PIPELINE RISK ASSESSMENT RTO/TRC/SONATRACH

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Abstract: The responsibility to protect public safety and the environment with respect to pipeline transportation is a very serious one; a responsibility that RTO (Regional Direction of Transportation of Hydrocarbons by Pipelines/Sonatrach Division) should not treat lightly. When pipeline accidents happen, even though they occur rarely, the consequences can be disastrous.

The preparation of a risk assessment is an important first step in the emergency planning process. The results of this study will be of value in helping RTO Staff understand the probability and severity of emergencies that may occur in the region.

The implementation of a risk assessment strategy as part of RTO Company's overall risk management program usually generates two important benefits: enhanced detection of potential problem areas (heightened RTO awareness along the 500 Km of pipeline); and maintenance project selection based on maximizing the corrosion and risk reduction potential of the system given limited financial and manpower resources. It should be noted that risk management is not perceived as a means to lower the amount of money spent on system maintenance, but is a process for enhancing and correctly leveraging the available maintenance dollars. The ultimate goal is to reduce the potential for a release or explosion, thereby increasing public safety, environment protection and pipeline profitability.

Keywords: Risk assessment process; Indexing model of Kent Muhlbauer

1. INTRODUCTION

Once a pipeline is built and buried, it cannot be ignored. Third-party damage, corrosion and geologic hazards all pose cumulative risks to a pipeline's integrity. So, the need to conduct pipeline risk assessment by RTO becomes an immediate obligation.

There are many risk assessment methods currently being used within the Pipeline Industry. Each method has certain advantages and disadvantages over the other depending upon the user's familiarity with risk assessment concepts.

It is vital to recognize what a risk assessment can and cannot do, regardless of the methodology used. The ability to predict pipeline failures (when and where they will occur) is a great advantage in reducing risk. Unluckily, this cannot be done in RTO at present. Pipeline accidents are relatively rare and often involve the simultaneous failure of many safety provisions. This makes accurate failure predictions almost impossible, therefore modern risk assessment methodologies provide a replacement for such predictions. Assessment efforts by pipeline operating companies are normally not attempts to predict how many failures will occur or where the next failure will occur. Rather, efforts are designed to systematically and objectively capture everything that can be known about the pipelines and their environments.

This study outlines an indexing methodology of Muhlbauer because it uses existing knowledge and experience and, compared with formal RA, easier to apply by existing personnel.

2. AIMS AND OBJECTIVES

The aim of this study is to provide a clear pipeline risk assessment approach to RTO Staff

The study is addressed to:

- Enable RTO Regional Staff to appreciate and understand both the advantages and limitations inherent in the development of risk management strategies;
- Help RTO Regional Staff to understand the pipeline hazards, the probability and severity of the attendant pipeline risks that may occur in the region and application of this knowledge to their decision making processes;
- Clarify the various definitions of the major terms and principles to RTO Regional Staff;
- Clarify the different stages of risk assessment, the activities, the contributors and the deliverables;
- Explore the indexing model of Muhlbauer as an adequate one for pipeline risk assessment;
- Show that the indexing model of Muhlbauer can be more feasibly and successfully implemented throughout its pipeline network using existing RTO experience and skills;
- Ensure nature of risks is well understood;

3. AREA OVERVIEW

The transportation of oil and gas by pipeline is economically very important in all countries. It is also a potentially dangerous activity in that they convey highly flammable substances in high-energy containment systems. Furthermore, pipelines pass through a variety of terrains with latent potential for damage hazards e.g. earthquake zones, erosion and washout at river crossings, excavation, construction or agricultural activities. Human activities in urban areas, the passage of vehicles at road crossings and trains at railway crossings, present both the potential for damage to pipelines and harm to persons from pipelines.

RTO must therefore have a comprehensive, formal risk management decision making system in place utilizing the best of current science and technology to target investment in pipeline improvements and future developments, optimisation of operation and operational safety, effective pipeline integrity management, emergency planning and in the preservation of human safety.

Risk assessment is now considered a proven technology for operators to effectively manage, eliminate, minimise or mitigate the risks arising from credible hazards in a structured manner. A risk assessment approach provides decision makers with quantitative or qualitative information about the risk levels and exposure inherent in given scenario's indicating what is, or what must still be done to achieve, lowest risk solutions.

