Penspen Integrity
Units 7-8
St. Peter's Wharf
Newcastle upon Tyne
NE6 1TZ
United Kingdom

Telephone: +44 (0)191 238 2200
Fax: +44 (0)191 275 9786
Email: integrity.ncl@penspen.com
Website: www.penspenintegrity.com

Extending the Life of Ageing Pipelines

Andrew Palmer and Associates
A member of the Penspen Group

PENSPEN

Paul A Henderson,
Phil Hopkins
and
Andrew Cosham

of Andrew Palmer and Associates

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Andrew Palmer and Associates
40 Carden Place
Aberdeen
Scotland, U.K.
AB10 1UP
www.penspen.com

EXTENDING THE LIFE OF AGEING PIPELINES

ABSTRACT

Many of our offshore pipelines are now either showing signs of age (e.g. corrosion), or are approaching the end of their design life. This problem can be addressed by using a variety of engineering methods to predict the remaining safe life of the pipelines. These methods include both simple and complex fitness for purpose analyses, but must consider other aspects of the care of an ageing asset, e.g. inspection and repair.

This paper presents a holistic view to pipeline life extension and describes the technologies in use today, and the technologies needed in future to ensure safe, long life operation

INTRODUCTION

Offshore pipelines are expected to operate safely and securely in a variety of hostile environments. At their start of life, given they are designed and constructed to recognised standards, their 'day 1' safety and security will be excellent. However, as the pipelines age, they will inevitably deteriorate or become defective, and hence an Operator must be able to both assess the significance of this damage, and ensure that the pipelines do not fail as they age. Failure does not necessary mean an escape of product from the pressure envelope, it may be outwith a service limit. This is the 'whole life' approach to pipeline design and operation.

Additionally, an Operator may wish to extend the life of the pipeline; this can be achieved by adopting methods of analysis that show the line is safe for an extended life.

Figure 1 shows the oil spills/annum recorded in onshore oil lines in Western Europe. The age of the pipeline is not a significant factor, provided it is inspected and maintained correctly[(1)].

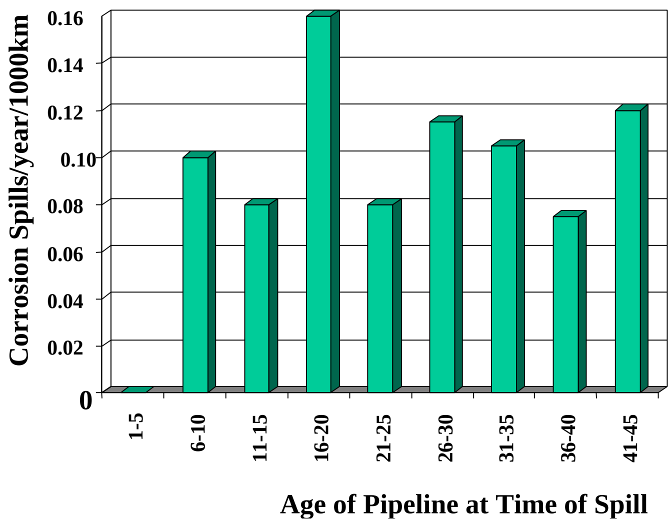


Figure 1. The Effect of Pipeline Age on Spills Caused by Corrosion [(1)]

Hence, we have clear evidence that pipelines can continue safely into later life, or even extended life, provided we manage their integrity. This paper starts with a simple summary of what pipeline integrity is, and how we manage our pipeline integrity. It then suggests inspection strategies to check the pipeline's integrity and then presents a holistic view of the work required to extend pipeline life. and methods for assessing defects detected in pipelines

WHAT IS PIPELINE INTEGRITY, AND INTEGRITY MANAGEMENT?

Pipeline integrity is ensuring a pipeline is safe and secure for the efficient transportation of hydrocarbons [2,3]. This not only includes the obvious physical and human aspects but also protects the investment, operation and environment. It involves all aspects of a pipeline's design, management, inspection and maintenance. This presents an Operator with a complex 'jigsaw' to solve if they are to maintain high integrity while optimising available resources, Figure 2.

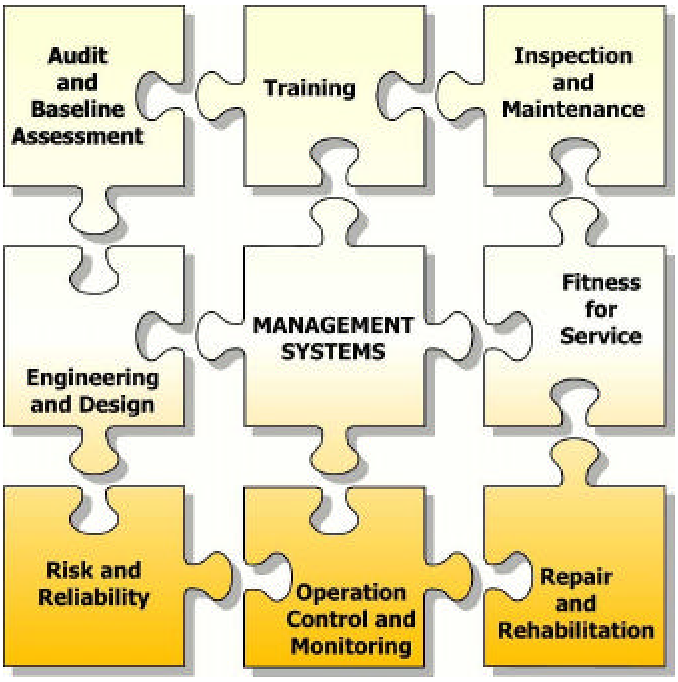


Figure 2. The Pipeline Integrity 'Jigsaw' [4]

Pipeline integrity management is the management of all the elements of this complex jigsaw; the management brings all these pieces of the jigsaw together for each specific pipeline system and ensures their continued integration.

