

The Invisible Ignition: Re-evaluating the "non-credible" hazard in tank safeguarding

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flow forward



Visualizations in this presentation are AI-generated
for illustrative and conceptual purposes.

The Disconnect: Physics vs. History

The Physics: A dry-running pump acts as a thermal reactor.

The Logical Conclusion: This mechanism may cause vapor space explosions in our tanks.

The Industry Silence: Historical incident data rarely mentions this. (Is it misdiagnosis, luck, or successful N₂ blanketing?)

The Rabbit Hole: Why is there a gap between what the physics dictate and what our history records?



The Incident – Hong Kong, 2012



The Setup: MDO transfer via portable pump + open manhole hatches.

The "Official" Trigger: Spark from a non-EX electrical plug.

The Outcome: Fatal explosion and tank flashback.

The Kum Song 8 Paradox



**CARGO: MARINE
DIESEL OIL (MDO)
FLASHPOINT: >60°C**



**AMBIENT TEMP:
<20°C
(40°C BELOW
FLASHPOINT)**



**VAPOR GENERATION?
THERMODYNAMICALLY
IMPOSSIBLE.**



**OFFICIAL CAUSE:
EXTERNAL
ELECTRIC SPARK.**

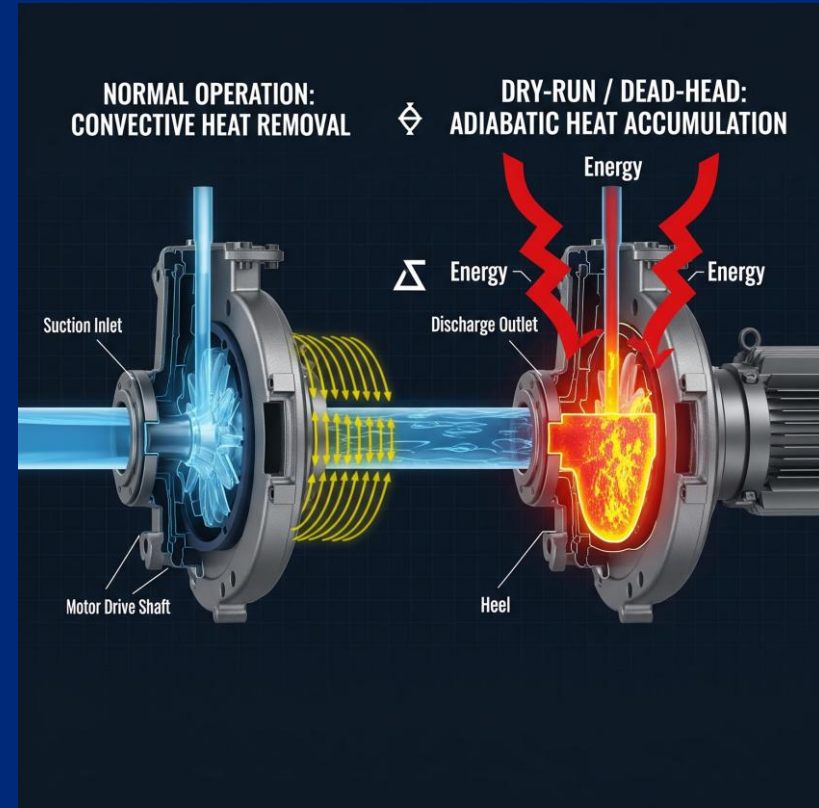
The Thermal Reactor

The Missing Heat Source

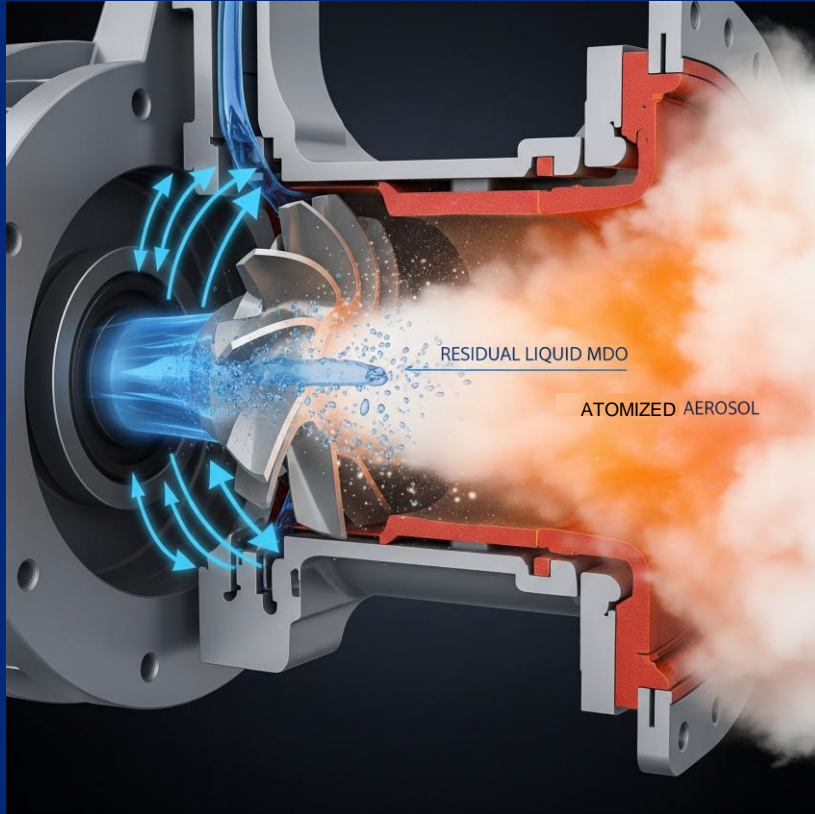
The Proven Physics (Giles & Lodal, 2001): A pump at no flow transfers massive mechanical energy directly into the trapped liquid, acting as a powerful heater.

The Speed of Heating: In a blocked-in state, the temperature of the trapped fluid can rise by 1 to 2°C per second (reaches auto-ignition (~250°C) in under 4 minutes).

Cross-Industry Reality: The FAA issued safety directives for Boeing aircraft specifically because dry-running center tank fuel pumps were heating up empty tanks.



Mist & Flashpoint



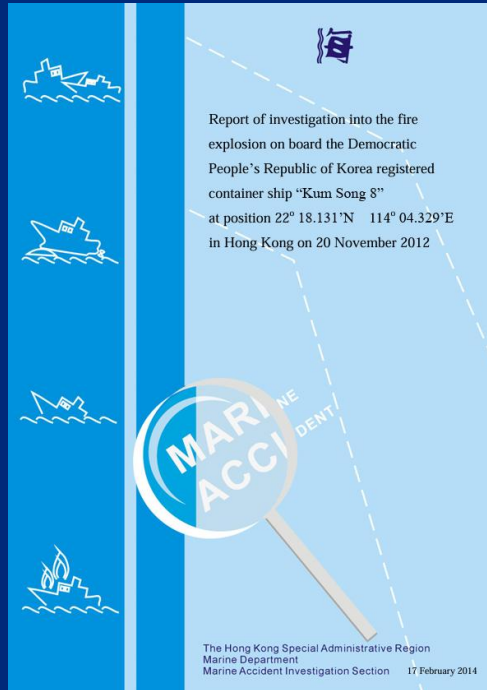
The Action: The dryrunning pump acts as a high-shear mixer.

The Result: Mechanical rotation atomizes the liquid into a suspended aerosol (mist).

The Danger: Mists bypass standard flashpoints and become highly explosive at lower temperatures.

The Conclusion: The pump built the explosive atmosphere and provided the spark.

