Chapter 11
SaskEnergy—Keeping Existing Transmission Pipelines Operating Safely

1.0 Main Points

SaskEnergy owns and operates about 15,000 kilometres of natural gas transmission pipelines in the province to deliver natural gas to more than 390,000 customers located throughout Saskatchewan.

Overall, at January 2020, SaskEnergy has effective processes in place to keep existing natural gas transmission pipelines operating safely other than needing improvements in the following areas.

- Documenting the rationale for how often it carries out each of its pipeline inspection activities. SaskEnergy uses pipeline inspections to monitor the condition of pipelines, and assess the risk of pipeline failure (e.g., natural gas leakage). It also uses inspections to assess its compliance with regulatory requirements. Our testing found it did not document the rationale for the frequency of three of its ten types of inspection activities. Documented rationale shows how SaskEnergy is addressing the key risks. This guidance also helps personnel understand basis for planned frequency of inspections.

- Setting clear expectations as to when contractors are to submit final inspection reports and when staff are to review, approve, and enter them into its risk-modelling IT system. Our testing of ten inspections found SaskEnergy received the final reports up to 86 days after an inspection. Delays in receipt of reports cause delays in approval and entry of results into the application. Using final inspection results about the most recent pipeline condition in its risk-modelling IT system supports more reliable assessments of pipeline condition and risk of failures.

- Including results of key pipeline inspection and repair activities in its data storage IT system within specified timelines. Our testing found certain inspection reports not entered into the IT system until four or five months after inspection completion. Having complete and up-to-date records helps support effective decision-making about upcoming inspection plans and repairs.

Without properly designed and effective processes to operate pipelines safely, SaskEnergy faces the risk of fires or explosions caused by ignition of the natural gas that has leaked from transmission pipelines. This can cause serious injuries, death or significant property damage.

2.0 Introduction

2.1 Natural Gas Pipelines Provincially Regulated

The Pipelines Act, 1998 and related regulations place various requirements on pipeline operators. For example, they must obtain a licence from the Ministry of Energy and Resources for each pipeline they plan to operate, and report to the Ministry certain types of incidents (e.g., unplanned releases of natural gas).[1] In addition, they must adhere to minimum requirements for design, construction, testing, operation, maintenance, and repair of transmission pipelines, and documentation thereof.[2]

2.2 SaskEnergy's Pipeline Responsibilities

SaskEnergy is a pipeline operator subject to provincial regulation. It owns about 15,000 kilometers of transmission pipelines.

As **Figure 1** shows, transmission pipelines are key to transporting natural gas from production and processing facilities to a customer. SaskEnergy transports natural gas to more than 390,000 residential, farm, commercial, and industrial customers located throughout the province.[3]

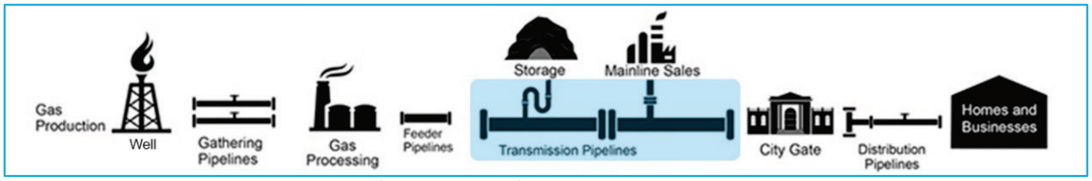
As shown in **Section 5.0**, almost all of SaskEnergy's transmission pipelines are located near 10 or less residences. See **Section 6.0** for a map of the pipelines.

SaskEnergy, a provincial crown corporation, is responsible for the safe operation of its natural gas transmission pipelines.[4] Its stated priority is to maintain a safe and reliable pipeline system.[5]

SaskEnergy makes its System Integrity and Standards Department responsible for managing the integrity of its transmission pipelines. The Department has five SaskEnergy employees focused on pipeline integrity. In addition, it has six contracted engineers to assist with planning and overseeing pipeline integrity activities, along with third-party contractors to complete pipeline inspection activities, conduct repairs and check the quality of repairs. For 2019-20, the Department had a budget of $26.7 million primarily for inspection activities.[6]

[1] *The Pipelines Regulations, 2000.*
[2] *The Pipeline Regulations, 2000* .set the Canadian Standards Association (CSA) Z662 as the minimum requirements for design, construction, testing, operation, maintenance and repair of transmission pipelines.
[3] www.saskenergy.com/about_saskenergy/default.asp (25 March 2020).
[4] *The SaskEnergy Act,* s. 15.
[5] SaskEnergy Incorporated, *2018-19 Annual Report*, p. 4. www.saskenergy.com/about_saskenergy/annual_report/ (25 March 2020).
[6] SaskEnergy records, The Department 2019-20 budget includes approximately $3 million for other activities such as modifying pipelines to allow for future in-line inspections.

Figure 1—Natural Gas Production Process



Transmission pipelines receive natural gas from processing facilities and carry it to distribution pipelines. These pipelines are larger, generally measuring 1 ½–20 inches in diameter, and are used to transport natural gas long distances at high pressures (often 200–1500 psi). (www.saskenergy.com/about_saskenergy/default.asp [25 March 2020]).
Distribution pipelines are a network of mains and service lines used to move natural gas at relatively low pressures to individual homes and businesses. (paallianceforenergy.com/difference-gathering-transmission-pipelines/ [25 March 2020]).
Source: Adapted from Canada Energy Regulator information.

