Managing the risk of catastrophic failure
Developing a risk-informed investment strategy for critical assets
Two billion dollars. That could be the shareholders’ cost for a critical asset failure. Of course, that amount may only cover restitution and rebuilding. The cost to a company’s reputation is often incalculable. Certainly that’s what one large, diversified utility company is learning following an explosion that destroyed lives, homes and reputations.

Two billion dollars. That’s the number planners, regulators, lawyers, engineers and consultants will use in their spreadsheets to analyze power and utilities risk – to determine risk profiles and risk tolerance following recent high-profile asset failures.

Aging assets present an increasing risk of failure. Failure of these assets in densely populated areas exposes the operator to greater consequences. The recent high-profile pipeline failures were all associated with older assets in high-consequence areas. These are not the only aging critical assets in the US. The full financial impact of the next catastrophe-in-waiting cannot be ignored.

Critical asset risk and investment planning (CARIP) can help utilities do a better job of managing the risks that impact safety and financial integrity. It can also help to lower operational and maintenance costs, while improving reliability.

Most importantly, CARIP may be able to help utilities make a compelling regulatory case that can accelerate the replacement of high-risk assets or otherwise mitigate the risk. It can allow utilities to calculate the relative likelihood and quantify the consequence of failure for assets that are too critical to fail and too unique to be left to traditional compliance measures and recovery trade-offs.
Critical asset risk and investment planning – key concepts

- Continuing costs of regulatory compliance
- Relative likelihood of failure
- Consequence of failure
- Risk-weighted failure exposure
- Total asset exposure
- Improved regulatory strategy
- Reduced shareholder risk impacts of critical asset failures

2 billion

Total asset exposure
Managing the risk of catastrophic failure
Introduction

Making the shift from compliance to risk management

Historically, utilities have designed, built and maintained regulated assets to a precise level of recoverable compliance costs. Regulators have traditionally authorized recovery based on the practical cost to achieve and maintain compliance. Only now has the true consequence of failure been quantifiable.
As a result, asset management has generally been guided by compliance. It’s a relationship that is both logical and effective, as long as compliance regulations achieve an acceptable level of risk and an associated recovery that allows a profitable return.

It is not unusual for certain core assets deployed 40, 50, even 60 or more years ago, to remain in service well past what may have been their originally intended service lives.

Most utilities have been in operation for a century or more and much of their infrastructure has been continually updated over time. Some utility assets are designed to last for decades. It is not unusual for certain core assets deployed 40, 50, even 60 or more years ago, to remain in service well past what may have been their originally intended service lives.

Why? Because the high cost of replacing infrastructure is competing for limited funding with other priorities that increase ratepayer bills. And these costs are only now being viewed in the context of the consequences of failure associated with a catastrophic event.

More oversight, but incidents still occur

Large high-pressure natural gas transmission and distribution pipelines exemplify aging assets increasingly facing the potential for failure. Although a certain level of regulation guided the construction and operation of older assets, the safety of natural gas distribution systems has improved significantly since the enactment of the Natural Gas Pipeline Safety Act of 1968. This Act provided the Department of Transportation (DOT) with the authority to establish safety standards for natural gas systems. And yet, despite the increased oversight, a number of serious incidents in natural gas distribution systems still occur each year. Often, failures of older high-risk pipelines are to blame.

Today, the Pipeline and Hazardous Materials Safety Administration (PHMSA) regulates the safety of US pipelines. PHMSA sets the minimum requirements for intrastate pipeline compliance and has essentially delegated pipeline safety inspections to individual state representatives. These state representatives inspect nearly 90% of the nation’s 2.3 million miles of pipeline. PHMSA can provide direction and guidance. However, it does not have the authority to determine the routing, rates or other terms and conditions of service for gas pipelines. Although the Federal Energy Regulatory Commission makes these determinations for interstate gas pipelines, state public utility commissions typically do the same for intrastate gas pipelines. As a result, intrastate pipeline safety guidelines are set at the federal level, but compliance is inspected and funded at the state level.

Beware the speed of degradation

Regardless of how they are regulated, pipelines degrade over time. The degradation speed depends on many factors, including:

- The manufacturing process
- The installation process
- The operational process
- The surrounding environment and external interaction by third parties

Older pipe can be grandfathered or otherwise maintained in compliance. However, these aging yet compliant assets may have an increased likelihood of failure relative to more modern assets.

For that reason and because of a number of recent catastrophic transmission and distribution gas pipeline failures — failures that include significant loss of life, property damage and fines — the focus on risk associated with these critical assets is acute and will only intensify, as has the pressure to replace the assets or otherwise mitigate the risk.

Until natural gas pipeline owners and operators make their own case before their respective commissions, they will continue to bear the financial and operational risks associated with potential failure.

