative risk assessment (QRA) and consequence modelling (i.e., a QRA without quantification of the probability of scenarios). The analysis uses a combination of information and data regarding the fuelling station design and operation, validated physical models, and probabilistic models that meet the criteria discussed in the remainder of this clause.

Use of a common toolkit, preferably validated for hydrogen, is recommended.

Do we have this? What are the uncertainties in the current toolkit?

NFPA suggest risk assessment for safety zone specification



Risk-based safety zone

The trade-off between frequency and consequence based on quantitative risk analysis model

High probability → Long distance

Large consequence → Long distance

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Driving cost of land use

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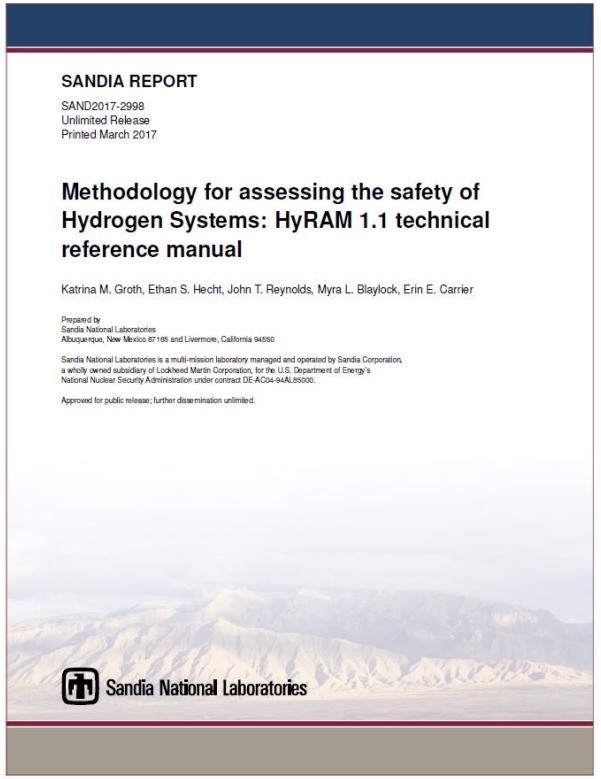
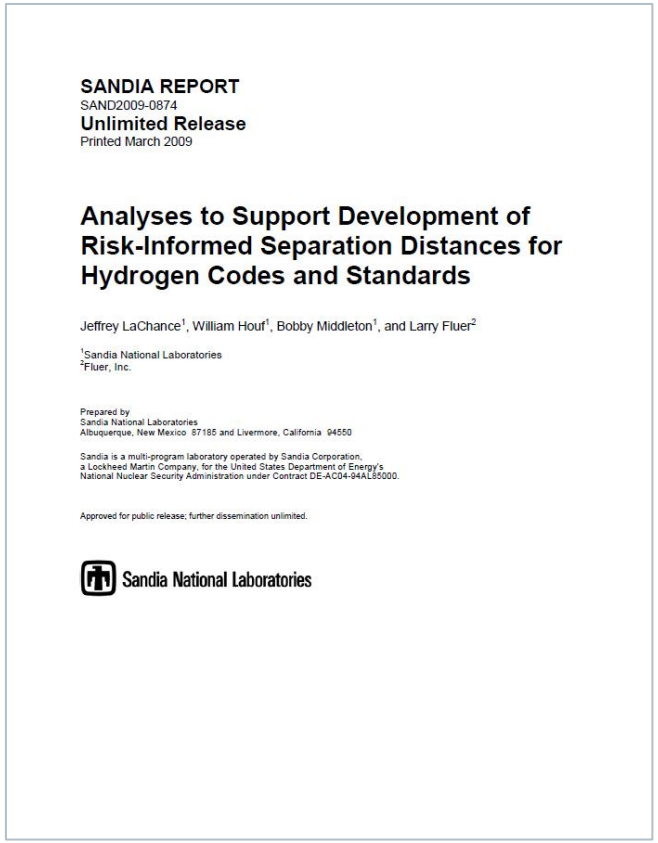
Norwegian regulations