Pipeline Integrity Management Systems not only stipulate the requirements of the various functions but also specifically identify the need for an integrity monitoring scheme for the pipeline system. Integrity monitoring collates all the data from condition monitoring, process control and production control to produce an overall review of the pipeline condition, this is shown in Figure 3. No one technique can provide sufficient information to give the complete picture of the pipeline's condition. The collection and analysis of all this data is the ultimate deliverable required of the pipeline integrity monitoring scheme.

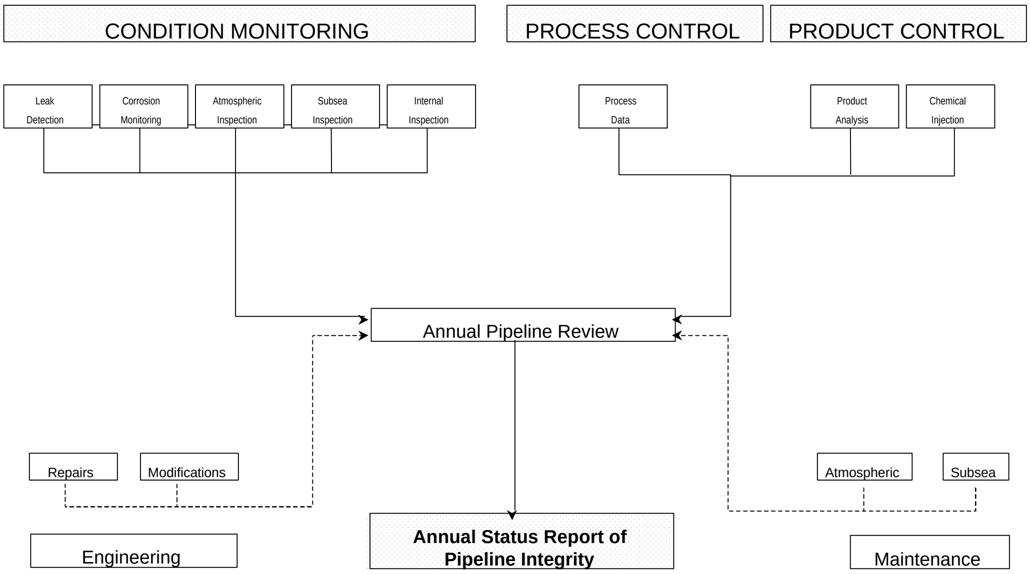


Figure 3. Pipeline Integrity Monitoring Scheme

To give the true picture of the pipeline condition the integrity monitoring scheme must identify those elements of the pipeline, which are at most risk to potential modes of failure. To achieve this we adopt a Risk and Reliability Based Inspection Strategy.

Pipeline failures are usually related to a breakdown in a 'system', e.g. the corrosion protection 'system' has become faulty, and a combination of ageing coating, aggressive environment, and rapid corrosion growth may lead to a corrosion failure. This type of failure is not simply a 'corrosion' failure, but a 'corrosion control system' failure. Therefore, an engineer must appreciate the system to prevent the failure; understanding the equation that quantifies failure pressure is just one aspect. Figure 2 summarises the many aspects of pipeline integrity that need to be appreciated to be able to manage a pipeline effectively and safely.

Additionally, failures affect the as the shareholders investment as well the surrounding people and environment, therefore an appreciation of the consequences of failure is essential. This means an understanding of risk analysis.

The need to understand the many aspects of pipeline integrity means that a 'holistic' approach (Figure 2) to pipeline integrity training is needed. This approach will allow a company to present a training course that will provide the engineer with all the necessary skills to assess pipeline integrity[(4)] .

THE MOVE TOWARDS REGULATING AND STANDARDISING PIPELINE INTEGRITY

REGULATION

In 2000[Note 1], the U.S. Department of Transportation (DOT) proposed regulations that will require pipeline integrity validation through inspection, testing, and analysis of pipelines that run through or near high consequence areas (HCAs). HCAs are defined as populated areas, commercially navigable waterways, and areas that are unusually sensitive to environmental damage.

