

# PHMSA Pipeline Risk Modeling Methodologies Public Workshop



## General Knowledge – Paper Study on Risk Tolerance

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# Introduction



- It is important for pipeline operators to make risk-based decisions regarding the operation and maintenance of their pipelines.
- Many operators use some type of risk model or tool to help determine inspection intervals and prioritize maintenance schedules.
- Many use these models to provide a basis for decisions concerning additional preventive and mitigative measures.

# Challenge

- Regardless of the particular risk assessment approach, all pipeline companies must identify risks, prioritize them, and implement strategies to reduce the risk.
- Risk reduction comes at a cost.
- Setting and communicating risk criteria can be challenging.
- Defining risk tolerability criteria helps decision-makers objectively evaluate risk reduction options based on the companies risk tolerance.



# Tolerable versus Intolerable



- The key is to determine a level of risk that is intolerable (reduce at any cost) and a level of risk that is tolerable (nothing needs to be fixed).
- For risks that fall between the two levels, operators should work to lower the risk in areas where the benefits outweigh the costs.
- How low is low enough?
- There are a number of approaches for defining risk criteria and the degree of risk tolerance is expected to vary from company to company.
- Some are qualitative, semi-quantitative, or quantitative.

# Tolerable versus Intolerable



- One way to gauge relative risk

Consequence Category	Catastrophic	Yellow	Red	Red	Red	Red
	Severe	Green	Yellow	Yellow	Red	Red
	Marginal	Green	Green	Yellow	Yellow	Red
	Negligible	Green	Green	Green	Yellow	Yellow
		Improbable	Remote	Occasional	Probable	Frequent
		Frequency Category				

*ALARP* (As Low As Reasonably Practicable) is indicated in the yellow cells.

*Tolerable* is indicated in the green cells.

*Intolerable* is indicated in the red cells.

**ALARP: "As low as reasonably practicable"**

UK Health and Safety Law

# Purpose of this Project



- The purpose of this project is to study risk tolerability practices currently used by pipeline companies as well as other relevant industries, government agencies, and countries as a basis for comparison and guidance for use in the pipeline industry.

# Risk Acceptance Criteria



- Criteria can be established on the basis of:
  - human life
  - environmental damage
  - equipment/property damage
  - business loss
  - litigation costs
  - other factors.
  
- For natural gas pipelines, human life or life safety would be a driving factor, whereas a crude oil pipeline might be more impacted by environmental damages.

# Risk Acceptance Criteria



- European regulatory bodies tend to define more quantitative risk criteria
- A number of other government agencies define more qualitative risk criteria using risk matrices or impact criteria based on the distance to a specified level of harm for consequences.

# Types of Risk Criteria



- Individual Risk
  - Quantitative
  - Fatalities from any given incident
  - Set by comparing the risk associated with a specific activity to risks posed by other activities that individuals are exposed to on both a daily and intermittent basis – like..
    - Driving a car or flying a plane
    - Using electricity or gas

