Review of OPR Pipeline Integrity Topic Paper

Executive Summary

The Canadian Energy Regulator's (CER) "OPR – Pipeline Integrity" topic paper proposes several amendments to strengthen pipeline integrity regulation. This evaluation assesses those proposals while referring to industry best practices (API Recommended Practice 1173 on Pipeline Safety Management Systems) and the author's lessons learned from major pipeline incidents investigated by the U.S. NTSB and PHMSA.

Overall, the OPR proposals address key integrity issues—including expanding regulatory scope to new commodities, mandating risk and geohazard assessments, improving material traceability, and enhancing safety controls—that are consistent with known safety gaps. Major pipeline failures such as the 2010 San Bruno gas explosion and Enbridge's 2010 Marshall oil spill illustrate how deficiencies in risk management, material records, and safety culture can lead to catastrophe.

The OPR proposals generally align with API RP 1173 principles by introducing more rigorous requirements for risk assessment, quality assurance, and design controls. However, certain gaps are noted—notably the need for stronger emphasis on management leadership and safety culture, and ensuring continuous improvement of integrity programs over a pipeline's lifecycle.

Key recommendations include formally adopting pipeline safety management systems (per API RP 1173), requiring ongoing geohazard management and risk reviews, enhancing material traceability requirements, mandating periodic integrity program evaluations, establishing leadership accountability mechanisms, and improving stakeholder communication. These measures will bolster the regulatory framework's effectiveness in improving pipeline integrity and safety performance.

1. Introduction

Pipeline integrity failures can have catastrophic consequences for public safety, environmental protection, and energy security. Recognizing this, the Canadian Energy Regulator has proposed amendments to the Onshore Pipeline Regulations (OPR) to strengthen pipeline integrity management. This review evaluates these proposals against established best practices and lessons from past failures to identify strengths, gaps, and opportunities for enhancement.

Major pipeline incidents such as the 2010 San Bruno explosion (which killed eight people and destroyed 38 homes) and the 2010 Marshall, Michigan oil spill (which released over 20,000 barrels of crude into the Kalamazoo River) have driven regulatory improvements in the United States. The American Petroleum Institute's Recommended Practice 1173 (Pipeline Safety Management Systems) emerged as an industry response to these events, providing a

comprehensive framework for pipeline safety. Meanwhile, regulatory bodies like PHMSA have implemented increasingly detailed requirements for integrity management.

This review examines the CER's proposed amendments through the lens of these developments, with particular attention to how they address known failure mechanisms and incorporate proven safety practices.

2. Evaluation of Proposed Amendments

2.1 Scope Expansion to New Commodities

Proposal Summary: The CER proposes to expand the definition of "onshore pipeline" to include hydrogen and carbon dioxide (CO_2) pipelines, ensuring they meet the same integrity and safety standards as hydrocarbon pipelines.

Analysis: This scope expansion demonstrates a forward-looking risk management approach. Hydrogen and CO_2 present unique integrity challenges: hydrogen can cause embrittlement of steel, and CO_2 (especially in dense phase) poses dispersion and corrosion risks. By bringing these pipelines under OPR integrity requirements, the CER is proactively closing a regulatory gap that could otherwise lead to safety risks.

This aligns with API RP 1173's principle of identifying and addressing all potential hazards in pipeline operations. Recent incidents with CO_2 pipelines, such as the 2020 Satartia, Mississippi rupture that sickened dozens, demonstrate the need for robust regulation of these emerging commodities.[Denbury Gulf Coast Pipelines' 24-inch Delhi Pipeline ruptured, releasing liquid CO_2 that immediately began to vaporize in atmospheric conditions. The rupture site was located on the northeast side of Highway 433, approximately one-mile southeast of Satartia. Denbury subsequently reported the rupture released an estimated total of 31,405 barrels of CO_2. According to news reports, when the carbon dioxide moved through the rural community, more than 200 people evacuated and at least 45 people were hospitalized. Cars stopped working, hobbling emergency response. People lay on the ground, shaking and unable to breathe.]

Assessment: The proposed expansion is well-justified and represents regulatory leadership in safety—a core aspect of API RP 1173's emphasis on leadership commitment. Additional guidance or standards may be needed to address the unique properties of these commodities.

2.2 Use of New Technologies Lacking Standards

Proposal Summary: The CER suggests requiring companies to: (1) notify the CER when planning to use technology not covered by existing standards and that has not been independently reviewed, and (2) have a documented process for evaluating novel technology for safety before implementation.

