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PIR for Hydrogen and Carbon Dioxide Pipelines

Some Thoughts on Hazard Modelling

presented by

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PHMSA Public Meeting, Houston, TX

December 14, 2022

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Product Characteristics

Attribute	Natural Gas	Hydrogen	Carbon Dioxide
Density (behaviour)	lighter than air (buoyant rise)	lighter than air (buoyant rise)	heavier than air (ground hugging)
Hazards	fires & explosions	fires & explosions	toxic & asphyxiating vapour
Concentration of interest	5 to 15% (flammable range)	4 to 75% (flammable range)	> about 60% (asphyxiation) > about 7% (toxicity)?
Fuel gas category	low reactivity	high reactivity	not applicable
Energy to ignite	high	low	not applicable
Flame speed	low	high	not applicable

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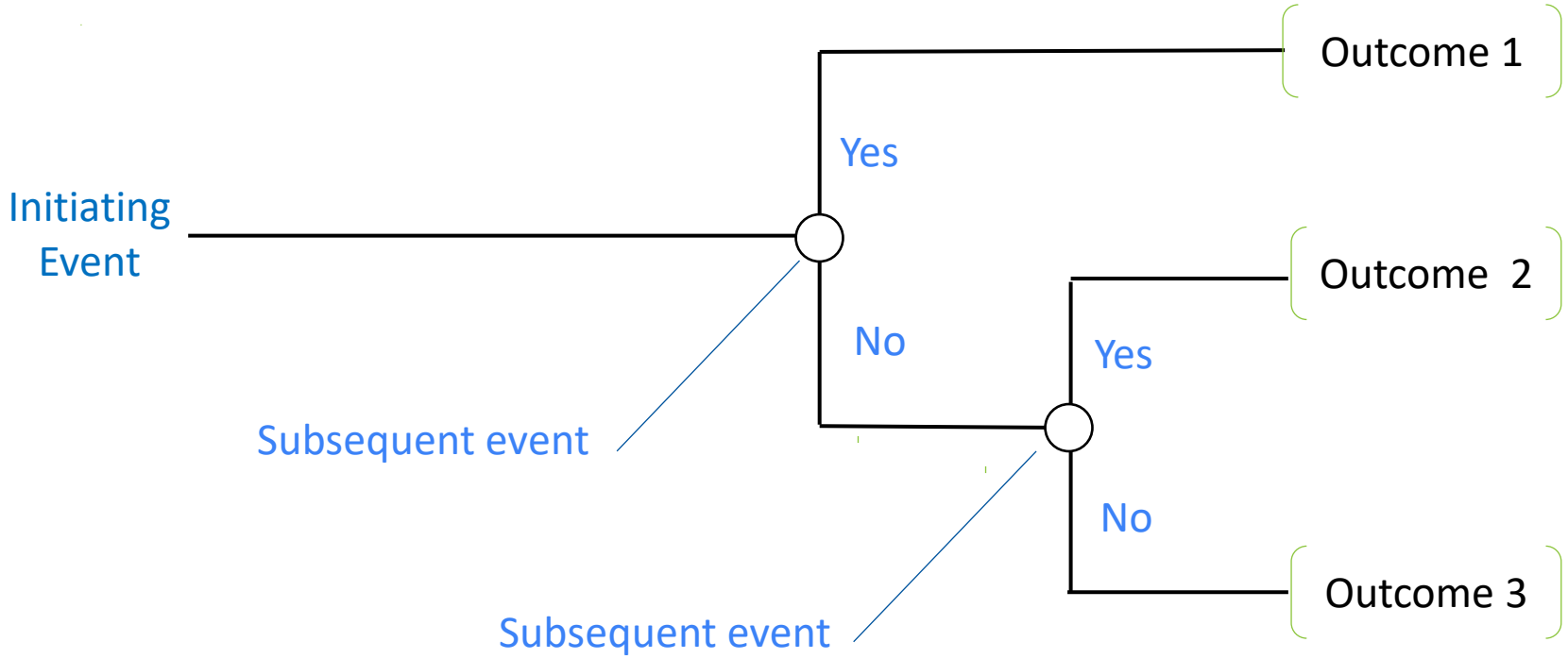
Event Tree for Pipelines Transporting Buoyant Flammable Gases

- What is an event tree?



