A hierarchical guide to evaluating your Asset Integrity Management System against international practice

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There is no denying that the operation of assets such as pipelines and plant carries intrinsic risks, as evidenced by major incidents such as the pipeline failure in San Bruno in the USA and the explosion plus fire at Buncefield storage depot in the UK.

Nevertheless, the industry has a proven track record of reducing such incidents. EGIG reported a 5-fold decrease in incidents between 1970 and 2013 – down from 0.87 to 0.16 incidents per 1000km-years. Despite this, operators are being continually challenged to reduce incident levels further; indeed, the recently proposed U.S. pipeline legislation and guidance has the explicit goal of 'zero incidents'. Unfortunately for operators there is no magic bullet that will entirely eliminate risk and result in zero incidents.

Whilst continuing technological advances will undoubtedly lead to further reductions in incidents, analyses of major incidents almost always find missed opportunities where robust processes could have prevented or minimised the failure. Examples of best-practice asset integrity management principles abound in numerous publications, standards and recommended practices and have recently been comprehensively documented in ISO 55000 and API RP 1173 among others. However, these documents remain voluntary and still provide a lot of flexibility for interpretation and implementation.

The authors have been working closely with a number of international pipeline operators to assess and develop their asset integrity management schemes. That experience has been distilled and compiled into a hierarchy of guidelines to asset integrity management practices, intended as a self-assessment tool for operators. Details of these guidelines, which incorporate what the authors found to be effective industry practice in real world conditions, will be presented in this paper.

Keywords: Asset Management, Integrity Management, Systems, Safety, Engineering

Introduction

Ensuring public and worker safety is the primary responsibility for operators of plant and pipelines. Operational and technological improvements, as well as regulatory oversight, have led to a demonstrable improvement in safety in many sectors of the pipeline industry but significant challenges remain. Indeed the recently proposed rule change governing the United States pipeline industry has the explicit goal of zero incidents (PHMSA, 2016). This proposed rule change also represents a paradigm shift for the US pipeline industry with their regulatory environment changing from a prescriptive to a goal-orientated philosophy. Neither of these approaches is without problems for operators. The prescriptive regime tends to promote blind compliance and unnecessary expenditure where the minimum and maximum levels of integrity activity are identical; whereas the goal-orientated regime results in less certainty and greater variation in integrity management activities. Irrespective of the regulatory regime, the common element across the majority of jurisdictions is the existence of a formalised management system: be it a safety management process, integrity management system, written scheme of examination or other similar scheme. These schemes generally comprise both technical and management elements that together formalise and govern integrity processes and procedures and are rightly seen as essential tools for safe and effective asset management.

What should also be recognised are the limitations of these types of schemes, some of which are inherent to a particular scheme and some associated with interpretation and implementation of a scheme. Management systems often incorporate the quality management philosophy of ISO 9001 (ISO, 2015), the ontology of which was based upon practices across manufacturing industries, i.e. that a defined process carried out by a competent and trained individual would produce a consistent product. This approach is generally sound and well understood but explicitly reactive i.e. evolution and refinement often relies on trial and error, but in the pipeline industry any error can result in potentially catastrophic consequences, so the ISO 9001 approach is not entirely appropriate. Even assuming that the management systems are in good order, given their limitations they are unlikely to be successful in identifying and reducing low frequency / high consequence events which is one of the key strategic goals of the Health and Safety Executive (HSE, 2016) and a key goal for many other regulatory authorities around the world.

Auditing and helping to develop strategies for effective integrity management systems for the pipeline industry world-wide has demonstrated a wide variation in approach and maturity of existing systems. Whilst there are widespread examples of good practice, there are a number of common idiosyncrasies that seem to persist to some extent, irrespective of jurisdiction:

- Leadership and commitment – direct leadership for statutory compliance (safety) is often absent from corporate level thinking because it is seen as a purely technical function rather than a strategic function (responsibility is often discharged to the QHSE lead). This is most evident when you compare the strategic goals of the company to those of the integrity system.

- Top heavy – systems are written from a top-down perspective and represent idealised conditions which are rarely found in practice, so it is unsurprising that we find actual working practices are significantly different. This issue is particularly evident in those companies where there is a lack of training and information sharing.

