Causal modeling of hydrocarbon leaks on offshore installations

A model with leak scenarios and risk influencing factors

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Background

In Norway, the Petroleum Safety Authority (PSA) has collected the data of hydrocarbon (HC) leaks on offshore installation in the Norwegian Continental Shelf (NCS) since 2000, recognizing HC leaks a critical indicator for safety [1]. Furthermore, a method was developed in 2006 for analysis of the platform specific HC leak frequency, called BORA-Release [2]. As the further work, the Risk OMT model presented more comprehensive Risk Influencing Factor (RIF) models for operational leaks (which are caused by human interventions) [3], however, there are still no further studies on non-operational leaks.

Objectives

- Investigation into previous leaks to identify the leak scenarios and the RIFs for non-operational HC leaks (caused by technical degradation and design error).
- Developing a model to estimate the platform specific frequency of non-operational HC leaks on offshore installations, based on the finding through the investigation.

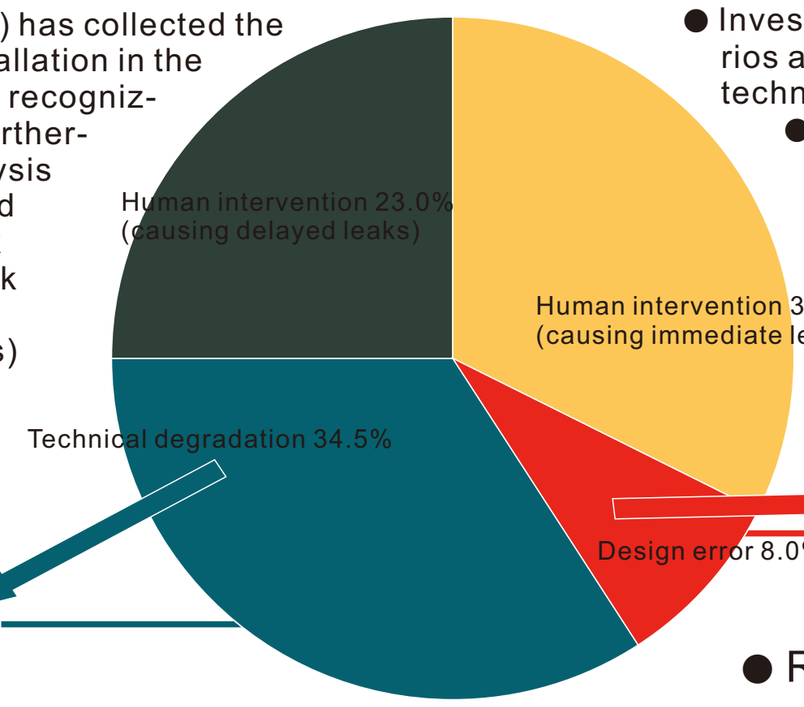

Figure 1. Distribution of initiating events of HC leaks on the NCS in the period 2011-2013 [4]

HC leaks caused by technical degradtion

Leak scenarios:

Initiating event (A type)	Another event to trigger a leak	Failure to detect the technical degradation	End event

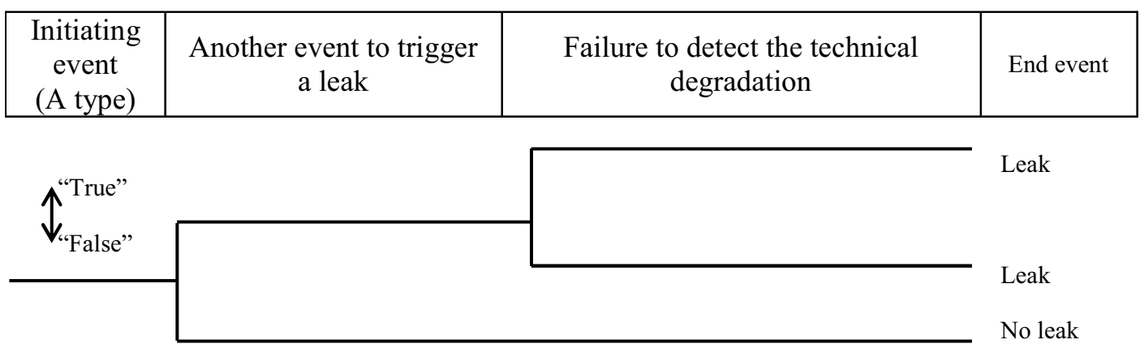

Figure 2. Leak scenarios associated with technical degradation leaks

RIF model:

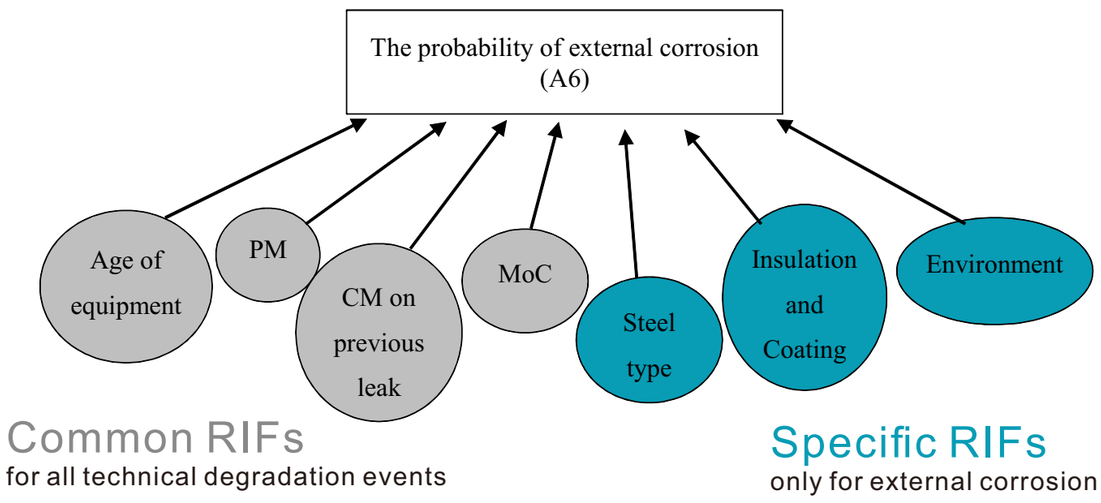

Figure 3. Risk influence diagram for external corrosion, one of eight types technical degradation events