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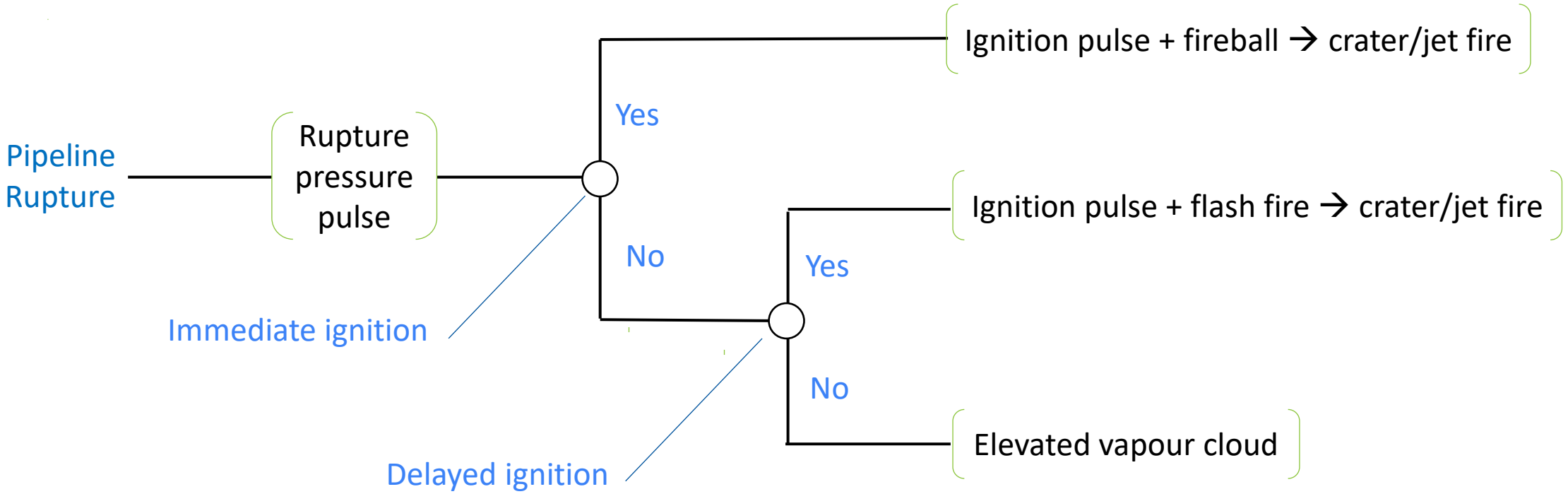
Event Tree for Pipelines Transporting Buoyant Flammable Gases