In 2018, SaskEnergy reported to its regulator (the Ministry of Energy and Resources) seven incidents related to transmission pipelines. These incidents resulted in the release of about 318 thousand cubic meters of natural gas. The most significant in 2018 occurred near Meadow Lake, and resulted in a pipeline involuntarily releasing about 303,000 cubic meters of natural gas into the environment.[7] No reportable incidents occurred in 2019 relating to the release of natural gas or contact with transmission pipelines.

Without properly designed and effective processes to operate pipelines safely, SaskEnergy faces the risk of fires or explosions caused by ignition of the natural gas that has leaked from transmission pipelines. This can cause serious injuries, death or significant property damage. Also, the release of natural gas, primarily methane (a very potent greenhouse gas), contributes to climate change.

3.0 Audit Conclusion

We concluded that, for the 12-month period ended January 31, 2020, SaskEnergy Incorporated had effective processes, except in the following areas, to keep existing natural gas transmission pipelines operating safely.

SaskEnergy needs to:

- **Document the rationale for how often it carries out each of its pipeline inspection activities**
- **Set clear expectations as to when contractors are to submit final inspection reports, and when staff are to review, approve, and enter them into its risk-modelling IT system**
- **Include key inspection results and repairs in its data storage IT system before it prepares its annual inspection plan**

[7] Saskatchewan Upstream Oil and Gas IRIS Incident Report. Saskatchewan. Oil and Gas News, Bulletins, Statistics and Reports. www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/oil-and-gas/oil-and-gas-news-and-bulletins (25 March 2020).

Figure 2—Audit Objective, Criteria, and Approach

Audit Objective:
The objective of this audit was to assess whether SaskEnergy Inc. had effective processes to keep existing natural gas transmission pipelines operating safely for the 12-month period February 1, 2019 to January 31, 2020. The audit did not cover the design, construction, or commissioning of new pipelines or abandonment of existing pipelines.

Audit Criteria:

Processes to operate existing natural gas transmission pipelines safely:

1. <u>Use reliable information to establish inspection plan</u>
   1.1 Maintain accurate information about pipelines (e.g., location of pipeline, pipeline condition, inspection and repair history)
   1.2 Develop an inspection plan (e.g., risk-based)
   1.3 Adjust inspection plan as new information becomes available (e.g., incidents, resource capacity, review of previous plan results)

2. <u>Regularly inspect pipelines</u>
   2.1 Set clear guidance to carry out inspections consistent with standards (e.g., CSA Z662-19)
   2.2 Use qualified personnel
   2.3 Conduct inspections in accordance with the plan (e.g., in-line inspections, ground patrols, aerial patrols)

3. <u>Repair pipelines with identified defects</u>
   3.1 Develop risk-based pipeline repair plan
   3.2 Conduct timely repairs on pipelines with identified defects
   3.3 Confirm repairs sufficiently addressed identified defects

Audit Approach:

To conduct this audit, we followed the standards for assurance engagements published in the *CPA Canada Handbook—Assurance* (CSAE 3001). To evaluate SaskEnergy's processes, we used the above criteria based on our related work, reviews of literature including reports of other auditors, and consultations with management and an external advisor. **Section 7.0** includes key sources for these criteria. SaskEnergy's management agreed with the above criteria.

Our examination included discussions with SaskEnergy staff. We examined plans, plan adjustments, policies, and procedures relating to inspections of natural gas transmission pipelines. We hired an external consultant to assist us in assessing SaskEnergy's policies and procedures against good practice. We tested a sample of pipeline inspections, surveys, and patrols and a sample of pipeline repairs. We reviewed staff and contractor qualifications.

4.0 Key Findings and Recommendations

4.1 Clearly Documented Pipeline Integrity Management Program

SaskEnergy's documented Pipeline Integrity Management Program provides a clear strategy for keeping transmission pipelines safe.

The Program's purpose is to maintain the safety and reliability of natural gas pipelines and other materials (e.g., block valves) that form part of the transmission pipelines, manage risks; and keep employees, the public, and the environment safe.[8]

The Program sets out SaskEnergy's key risk management and safety processes, and related policies. It clearly identifies risks related to different types of pipeline defects (e.g., corrosion, cracking, and dents) as well as risks related to external interference or the environment around the pipeline (e.g. ground movement). The Program recognizes that not properly managing these risks may result in pipeline failures including leak or rupture,

[8] SaskEnergy, *Pipeline Integrity Management Program.*

which could lead to expensive downtime, property damage, public safety issues or environmental hazards. See **Figure 3** for a brief description of risks.

Figure 3—Brief Description of Risks related to Types of Pipeline Defects

Corrosion: is when a material deteriorates because of a reaction with its environment. External corrosion is the primary corrosion hazard to the pipeline system. Exposure to the elements causes external corrosion. Internal corrosion occurs due to environmental conditions inside of the pipeline. Corrosion can result in gradual metal loss on the pipeline reducing the wall thickness of the pipe.[A]

Cracking: stress corrosion cracking is the primary cracking hazard to the pipeline system. Contributing factors to crack growth include residual stresses, temperature, load stress, bending, and local stresses (e.g., shifting soil) when corrosion appears on a pipeline.[B]

External Interference: occurs when SaskEnergy, contractors, or the public hits a pipeline. For example, hitting a pipeline may occur when planting a tree, digging fence postholes, or other underground construction activities.[C]

Geotechnical: includes water crossing (hydrotechnical) and ground movement (geotechnical hazards to the pipeline system).