The Investigation

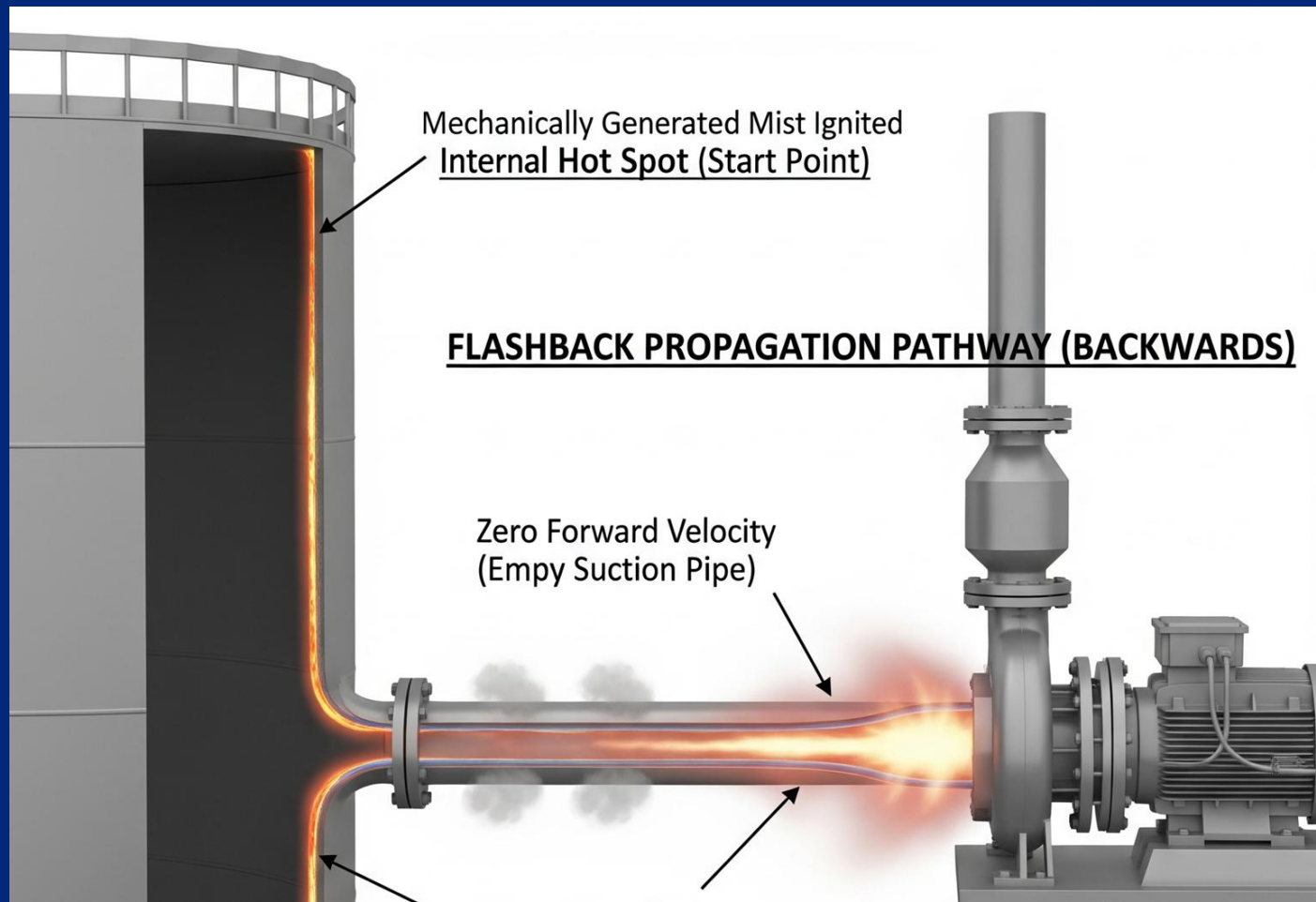


- Conducted by the Hong Kong Marine Department under IMO standards.
- 2012 Era: Strict institutional independence and transparency.
- **The Takeaway:** Even world-class investigators can be blinded by traditional assumptions.



INTERNATIONAL
MARITIME
ORGANIZATION

The Flashback Pathway



Cannon vs. Bomb

Slow-burning mist allows for a vented deflagration (The Diesel Cannon).