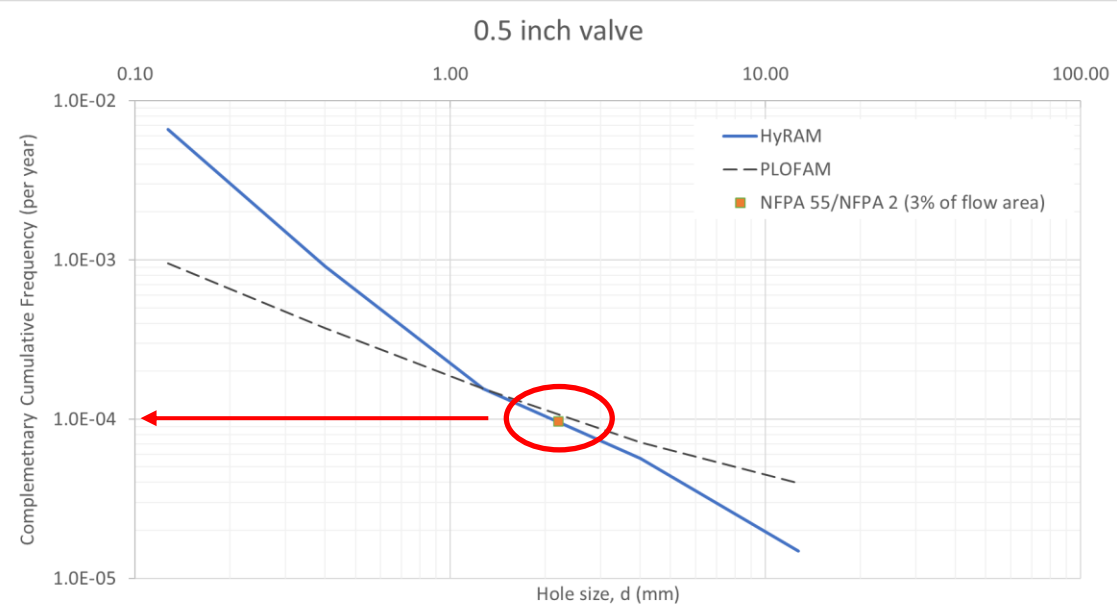
Risk-based regime for land use

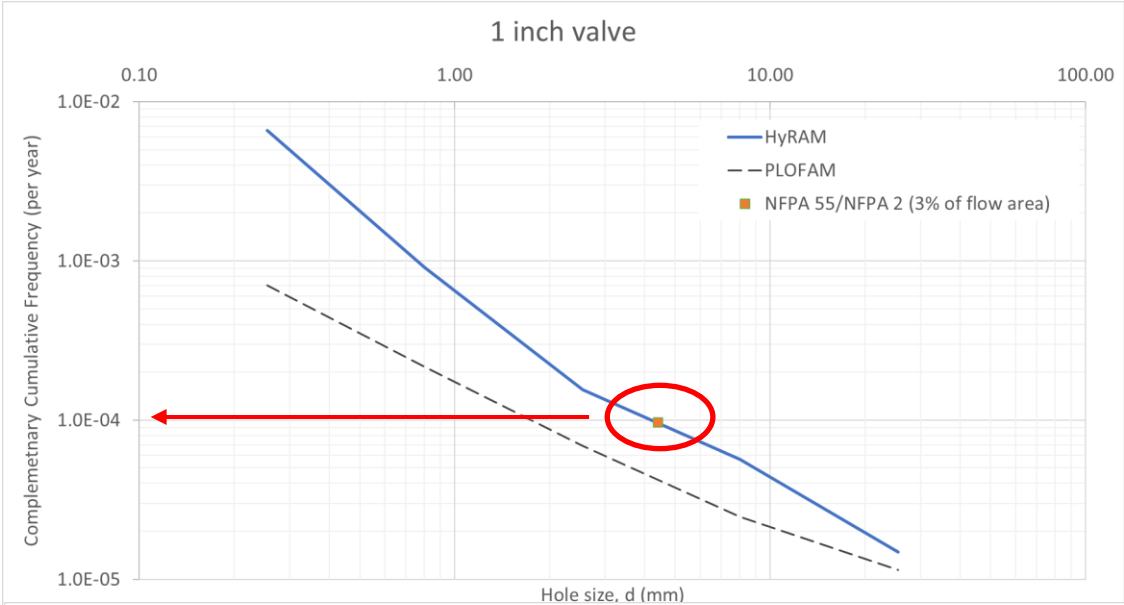


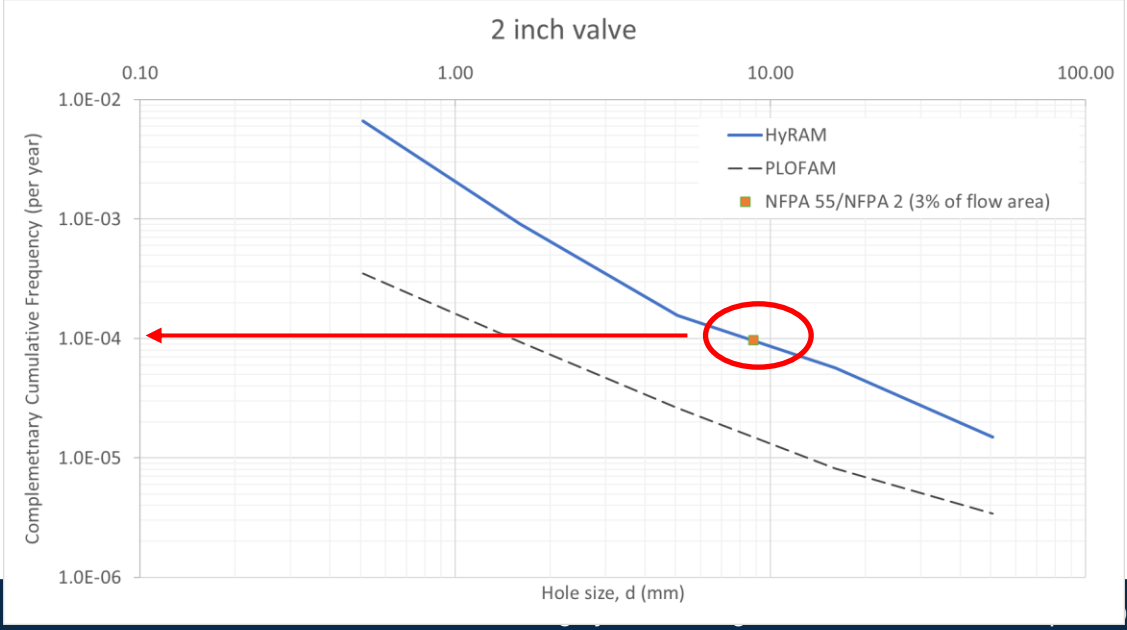