Source: Adapted from SaskEnergy Pipeline Integrity Program.
[A] Pipeline and Hazardous Materials Safety Administration. *Fact Sheet: Internal Corrosion*. Washington D.C.: U.S. Department of Transportation, primis.phmsa.dot.gov/comm/FactSheets/FSInternalCorrosion.htm?nocache=2447 (26 March 2020).
[B] Ginzel, R.K. & Kanters, W.A. (July 2002). *Pipeline Corrosion and Cracking and the Associated Calibration Considerations for Same Side*.
[C] *Sizing Applications*. www.ndt.net/article/v07n07/ginzel_r/ginzel_r.htm (26 March 2020).
www.saskenergy.com/safety/beforeyoudig.asp (26 March 2020).

Furthermore, the Program describes a series of inspection activities designed to detect pipeline defects such as corrosion and cracking. As **Figure 4** shows, activities include ten different types of inspections, and/or surveys.

Figure 4—Major Transmission Pipeline Inspection Activities and Planned Inspection Frequency

Activity	Description	Planned Inspection Frequency
In-line Inspections	- Is a non-destructive examination of the pipeline performed by equipment that can travel internally along a pipeline of 6 inches in diameter or greater. SaskEnergy uses several different in-line inspection tools; each tool has a different purpose (e.g., to find corrosion, stress corrosion, cracking, dents, seam defects, or to map the pipeline). - May identify features that are indications of an anomaly (e.g., change in wall thickness). - Supplies data that is used to determine where and when further investigation is needed through a direct examination (i.e., dig).	- Uses its annual risk analysis and its typical re-inspection intervals to determine the timing and frequency of inspections. - Conducts a baseline in-line inspection on all new pipelines after construction. - Typical maximum re-inspection interval is 10 years and the typical minimum re-inspection interval is 4 years. SaskEnergy can inspect approximately 50% of its transmission pipeline using in-line inspections because available in-line inspection tools can only go through larger diameter pipelines. It did not design its pipelines built prior to the 2000s for in-line inspections.
Direct Examinations (i.e., Digs)	- Involves excavating pipelines (i.e., digs) and then conducting various non-destructive testing on the pipe. - Mainly performed because of analysis of in-line inspection data. - Assesses features identified through the in-line inspection to determine whether a defect exists that needs to be repaired.	- Schedules digs based on the analysis of in-line inspection data thereby no set timing and frequency for direct examinations (i.e., digs). - Plans to do digs either later in the year when in-line inspections are completed, or more commonly, the following year.

Activity	Description	Planned Inspection Frequency
Block Valve Inspections	- Looks for corrosion, cracking, leaks, and damage of block values (areas that cannot be inspected by, or may not provide accurate results, through an in-line inspection). Block valves are used to stop the flow of natural gas through a pipe (about 400 in the transmission pipeline system).	- Inspects approximately 20 of 400 block valves each year (i.e., all block valves inspected over a 20-year period). - Prioritizes inspections based on the combined risk of the pipeline that the block valve is designed to control.
Cased Crossing Management	- Assesses the integrity of the cased crossing and potentially mitigate or remove the casing. Casings (cased crossing) are pipes of larger sizes placed around the transmission pipeline under roads and railways to protect it from external loads. This makes the pipeline more vulnerable to corrosion (around 400 cased crossings in the transmission pipeline system). Cased crossings are not SaskEnergy's current practice as it now uses thicker pipe at crossings instead of casings.	- Prioritizes cased crossings annually where information on the cased crossing (e.g., in-line inspection data, cathodic protection data) indicates metal loss.
Close Interval Surveys	- Provides data used to detect corrosion on the pipeline. - Tests posts, located approximately every 2 to 3 km along the transmission pipelines are monitored annually to determine the cathodic protection level of the pipeline. Cathodic protection is a technique used to reduce the corrosion of a metal surface. If the cathodic protection level of the pipeline goes below the natural cathodic protection level of the soil around the pipeline, corrosion begins to occur. When SaskEnergy identifies that the cathodic protection level is below this threshold, it performs a close interval survey.	- Prioritizes annually based on the results of its annual risk analysis, data from in-line inspections, and, monitoring of test posts located along the pipeline.
Direct Current Voltage Gradient Surveys	- Detects if the coating (i.e., non-conductive material on the pipeline that prevents interaction of the steel with soil, water, or contaminants) has degraded and the extent of the degradation.	- Completed by request.
Depth of Cover Surveys	- Assesses the depth of the ground soil covering the pipeline to ensure it is sufficient.	- Completes depth of cover surveys of all non-class 1 pipelines and CER-regulated pipelines on a three-year basis (see **Section 5.0**).[A]
Encroachment Patrols	- Identifies when construction or digging occurs too close to a pipeline, increasing the risk that a pipeline hit may occur. SaskEnergy does two types of encroachment patrols: aerial patrols and ground patrols.	- Aerial patrols completed twice monthly on all pipelines six inch diameter or greater throughout the period from April to October each year (for construction activity). - Aerial patrols completed for all other pipelines twice from April to October each year. - Ground patrols for construction activity and for major class 3 locations completed twice per day (see **Section 5.0**).