- Failure to maintain the system – the asset management system contains outdated information and protocols as well as obsolete asset details and documentation that contains incorrect asset review dates. Conversely we find there is other information that has yet to be incorporated into the system, in particular an updating of the asset and risk register and data such as inspection results.
- Lack of feedback – incomplete or insufficient feedback mechanisms for processing information which results in useful information being neglected or ignored.

All of the above points can be categorised under the single term 'commitment', which should not be misconstrued as a criticism of any single person or entity, rather it expresses a need for the industry as a whole to reflect, consider and commit to further improvements to address ongoing challenges.

Organisational and human errors have been identified in a number of high profile catastrophic failures in the oil and gas industry, including the pipeline failure in San Bruno in the USA (NTSB, 2011) and the explosion plus fire at the Buncefield storage depot in the UK.

In both cases, there were missed opportunities to prevent failure had people acted upon available information. Maximising the chances of discovery and taking action to prevent such failures has been described as 'operational mindfulness' (Weick, et al, 2007) and has the following five key characteristics:

1. Pre-occupation with asset failure.
2. Care not to oversimplify issues.
3. Sensitivity to process operations.
4. Commitment to asset resilience.
5. Recognition of the role of experts.

These behaviours and characteristics are evident in high reliability organisations. However, they cannot simply be acquired by formal training thereby identifying the pathways to attain this status can be somewhat intangible. Nevertheless it is clear there are benefits to be gained by creating a culture where these behaviours and characteristics become the norm. This existing body of evidence, emanating from a wide range of industries and from observations by social scientists, should be considered in support of development and enhancement of management systems. Incorporating human factors based risk assessments is evidence that these concepts are entering mainstream asset management.

Whilst future technological developments will undoubtedly lead to further improvements in safety, it is the development of systems that generate an appropriate culture that will also be required to control asset risks and meet increasingly challenging regulatory requirements.

A Hierarchical Guide

Based upon observations and appraisals of management systems made whilst working with a range of international plant and pipeline operators1 a hierarchy of good asset management practices has been formulated. The hierarchy is intended to be a high level self-assessment comparison tool for operational management and senior management and examines behaviours, characteristics and processes rather than specific technical elements. The nature of the presented hierarchy is that implicitly it indicates evolutionary steps requiring completion of a number of facets before proceeding to the next level. Individual behaviours are ranked on a relative scale from 0 (lowest) to 5 (highest) where the lowest overall individual score should be considered the final result. The hierarchy levels displayed in Figure 1 are accompanied by descriptive terms.

[1] Operators of pipeline systems and associated facilities in Europe, North & South America, Asia and Australasia.