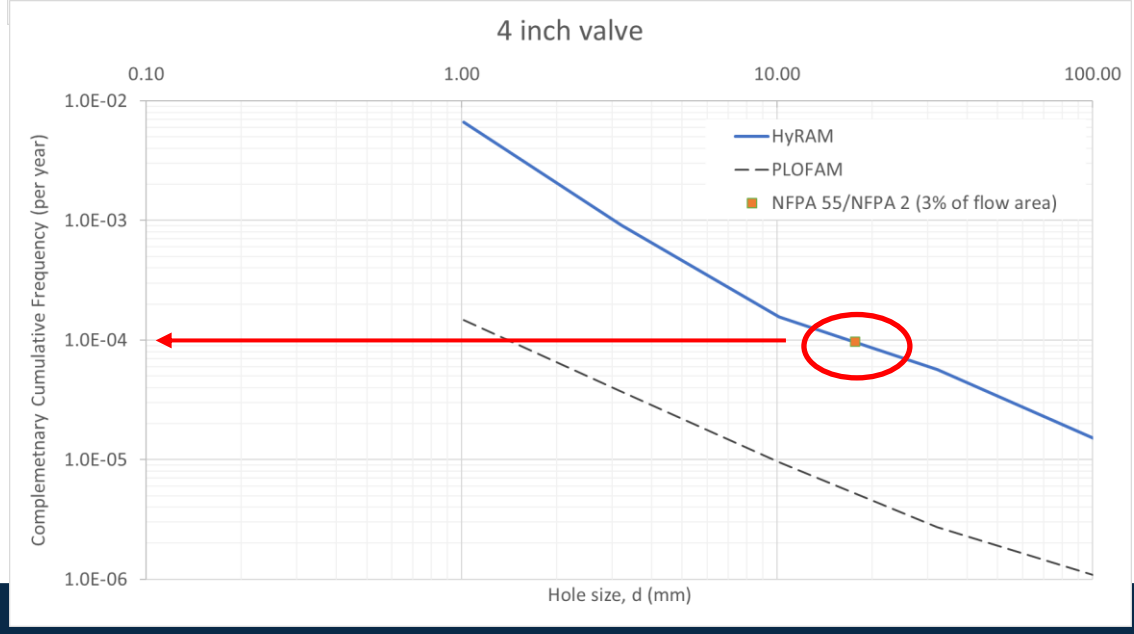
Guidelines recommend HyRAM for H_2

Equipment size dependency in HyRAM compared with offshore standard model (PLOFAM)