# Individual Risk



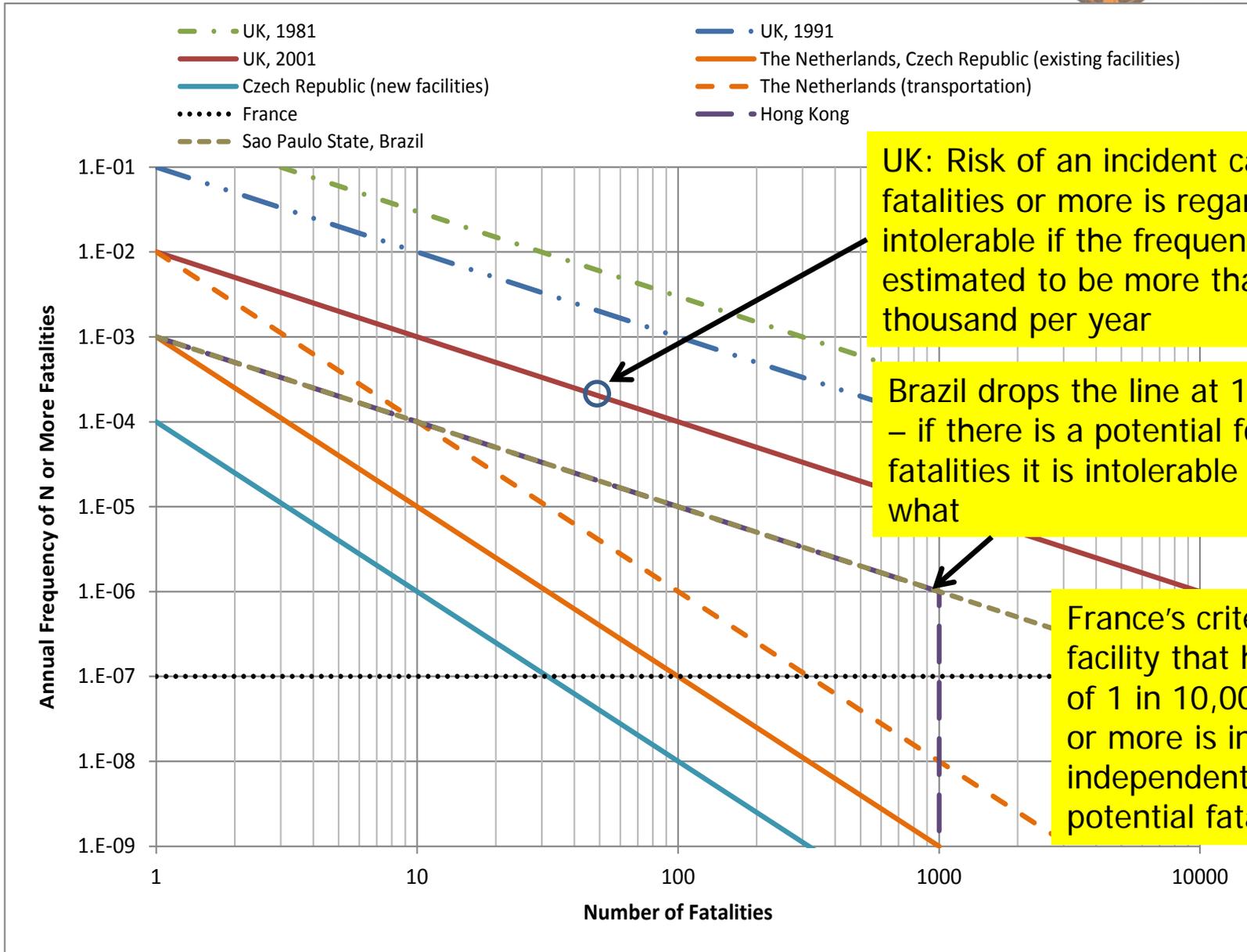
- Examples (fatality/year)
  - UK
    - $1 \times 10^{-3}$  Intolerable limit for workers acutely aware of the risks
    - $1 \times 10^{-4}$  Intolerable limit for members of the public
    - $1 \times 10^{-5}$  Risk has to be reduced to the level ALARP
    - $1 \times 10^{-6}$  Limit for broadly acceptable level of risk
    - $1 \times 10^{-7}$  Negligible level of risk
  - Sao Paulo State, Brazil
    - For Industrial Activities:
      - $1 \times 10^{-5}$  Intolerable limit for members of the public
      - $1 \times 10^{-6}$  Limit for broadly acceptable level of risk
    - For Pipelines:
      - $1 \times 10^{-4}$  Intolerable limit for members of the public
      - $1 \times 10^{-5}$  Limit for broadly acceptable level of risk

# Types of Risk Criteria



- Societal Risk
  - Quantitative
  - Risk of multiple fatalities occurring from one single event
  - Used to evaluate the risk of fixed facilities to the general public
  - F-N curves are broadly used: expected annual frequency (F) of the number (N or more) of casualties
  - Many corporations have also adopted this method for internal evaluation of the relative risk of projects, plants and businesses, setting their own criteria.