RTO manages 9 pipelines (2 crude oil pipelines, 4 natural gas pipelines, 2 LPG pipelines and a condensate pipeline). They traverse 6 provinces (Laghouat, Tiaret, Relizane, Mascara, Mostaganem and Oran) having different climates, population densities, activities, soils, flora and fauna. [1]

4. RISK TERMINOLOGY

Risk studies are based on the understanding of the following terminology:

- **Risk analysis** is the quantification of risks without making judgements about their significance. It involves identifying hazards and estimating their frequencies and consequences, so that the results can be presented as risks.
- **Risk assessment** is a means of making a systematic evaluation of the risk from hazardous activities, and making a rational evaluation of their significance, in order to provide input to a decision- making process. This may be qualitative or quantitative. Risk assessment is a technical and scientific process by which the risks of a given situation for a system are modeled and quantified. Risk assessment can require and/or provide both qualitative and quantitative data to decision makers for use in risk management. [2]
- **Risk management** is the making of decisions concerning the risk, and the subsequent implementation of the decisions in the safety management system. Risk management is a systematic and analytical process by which an organization identifies, reduces, and controls its potential risks and losses. [3]

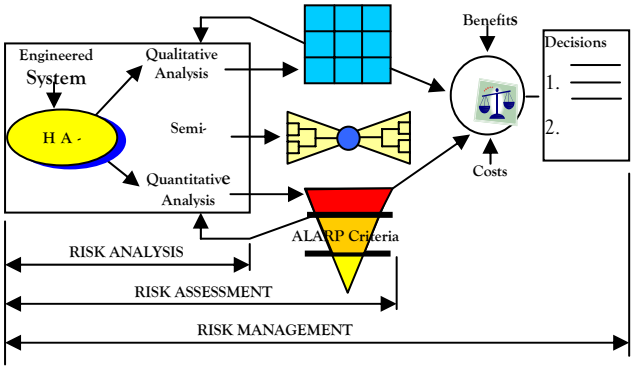


FIGURE 4.1: Risk Assessment Approaches [4]

The figure 4.1 clarifies the interval of each risk study and shows that the hazard identification is an intrinsic part of them.

The figure shows clearly that a risk assessment is the process by which the results from a risk analysis are used to assist in making decisions.

5. RISK ASSESSMENT PROCESS

RTO Regional Staff can now focus on the actual steps involved in risk management. The following are the recommended basic steps [5].

Step 1: Risk modeling

The acquisition of a risk assessment process, usually in the form of a model, is a logical first step. A pipeline risk assessment model is a set of algorithms or rules that use available information and data relationships to measure levels of risk along a pipeline. There are three types of model:

A) Matrix models

It ranks pipeline risks according to the likelihood and the potential consequences of an event by a simple scale, such as high, medium, or low, or a numerical scale; from 1 to 5.

B) Probabilistic models

PRA is a rigorous mathematical and statistical technique that relies heavily on historical failure data and event-tree/fault-tree analysis.

c) Indexing models

The most popular pipeline risk assessment technique is the index model. In this approach, numerical values (scores) are assigned to important conditions and activities on the pipeline system that contribute to the risk picture.

Step 2: Data collection and preparation

Data collection entails the gathering of everything that can be known about the pipeline, including all inspection data, original construction information, environmental conditions, operating and maintenance history and past failures.

Step 3: Segmentation

Because risks are rarely constant along a pipeline, it is advantageous to segment the line into sections with constant risk characteristics (dynamic segmentation) or otherwise divide the pipeline into manageable pieces. There are three types of segmentation:

A) Fixed-length approach

based on rules such as "every mile" or "between pump stations" or "between block valves," is often proposed. It will usually reduce accuracy and increase costs.

B) Dynamic segmentation approach

The most adequate method for sectioning the pipeline is to insert a break point wherever significant risk changes occur.

C) Manually establishing sections

The evaluator should note conditions that are most variable in the pipeline system being studied and rank those items with regard to magnitude of change and frequency of change.

Step 4: Assessing risks

Now the previously selected risk assessment model can be applied to each segment to get a unique risk "score" for that segment. These relative risk numbers can later be converted into absolute risk numbers.

Step 5: Managing risks

We now face the critical step of managing the risks. In this area, the emphasis is on decision support-providing the tools needed to best optimize resource allocation.