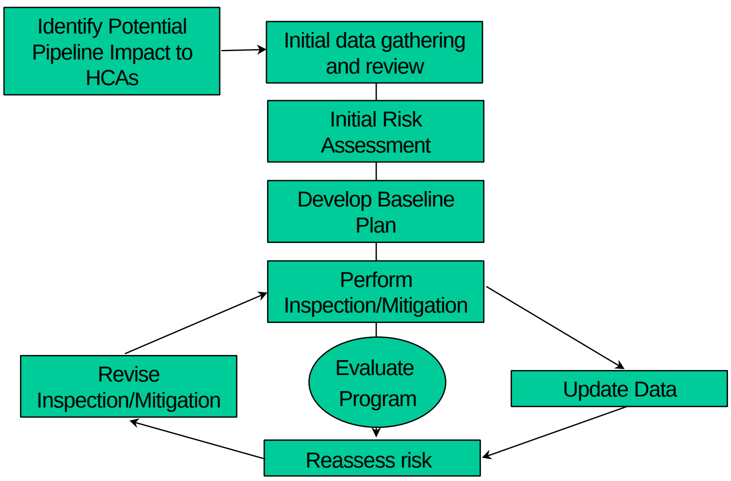
The DOT's Office of Pipeline Safety (OPS) now expects Operators of HCA pipelines to have an integrity management programme that continually assesses and evaluates the integrity of HCA pipelines. These programmes would be applied on the basis of either prescriptive requirements from OPS or risk-based decisions made by the pipeline Operator.

The OPS do not consider the investment aspect. It is incumbent on the Operator to protect the investment on behalf of the Partners and Shareholders of the pipeline.

STANDARDISATION OF PIPELINE INTEGRITY MANAGEMENT - API 1160 [(5)]

The American Petroleum Institute (API) is developing an industry consensus standard that could provide a basis for a company's approach to satisfying the proposed DOT regulation.

This standard development initiative is titled "High Consequence Area Pipeline Integrity Standard, API 1160." It is expected to be finalised in 2001. API 1160 gives guidance on developing Integrity Management Programmes. An outline of the suggested API framework is given in Figure 4.



Note 1. A 'final rule' applying to hazardous liquid pipeline operators was issued in 2000; operators are required to perform a 'baseline assessment' of their pipeline system by e.g. smart pigs, hydrotesting, etc.. Baseline assessment must include identification of all pipeline segments, methods to assess integrity, schedule for integrity assessments, and explanation of all risk factors. Additionally, operators must maintain a written integrity management plan.

Figure 4. API 1160 Approach to Integrity Management

These programmes must:

- Identify & analyse all events that could lead to failure,
- Examine the likelihood and consequences of potential pipeline incidents,
- Examine and compare all risks,
- Provide a framework to select and implement risk mitigation measures,
- Track performance.

The programme starts with a good pipeline design and construction, satisfying all other legal and code requirements, and:

- It is flexible,
- It is built on trained people, using defined processes,
- It should be tailored to an operator's needs,
- An integral part is a risk assessment, and this is a continuous process,
- It should be externally audited,
- There is no 'best approach'.

The above API 1160 approach is in agreement with approaches being adopted by other pipeline companies around the world, and other regulators(6), although the above is often referred to as 'risk' management, rather than integrity management.

EXTENDING LIFE THROUGH BASELINE PLANNING AND SURVEYS

An Operator with an ageing asset who wants to determine extended life beyond initial design limits and ensure future integrity must first of all conduct some type of baseline survey against which the performance of the pipeline can be judged. This may be a smart pig run, a review of operating records, etc. It is however important to recognise that an accurate assessment depends on good quality data collected over the life of the pipeline. Good quality data requires preparation and cleanliness of the pipeline. API 1160 again gives guidance, and recent proposed legislation by the Railroad Commission of Texas is also informative:

The baseline assessment should contain at least:

- Identification of the pipelines & segments covered by the plan
- A priority ranking of the pipeline/segments of each system based on an analysis of risks
- Assessment of pipeline integrity using at least one of the following methods appropriate for each segment:
    - in-line inspection,
    - pressure test
    - 'direct assessment' (e.g. coating inspection), or
    - other new technology.
- Management methods for the pipeline segments which may include remediation or increased inspections as necessary; and
- Periodic reviews of the pipeline integrity assessment and management plan every 36 months or more frequently if necessary.

Clearly we will have to decide on an optimum plan. The following section shows how we can assess the benefits of inspection methods using probabilistic methods.

RISK AND RELIABILITY BASED INSPECTION STRATEGY

The aim of this strategy is to answer the questions of what, where, how and when to examine or test pipelines in order to maintain the integrity of the pipeline.

To achieve this strategy a structured approach must be used to identify the hazards that threaten the integrity of the pipeline, then analyse the risks associated with those hazards and identify the inspection techniques and tools to report on those hazards. Those hazards that are more onerous can be further analysed using reliability techniques.

Hence inspection will only be directed to those failure modes where change in the degradation of the pipeline can be detected.

The structured approach to a risk and reliability based inspection strategy [2] is shown in Figure 5 and it can be seen that this is similar to the API 1160 approach.