# Societal Risk

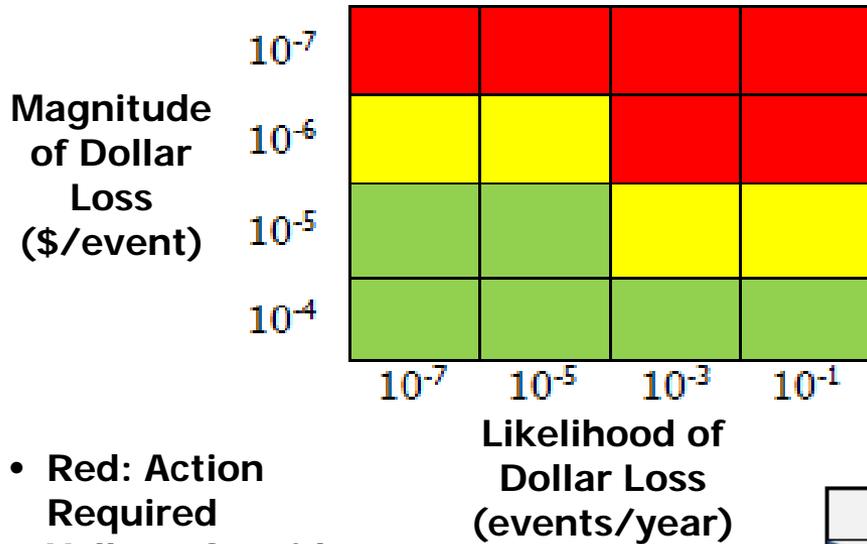


UK: Risk of an incident causing 50 fatalities or more is regarded as intolerable if the frequency is estimated to be more than one in five thousand per year

Brazil drops the line at 1,000 fatalities – if there is a potential for 1,000 fatalities it is intolerable no matter what

France's criteria is any facility that has a risk level of 1 in 10,000,000 years or more is intolerable independent of number of potential fatalities.