Analysis: This proposal strongly aligns with API RP 1173's management of change (MOC) process, which requires pipeline operators to evaluate changes—including new tools, materials, or processes—for potential risks before adoption. The notification requirement provides an extra

layer of oversight and knowledge-sharing, allowing the CER to review novel applications and potentially develop guidance or share lessons learned across industry.

Many advances in pipeline integrity—such as new inline inspection tools, composite repair materials, or advanced leak detection systems—hold promise for safety but need proper vetting to prevent introducing new failure modes. The NTSB has emphasized that robust safety management includes evaluating new technology and incorporating learnings.

Assessment: The proposed risk-based notification and evaluation process is a positive step that mirrors API RP 1173's call to make risk reduction and continuous improvement routine in all facets of pipeline operations. One gap is that the OPR text doesn't explicitly require learning from the outcomes of new technology deployments. A best practice would be to feed back performance data from these implementations into the operator's safety management system.

2.3 Pipeline Design: Risk Assessments and Geohazard Evaluation

Proposal Summary: The CER plans to strengthen requirements for pipeline design by explicitly requiring supporting risk assessments and geohazard assessments as part of design processes. It also considers requiring companies to notify the CER when using trenchless installation techniques under water bodies or large crossings.

Analysis: Mandating risk and geohazard assessments at the design stage is highly consistent with modern integrity management principles. Pipeline failures have repeatedly demonstrated that geological and environmental hazards are a major threat to integrity if not accounted for. PHMSA has issued multiple advisories highlighting incidents where earth movement caused pipeline ruptures, including a 2018 gas transmission pipeline rupture in West Virginia and a 2016 crude oil pipeline break in North Dakota. These cases underscore the vulnerability of pipelines to natural forces like land subsidence and landslides, especially in regions with challenging terrain. They also highlight the need for improved monitoring systems and stricter safety measures to prevent similar accidents.

The CER's proposal directly targets this gap: by requiring geohazard assessments, operators will need to identify slope stability issues, flood hazards, seismic faults, permafrost, or other conditions during design and take preventive measures. This reflects API RP 1173's risk management element, which calls for systematic hazard identification and risk analysis throughout the pipeline lifecycle.

Assessment: The design-related proposals exhibit strong alignment with API RP 1173's risk management and operational control principles. One gap is that while design-stage assessments are critical, geohazard risks are not static. Climate change is altering rainfall patterns, erosion rates, and permafrost stability, meaning new geohazards can emerge after construction. The OPR amendment could be strengthened by explicitly linking to lifecycle risk management, ensuring that geohazard assessments are periodically updated.

2.4 Enhanced Safety Requirements for Storage Facilities

Proposal Summary: The CER proposes requiring that storage facilities: (1) have an alternate power source for emergency shutdown systems and emergency lighting, (2) be designed with secondary containment capable of confining ignited spills, (3) have fire detection and protection systems, and (4) maintain the capability to extinguish a fire.

Analysis: These proposals address a logical extension of integrity management to associated infrastructure. Incidents at storage terminals can be devastating—a tank fire or explosion can result in multi-tank domino effects and community impacts. The proposed measures draw from well-known engineering safeguards: backup power ensures critical valves and pumps can operate during emergencies; secondary containment limits pool fires; and fire detection and suppression systems are critical for early control.

These measures resonate with API RP 1173's operational control and emergency preparedness elements. They demonstrate a commitment to protecting the public and environment by layering safeguards (redundant power, containment, detection, suppression).

Assessment: The storage facility safety proposals are consistent with industry best practices and API RP 1173's calls for operational preparedness. One gap to consider is how these requirements will be verified—e.g., will companies need to periodically test backup generators or fire systems? Another consideration is human factors and training: having equipment is one aspect, but proper training is needed so that personnel can effectively utilize these systems in an emergency.

2.5 Material Traceability and Quality Assurance Improvements

Proposal Summary: The CER proposes to enhance material traceability and quality assurance for pipelines through multiple new requirements: (1) all materials must be traceable over the pipeline's life, (2) companies must notify the CER if materials that don't meet standards are discovered, (3) steel pipe and components must have proven notch toughness properties, and (4) quality assurance information must be retained for at least two years after pipeline abandonment.

Analysis: These proposals directly tackle issues of material quality and recordkeeping that have been implicated in past pipeline failures. The importance of traceable, verifiable, and complete records was starkly illustrated by the 2010 PG&E San Bruno gas pipeline explosion, where a pipeline segment with an unknown manufacturing weld flaw ruptured due to misidentified pipe records.