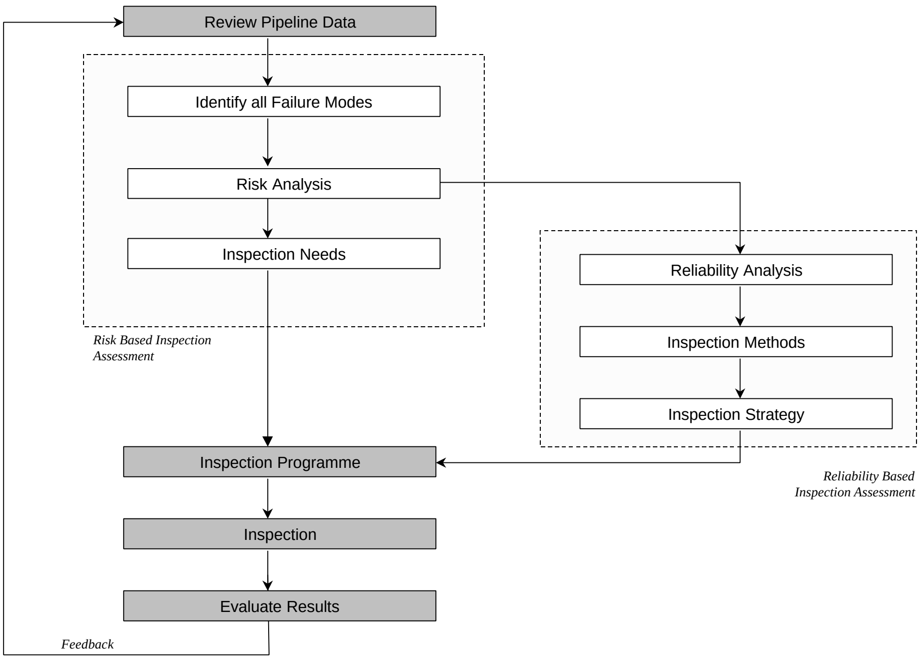


Figure 5. Risk and Reliability Based Inspection Strategy

RISK BASED INSPECTION

Review of Pipeline Data

It is, for example, important to understand the rate of degradation of a pipeline and to be able to forecast future degradation. The better the data quality then the smaller the associated uncertainties and hence a reduced perceived risk is achieved.

Typical information required is:

- Design data
- As-built data
- Past and present operating conditions
- Forecast operating conditions
- Inspection data available
- Loading and environmental data

Identification of all Failure Modes and Mechanisms

Dependent on the location over its length, the pipeline will be exposed to different hazards with their associated frequency and consequence. For example dropped objects may be more prevalent adjacent to platforms than at mid line or erosion be more prevalent at bends rather than on straight sections.

To assist in the identification of all hazards and their potential to effect the integrity of the pipeline, the pipeline is divided into the following sections:

- Valves and fittings
- Riser and Spool pieces
- Safety zone
- Mid-line
- Shore approach

By adopting hazard identification analysis techniques all potential hazards affecting the integrity of a pipeline can be identified. In conjunction, by using a simplified version of fault tree analysis and event tree analysis the failure modes and mechanism respectively can be identified.

Risk Assessment

For each failure mechanism/mode identified for each section of the pipeline system the qualitative risk on the system is determined as follows:

Risk = Frequency or Probability of the event x Consequence of the event

Limit State may be approach used to define failure events as follows:

- Major System Failure
- Minor System Failure
- Operability
- Serviceability

By combining the assessed Probabilities and Consequence for each failure mode or mechanism on each section of a pipeline the risk of failure is determined. This is presented by “Boston Square” technique and gives a subjective number. It provides as a glance those failure modes at low risk, the bottom left hand corner and those failure modes at high risk which require immediate attention, the top right hand corner.

Inspection Criticality Analysis

Having identified the high risk scenarios for each mode and mechanism on every section of the pipeline the value of inspection is assessed. For example internal corrosion can be monitored closely by inspection and measures taken to remedy the rate of decay. This technique of inspection has a high value. Conversely the risk of trawl board impact cannot be monitored by inspection as the event can occur immediately after inspection and therefore this inspection technique has a low value.

Inspection Techniques and Equipment

Having determined the critical failure modes for which inspection can provide a good return, the corresponding type of defects will be known. With this knowledge the critical defect size that will pose a threat to the integrity of the pipeline can be determined.

Knowing the type and size of defects that can be tolerated the appropriate inspection technique and associated equipment can be identified.

This process is repeat for all failure modes and mechanism identified for each pipeline section.

RELIABILITY BASED INSPECTION

From the subjective list of risk assessment those modes and mechanisms that pose the greatest threat to a pipeline system can be more accurately analysed. Using reliability based inspection methods a quantitative value for probability of failure at present and also over the remaining life of the pipeline system can be determined. Similarly a more detailed analysis of the effects of different types of inspection techniques, equipment and inspection intervals can be evaluated. Reliability based analysis is numerically intensive and time consuming an should therefore be limited to only the most onerous failure modes and mechanisms. To limit the uncertainties good quality data must be used.

Probabilistic Analysis

The statistics of the input parameters and the engineering models then determine, by probabilistic analysis, the failure probability for each particular failure mode or mechanism and the variation of this failure probability over time. Using the Monte Carlo simulation method the predicted growth of defects over time can also be established.

Inspection Techniques and Equipment

Each different inspection method and its associated equipment will have different capabilities of observing and reporting defects. These capabilities can alter the failure probability of a pipeline that in turn may effect the inspection strategy in terms of the inspection interval. The inspection capabilities that need to addressed are:

- Detection Limits
- Probability of Detection
- Sizing Accuracy
- Repeatability
- Locational Accuracy

INTRODUCING PROBABILISTIC CONSIDERATIONS FOR INSPECTION

The best approach to assessing the benefits of any inspection (e.g. a smart pig run) is to use probabilistic methods that accommodate these uncertainties.