Activity	Description	Planned Inspection Frequency
Leak Surveys	- Identifies dead spots in vegetation along the pipelines and senses gas (technology varies on survey type) indicating that a pipeline is leaking natural gas.	- Conducts an aerial leak survey on the entire transmission pipeline system annually. - Conducts ground leak surveys on class 2 and 3 locations annually (see **Section 5.0**). - Conducts ground leak survey on the entire transmission system on a four-year cycle.
Geotechnical Inspections	- Monitors geotechnical hazards (e.g., slopes) near pipelines to determine the stability of the slope. Unstable slopes can cause damage to the pipeline - Also monitors hydrotechnical hazards (i.e., waterways, such as streams and rivers, that the pipeline crosses) to determine that the waterway is not causing issues with the pipeline.	- Categorizes geotechnical and hydrotechnical hazards based on risk to determine the re-inspection interval for each hazard. - Inspects all category 1 and 2 sites (i.e., highest risk) each year. - Divides the transmission system into four districts. - Inspects all sites in one of the four districts annually, selecting a different district each year.

Source: Adapted from various SaskEnergy documents and records.
[A] The Canada Energy Regulator (CER) regulates SaskEnergy's transmission pipelines that cross Saskatchewan's borders.

Having a clear strategy to keep transmission pipelines operating safely provides a solid foundation for the development of a risk-based inspection plan.

4.2 Qualified Personnel Responsible for Transmission Pipeline Integrity

SaskEnergy staff and contracted engineers responsible for Transmission Pipeline Integrity Management Program, and welders carrying out certain pipeline repairs are suitably qualified.

Including a manager, the pipeline integrity staff consists of eleven engineering positions – five SaskEnergy employees and six contracted engineers from various companies. In addition, SaskEnergy employs 14 welders.[9]

SaskEnergy maintains up-to-date job descriptions for its engineering staff in the System Integrity and Standards Department. SaskEnergy outlines qualifications and performance requirements in contracts with companies for contracted engineers.

Our review of job descriptions in this Department found they appropriately outline key responsibilities and necessary qualifications. We found the job description for engineers require them to possess an engineering degree and commit to continuous learning. We also found it requires them to be able to provide technical support by applying engineering principles in the investigation, analysis and resolution of integrity-related problems.

For four SaskEnergy employees and two contracted engineers in the System Integrity and Standards Department we tested, each had professional engineer designations as expected. We note SaskEnergy has a process to formally evaluate the performance of

[9] SaskEnergy also contracts additional welders to help repair transmission pipelines.

each of its employees. In addition, each year consistent with contract provisions, it formally assesses the performance of contracted engineers.

Consistent with the CSA Z662-19 standards, SaskEnergy requires welders to have a valid pressure welder's licence. Having a valid licence shows welders are up to date with standards. TSASK licenses these welders.[10]

Each month, SaskEnergy monitors the expiry of staff welders' qualifications. It actively reminds welders of their TSASK licence expiry date, and requests a copy of the new licence upon successful completion. We found that, at January 31, 2020, each of SaskEnergy's welders held a valid welder licence.

Having qualified personnel, reduces the risk of errors and mistakes, and increases the likelihood of personnel being able to identify areas in which to make improvements. This, in turn, helps ensure the successful delivery of the Pipeline Integrity Management Program.

4.3 Updates to Standards related to Pipelines Communicated

SaskEnergy informs staff and contracted engineers about changes to the Canadian Standards Association (CSA) Z662-19 Standards.[11] *The Pipelines Regulations, 2000* requires SaskEnergy to follow these standards. The Government last updated *The Pipelines Administration and Licensing Regulations* in January 2020.

The Association updates CSA Z662-19 Standards every four years. The last two updates occurred in 2015 and 2019.

SaskEnergy provides comments to the Association on proposed changes to the CSA Z662 Standards. It asks specific staff to identify and comment on changes to CSA Z662, and communicates the final, revised standard to the appropriate staff and contracted engineers. In addition, SaskEnergy indicated it provides new staff or contracted engineers with on the job training on CSA Z662.

SaskEnergy also maintains a training plan for the System Integrity and Standards Department personnel. The training plan sets out required courses, and how often each position must take them (e.g., annually). SaskEnergy actively monitors whether personnel took courses required. Monthly, it reports to management on personnel's status of completion of required training (e.g., who is due for training and who has not completed courses within the required timeframe).

We found this training plan focused on current safety and environmental protection matters. We also found the Department personnel completed training consistent with the requirements of the training plan.

Keeping personnel trained and current with relevant regulatory standards decreases the risk of them not understanding applicable regulatory requirements and detecting minor issues prior to a major failure occurring.

[10] The Technical Safety Authority of Saskatchewan oversees pressure vessels in Saskatchewan.
[11] Canadian Standards Association (CSA) Z662 is a standard governing oil and gas pipeline systems.

4.4 Policies Consistent with Regulatory Requirements But Missing Documented Rationale for Some Inspection Frequency

SaskEnergy pipeline integrity management policies are consistent with applicable provincial regulatory requirements—CSA Z662 Standards. These policies (or supporting written procedures) set out the rationale for the frequency of most, but not all, pipeline inspection activities, including block value, depth of cover and leak surveys.

SaskEnergy has around 40 different policies designed to support the implementation of its Pipeline Integrity Management Program.

SaskEnergy clearly assigned the responsibility to keep these policies current. We found responsible personnel actively monitor changes to regulations and standards, and seek approval for revisions to policies, as needed. Our interviews of five System Integrity and Standards Department personnel found them knowledgeable about the content of the policies, and their location.