6. WHY THIS MODEL?

- Provides immediate answers
- Is low-cost analysis
- Is Comprehensive
- Acts as a decision support tool
- Places values on risk mitigation opportunities

TABLE 5.1: Choosing a risk assessment approach

When the need is to…	A technique to use might be…
Study specific events, perform post-incident investigations, compare risks of specific failures, calculate specific event probabilities	Event trees, fault trees, FMEA, PRA, HAZOP
Obtain an inexpensive overall risk model, create a resource allocation model, model the interaction of many potential failure mechanisms, study or create an operating discipline	Indexing model of Kent Muhlbauer (our choice)
Better quantify a belief, create a simple decision support tool, combine several beliefs into a single solution, document choices in resource allocation	Matrix

7. MODEL STRUCTURE OF MUHLBAUER

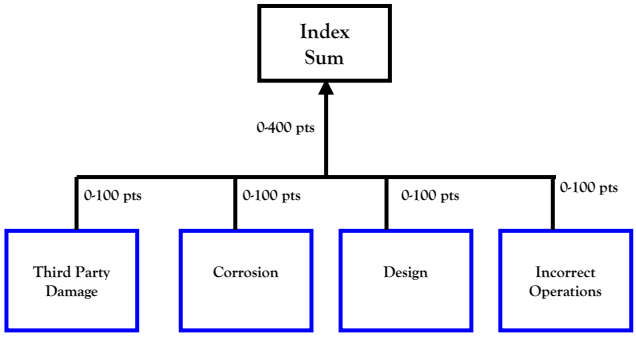
Many variables were used in quantifying the relative POF for each pipeline segment. Environmental assessment risk model variables were selected and weighted based on their role in the actual risk and on availability of information. Wherever possible, measurable data were used to assign risk points to these variables. When such data were unavailable, more qualitative assessments were made. Common industry practices, engineering judgement, and pipeline operations experience were used to support this effort in cases where measurable data were absent.

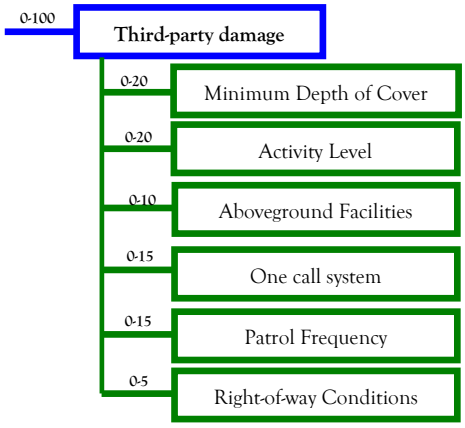
Probability-of-failure scores are grouped into the four failure probability indices: third party damage, corrosion, design, and incorrect operations. Together these index scores comprise the relative POF for the segment of pipeline or pump station evaluated [6].

The relative risk assessment model is designed to be a simple and straightforward pipeline risk assessment model that focuses on potential consequences to public safety and environment preservation. It provides a framework to ensure that all critical aspects of risk are captured (Figure 7.1 shows a flowchart of this model).

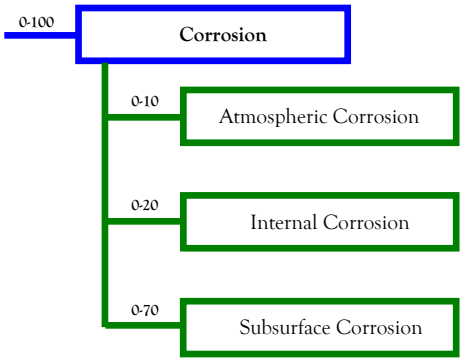
This framework is flexible enough to accommodate any level of detail and data availability.

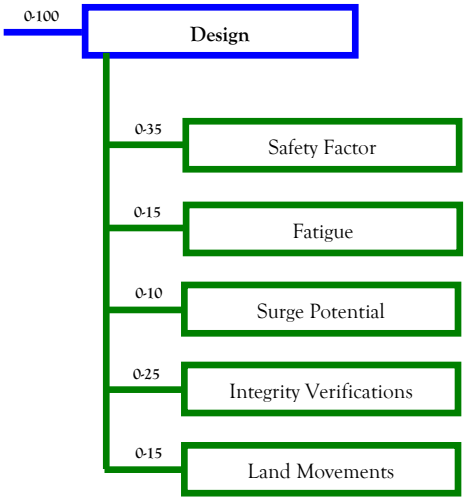
FIGURE 7.1: Flow chart of relative risk index system (Muhlbauer)