The RIF, preventive maintenance is further divided:

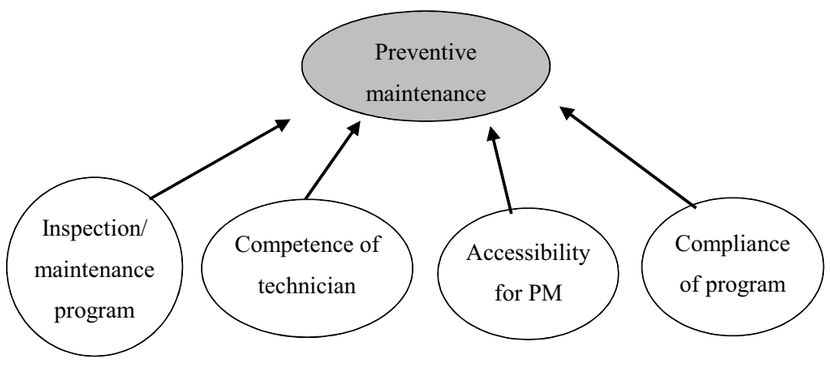

Figure 4. Risk influence diagram for preventive maintenance

RIF description:

PM - preventive maintenance
CM on previous leak - corrective maintenance of previous similar leaks
MoC - management of process/equipment change
Environment - corrosive substance, temperature, residual substance, and construction details

HC leaks caused by design error

RIF model:

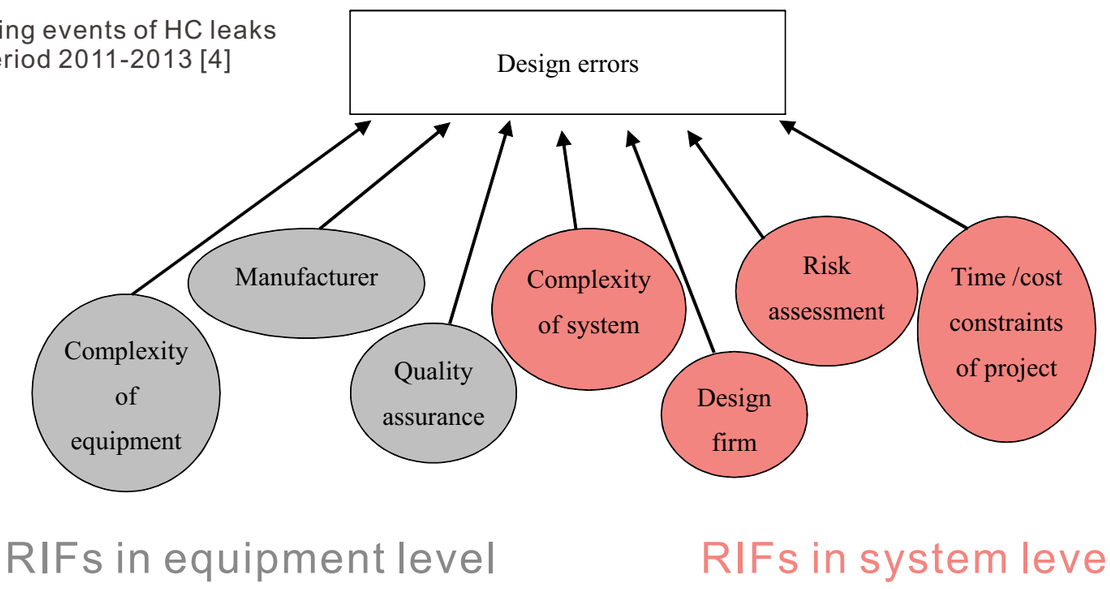

Figure 5. Risk influence diagram for design error

RIF description:

Manufacturer - experience, history of design errors, and training program of equipment manufacturer
Quality assurance - function test / leak test before and after equipment installation
Design firm - experience, history of design errors, and training program of system design firm

Conclusion

- For the leaks caused by technical degradation, the generic leak scenarios and the RIF models with the common RIFs and the specific RIFs are identified.
- For the leaks caused by design error, the RIF model is identified in equipment and system levels.
- Many of the identified RIFs are relevant to human, organizational, and cultural aspects even though the initiating events are technical issues.
- If this model is combined with the Risk OMT model which covers the leaks due to human intervention, the platform specific frequency can be estimated for all types of HC leaks.

Reference

1. PSA. Trends in risk level in the petroleum activity (RNNP). 2015 [cited 2015 10 Mar]; Available from: http://www.psa.no/about-rnnp/category911.html.
2. Aven, T., S. Sklet, and J.E. Vinnem, Barrier and operational risk analysis of hydrocarbon releases (BORA-Release): Part I. Method description. Journal of hazardous Materials, 2006. 137(2): p. 681-691.
3. Vinnem, J.E., et al., Risk modelling of maintenance work on major process equipment on offshore petroleum installations. Journal of Loss Prevention in the Process Industries, 2012. 25(2): p. 274-292.
4. Vinnem, J.E. and W. Røed, Root causes of hydrocarbon leaks on offshore petroleum installations. Subitted for publication.