Our assessment of policies for each of the ten inspection activities listed in **Figure 4** found each appropriately approved and complied with the 2019 version of CSA Z662 Standards.

We also found these policies set out clear requirements for various types of pipeline inspections and surveys designed to detect damaged pipelines. Where applicable, the frequencies of pipeline inspection set out in the policies (or supporting procedures) aligned with the CSA Z662-19 Standards where the standards set out frequency requirements.[12] For example, as described in **Figure 4**, the policies require in-line inspections on a sample of larger diameter high-pressure pipelines every year and annual routine encroachment patrols.

However, neither SaskEnergy policies nor supporting procedures document the rationale for the frequency of the following three types of inspection activities: block valve inspections, depth of cover surveys, and leak surveys (see **Figure 4**).

Having a documented rationale for the planned frequency of all types of inspection activities aids SaskEnergy in ensuring its plans adequately address the risks in its Pipeline Integrity Management Program. For organizations such as SaskEnergy who routinely use contracted engineers, having documented rationale for the frequency of all types of inspection activities helps personnel understand the basis for planned frequency.

1. **We recommend SaskEnergy Incorporated document the rationale for how often it carries out each of its transmission pipeline inspection activities.**

4.5 IT Systems Track Key Pipeline Information

SaskEnergy uses various IT applications to help determine the structure and integrity of its transmission pipelines, and to store key details about its pipelines and their structure and integrity. Key IT applications include:

[12] CSA Z662-19 generally expect pipeline operators to use professional judgment to set the timing and frequency of inspection activities.

- **A corrosion growth application**—calculates corrosion of each larger diameter transmission pipeline using information from the results of in-line inspections. In addition, it suggests re-inspection scenarios (e.g., recommended dates for re-inspection) and locations to carry out direct examinations (i.e., dig sites). It is a widely accepted and used IT application in the natural gas pipeline industry.

- **An in-line inspection data application**—electronically captures, stores, and manages data accumulated from in-line inspection tools for each in-line inspection run. The in-line inspection contractors use this data to prepare in-line inspection reports.

- **A pipeline risk-modelling application**—evaluates the pipeline's reliability directly, or uses the included consequence models to calculate risk of pipeline failure for each transmission pipeline (or portion thereof), and the probability and consequences of failure of each transmission pipeline. It is a well accepted IT application in the natural gas pipeline industry. Its calculations consider the following:
  - Attributes (e.g., pipe diameter, maximum operating pressure, wall thickness)
  - Condition (e.g., known condition based on the results of in-line inspections, and direct examinations [i.e., digs], and estimated corrosion growth based on the corrosion growth application)
  - Class (e.g., proximity of residents to pipelines – see **Section 5.0** for further detail)
  - Environment (e.g., nearby water, slope movement)

  Because this application does not electronically track updates to its data (i.e., when, or what), SaskEnergy maintains a worksheet (in Excel) to document that it inputs results of in-line inspections into the application. SaskEnergy does not track its inputting of results of direct examinations (i.e., digs) or repairs made to the pipeline.

  SaskEnergy personnel use their professional judgment to assess the reasonableness of the application's calculated risk results. SaskEnergy uses its risk-modelling IT application in its annual analysis of risks of defects and failures of individual pipelines done in December each year.

- **A data storage application**—stores key historical detail about each licenced pipeline (e.g., location, pipeline size, in-service date, drawings, results of inspection activities and maintenance and repair history).

  SaskEnergy personnel electronically add the relevant documents on a licenced pipeline in this application, and use them when making future inspection plans and repair decisions.

We found SaskEnergy accurately inputs data about pipeline condition from in-line inspection reports and its corrosion growth IT application into the risk-modelling IT application. For one larger diameter pipeline 2019 inspection we tested, the information SaskEnergy input into the risk-modelling IT application agreed with the in-line inspection report.

We also found the documentation that SaskEnergy keeps about its inspection and repair of transmission pipelines meets the regulator's documentation requirements. For 10 licenced pipelines, we compared the following information in SaskEnergy's data storage application to the regulator's (the Ministry of Energy and Resources) licence records:

pipeline location, pipeline size, in-service date, and inspection and maintenance history. For each of these10 pipelines we tested, the information agreed.

In addition, we found SaskEnergy assessed the completeness of its documentation as its regulator expects. Starting in 2016, its pipeline regulator requires SaskEnergy to self-assess if its historical pipeline documentation met regulatory requirements. While SaskEnergy identified several areas where it could improve its documentation, none of these areas related to missing information about pipeline inspection activities and repairs.

However, SaskEnergy does not always keep up-to-date information in key IT systems it used to determine the condition (structure and integrity) of its pipelines—see **Recommendations 2** and **3**.

4.6 Risks of Pipeline Failure Analyzed

SaskEnergy systematically analyzes electronically-calculated risks of defects and failures of individual pipelines.

Each year, typically in December, SaskEnergy analyzes risks of pipeline failure using electronically-calculated risks of pipeline failure of individual pipelines.

SaskEnergy uses data from its risk-modelling IT application to identify individual pipelines with the highest risk. It compares electronically calculated risks to its acceptable risk thresholds. These include a maximum individual risk ratio (less than or equal to 0.8), failure rate (less than a maximum value of 0.1), failures/km-year, combined impact (i.e., considers: safety, financial, environmental), and consequence (i.e., considers: pipeline pressure, population density). It documents its analysis in an annual risk report, and provides the report to senior management.