Requiring traceability ensures that operators know the grade, manufacturing origin, and test history of every pipe joint and component—which is critical for risk assessments and determining safe operating pressures. Notification about non-conforming materials creates a formal mechanism for regulators to be alerted to potential problems. The notch toughness requirement aims to prevent brittle fracture, a factor in some historical failures.

Assessment: The material traceability and QA enhancements correspond closely with "Operational Controls" and "Risk Management" elements of API RP 1173. One gap in the proposal is the retention period—ensuring key records are kept for the pipeline's life (and

beyond) is crucial. Another gap is how to handle legacy pipelines: Will the traceability requirement apply only to new materials going forward, or will companies be expected to retroactively establish traceability for existing pipelines?

2.6 Operating Pressure Definition Clarifications

Proposal Summary: The CER proposes to add clear definitions for "Approved Maximum Operating Pressure (MOP)," "Qualified MOP," and "Amended MOP." The impact of these definitions is that if a company wants to increase the MOP, it must apply to the CER, and if it voluntarily lowers MOP for safety reasons, that becomes an Amended MOP and any future increase would require regulatory review.

Analysis: These clarifications have important integrity implications. They enforce regulatory control and thorough review over any elevation of operating pressure. This is a direct response to historical issues where pipelines might have been allowed to operate at high pressures without sufficient verification of their integrity, as occurred with the San Bruno pipeline that was operating at a pressure that had been grandfathered in without a pressure test.

From an API RP 1173 perspective, this ties into risk management and operational control of pressure. By formalizing these definitions, CER is strengthening the operational control around pressure management. It also touches on leadership and management commitment: companies will need management oversight to ensure compliance with these definitions.

Assessment: The definitions of operating pressures and associated rules align with the principle of strict operational control over critical parameters. A potential gap is that integrity management is not explicitly mentioned in how a company would justify an MOP increase. One would expect that to raise a pipeline's MOP, an operator should conduct a comprehensive integrity assessment to demonstrate the pipeline can handle it.

3. Alignment with API RP 1173 Core Principles

3.1 Leadership Commitment

API RP 1173 places leadership and management commitment at the forefront of pipeline safety management. It calls for executives and senior management to actively promote a culture of safety, provide resources, and ensure accountability for safety performance.

The OPR Integrity paper's proposals implicitly demand strong leadership to implement. For instance, establishing enterprise-wide material traceability or conducting thorough risk assessments for geohazards will require management commitment of time, budget, and policy enforcement. However, the OPR document itself does not explicitly mention leadership or safety culture initiatives in these amendments.

This could be viewed as a gap—the paper focuses on technical program improvements but not on how companies' leadership should drive these changes. NTSB investigations have repeatedly found that lack of management oversight and safety culture contributed to accidents. The NTSB

has advocated for pipeline operators to adopt safety management systems with management commitment at the core, warning that "without full commitment from the pipeline industry to implement and mature PSMS, pipeline accidents will continue to occur."

3.2 Risk Management

Risk management is a thread running through nearly all the proposed amendments. API RP 1173 requires a systematic risk management process—identifying hazards, assessing risks, and mitigating them—in a continual cycle. The OPR paper clearly aligns with this by introducing explicit risk assessments in pipeline design, considering geotechnical and future risks, and addressing specific known risks.

One observation is that API RP 1173 encourages operators to continually evaluate risk (not a one-time activity). The OPR proposals mostly introduce one-time or condition-based requirements. To fully align with API RP 1173, the regulatory framework should ensure that risk assessments are living processes, updated regularly and whenever operating conditions change.

The Merrimack Valley disaster in 2018 showcased how failure to update risk assessments during a pipeline modification project led to catastrophe; a robust PSMS would have caught the risk of over-pressurization during construction planning.

3.3 Operational Controls

API RP 1173 emphasizes having effective operational controls—the procedures, equipment, and practices to ensure the pipeline operates within safe limits. The OPR amendments significantly enhance operational controls. For example, clarifying MOP definitions is an operational control on pressure management; requiring backup power and fire protection at storage facilities is an operational control for emergency conditions; mandating adherence to material standards and traceability is an operational control in procurement and construction.

Alignment is strong here—each proposal can be mapped to a control mechanism. The OPR proposals provide the "what" of operational controls, while API RP 1173 provides the overarching "how" to effectively implement and manage those controls within a structured safety management system.