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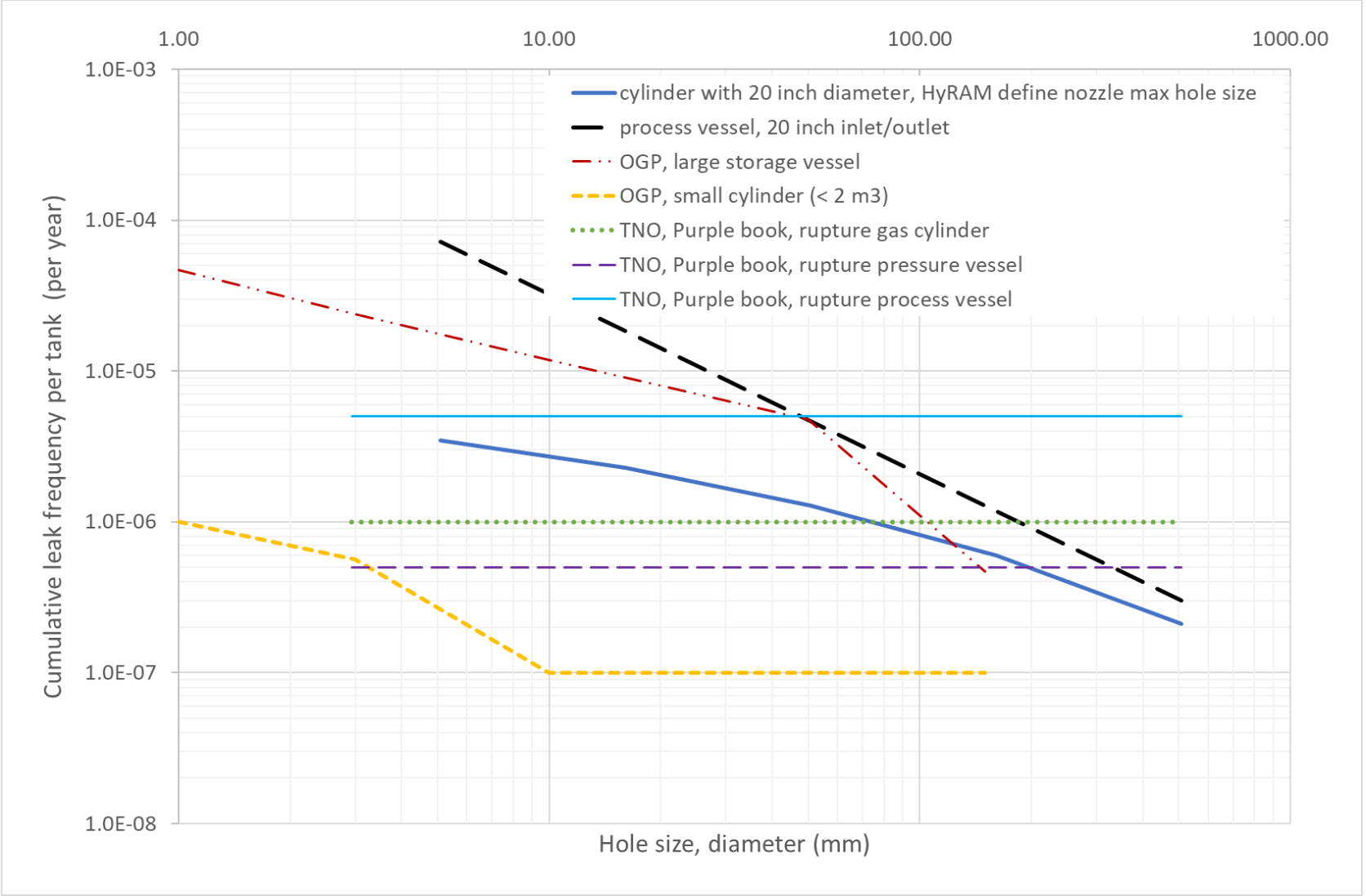
Risk based safety distance due to tank ruptures?