Our review of the 2018 Risk Management Report found SaskEnergy appropriately used risk projections from its risk-modelling IT application, highlighted individual pipelines (or portions thereof) with the highest risks of failure or risk to cause harm, and included a strategy to mitigate the risk.[13] We found the Report did not list any transmission pipelines with a risk above SaskEnergy's acceptable risk threshold. This suggests SaskEnergy is sufficiently maintaining transmission pipelines.

Having clearly defined risk factors and risk assessment processes to consider when selecting pipelines for inspection focuses inspection resources on pipelines at greater risk of defect and leakage. See **Recommendation 2** about keeping up-to-date information in SaskEnergy's risk modelling IT system.

4.7 Risk-based Inspection Plan Maintained

SaskEnergy maintains an annual risk-based plan for each of its major inspection activities (see **Figure 4**) and a ten-year in-line inspection plan. SaskEnergy establishes an annual budget for its inspection activities.

[13] SaskEnergy's 2019 Year End report was not finished as of February 2020.

As its Pipeline Integrity Management Program and policies expect, SaskEnergy systematically gathers key information to aid in determining the condition (structure and integrity) of its transmission pipelines through various inspection activities. It designs pipeline inspections to identify existing and potential hazards. In addition, inspections gather key information to determine appropriate corrective action (e.g., repair it or continue to monitor the pipeline for further deterioration).

SaskEnergy uses the results of its annual analysis of risks to decide which individual transmission pipelines to inspect and when.

SaskEnergy documents its decisions about which individual pipeline to inspect, when, and how in various planning documents (e.g., a annual plans, a ten-year in-line inspection plan, pipeline integrity work plan).

Our review of the 2019 planning documents found the following:

- They cover each of the types of inspections and surveys (e.g., in-line inspections, block valve inspections, depth of cover surveys) expected in the Pipeline Integrity Program. They show in-line inspections are SaskEnergy's main inspection activity.

- They set out individual pipeline SaskEnergy plans to inspect/survey along with a budget. For 2019-20, the combined budget for all its Department activities including inspection activities was $26.7 million. We found this budget was included in the Systems and Integrity Department's budget approved by senior management.

- They are risk-based. They include the higher-risk pipelines identified in the annual risk assessment, and prioritize the inspection of higher risk areas. For example, SaskEnergy prioritized block valve inspections based on the risk of the pipeline that the block valve is designed to control.

Senior management approves annual plans and the revised ten-year in-line inspection plan each year. We found appropriate approvals of the 2019 inspection plans for each of its major inspection activities as part of the pipeline integrity work plan.

SaskEnergy has processes to adjust inspection plans as new information becomes available.

Having an annual detailed risk-based plan for each of its major inspection activities helps ensure SaskEnergy obtains a sufficient overall assessment of integrity of its natural gas transmission pipeline system, and gathers sufficient information to make decisions about necessary repairs and pipeline replacement.

4.8 Clear Timelines for Reviewing Contractors' Inspection Reports and Entry of Results into Key IT System Needed

SaskEnergy does not have clear expectations as to when contractors are to submit final in-line inspection reports, and its Systems Integrity personnel are to review, approve, and enter the reports into its risk-modelling application. The timing of SaskEnergy's review and approval of in-line inspection reports varies.

As previously noted, in-line inspections are SaskEnergy's primary inspection activity to gather information about the structure and integrity of its transmission pipelines.

SaskEnergy policies require all contractors to notify it immediately of significant defects found during inspections. Policies also require contractors doing inspections to complete and submit inspection reports. For in-line inspections, contractors are to submit preliminary and final inspections reports.[14]

Policies expect SaskEnergy personnel to review and approve inspection reports. They input the inspection results into the risk-modelling application to enable electronically determining the current state of the transmission pipeline system and the risk of pipeline failure.

While policy expects contractors to submit preliminary in-line inspection reports within 15 business days after completing the in-line inspection, it does not set out when contractors must submit final reports. SaskEnergy policies clearly set out when SaskEnergy expects contractors carrying out other types of inspection activities to submit the results of their work. For example, contractors doing block valve inspections must provide an inspection report within one week after the inspection.

However, SaskEnergy does not track when it receives, reviews, or approves the results of all inspections (inspection reports). For example, it does not stamp the receipt date on inspection reports received. Other than in-line inspection reports, it does not document or date their approval of inspection reports.

Policies also do not set out timeframes by which personnel should complete and document their review, approval, and entry of inspection reports into its risk-modelling application.

For ten in-line inspections we tested, we found:

- For seven in-line inspections, SaskEnergy received a final report between 27 and 86 days after the contractor performed the inspection.

- For seven pipelines related to in-line inspections we tested, SaskEnergy had completed a more in-depth review and approval of additional digs or repairs. This review occurred between three and 62 days after receipt of the final in-line inspection report.

- For three in-line inspections, SaskEnergy had not received, at January 31, 2020, the final reports (between 43 and 64 days after the inspection).

Furthermore, SaskEnergy does not have a well-defined timeframes as to when personnel should enter inspection reports into its risk-modelling application.

For the ten in-line inspections we tested, personnel entered the results of in-line inspections into SaskEnergy's risk-modelling IT application before they had completed their review and approval of the final in-line inspection analysis reports.

[14] Preliminary in-line inspection reports indicate whether the in-line tool was successful in collecting data about the condition of the inspected pipeline. Final in-line inspection reports include the results of the inspection (detailed data about the condition of the pipeline).