3.4 Continuous Improvement

A cornerstone of API RP 1173 is the concept of continuous improvement—the idea that a pipeline operator's safety system should be constantly learning, adapting, and improving based on performance data, audits, and emerging risks. The OPR topic paper itself is a product of continuous improvement from the regulator's side ("Based on learnings from implementing the OPR..." appears in several subtopics).

There is room to more explicitly require continuous improvement processes in the regulation. For example, the CER could require companies to conduct periodic management reviews of their

integrity management program effectiveness (which API RP 1173 Section 11 calls for). This would ensure that, over time, if weaknesses are found, they update their processes.

The NTSB strongly advocates for adopting PSMS precisely because it institutionalizes continuous improvement. As they note, one hallmark of a good PSMS is that it "continuously evolves and improves safety programs" rather than remaining static.

4. Recommendations for Enhancement

Based on this evaluation, the following recommendations are offered to enhance the regulatory framework's effectiveness in improving pipeline integrity and safety:

4.1 Formally Adopt Pipeline Safety Management Systems Framework

The CER should encourage or require regulated companies to implement a Pipeline Safety Management System (PSMS) consistent with API RP 1173, to provide an overarching structure for the proposed integrity measures. The NTSB has explicitly urged regulators to promote the benefits of PSMS and have operators implement systems based on API RP 1173, which was developed in response to the significant pipeline incident in 2010 in Marshall, Michigan, where hundreds of thousands of gallons of oil spilled into surrounding lands and rivers. [The National Transportation Safety Board (NTSB) investigated this incident and concluded that inadequate pipeline safety was the root cause. Following this investigation, the NTSB issued Safety Recommendation P-12-17, advising API to “facilitate the development of a safety management system standard specific to the pipeline industry.” In response to the NTSB recommendation, API formed a multi-stakeholder work group, including representatives from the Pipeline and Hazardous Materials Safety Administration (PHMSA), to develop a PSMS recommended practice. This collaborative effort culminated in the issuance of API RP 1173 on July 8, 2015.]

Embracing PSMS will ensure that leadership commitment, risk management, operational controls, and continuous improvement—the core principles of API RP 1173—are integrated into every aspect of a company's pipeline operations. Regulatory encouragement of PSMS could take the form of guidance notes, audit protocols referencing API RP 1173 elements, or incorporation of PSMS requirements into the OPR.

As evidence, the NTSB found that accidents (Marshall, San Bruno, etc.) could have been prevented or mitigated by a functioning PSMS; thus, implementing PSMS industry-wide is a proactive step toward zero incidents.

4.2 Strengthen Leadership Accountability and Safety Culture Oversight

To address the gap in explicit leadership focus, the CER should introduce mechanisms to hold company leadership accountable for pipeline integrity outcomes. For example, the regulator could require an annual Management Accountability Statement where an accountable senior executive certifies the effectiveness of the company's integrity management program and compliance with OPR requirements.

The CER could further perform safety culture assessments during audits to ensure that the tone from the top supports the new integrity measures. Given that "without full commitment...accidents will continue to occur," reinforcing leadership responsibility is essential. An actionable step is to develop a CER guidance or expectation that companies conduct periodic safety culture surveys and share results/improvement actions with the regulator.

4.3 Mandate Comprehensive Geohazard Management Programs

Expanding on the design-phase geohazard assessment, the CER should require operators to implement an ongoing Geohazard Management Program for pipelines in areas prone to land movement, flooding, or seismic activity. This program should include periodic re-assessments of geotechnical risks, monitoring of ground conditions, and prompt mitigation actions when new hazards are identified.

PHMSA's advisory bulletin on geological hazards provides a list of actions operators should consider—for example, patrols during heavy rain, slope-stability monitoring devices, and drainage improvements on unstable slopes. Incorporating these as regulatory expectations would ensure that geohazard assessment is not a one-time event but a continuous process.

Actionable items for operators would include mapping all pipeline segments with geohazard susceptibility, establishing thresholds for intervention (e.g., if slope movement exceeds X, reduce pressure), and integrating geohazard status into their risk assessment updates. The expected outcome would be early identification and remediation of geotechnical threats before they lead to pipeline failures.

4.4 Enhance Material Traceability and Verification Requirements

While the proposed material traceability rules are excellent, several enhancements would maximize their effectiveness. First, require that traceability records be maintained for the life of the pipeline (and not destroyed shortly after abandonment)—this aligns with PHMSA's mandate for life-of-asset record retention for critical records.