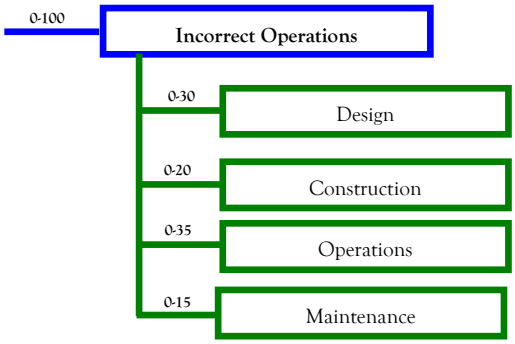




	Third Party Damage	Corrosion	Design	Incorrect Operations	Index Sum
Negligible	>90	>90	>85	>95	>360
Low	60-90	50-90	60-85	85-95	255-360
Intermediate	40-60	20-50	30-60	80-85	255-170
High	<40	<20	<30	<80	<170







8. RISK CRITERIA OF THE MUHLBAUER MODEL

Risk criteria bridge the gap between numerical risk estimates and decision criteria such as “negligible risk” or “high risk,” which incorporates a value judgment.

The risk levels are classified in the table (8.1): [6]

TABLE 8.1: Risk criteria of the model

9. CASE STUDY

The study focussed on the GZ2 gas pipeline (Æ=40 in) which transports the natural gas from Hassi R’mel to Arzew terminal.

The GZ2 was chosen because many accidents were recently recorded along this pipeline.

To avoid complications, the break point has been done where the GZ2 traverses the population (dynamic segmentation).

I have recorded 2 segments where the pipe traverses population.

Bendaoud village segment (1.6 Km) located in Relizane province;

Oued Tolba City segment (1.2 Km) located in Tiaret Province;

TABLE 9.1: Case study results

	Third party damage index	Corrosion index	Design index	Incorrect operation index	Index sum
Bendaoud segment (1.6 Km)	30 (high)	62 (low)	42.55 intermediate	56 (high)	190.55 intermediate
Oued Tolba segment (1.2 Km)	38 (high)	63 (low)	44.75 intermediate	56 (high)	201.75 intermediate

10. CASE STUDY RECOMMENDATIONS

Acording to the table 9.1 which shows the results of this case study, we can mention that:

- The indexing model of Muhlbauer is morefeasibleand could be successfully implemented by RTO along its pipeline network.
- Regular patrolling of the pipelines should be carried out especially when the transfer operation is in progress. This will help in identifying any activity that has the potential to cause pipeline damage or to identify small leaks whose effects are too small to be detected by instruments.
- Pipeline failures due to third party activity can be reduced by ensuring that the members of the public, surrounding agricultural population and the district administration are aware of the pipeline.
- At locations where the pipelines / pipe racks are close to traffic movement, adequate crash guards may be provided.
- The pipelines should be subjected to requalification hydrotest at least once in 5 years. (ILI pigging as part of a risk based maintenance system would serve better)

11. CONCLUSION

The risk assessment must be reviewed and revised periodically to ensure that the information available on hazards is up-to-date and that the degree of risk for the various hazards has not changed.

The risk assessment methodology should 'get smarter' as we ourselves learn. As more information becomes available or as new techniques come into favor, the methodology should be flexible enough to incorporate the new knowledge, whether that new knowledge is in the form of hard statistics, new beliefs, or better ways to combine risk variables.

Increasing the awareness of, and expanding the application of, risk management within RTO will provide significant benefits to the company and the communities they serve. Although the total elimination of risk is neither practical nor possible, pipeline operators who embrace the risk assessment philosophy will be in an ever increasingly better position to make appropriate resource allocation decisions, and in the unfortunate event of a release, be able to proactively adjust their risk models to minimize the potential and occurrence of similar releases in future.

The risk assessment process enables RTO to:

- formally identify the risks
- measure the risks
- minimise the risks
- engineer out the risks by the use of engineering resources, to an approved, acceptable standard or improved safe working practices.

As a result of this project, regulatory compliance will be greatly enhanced, significant information gained about the integrity of their pipelines and excessively expensive assessment techniques avoided.

12. REFERENCES

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