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Safety and Integrity of Pipelines: Controlling Risk Associated with Pipelines

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***Abstract*— In this article we introduce some of the risks associated with pipelines. This article is dedicated to Trans Adriatic Pipeline which currently is constructed in Albanian Part. Since this pipeline is currently in its initial phase identifying and managing risks associated with the pipeline roots are to be analyzed. After identifying and presenting risks associated to pipelines we will explain some auditing methods of risks and measures to be taken to reduce them. Measures reducing risks will be introduced.**

***Index Terms*— Risk Management, Pipeline Safety, Controlling Consequences.**

I. INTRODUCTION

Pipelines must be safe for the community where those are passing by. Pipelines are considered safe as those are installed and operating through strict codes. However continues maintenance plays an important role in decreasing failures and fatalities compare to other means of transportation. Being aware of the risks several tests before installation and distance from the public are kept. Test in service is conducted to reduce risks while construction however other tests should be taken after those have been constructed. In this paper we analyze the risks that pipelines face and methods taken to reduce the risks associated with pipelines.

II. SOME DATA FOR THE PIPELINE SAFETY

Pipelines are safe while transporting gas or liquids. Pipelines are tested in factory before those are installed. Pipelines are safer than other means of transport such are highway tanks, railroad tanks and boating tanks. In period of time 1985- 1995 in the United States with a pipeline length of 550,000 miles have caused 60 deaths and 400 injuries. Comparing with same period of time highway accidents happening in the United States counts for 42,000 people dying, 840 deaths on rail road accidents. Similarly in Western Europe accidents caused by rail roads and highways are higher than those caused by pipeline. In period of time from 1971 to 1994 there have caused 12 deaths from pipelines for same period of time from road accidents caused 678 deaths, whereas accidents caused by railroads count for 475 deaths[1]. For propose of this article we will focus on accidents caused by pipelines.

Since pipelines are safe when those are produced, because those are tested, to minimize risks while operation those should be controlled while installation and maintenance. In order to minimize risks the operators must use good technology of installation, inspection to prevent any damages caused by corrosion and third party damages. Controlling risks of pipelines are guided by regulatory codes which those are designed.

Table 1.Accidents caused by pipelines in percentage Albania

Cause	Number
Third Parties	45%
Corrosion	12%
Ground Movement	4%
Construction material defects	12%
Hot tap by error	4%

[1]Penn West .The Cost of a Pipeline Failure. PENNWEST.

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Other	5%
Total Incident	845
Frequencies	0.41

III. RISK MANAGEMENT IN PIPELINE INDUSTRY

When dealing with risk management companies deal only with the risks associated to their benefits. Same method has been followed in pipeline industry. However now in modern times when managing risks besides its own profits companies should evaluate and control risks associated with a broader scope, such are environment, stakeholders and community. However strict implementation of pipeline codes is not cost effective to reduce risks. Probability of risks and their management should be monitored by analyzing unpredictable risks. Nowadays safety should not be considered indoor (where the pipelines are designed), but it should be outdoor considering other risks of installation and operating.

In order to reduce costs operators want to minimize risks associated with pipelines. In order for them to deal with risks they need to identify and understand what is a risk? In order to reduce a risk operators should control probability of failure or controlling the consequences of failure, or both of them. In most of cases pipelines are designed by the American Pipeline Standards ASME B31.4 or B31.8. Those are considered safe[2]. Controlling risks by design.

Pipelines are controlled by designed them by limiting Specified Minimum Length Stress. Based on the pressure that pipeline is to transmit is designed the thickness of the pipeline wall. Probability of pipeline failure is limited by limiting stress. Even though we take measures to limit failure of pipelines we should take measures to control consequences if the failure occurs.

IV. CONTROLLING CONSEQUENCES

In case when pipelines transmit liquid e.g. oil we need to have a sophisticated design and quality of material used in order to limit spill over of liquid. In case when pipelines transmit natural gas besides measures taken to avoid spillages we need to construct the pipeline far from inhabited zones. Different countries use different standards based on their legal codes based on the distance and density of population where the pipeline operates. Measures taken by operators depend on the danger that a liquid or gas poses to population and environment. We are presenting a list below based on the danger of the liquids and gases transmitted by pipelines, starting with the most to list dangerous substances.

1. Flammable and toxic substances such is methane
2. Flammable and toxic substances liquids that are at normal temperature.
3. Non flammable substances
4. Water based liquid substances.

Pipelines transmitting gas safety is focused on the proximity of the pipeline route to population and houses. Pipelines transmitting liquids present lower risk to community however those should have extra protection to limit the costs of liquid spill over.