Entering in-line inspection data before review and approval of a final inspection report increases the risk of using inaccurate data in the risk-modelling IT system, which may lead to a less reliable pipeline risk assessment. Using final inspection results about the most recent pipeline condition in its risk-modelling IT system supports more reliable assessments of pipeline integrity and risk of failures, which in turn supports the development of appropriate inspection plans.

2. **We recommend SaskEnergy Incorporated implement timeframes for including the results of inspections of transmission pipelines into its risk-modelling IT system.**

4.9 Key Inspection Activities Required in IT System to Support Annual Inspection Plan

SaskEnergy does not ensure it includes reports from its inspection activities (e.g., in-line inspection, block valve inspections, repair reports) in its data storage IT application within specific timelines, for inclusion in its annual inspection plan.

Each year (typically in the spring), SaskEnergy checks whether it has included all in-line inspection reports and dig inspection reports from the prior construction season in its data storage IT application. In February 2019, it confirmed it included all reports of inspections and digs done during the construction season (April to October 2018).

We found SaskEnergy does not have a similar process to check whether it had included reports from its other types of inspection activities (e.g., block valve inspections) in its data storage IT application.

For the two close interval surveys and five block valve inspections we tested, SaskEnergy had not included the related reports of inspections in its data storage IT system as of January 2020. Completion of these reports ranged from five to seven months earlier. Therefore, these reports may not be available to staff preparing its next annual inspection plan.

We found at January 31, 2020 the data storage IT application included six of the ten 2019 in-line inspection reports because it had not yet finalized the remaining four in-line inspections carried out between September and December.

For the five 2019 repair reports we tested, SaskEnergy had not included documentation of repairs in its data storage IT application as of January 2020. Completion of these reports ranged from between four to five months earlier. Therefore, the reports may not be available to staff preparing the annual inspection plan.

Having up-to-date records reflecting current, reliable assessments of pipeline condition better supports decisions about future inspection plans and repairs.

3. **We recommend SaskEnergy Incorporated include the results of key inspection activities and repairs done during the year in its pipeline data storage IT system within specified timelines.**

4.10 Qualified Contractors Used for Pipeline Inspections and Repairs

SaskEnergy engages contractors with suitable qualifications to inspect and repair its transmission pipelines.

SaskEnergy spends about $35 million each year on Department activities, including contracted inspections and repairs of transmission pipelines.

SaskEnergy primarily uses contractors to carry out its pipeline inspections, surveys, and repairs. At January 2020, it had contracts with about 15 different contractors to inspect or repair transmission pipelines.

We found SaskEnergy uses requests for proposals (a competitive procurement method) to hire these contractors. The requests for proposals set out the required qualifications. SaskEnergy includes the request for proposals as part of its contracts with selected contractors. Contracts are typically for a one-year term, with an option to extend for up to four years. In practice, SaskEnergy routinely extends these contracts beyond one year.

For three contracts we tested, the qualifications set out in the contract seemed suitable for contracted inspection activity (e.g., engineering background for pipeline inspectors, required valid certificate for radiography).

SaskEnergy relies on contractors to supply personnel with the contracted qualifications. Also for transmission pipeline repairs, SaskEnergy contracts industrial radiographers to confirm completed repairs to pipelines sufficiently address identified defects. Industrial radiographers are qualified to use X-rays to verify the internal structure and integrity of a pipeline.

For all five repairs we tested, the contracted radiographer inspected completed repairs, and signed off indicating repairs sufficiently addressed identified defects.

Engaging suitably qualified contractors to inspect and/or repair transmission pipelines increases the likelihood of properly repaired and inspected pipelines.

4.11 Completion of Inspections Actively Monitored

SaskEnergy actively monitors the completion of the annual inspection plan and adjusts the plan considering the assessed risk of potential pipeline defects.

Most of SaskEnergy's inspection activities take place between April and October each year (construction season).

The Systems Integrity and Standards Department actively monitor and track the completion of the annual inspection plan, and costs incurred. In addition, it considers assessed risks of pipeline failure when adjusting the timing of planned inspection activities. Senior management of the Department must approve adjustments to the annual plan.

As at March 2020, SaskEnergy spent $34.9 million on Department activities, including inspection activities during the 2019 construction season; it budgeted to spend $26.7 million.[15]

As shown in **Figure 5**, for the 2019 construction season, SaskEnergy completed just over two-thirds of the kilometres of its planned in-line inspections, and all or almost all of its plans for the nine other types of inspection activities.

Most of the delays in 2019 were the result of SaskEnergy staff being not available to supervise inspection activities during October 2019 due to job action by unionized employees.