This approach requires the operator to maintain the pipeline below a specified failure probability, i.e. the pipeline failure probability is not allowed to exceed a certain level throughout the design life. Therefore, inspections are only undertaken when the failure probability approaches this specified level, and the accuracy and reliability of the inspection tool is included in the calculations, as it will affect failure probability.

The mathematics behind this probabilistic approach is beyond the scope of this paper, but an example of the type of relationship can be illustrated on a pipeline with corrosion problems when its fluid is both flowing, and stagnant.

$$P_f\left(Pipeline\right)=\left[1-\left(1-P_{i\_flowing}\right)^{N_{flowing}}\right]+\left[1-\left(1-P_{i\_stagnant}\right)^{N_{stagnant}}\right]$$

where:-

P_f(Pipeline)	=	probability, either Serviceability or Ultimate, of the failure of the pipeline.
$P_{i\_flowing}$	=	probability, either Serviceability or Ultimate, for individual defect failing under flowing conditions.
$N_{flowing}$	=	Number of individual defects under flowing conditions.
$P_{i\_stagnant}$	=	probability, either Serviceability or Ultimate, for individual defect failing under Stagnant conditions.
$N_{stagnant}$	=	Number of individual defects under Stagnant conditions.

Two types of possible 'failures' are considered; an 'ultimate' failure where the pipeline reaches some condition where it is unsafe e.g. a rupture causes a loss of containment of the fluid, or a 'serviceability' failure, where the pipeline reaches a condition where it cannot be operated effectively, e.g. stressing above the pipeline's yield strength.

The information needed for this calculation needs an estimate of the defects expected, which will require both estimation and expert judgement.

When the effect of a smart pig inspection is included in the above Equation it is essential not only to have an estimate of the expected defect lengths and depths (so that an inspection is not undertaken when these defects may fall below the threshold limit of the inspection tool), but also the inspection tools threshold limits, and tolerances on readings.

We will now look closer at probabilistic methods and pigging.

Using Probabilistic Methods to Determine Which Smart Pig to Use

We can again illustrate the effect of differing pigs, using this probabilistic approach. If we take an example of a 36 inch diameter trunk line with a nominal wall thickness of 28.6 mm ($1^{1}/_{8}$ inches).

We assume two different pigs, and want to evaluate which of these pigs to use on our pipeline, which has an active corrosion mechanism. The two pigs are:

1. **Pig 1**. The detection threshold of corrosion depth of this tool for general corrosion defects i.e. defect length > 3t, is quoted as 0.1t, where t is the nominal wall thickness. These correspond to ~2.9 mm for any defect ≥ 85.7mm in length in this particular pipeline. The accuracy of this tool is quoted as ± 0.1t, corresponding to ± 2.9mm.
2. **Pig 2**. This tool has a quoted standard detection threshold depth of 1 mm, and a quoted accuracy of ± 0.5 mm.

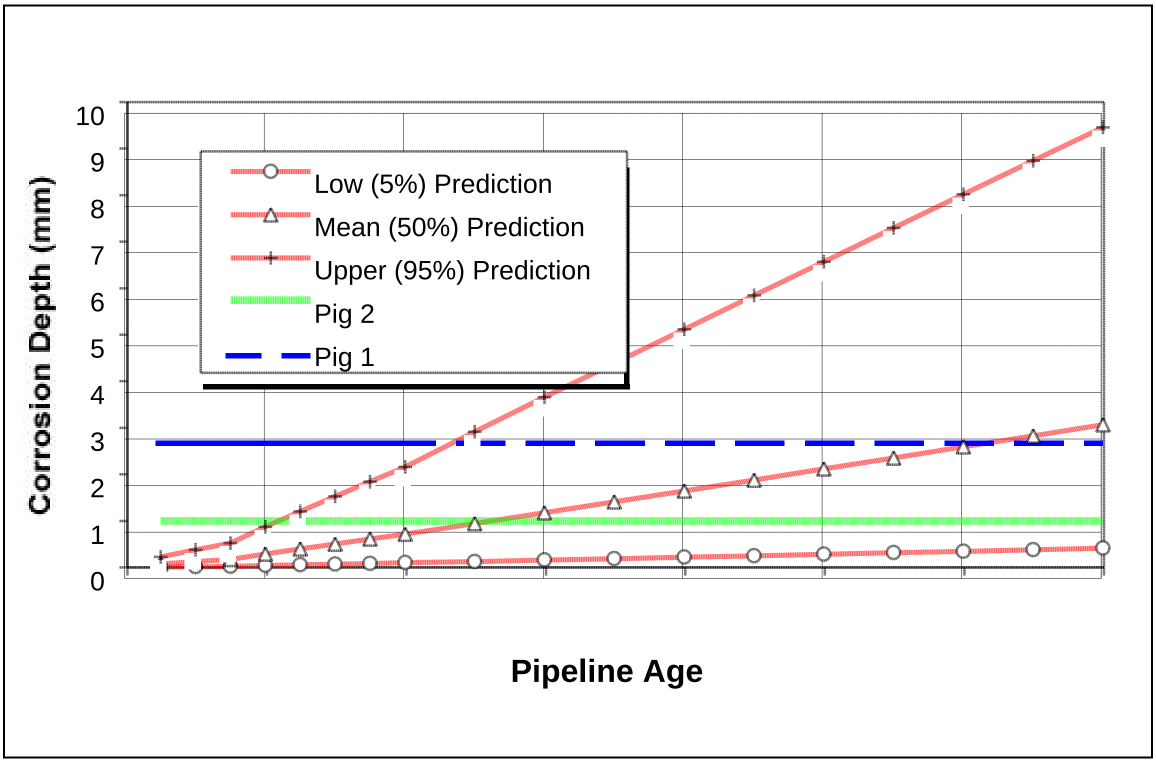


Figure 6. Selecting the Most Suitable Intelligent Pig Using Probabilistic Methods

It is important to note that the above detection and accuracy limits are based on present inspection technology. Over time, inspection technology will be expected to improve results in the lower threshold limits and report with greater accuracy. There is also the possibility that new inspection methods may be developed.