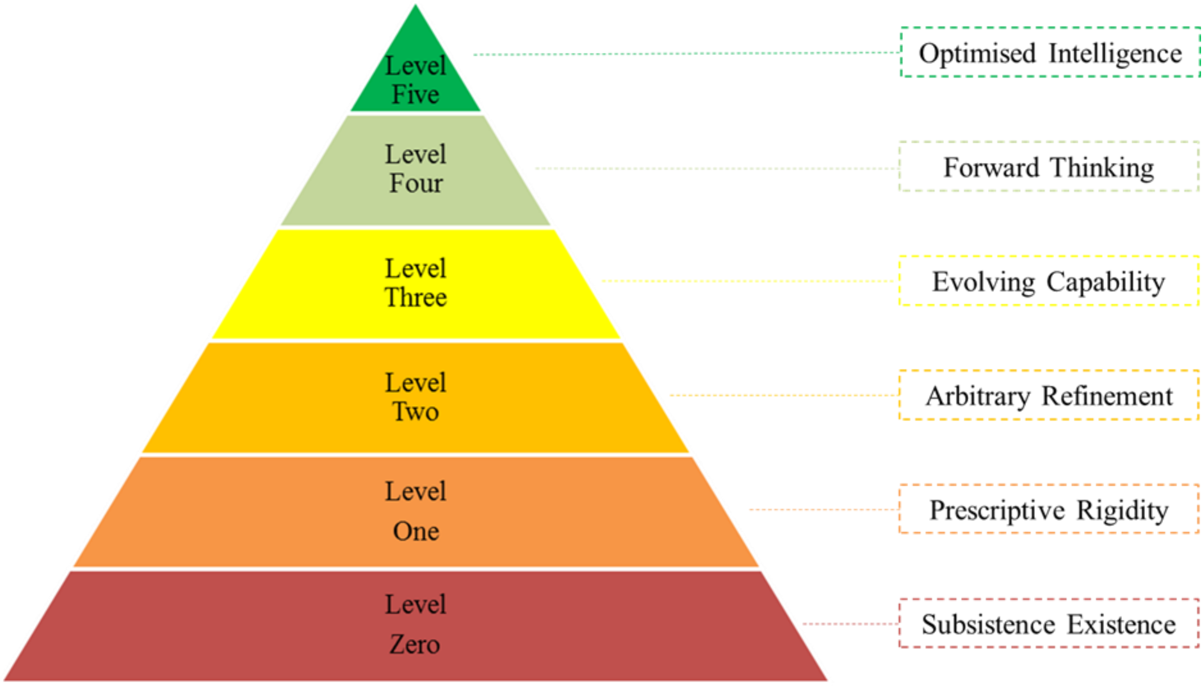

Figure 1: Asset Management Hierarchy

Level 0: Subsistence Existence

Operators at this level generally have little to no formal systems or maintenance philosophy. Any activity is usually reactive and viewed as incidental. Paradoxically, these operators have rarely experienced a significant failure and use this record to justify their current situation. However such incidents are by definition low frequency, therefore how can an operator be confident that a significant incident is not going to happen in the future.

Level 1: Prescriptive Rigidity

These operators have little to no formal systems but have formulated a basic plan for some preventative maintenance activities which are performed according to rigid time frames, so that the majority of activities remain reactive.

Level 2: Arbitrary Refinement

Operators in this category typically have a formal but rudimentary system either in its infancy or lacking any iteration elements. The majority of knowledge is inferred and held by a limited group of one or more individuals and not readily shared. Maintenance is based on established frequencies but with no real questioning of why these frequencies are implemented.

Level 3: Evolving Capability

Operators in this category have established systems including risk management capability that is applicable to a limited number of assets, although there remains a tendency to revert to the perceived safety of standardised guidance. They are active members of industry bodies and seek to develop the breadth of their knowledge, though such knowledge remains in the hands of a few technical specialists and is not widely disseminated in the company.

Level 4: Forward Thinking

Operators in this category have mature and effective systems and high levels of technical expertise across the business. Active and formal lines of communication exist within the company and up and down their supply chains. They are supported by external technical specialists with whom they have long-standing and trusted relationships. Data and information is well catalogued and the status of company assets well understood. Staff are active members of industrial bodies with some providing leadership or recognised as authorities in some areas.

Level 5: Optimized Intelligence

Operators in this category are usually exemplary and have highly dynamic systems with strong emphases on predictive and learning capacities. They will usually be regarded as technical authorities in most areas and be highly invested in industry bodies and committees on an international stage.

Assessment Categories

The eight assessment categories along with criteria and levels are listed in Table 1. The assessment is carried out by selecting the criteria in each category that most accurately describes the current situation. Where criteria are the same across levels, the maximum may be selected up to the minimum of other criteria.

Discussion

One of the most common issues with the systems we investigated was a disconnect between corporate and technical functions, especially when the technical function is not represented at corporate level. In this situation, there are often significant technical barriers to involvement and understanding of asset management by senior management. The above hierarchy and explicitly qualitative criteria in the accompanying table are intended as a self-assessment tool for operational management and senior management to facilitate a non-technical review and appraisal of the current asset management status. Operating at level 5 may not be necessary, desirable or reasonably practicable in many cases but for those companies looking to improve they can use the table to identify the types of activities necessary to make progress. It does not consider the quality, effectiveness or technical supremacy of any particular aspect but is more a general overview of systems and procedures that have been observed in a range of operating environments and jurisdictions and should be considered as a prompt for further review.

In many cases asset integrity systems have been the responsibility of, and remained within the jurisdiction of, senior technical staff. To increase the effectiveness of these systems, responsibility should be delegated throughout the organisation to tap into a broader range of skills and experience. One of the key characteristics of high performing systems is the level of feedback and dynamic improvement incorporated into them. This is facilitated by the involvement of front line staff, many of whom hold much of the real operational intelligence; they are the eyes and ears of the organisation and often have the best insight into the true operational status of company assets. It is incumbent upon senior management to ensure this information flows freely throughout the organisation by creating an appropriate culture. To quantify the effect of increased operational mindfulness is difficult but creating a climate of increased awareness whereby key interventions are readily identified is undoubtedly desirable for all operators.