# Risk Matrices



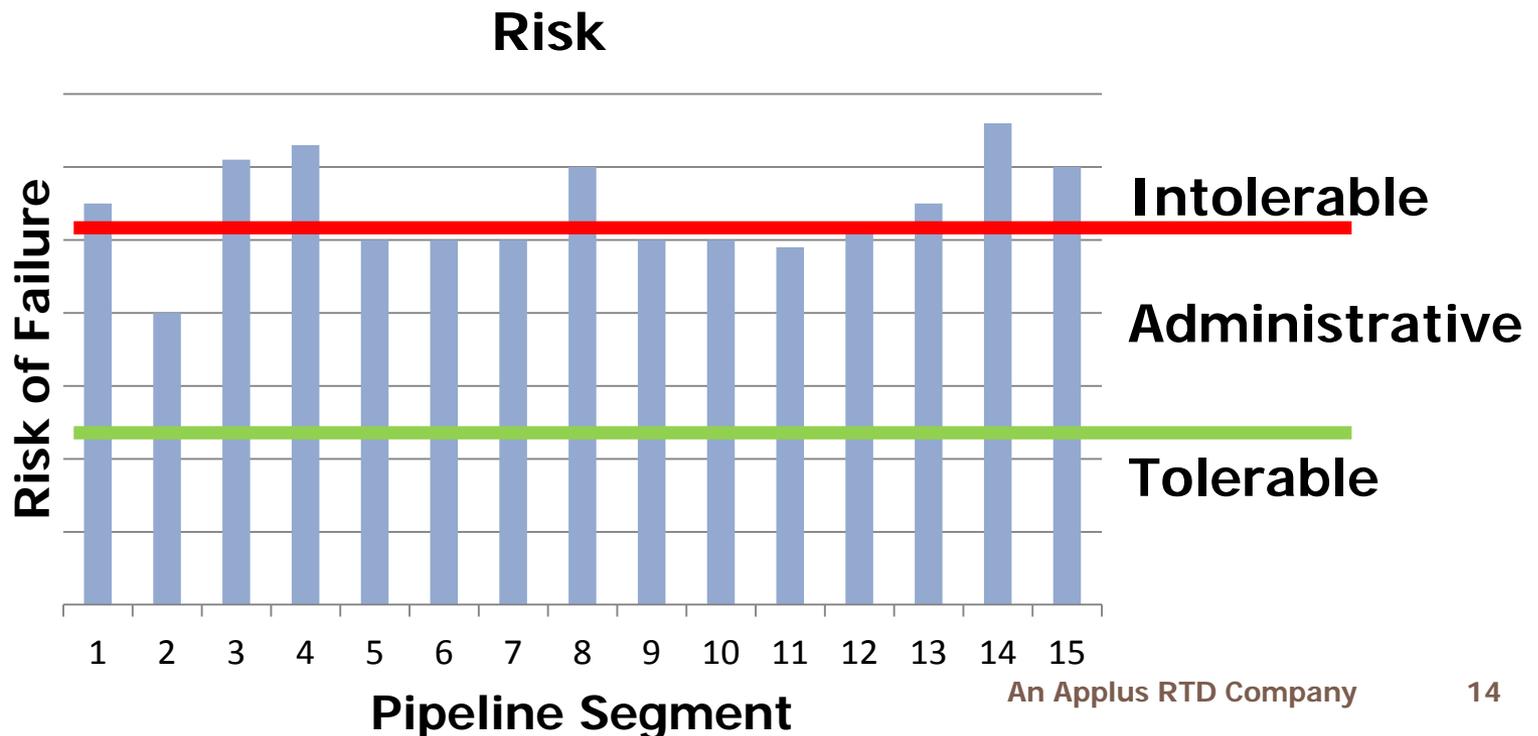
- Red: Action Required
- Yellow: Consider Action
- Green: No Action Required

RISK ASSESSMENT MATRIX				
SEVERITY \ PROBABILITY	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional (C)	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable (E)	Medium	Medium	Medium	Low
Eliminated (F)	Eliminated			