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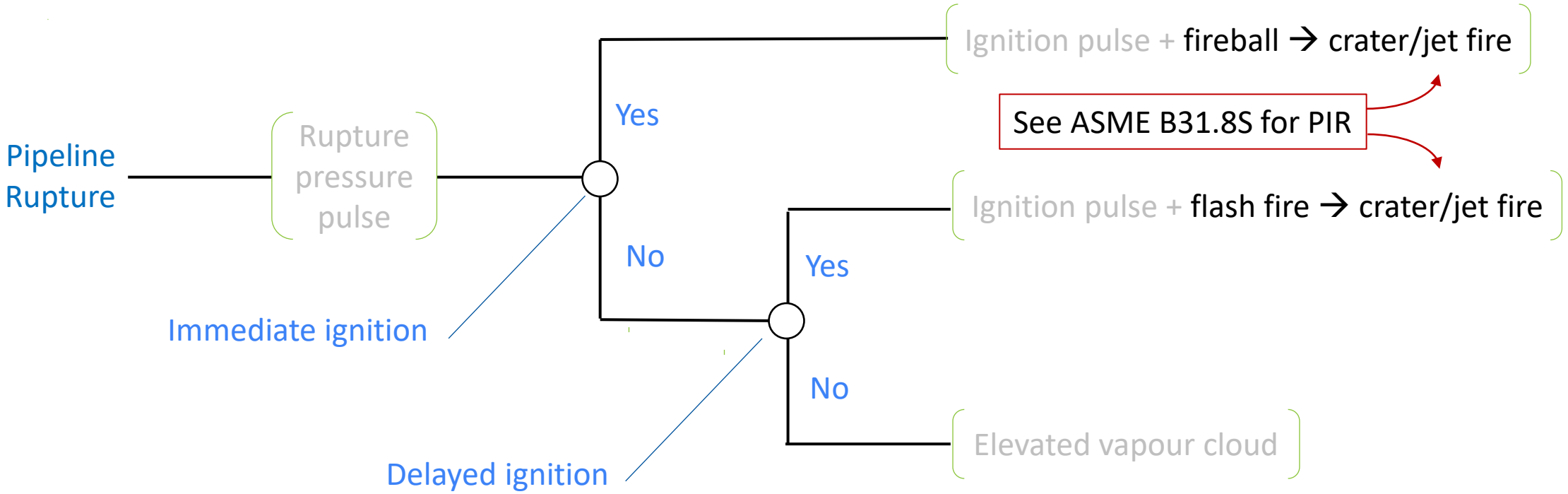
Event Tree for Pipelines Transporting Natural Gas



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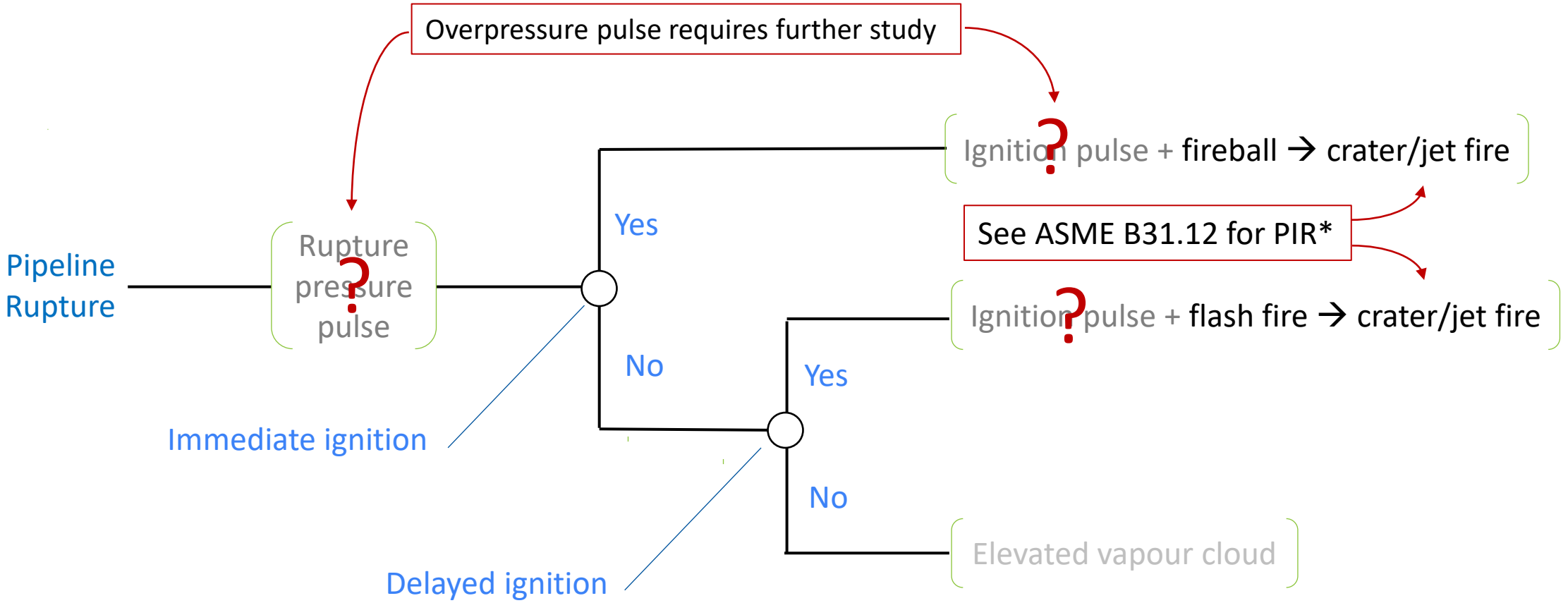
Event Tree for Pipelines Transporting Hydrogen Gas