In order to further reduce the risk that a pipeline may face classifying the location of pipeline route is important. Pipelines should be constructed as far as possible from the inhabited areas. Having the pipeline constructed far t from the inhabited areas; in case of failure will have less impact to people due to their distance from the pipe route. Also considerable distance from the inhabited areas will limit the possibilities of external interventions. There will be less people and vehicles circulating around the pipeline, as result probability for damage decreases. Pipeline

[2]Graham McIntosh. Risk Management in the Operations Of A Subsea Pipeline. rincipal Subsea and Pipelines Engineer
[3]National Transportation Safety Board. Integrity Management of Gas Transmission Pipelines in High Consequence Areas, Safety Study

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standards require that house density close to the pipeline to be limited in number or those to be located as far as possible from the pipeline route[3].

In Albania Trans Adriatic Pipeline (TAP) construction, where we have highly stressed gas pipelines, distance is calculated based on the proximity limits, diameter and pressure that pipeline possess. In this case the radiation level is considered 33kW/m2, this radiation level is considered high. This proximity level is considered as high. As result population found indoors will be in danger when those are 3 times far of proximity level and being outdoors will be 8 times of proximity level in danger. Pipeline pressure strength and density of population are two parameters to be considered reducing risk for pipeline failure. However, once constructed the pipeline should be inspected maintained in order to reduce its failure[4].

Onshore pipelines are controlled by patrols, helicopters to identify any danger approaching to the pipes. Monitoring pipelines should identify any excavation taking place close to pipeline or any building being constructed near to pipeline. Helicopters can identify such problems which normally should be conducted once in two weeks; however corrosion cannot be identified by air surveys. Offshore pipelines are in danger from ships. In this case a communication among pipeline companies and ship organizations is very important. Organization of ships should be informed on the locations of pipelines found in waters[5].

Despite the measures taken to reduce pipeline failures those will fail at some pint. For that reason pipelines must be controlled for leaks in order to reduce risk for destruction. Detecting leeks may be conducted by walking around the pipe and seeing the leak or controlling the pressure. If pressure decreases than we have pipeline leak somewhere. Large leeks are easy to be identified. We will notice a considerable pressure decrease and we can easily identify. More difficult to identify are small leeks.

Simple process of identifying leeks is done by seeing or smelling. Workers around pipeline may notice some liquid leak and they may repair it straight way. Also people leaving around the pipeline route may identify a leakage and notify authorities. Gas smells as result people around the pipeline can identify through smelling and report the problem. Flow balance of the gas or liquid injected in pipe should come out of it. If the amount of substance does not come out of pipe with same density than we can tell that pipeline is leaking. Noises occurring while pipeline leaks can easily be detected through equipment installed at some part of the pipe[6]. Also nowadays exist some technologies which with input of some data will predict the failure of pipeline.

V. CORROSION AS RISK FOR FAILURE, MONITORING CORROSION.

Quality of liquid injected within the pipeline has an impact on corrosion. If in the pipe is injected water or carbon dioxide with the primer liquid than we will have internal corrosion which will rapidly expand. This internal corrosion is more present to offshore pipelines rather than to onshore pipelines. Onshore pipelines face the risk of external interference. Despite measures taken to reduce risk from measures we discussed above still dangers for the pipelines are present. In order to increase the pipeline protection we use coating and catholically protected pipelines. Even so protected cover protection should be inspected.

Inspections can be conducted via intelligent pigs and utility pigs. We are mentioning few of them. Some of the utility pigs are Gauging, Batching, cleaning, meter proving etc. Intelligent pigs are: Geometry mapping, leak detection, metal lose, cracking etc. Pigs make several functions Utility pigs are used to assist in the operation and maintenance of the pipeline. Mapping and geometry pigs serve to identify the location of pipe damaged. Also pigs identify cracks. Intelligent pigs identify even the small leakages through magnetic flux. Other ultrasonic pigs control even the thickness of the wall[7]. If the wall thickness is becoming thin than intervention must be taken to avoid the leak.
Hydro testing is another method the check the integrity of pipeline in service. However this testing is reliable only for the time as the pipe moves out of factory. After the pipe moves to ground or water this test its not valuable. The

[4]Lorena Pelegrín. Using STAMP Principles in Risk Management of Large Scale Pipeline Projects. Consulting Engineering
[5]P Hopkins, R Fletcher, R Palmer-Jones. A METHOD FOR THE MONITORING AND MANAGEMENT OF PIPELINE RISK
[6]P Hopkins, R Fletcher, R Palmer-Jones. A METHOD FOR THE MONITORING AND MANAGEMENT OF PIPELINE RISK
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pipeline integrity will reduce as it being transported and installed. As result inspection should be continued to reduce risks. Risks may be eminent an any stage as the pipes are installed or staring to operate.

VI. CONCLUSIONS

Even though pipelines are safer compare to other means of transportation, measures are taken to reduce into maximum its danger. Pipelines are protected old and new methods of risk controlling. Monitoring pipelines and testing them from production to installation and operation are some of stages that operators undertake to control risks. Corrosion, external threats and damage from overpressure are some of the dangers operators identify. Physical monitoring and using sophisticated technology such are intelligent pigs have reduced the danger deriving from pipelines.

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