Prioritizing critical infrastructure investments

PHMSA is encouraging federal and state regulators to make these critical infrastructure investments a priority. But it does not have the authority to order recovery for these necessary rehabilitations, repairs or replacements of high-risk gas pipelines.

As a result, until natural gas pipeline owners and operators make their own case before their respective commissions, they will continue to bear the financial and operational risks associated with potential failure.
Not fit for service

The following high-risk pipeline infrastructure could be characterized as no longer fit for service. According to PHMSA, state utility commissions should consider accelerating improvements to these assets.

- **Cast iron gas mains.** The use of these pipes dates back as early as the 1830s and remained prevalent until just after World War II. Cast iron mains can be prone to failure from graphitization or brittleness.

- **Plastic pipe manufactured in the 1960s to the early 1980s.** In April 1998, the National Transportation Safety Board (NTSB) released a Special Investigation Report on brittle-like cracking in plastic pipe for gas service. The NTSB found that the long-term strength and resistance of plastic pipe to brittle-like cracking may have been overrated for much of the plastic pipe manufactured and installed from the 1960s through the early 1980s.

- **Mechanical couplings used for joining and pressure sealing pipe.** These devices are prone to failure under certain conditions. In March 2008, PHMSA issued an Advisory Bulletin (ADB) on the use of mechanical couplings in natural gas distribution systems. The ADB noted that these devices are more likely to fail when there is inadequate restraint for the potential stresses on the two pipes, when the couplings are incorrectly installed or supported or when components experience age-related deterioration.

- **Bare steel pipe without adequate corrosion control and copper piping.** Steel piping without cathodic protection or coating to control corrosion and copper piping are both susceptible to an increased risk of failure.

- **Older pipe.** The age of a pipe should be considered in determining whether pipeline infrastructure is vulnerable to failure from time-dependent forces, such as corrosion, stress corrosion cracking, settlement or cyclic fatigue.

- **Pipelines with inadequate construction records or assessment results to verify their integrity.** In January 2011, PHMSA issued an ADB on the need to use traceable, verifiable and complete records in establishing the maximum allowable operating pressures and developing and implementing integrity management programs for natural gas pipelines.
Managing the risk of catastrophic failure
Proactively managing critical asset risk

CARIP shifts the regulated utility’s critical asset investment and recovery strategy from one primarily driven by compliance mandates to one that also includes a quantified risk of failure assessment for certain compliant but high-risk mission critical assets. It helps to identify the assets and develop a fully informed and comprehensive understanding of the relative likelihood and consequence of failure, a prioritized list of mitigation options and a risk ranking for all high-risk assets. This approach exposes the risk, informs overall risk tolerance and creates a compelling case for recovery. It also reduces shareholder risk by simply exposing all stakeholders to the likelihood and consequence of failure as part of a risk-informed request for mitigation support.
A three-step, jurisdictionally focused approach

CARIP prioritizes asset investments based on a careful evaluation of the likelihood and consequence of failure, building on a traditional ASME relativistic assessment without the complex data requirements found in a full probabilistic model. CARIP uses a three-step, jurisdictionally focused approach to implementation.

**Step one: assess jurisdictional risk exposure**

Step one of this approach begins by dividing pipeline assets into three asset investment categories (compliance risk, high-consequence risk, catastrophic risk) and conducting an assessment of these assets to confirm compliance, exposure and jurisdictional mitigation priorities.

Hybrid approach: CARIP adds sophistication and analytics to typical relative assessment models while avoiding the complications and cost of a probabilistic assessment.

**Step two: prioritize and optimize the investment plan**

Once all jurisdictions or business units have completed their individual assessment, their input helps shape a corporate-level view of the overall exposure that informs the corporate risk profile. This information, when combined with all other risk components, creates a structure against which a utility can consider all risk-informed investments and weigh risk mitigation scenarios to compare the risk impact of alternative mitigations.

The utility will then use these scenarios to develop internal, cross-jurisdictional consensus that incorporates the local reality of what can be achieved with the mitigation alternatives. From this information, the utility will create a final risk-ranking list that harmonizes all jurisdictional requests for investment funding with a clear view of the risk mitigation resulting from those investments.

**Step three: create risk and regulatory alignment**

In step three, a utility will share information developed from the first two steps with all external stakeholders to inform and gain support for the required investment plan. The objective is to clearly articulate the corporate risk tolerance and current risk profile and explain how each risk mitigation investment changes the profile and at what cost in order to build consensus with the regulators for the needed investments. The key output of this process is exposing the regulators to the relative likelihood and consequence of failure by demonstrating a compelling case for investment built on a sophisticated and professional analysis.