Conclusions

Safety and asset management systems are recognised as essential tools to maintain safe and effective operation of pipeline systems and although there is a wide variation, the basic elements of these systems are common across the industry. There are also recognised challenges both in terms of regulatory compliance and managing asset risks. Meeting these challenges will require development of both existing systems and incorporation of new and innovative thinking. The hierarchical scheme described in this paper is a non-technical self-assessment tool for operational management and senior management to facilitate appraisal of key features of their current system and understand where they are in terms of recognised best practice. Increased understanding of the requirements of such systems and best practice is a key to bridging any disconnect between senior management and the levels of leadership and commitment recognised as prerequisites for successful implementation and development of an effective asset integrity management scheme.

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	Maintenance Philosophy	Asset Management	Risk Management	Corporate Governance	Regulatory Disposition	Data Management	Assurance Pathways	Knowledge Management
Level 5	All possible inspection, monitoring and maintenance activities undertaken using risk based methodologies. Continuous feedback, review and optimisation loops	Live asset management and safety management systems. Widespread understanding and support from all staff. Continuous feedback, review and optimisation loops	Corporate/Enterprise risk based policies and procedures, routine use of risk assessment and risk based methodologies by all staff	Strong corporate governance and relationships between corporate and technical functions. Regular and effective communication between all functions	Collaborative external regulation	Dedicated software systems, digital data management and document control. Dedicated resources and support structures for training and security. Agreed data structures in supply chain and online monitoring	Robust quality assurance and escalation procedures for both internal and external resources. Clear communication pathways and action monitoring	Continuous knowledge sharing up and down the supply chain, regional and international bodies from multiple industries
Level 4	Combination of risk based and time based inspection, monitoring and maintenance activities. Frequent review of key performance indicators	Comprehensive asset management system, regular time based review by senior technical staff	Corporate/Enterprise risk based policies and procedures, routine use of risk assessment and risk based methodologies by specialist staff	Strong corporate governance and relationships between corporate and technical functions. Regular and effective communication between all functions	Collaborative external regulation	Dedicated software systems, digital data management and document control. Dedicated resources and support structures for training and security	Robust quality assurance and escalation procedures for both internal and external resources. Clear communication pathways and action monitoring	Continuous knowledge sharing up and down the supply chain and with regional and international bodies
Level 3	Some use of risk based methodologies but tendency to revert to codes and standards for the majority of activities	Rudimentary asset management system, infrequently reviewed with knowledge retained by senior technical staff only	Established major asset risk assessment routines performed by specialist staff	Little corporate governance but good relationships between corporate and technical functions. Infrequent communication e.g. annual report	Adversarial external regulation	Dedicated software systems and digital data management	Robust quality assurance and escalation procedures for internal resources. Clear communication pathways and action monitoring for critical activities	Frequent knowledge sharing and contact with regional industry bodies
Level 2	Prescriptive time based maintenance, adherence to internationally recognised standards and codes	Rudimentary asset management system, infrequently reviewed with knowledge retained by senior technical staff only	Task based risk assessment only	Little corporate governance, majority of responsibilities discharged to technical functions	Adversarial external regulation	Some digitisation but remnant gaps in historical data, No dedicated resources	Robust quality assurance and escalation procedures for internal resources. Clear communication pathways and action monitoring for critical activities	Occasional contact with external bodies
Level 1	Prescriptive time based maintenance, adherence to local standards and codes	No systematic approach to asset management	Task based risk assessment only	Little corporate governance, majority of responsibilities discharged to technical functions	Adversarial external regulation	Little to no digitisation, significant gaps in historical data	Limited quality assurance generally due to resource constraints	Infrequent contact with external bodies. Incidental knowledge sharing
Level 0	Reactive based maintenance	No systematic approach to asset management	No risk assessment capability	Little or no corporate governance	Little or no external regulation	Little to no digitisation, significant gaps in historical data	Little to no quality assurance generally due to resource constraints	No knowledge sharing

Table 1: Assessment Categories, Criteria and Levels