Figure 6 shows the time dependency of a predicted corrosion depth over time on the sensitivity of the two intelligent inspection tools. Three corrosion probability levels are presented in this example: 5%, 50%, and 95% percentiles. These predictions span the likely corrosion rates, and resulting depths. The 'mean' predicted corrosion growth is given by the 50% percentile.

Pig 2 has a higher probability of detecting defects earlier, than Pig 1, due to its smaller detection threshold. It can be seen that Pig 2 will detect corrosion very early, and there is little likelihood of Pig 1 detecting any corrosion in this pipeline until well into the life of the pipeline.

This difference can be quantified by analysing the probabilities calculated. Figure 6 does not show the results of this calculation, but Pig 2 is nearly 30 times more likely to detect corrosion early in the life of this pipeline, and then about 2 times more likely as the pipeline ages.

Figure 6 is purely an assessment of the pigs' capabilities, in terms of detectability. Operators have also to consider the 'track record' of a pig company; does the company have a good record for conducting the surveys on time, to cost, and do they deliver the results to the specified times and quality. However, most importantly, to allow the pig to perform to its specification it is vital that the pipewall is clean.

Having collated this information a decision can be made on which inspection technique will give the most meaningful results based on:

- How does the technique influence the failure probability of the pipeline?
- What are the predicted number and sizes of defects in the pipeline?
- How much does the inspection cost?

Based upon these factors the most appropriate inspection technique can be chosen

Using Probabilistic Methods to Set an Inspection Interval

The inspection interval depends on the following basic variables

1. Variation of the failure probability over time
2. Acceptance of failure probability
3. Rate of defect growth
4. Choice of inspection technique

Normally we use deterministic methods to set inspection intervals. The inspection interval is set when a defect depth reaches a level determined using failure calculations. The input into these calculations is usually lower bounds, or conservative estimates, with a suitable safety margin on the final calculation of failure. This means that we have a simple 'go/no go' situation and the inspection interval is set deterministically, when the predicted defect depth exceeds a predicted 'acceptable' defect size.

When using probabilistic methods, we use the same failure equations, but we input distributions for corrosion rates, etc.. Consequently, we obtain a failure probability from our calculations. This means that we need to inspect when the predicted failure probability, exceeds a predicted 'acceptable' failure probability.

The concept of "acceptable" failure probability is a complex issue, and deals with many aspects. It has received some attention in the literature, but much more work needs to be undertaken in this area. Table 1 shows some proposed acceptable corrosion failure probabilities, published for offshore pipelines [7], by the 'SUPERB' project (which formed the basis of section in the DNV offshore code DNV OS F101).

OFFSHORE	**ACCEPTABLE FAILURE PROBABILITIES (per year)**	
Limit States	**SAFETY ZONE**	**OPEN WATER**
Ultimate	10^{-5} - 10^{-6}	10^{-3} - 10^{-4}
Serviceability	10^{-1} - 10^{-2}	10^{-1} - 10^{-2}

Table 1. Acceptable Failure Probabilities [7]

The consequences of failure are controlled in the above table by introducing 'zones' in offshore pipelines. These have the effect of limiting the number of people in the vicinity of the pipeline, and hence reducing the number of people effected by a possible failure. This gives a measure of an acceptable *qualitative* risk level.

Using these type (Table 1) of acceptable failure probabilities, we can calculate the most suitable time to inspect. Figure 7 shows an example of this calculation, using the pipeline from Figure 6, and an acceptable or target failure probability of 10^{-6}.