# Risk Tolerance Levels



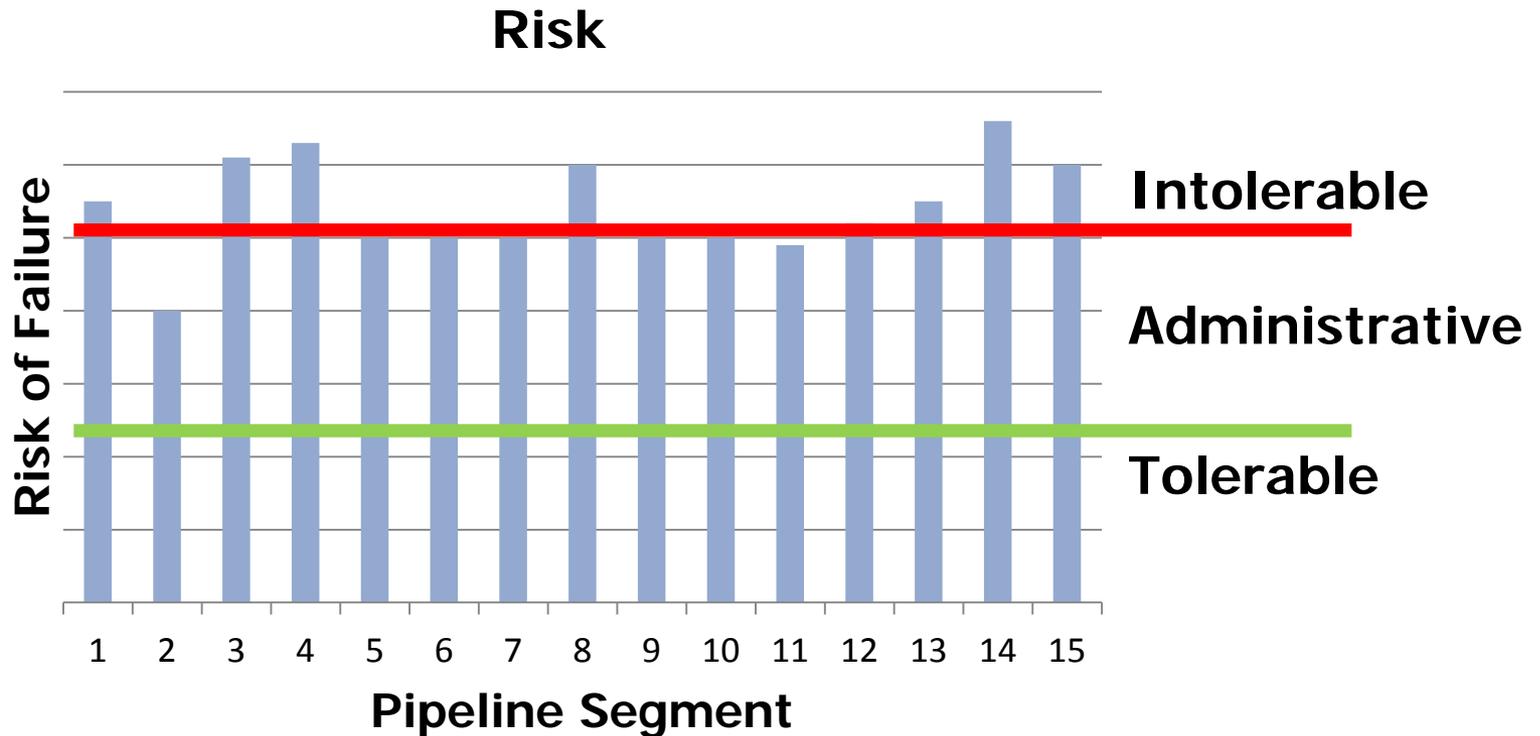
- Pipeline Risk Profile
- Risk tolerance levels based on a company's willingness to invest to avoid a certain event
- These risk tolerability criteria are generally established by senior management and therefore represent the corporate risk aversion



# Risk Tolerance Levels



- Index model: Relative risk score
- Quantitative model: Probability of failure
- Monetized model: Expected \$cost/year



# Impact (Consequence Endpoint) Criteria



- Only considers consequence distances resulting in a specified impact (fatality, injury, property damage)
- Used by the US EPA for their Risk Management Plan (RMP) Rule
- PHMSA for HCAs (high consequence areas)

# Pipeline Specific Risk Criteria



- Brazil
  - Individual risk criteria
- The Netherlands, UK
  - Societal risk criteria based on the F-N diagram for a given length of pipe

# Approach



## Task 1 – Conduct Literature Search

- Relevant industries and government agencies
- How risk acceptance criteria have been implemented, where maximum risk tolerance levels have been mandated

## Task 2 – Conduct Industry Survey

- Contact several industry members, primarily pipeline operators, to gain additional, specific information regarding their risk management decision-making process.
  - What risk models they use?
  - Whether they have established risk criteria?
  - Are the criteria qualitative, semi-quantitative, or quantitative?
  - What approach was taken to determine these criteria?
  - Are they using their risk model to evaluate potential preventive and mitigative measures?

## Task 3 – Final Report

# Schedule



Task	Description	First Quarter			Second Quarter		
		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
1	Conduct Literature Search						
2	Conduct Industry Survey						
3	Prepare Draft Report						
	Submit Final Report						

 = Quarterly Status Report  
 = Task Report

# Personnel



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# Technical Advisory Committee Kiefner

- The overall program will be guided by a Technical Advisory Committee comprised of pipeline operators:
  - Koch: Jim Andrew
  - Chevron: Nikos Salmatanis
  - PG&E: Manuel Leija, Calvin Lui, Ryan Lindblom