What type of model should be used?



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What about ignition models?

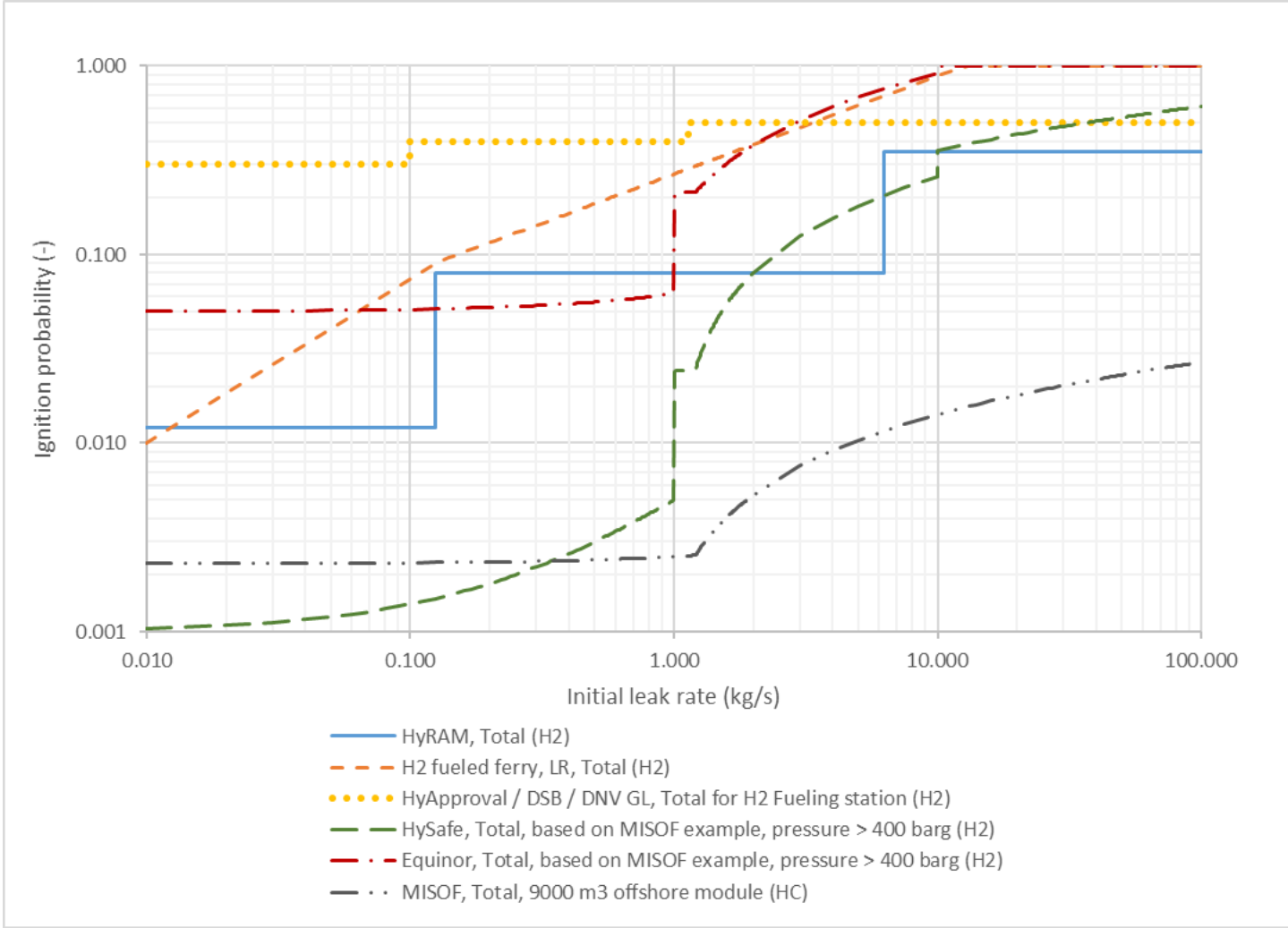
Do we have adequate knowledge about the ignition mechanisms?