Ongoing analysis and reporting during this step is critical. If the process occurs during a rate case or other specialized regulatory process, the tools for reporting the findings of the analysis and the alternative scenarios to all stakeholders must be extremely robust to address what will likely be the creation of alternative mitigation scenarios. This will be especially true if more than one jurisdiction is suggesting the scenarios in question, as any change in risk rankings and mitigation activities will affect the overall corporate risk profile. The settlement process will need to include specific line item approvals, not black box funding, to track a variety of assets in the filing, discovery, settlement and post-settlement process.

Utilities benefit from increased asset investing and reduction in risk. Ratepayers recognize an improved level of safety and reliability. This balance is achieved by exposing the true nature of the risk to the investment decision-maker, and in the process, allowing the risk to reside with the investment decision, where it rightly belongs.

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1This approach targets multi-jurisdictional or multi-business unit utilities that need to harmonize individual inputs at the corporate level before developing a risk-ranked asset investment priority list. If this is not the case, step two is not required.
Overview of CARIP implementation

1. Assess jurisdictional risk exposure
   - Shift from a compliance perspective to a CARIP perspective by assessing risk (failure likelihoods and consequences) across asset areas
   - Assess exposure under business-as-usual versus mitigation alternatives
   - Prepare risk profile and asset segment prioritization by jurisdiction

2. Prioritize and normalize investment plan
   - Develop corporate-level view of exposure given different mitigation scenarios
   - Prioritize replacement/maintenance/control investments
   - Adjust proposed investments based on judgment of regional regulatory climates
   - Socialize plans and achieve consensus on optimized risk approach

3. Create risk and regulatory alignment
   - Update stakeholder reporting process to highlight risk exposure to regulators
   - Develop or acquire tools, templates and systems to meet reporting program
   - Update settlement process to include risk filter

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Conclusion

Accelerating critical asset replacement and managing the risk

It’s an unavoidable fact that all things age. But when a utility infrastructure ages it assumes an increasing level of failure risk. Critical assets in high-consequence areas that have not been subjected to a dedicated risk assessment are exposing shareholders to disproportionate levels of risk.
The current compliance management approach to asset investment fails to account for this increasing level of risk. Recent critical asset failures have exposed the potential cost of this risk – a cost that in some cases can be catastrophic for shareholders. Shareholders of the utility involved in one recent pipeline explosion, for example, are bracing themselves for a loss of 15 to 20 years of earnings.

It’s time for utilities to make the shift from compliance to a more proactive risk management approach.

Used correctly, CARIP can help utilities to effectively manage the risk of critical asset failure. It can also produce a compelling regulatory case that can accelerate the replacement of high-risk assets – or make a constructive case for a more equitable approach to risk and consequence-sharing between shareholders and ratepayers.

**Comparison between traditional compliance management and CARIP approaches**
CARIP in action

Here are some examples of industries that already use a methodology similar to CARIP to proactively manage their risk and improve their performance.

Commercial airlines
Airlines and other commercial operators of large or turbine-powered aircraft follow a continuous inspection program approved by the Federal Aviation Administration (FAA) in the US to mitigate the potential for catastrophic failure. Operating within these guidelines, an airline company could maintain aging airframes indefinitely.

But they do not.
Most commercial airlines replace airframes every 20 years, even though a new commercial airframe costs between $59.4 million (737-600) and $332.9 million (747-8). Airline companies also know the cost of a catastrophic failure. In 2001, an aircraft crashed in a highly populated US neighborhood, killing more than 250 people. The financial compensation cost to that airline and its insurers reached $600 million.

Airline companies replace compliant airframes because they calculate the increasing risk and quantify the cost of mitigation and catastrophic failure. With that information, they compare the risk of failure to their corporate risk tolerance and they replace aging, but compliant, assets to balance their risk.

Nuclear power operators
The nuclear power industry has incorporated probabilistic analysis into licensing, maintenance and safety processes for decades. These processes, referred to as risk-informed asset management (RIAM), have matured into an approach nuclear power operators use to manage the unique risk associated with nuclear power plants.

RIAM is a plant-level analysis and decision-making process that analyzes the sensitivity of a plant’s economic risk to the reliability of structures, systems and components. Nuclear power operators use RIAM to evaluate and prioritize alternative investment scenarios by modeling their effect on reliability, as well as what impact changes in reliability have on economic risk.

RIAM uses statistical methods to evaluate performance and probabilistic models to incorporate uncertainty. The primary sources or risk nuclear operators consider include:

- Plant capital and operations and maintenance costs
- Lost revenue
- Exposure of the public and employees to hazards
- Fines and penalties
- Liability lawsuits

RIAM incorporates a framework for systematic analysis of a company’s management system, allowing nuclear operators to identify and manage risks as part of the overall portfolio. This portfolio approach to risk assessment and investment decisions enables nuclear power operators to assess and demonstrate the proper mix of risk mitigation and risk sharing through a formal process of probabilistic and financial analyses.