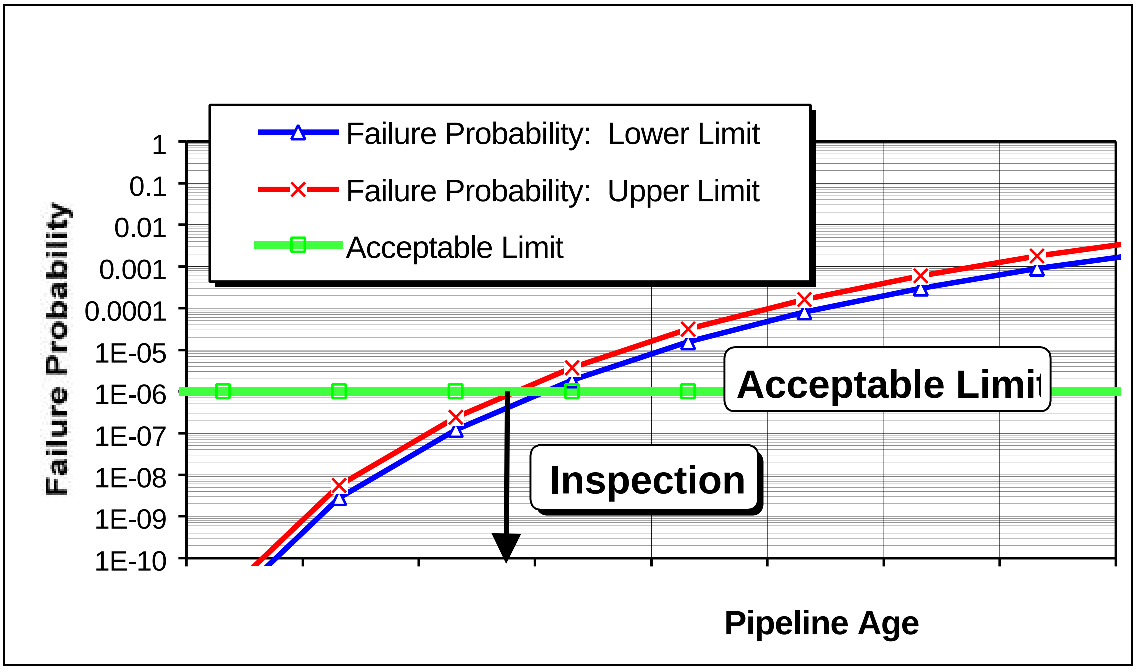


Figure 7. Setting the Time of Your First Intelligent Pig Inspection Using Probabilistic Methods

It is not usually appropriate to set the timing of a second inspection, because of the necessity to include the findings of this first inspection in the calculation of the second inspection timing.

The inspection strategy is therefore one where the pipeline system is maintained below the maximum failure probability throughout its design life. This is achieved by matching the correct inspection technique and inspection interval with the expected defects to be found. It is important to feed the results of any inspection back into the system to fine tune the future inspection campaigns.

By following this strategy greater confidence is achieved in the condition of the pipeline system and savings can be made in inspection programmes.

STEPPED APPROACH TO THE ASSESSMENT OF AGEING PIPELINES

A review of the pipeline design has to be undertaken to evaluate its fitness for purpose and demonstrate its future integrity. The review can be restricted to those areas of the original design that have changed if there is historic data on the performance of the pipeline. This is when the benefit of good record keeping is rewarded [8].

CHANGES TO DESIGN CONDITIONS

The changes can be categorised as:

- Errors or Unknowns at the Design Stage
- Revised Design Predictions Based on Operational Knowledge
- Extended Design Life

Errors or Unknowns at the Design Stage

During the design process an attempt is made to consider all the issues that affect the design. However, misunderstandings may sometimes occur during the design or improved understanding of some phenomena may now exist. Similarly issues may arise during the operational life of the pipeline that were unknown during the design phase.

Examples of these could be:

- Seabed conditions
- Thermal expansion
- Spanning
- Upheaval buckling

Revised Design Predictions Based on Operational Knowledge

Certain predictions would have been made at the design stage. These predictions can be characterised by a scarcity of initial data for the design such as environmental data, product data or external loading. With the benefit of hindsight actual data will be available which will permit an assessment of the pipeline service life as well as more accurate projected data for future use.

Predictions of product fluid with regard to volumes and composition would initially have been based on well tests. Subsequently real data would have been collected thereby providing a revised starting point for future predictions. The transported fluid would have varied in terms of pressure, temperature, flowrate and composition. These changes have an impact on the rate of internal corrosion, thermal expansion and suitability of pipeline fittings.

An example of changed loading would be fishing gear interaction loads of dropped object loads. New gear and larger bollard pull boats mean that there is the potential for loads greater than at the original design stage to be experienced.

Extended Design Life

Some failure mechanisms are time dependent. A pipeline is therefore conservatively designed for finite life, usually based on the predicted field life. Where there is an extension to predicted life of the pipeline, caused by, say new fields being tied back, then the time dependent mechanisms need to be reassessed. The availability of operational data may allow conservatively predicted degradation rates and safety factors to be replaced by real data and realistic predictions of future degradation.

Areas of unsupported pipe, such as risers or freespans, will allow some degree of movement and will, therefore attract a fatigue loading. Fatigue damage is time dependent and the increase in the anticipated life must be assessed against remaining fatigue life.

Some materials, such as concrete weight coating, degrade with time and this degradation has to be assessed, in this case against the stability of the pipeline.

Most corrosion protection systems are based on an anti-corrosion coating and cathodic protection afforded by sacrificial anodes. The systems are designed such that the anodes provide sufficient protection against poor application and degradation of the coating systems for the design life. An extension to the design life requires that the remaining life of the anodes and the condition of the anti-corrosion coating be assessed.

ASSESSING DEFECTS AND DAMAGE IN AN AGEING TRANSMISSION PIPELINE SYSTEM

Any reported defects in our pipeline can be assessed using fitness-for-purpose methods. However, the urgency of the analysis and any resulting repair depends upon:

i. defect severity: location, depth, length, orientation,
ii. financial/strategic value of pipeline,
iii. threat to environment & public relations,
iv. regulatory/legal/insurance considerations,
v. failure/further failures consequences.