Do we have statistical data to justify the ignition probability?

Will ignition control add value to H2 production units?

What about liquified hydrogen; should the ignition probability model be different?

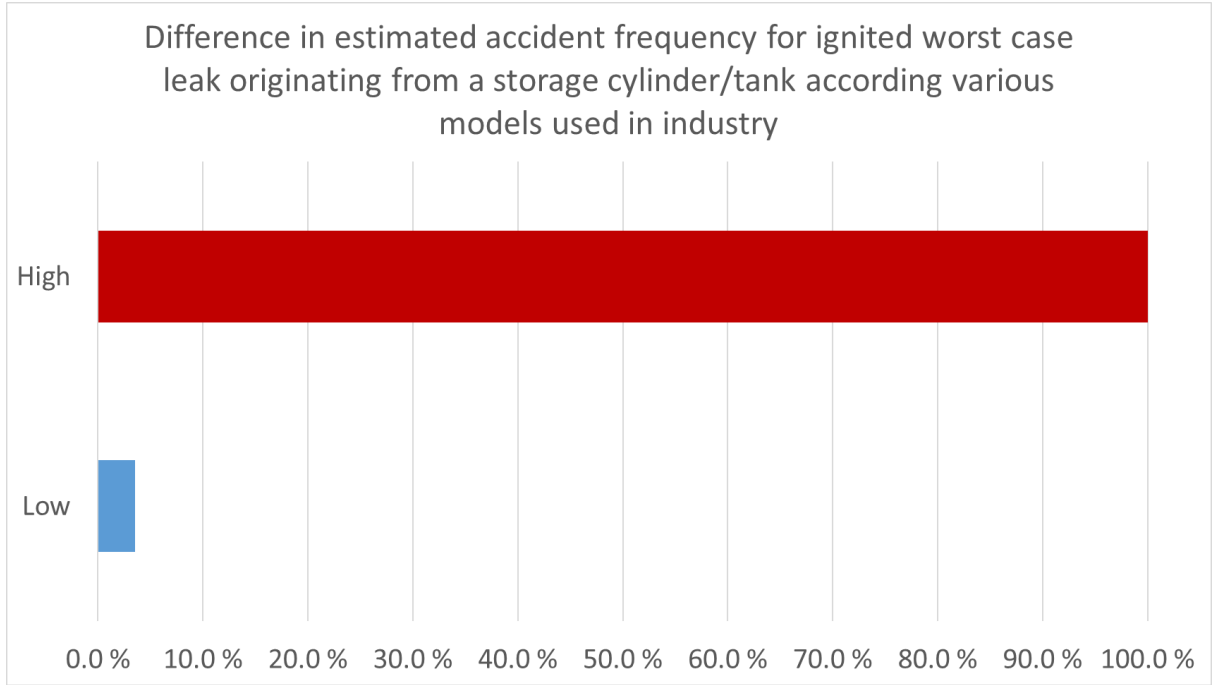
Overview ignition probability models



Risk based safety distance due to tank rupture

How to assess accident frequency for tank rupture?

What is the frequency for rupture scenarios for such a design, can we extrapolate from existing models; 129 tanks · X · 10^{-y} ruptures per tank/year?



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Summary and a way forward?

- Models are available, but there is a high variety between the different models and a lot of uncertainty regarding the validity of these models for hydrogen
- There is a need for more work related to this
- Safetec has taken an initiative together with Vysus Group, DNV Norway, Gexcon and Proactima to build a research project around this (SAFEN)
  - H_2, Ammonia and CO_2
  - Focus on loss of containment and ignition
  - Operation and human performance included in the project
- During the pre-project phase we have been encourage by Norwegian authorities and major stakeholders (such as Equinor, Linde, Air Liquide) to continue working on developing a project proposal
  - Draft ready soon
  - Application to the Norwegian Research Council (tentative early fall 2021)
- If you are interested – please contact us

Thank you

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