*From 2005 PHMSA Report TT013 by Baker & C-FER
- based on outdated flame emissivity data
- requires updating

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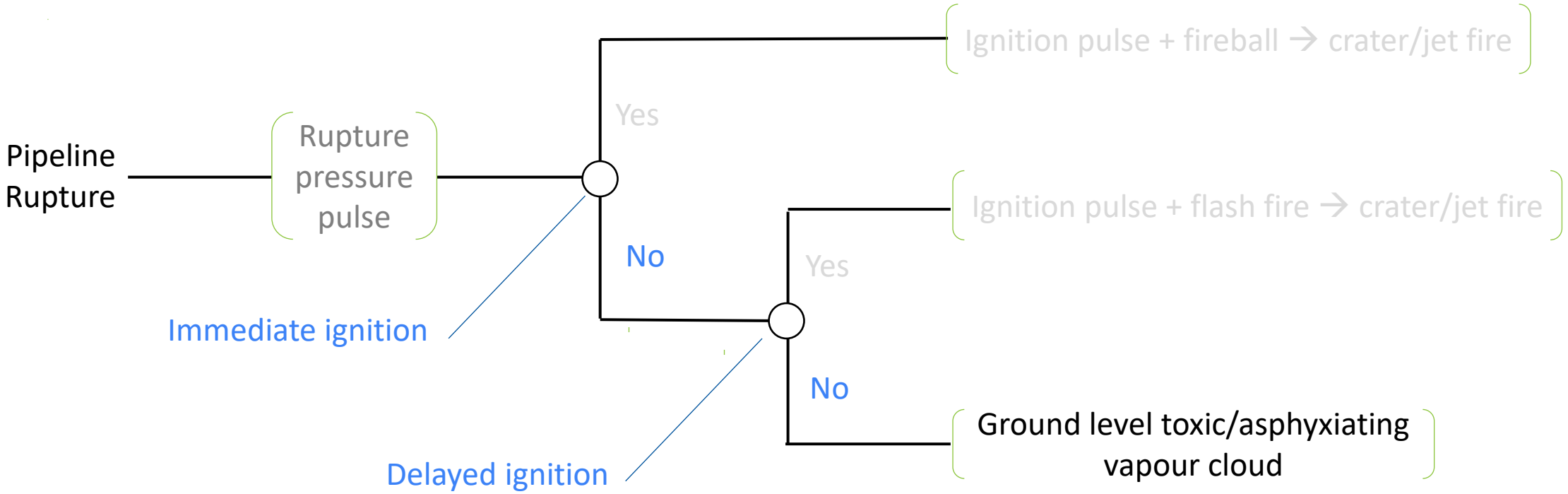
Event Tree for Pipelines Transporting Carbon Dioxide