Second, establish a material verification protocol for existing pipelines that lack complete records. This could be modeled on PHMSA's approach in 49 CFR 192.607, which obligates operators to perform tests or inspections on older pipeline segments where documentation is not traceable, verifiable, and complete. The CER could set a timeframe (e.g., within 5 years) for operators to identify any pipeline materials without full traceability and execute a plan to verify those materials' grade, seam type, and toughness.

Finally, to support these efforts, the CER might consider creating a central repository or template for material traceability data, facilitating consistent record-keeping. Making traceability truly end-to-end and covering legacy pipelines will ensure no unknown or sub-standard material remains in CER-regulated pipelines.

4.5 Require Periodic Integrity Risk Reviews and Continuous Improvement Cycles

To embed continuous improvement, the regulator should require companies to conduct regular integrity management program reviews and update risk assessments periodically (e.g., annually). This goes beyond the initial risk assessments at design or post-construction—it means at a set interval, operators re-evaluate all threats, incorporate the latest data, and adjust their integrity plans accordingly.

An actionable regulatory step could be to mandate that operators submit a periodic Integrity Management System Performance Report to CER, summarizing key integrity performance indicators, lessons learned, and improvements implemented. Additionally, the CER could institute a requirement for post-incident root cause analysis and knowledge sharing: if a pipeline incident or near-miss occurs, the operator must analyze root causes and share findings and corrective actions.

The continuous improvement recommendation ensures that the integrity process remains dynamic and self-correcting, constantly driving toward the goal of zero incidents. Regulators can facilitate this by reviewing these periodic reports and holding management accountable for follow-through on improvement actions.

4.6 Expand Integrity Management Program Scope and Depth

The CER should update its regulations to explicitly require robust Integrity Management Programs (IMP) for all pipelines under its jurisdiction, incorporating the new proposals as specific elements. The IMP should cover threat identification, risk assessment, inspection and mitigation plans, performance monitoring, and periodic program audit. Within this, special focus areas could be mandated: e.g., geohazard management, management of change, and emergency response integration.

PHMSA's integrity management rules initially applied to high-consequence areas; they are now expanding to broader segments. The CER should ensure that all pipelines—including those carrying new commodities or in remote areas—have a suitable integrity management process in place, scaled to their risk.

By viewing the amendments through the IMP lens, the regulator can also encourage a balanced approach—not only focusing on one threat but maintaining defense-in-depth. For instance, material traceability (quality threat), geohazard assessment (natural force threat), and other threats like corrosion or human error should all be managed under one coordinated program.

4.7 Improve Communication of Integrity Information and Stakeholder Engagement

In line with API RP 1173's stakeholder engagement element, CER can enhance requirements for how pipeline integrity information is communicated both to the regulator and to affected stakeholders (e.g., landowners, local authorities, Indigenous communities). One recommendation is for CER to develop a public-facing pipeline integrity report or dashboard for major pipelines, summarizing their safety performance and any integrity issues.

Another related recommendation is to require operators to notify local authorities of certain integrity activities—for example, if a geohazard is identified that could impact a community, or if a significant repair is happening that landowners should know about. Such engagement ensures that pipeline safety is a shared responsibility and that public concerns are heard in the integrity management process.

After the Merrimack Valley gas explosions, there was criticism that the community was unaware of the risks during the pipeline work; better communication and planning might have averted the incident. Therefore, formalizing communication protocols can be an effective preventative measure.

5. Conclusion

The OPR Pipeline Integrity Topic Paper demonstrates the CER's commitment to enhancing pipeline safety through improved regulatory requirements. The proposed amendments—including expansion to new commodities, material traceability improvements, geohazard assessment requirements, and operating pressure clarifications—address known gaps that have contributed to past failures.

When evaluated against API RP 1173 and lessons from major pipeline incidents, these proposals show good alignment with risk management and operational control principles. However, opportunities exist to strengthen the framework by more explicitly incorporating leadership commitment, continuous improvement, and stakeholder engagement elements of a comprehensive safety management system.

The recommendations provided in this review aim to build upon the solid foundation established by the CER's proposals. By adopting a PSMS approach, strengthening leadership accountability, establishing ongoing geohazard and risk management processes, enhancing material verification requirements, mandating continuous improvement cycles, expanding integrity program scope, and improving stakeholder communication, the CER can create a more robust regulatory framework that drives pipeline operators toward safety excellence.

These enhancements will help ensure that Canada's pipeline industry not only meets minimum safety requirements but actively works to prevent incidents through a proactive, systematic approach to integrity management. The ultimate goal—zero pipeline failures that impact people, property, or the environment—can only be achieved through this kind of comprehensive, integrated approach to pipeline safety.