Rapid-burning homogeneous vapor causes catastrophic rupture (The Gasoline Bomb).

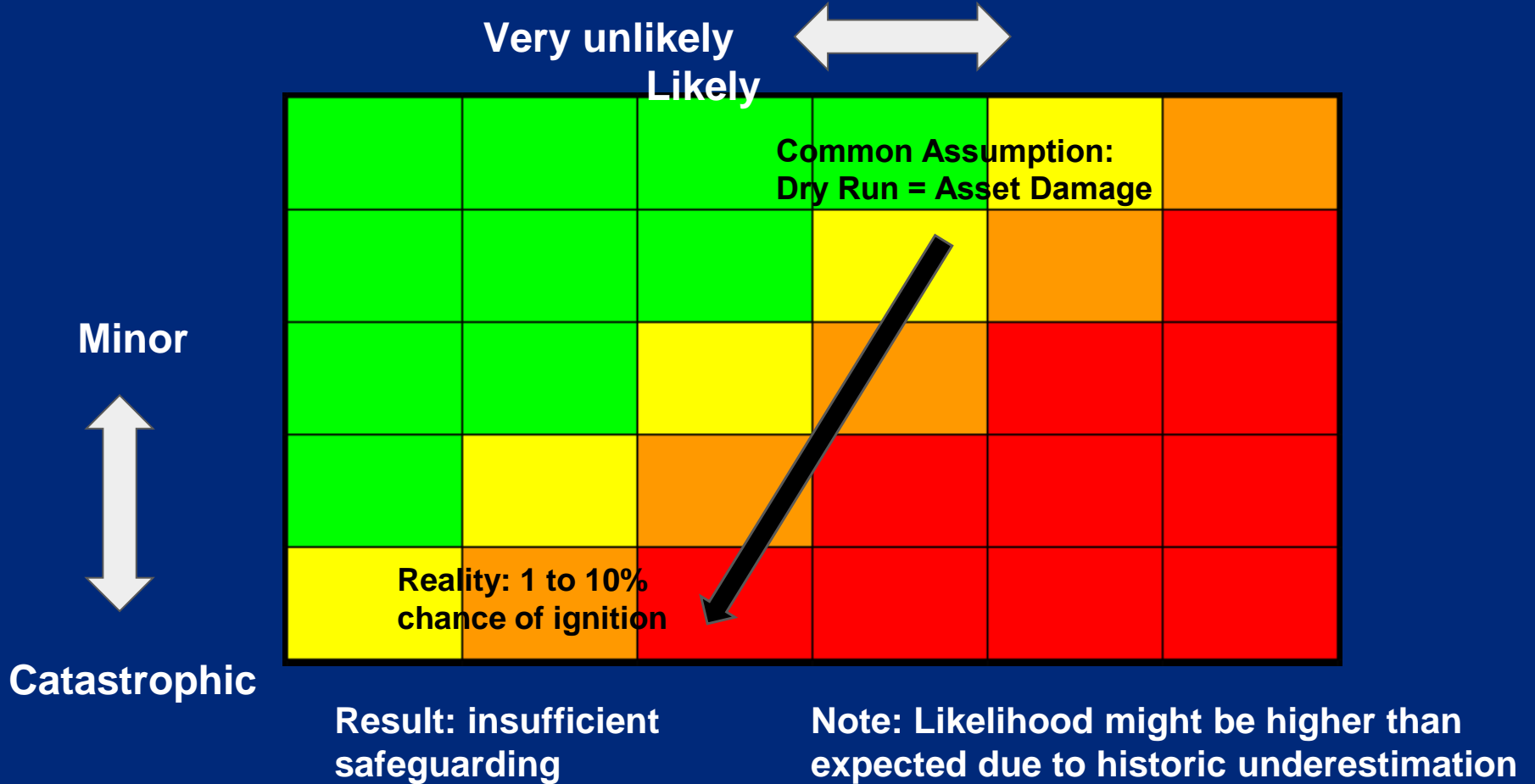


Vented Deflagration



Catastrophic Rupture

The HAZOP Trap



The Vopak Reality: Safeguarding by Standard

The Observation: We are not seeing these ignition events at our Vopak terminals.