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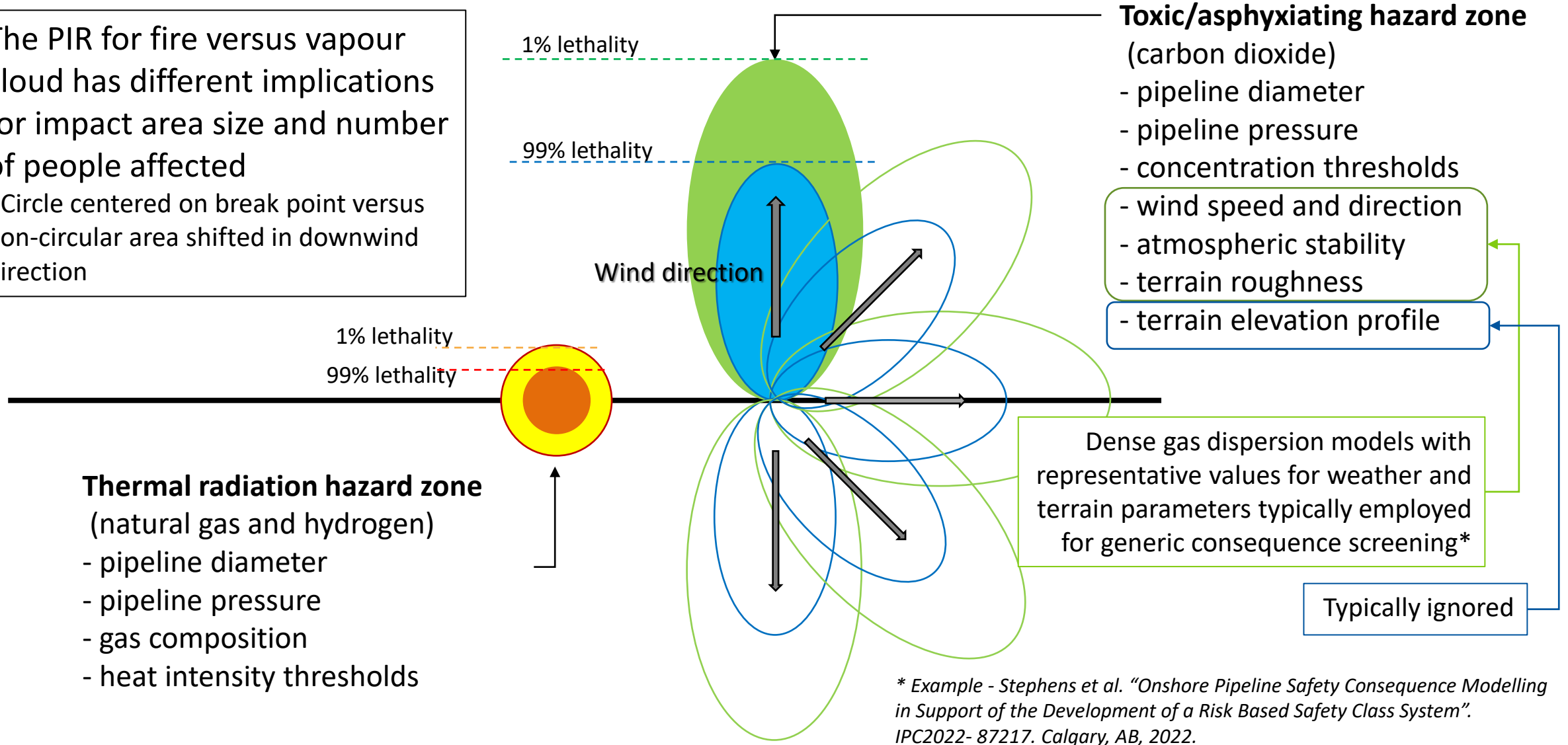
Factors Affecting Potential Impact Areas

The PIR for fire versus vapour cloud has different implications for impact area size and number of people affected
- Circle centered on break point versus non-circular area shifted in downwind direction



Toxic/asphyxiating hazard zone
(carbon dioxide)
- pipeline diameter
- pipeline pressure
- concentration thresholds
- wind speed and direction
- atmospheric stability
- terrain roughness
- terrain elevation profile

Thermal radiation hazard zone
(natural gas and hydrogen)
- pipeline diameter
- pipeline pressure
- gas composition
- heat intensity thresholds

Dense gas dispersion models with representative values for weather and terrain parameters typically employed for generic consequence screening*

Typically ignored

** Example - Stephens et al. "Onshore Pipeline Safety Consequence Modelling in Support of the Development of a Risk Based Safety Class System". IPC2022- 87217. Calgary, AB, 2022.*