This Section does not cover detailed assessment methods available to assess defects in pipelines, as they have been published extensively for over thirty years (e.g. 9-12). However it should be emphasised at the outset that these type of assessments are only as good as the data available as inputs; poor quality data should not be used. Also, most of these methods, although ostensibly simple, do require expert supervision.

This Section deals with the general methods of assessment.

ASSESSMENT METHODS

There are many documents and publications that assist pipeline operators to assess the significance of defects in pipelines. Most have their basis in Reference 9, and they are summarised in (for example) Reference 10.

It should be noted that not all 'defects' are pipewall defects. Some will be structural anomalies (e.g. buckles or unsupported spans) that will require design/structural analysis. Therefore, a fitness-for-purpose assessment may involve extensive engineering and require design support.

Deciding On the Correct 'Level' of Assessment

Having decided that a defect assessment can be conducted, it is now necessary to determine the level of detail and complexity that is required.

Different levels of defect assessment, ranging from simple 'screening' methods (e.g. the ASME B31.G) to very sophisticated finite element stress analyses or probabilistic/risk methods are available. The methods used depend on the defects detected, or the type of pipeline, or the Operator requirements. Figure 8 summarises the differing levels of defect assessments, and the required data. Generally, fitness-for-purpose assessments are conducted up to Level 3. If defects still remained 'unacceptable' at this stage, a higher level assessment, or repair would be necessary.

The higher levels may require risk analyses. Risk is a function of the probability of failure and the consequences of failure. Such analyses are becoming increasingly popular [6], but are also very complicated. Similarly, limit state analyses, which also work out the probability of failure, are also becoming popular [13].

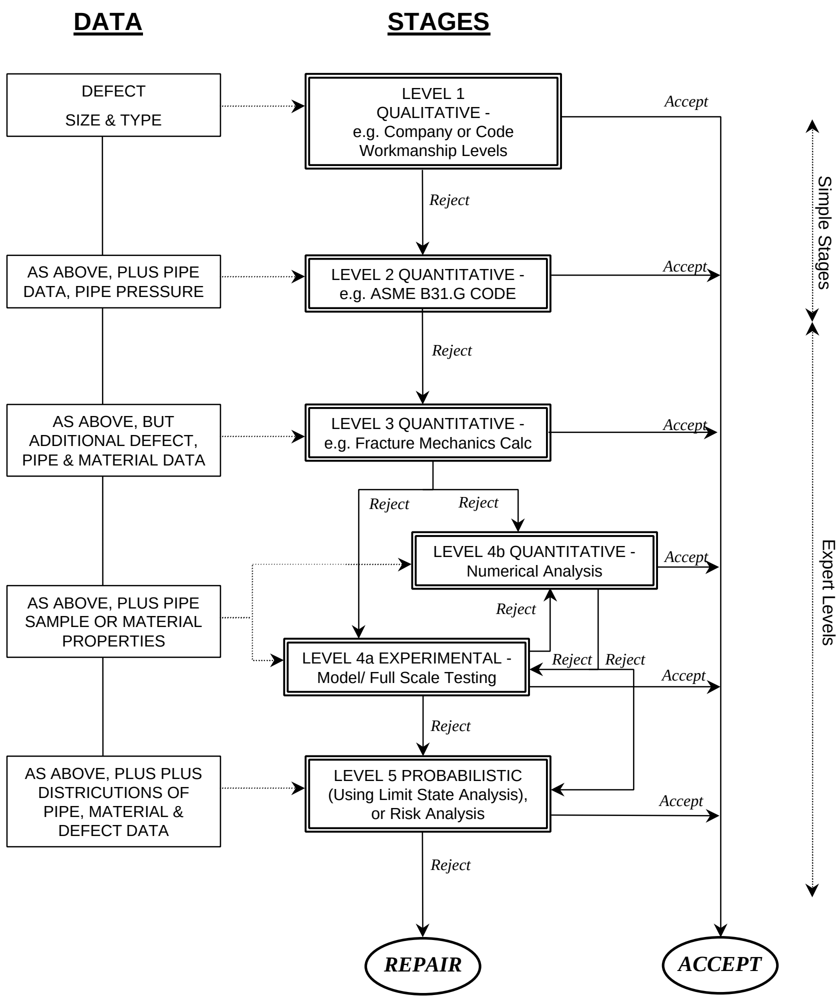


Figure 8. Differing Levels of Fitness-For-Purpose Assessments

If an Operator requires a risk analysis, then both probability and consequences of failure need to be considered in a probabilistic and detailed manner. Usually a fitness-for-purpose analysis of defects does not entail a risk analysis, although due account of the consequences of failure will be taken in a qualitative manner, and the recommended safety factor will reflect this. The fitness-for-purpose assessment will usually involve a deterministic assessment of the defects, on a go/no go basis. If there is a problem with the defects, or with defects with a significant consequence on failing, then a risk analysis may be recommended.

CONCLUSIONS

We now have methods and technologies to:

- assess risk of failure of ageing pipelines
- identify and apply appropriate inspection techniques
- set economic inspection intervals to prevent failures
- limit risks to an acceptable level
- quantify the present integrity
- predict the future integrity, with continued engineering effort

Operators can now safely extend the life of ageing pipelines by having a planned and structured approach to managing the integrity of these pipelines to ensure continued safe and efficient transportation for hydrocarbons.

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