The Reason: Not because the physics don't apply to us, but because Vopak's baseline engineering standards are highly robust.

The "Accidental" Defense: Basic automation, pump protection, and standard blanketing often interrupt the event chain.

The Vulnerability: Because these aren't always formally assessed as explosion hazards in HAZOP, these safeguards are not classified as Safety Critical Elements (SCE).

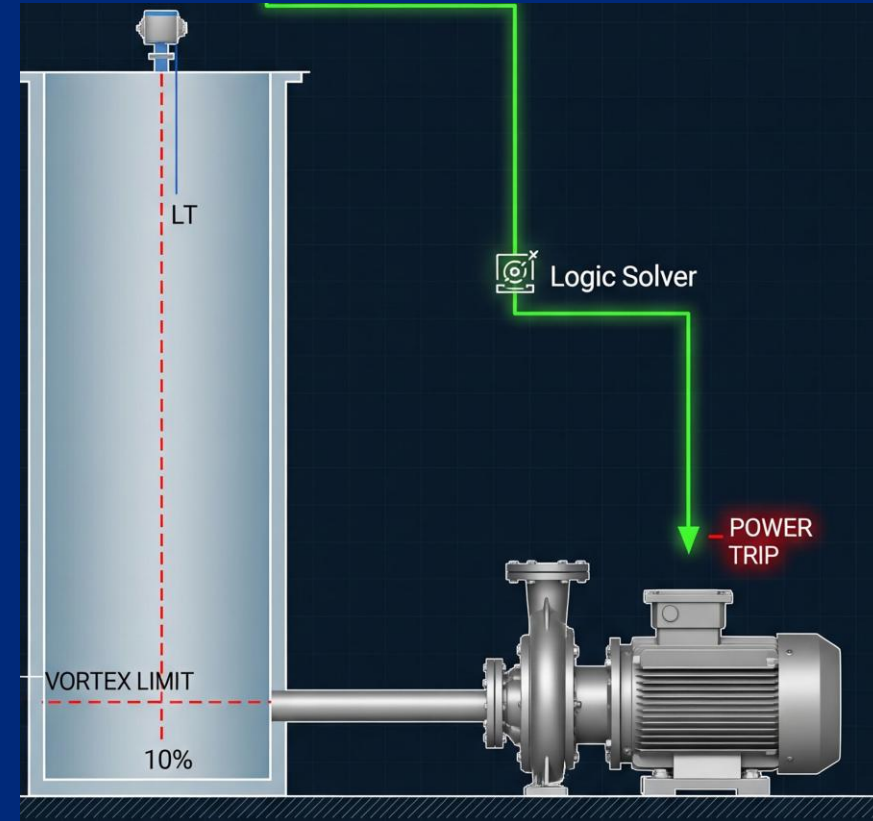


Engineering the Defense

We must stop assuming these events are non-credible.

We need to deliberately assess the dry-run scenario for every tank.

- Identify: Recognize the dry-run as an ignition source in the HAZOP.
- Classify: Determine if the product/consequence requires a "Reliable" defense (BPCS) or a "High-Integrity" defense (SIL).
- Consider which safeguard is most suitable



Conclusion

The Complete Mechanism: A dry-running pump isn't just an operational issue, it contains all elements for a catastrophic event.

We must adopt **structured methodologies** like Tripod Beta, to force ourselves out from under the "Streetlight." We need to hunt for the Latent Preconditions.

Engineered Integrity: Our goal is not to blindly retrofit every asset. It is to consciously assess the risk in our HAZOPs and define the right level of safeguarding.

Final Thought: In process safety, the most dangerous hazard is the one excluded from the risk assessment because it's "never happened before." The Invisible Ignition is only invisible if you refuse to look.