Figure 5—2019 Comparison of Planned and Completed Inspection Activities

Inspection Activity	2019 Planned	2019 Actual Completed
In-line Inspections	- 32 (17 baseline inspections and 15 re-inspections) 1,588 km of transmission lines.	- Completed 19 in-line inspections for a total of 1,206 km of transmission pipeline (comprised of 1,042 km in the plan (67% of planned), and 164 additional km not in initial plan but considered necessary). - Deferred 13 (11 baseline and 2 re-inspections) with a total of 546 km of transmission lines due to SaskEnergy job action and cost savings measures. - Rescheduled all deferred inspections for 2020-22.
Direct Examinations	- 89	- Completed 84 digs (94% of planned). - Deferred five digs to 2020 due to employee job action and weather.
Block Valve Inspections	- 21	- Completed 21 block valve inspections (100% of planned).
Cased Crossing Management	- 22	- Completed 22 cased crossing inspections (100% of planned).
Close Interval Surveys	- 13	- Completed 15 surveys (100% of planned) and two additional surveys not included on the plan.
Direct Current Voltage Gradient Surveys	- Completed by request.	- None completed or requested.
Depth of Cover Surveys	- 165 km of non-class 1 pipelines and CER-regulated pipelines based on its three-year plan (see **Section 5.0**).[A]	- Completed surveys (100%).
Encroachment Patrols	- Twice monthly aerial patrols on all six-inch or greater diameter pipelines. - Two aerial patrols for all other pipelines. - Twice per day ground patrols for construction activity in major class 3 locations.	- Completed aerial and ground patrols (100% as planned).

[15] Overage caused by completion of unplanned work due to the December 2018 Beacon Hill pipeline failure and the Coleville pipeline relocation.

Inspection Activity	2019 Planned	2019 Actual Completed
Leak Surveys	- Annual aerial leak survey on the entire transmission pipeline system. - Annual ground leak surveys on all class 2 and 3 locations and high consequence areas (207 km of transmission pipelines). - Survey 3,657 km of transmission pipelines as part of four-year cycle.	- Completed annual aerial and ground surveys (100% as planned).
Geotechnical Inspections	- All 45 category 1 and 2 sites (i.e., highest risk). - All sites in South transmission system district.	- Did not inspect nine category 1 and 2 sites as planned because it had mitigated the risks to these sites through other measures in 2019 and 2020. We found this to be reasonable. - Competed inspections on all 75 sites in the South district (100% as planned).

Source: Adapted from SaskEnergy records.
[A] The Canada Energy Regulator (CER) regulates SaskEnergy's transmission pipelines that cross Saskatchewan's borders.

For nine in-line inspections and digs (direct examinations), we assessed the reasonableness of SaskEnergy's rationale for selecting them for deferral. For each of the nine deferrals, we tested, the rationale appeared reasonable and consistent with SaskEnergy's risk-based approach and senior management appropriately approved them. In addition, we found SaskEnergy rescheduled deferred in-line inspections and digs within an acceptable timeframe (e.g., prior to predicted pipeline failure).

Using a risk-based approach to complete and adjust its annual inspection plan reduces the risk of SaskEnergy not effectively identifying defects in pipelines through inspections. Actively monitoring helps ensure sufficient inspections of pipelines at higher risk of defects. Undetected defects can lead to unplanned downtime and pipeline leaks, which in turn may cause failures (e.g., service disruptions and explosions).

4.12 Repairs Planned and Conducted Within Reasonable Timeframes

SaskEnergy plans for and completes repairs on pipelines within a reasonable timeframe, and uses a repair process that is consistent with CSA Z662 standards.

SaskEnergy uses the results of inspection assessments of pipelines to determine which portion of pipelines it must directly examine and potentially repair. SaskEnergy excavates specific portions of pipelines to allow for direct examination and assessment. It refers to these as digs.

For specific pipelines and portions thereof, SaskEnergy considers the assessed risk of pipeline failure, suggested re-inspection dates, recommended dig sites, and if available, predicted pipeline failure date. It uses this information to schedule the timing and location of digs with contractors. It usually schedules digs either in the same year the in-line inspection of that pipeline was done, or, more commonly, in the following year. It coordinates the timing of digs with planned pipeline outages to minimize disruptions in pipeline operations. It recognizes inclement weather can alter the planned timing of a dig.

For three of six in-line inspections we tested, the assessment results recommended digs. We found SaskEnergy had scheduled each of these digs for 2020 consistent with suggested timing or before the predicted failure date.

SaskEnergy has well-defined and detailed procedures about the purpose and steps to follow in carrying out digs. They require assessing the pipeline for suitability for continued service and considering the following potential defects: nature and extent of corrosion, evidence of gouges, groove, arc burns, dents, weld imperfections, cracks, ripples or buckles, etc. If SaskEnergy identifies defects during a dig requiring repair, it expects the repair to be done at the same time. This approach reduces costs by not digging up a pipeline more than once.

SaskEnergy primarily uses contractors to complete pipeline repairs. It gives them a handbook. We found the handbook clearly outlined the processes for making repairs of defects including requiring they meet CSA Z662-19 Standards.

SaskEnergy uses industry radiographers to verify the acceptability of welds completed (i.e., no leaks exist), and an independent contractor to inspect, and approve the repair.

In addition, SaskEnergy must seek prior regulatory approval from the Ministry of Energy and Resources for all repairs exceeding 100 metres in length. SaskEnergy is expected to keep specific documentation about the repair (e.g., pipeline name, location, details about the nature and time of the repair).

SaskEnergy tracks scheduled and completed digs using a spreadsheet. It records key details such as dig site (pipeline name, longitude, latitude, etc.), target joint in pipeline, nature of expected defect (e.g., dent, corrosion), inspector name, scheduled month, and details about the repair.

In 2019, SaskEnergy completed 45 repairs to its transmission pipelines for a cost of approximately $1.72 million.

For each of five repairs we tested, reports indicated contractors completed repairs within a reasonable timeframe after defect was identified during a dig (i.e., between 23 and 64 days). Also, for each of these five repairs, reports contained required documentation, and evidence of verification and approval of repairs completed. None of these five repairs exceeded 100 metres in length; therefore, they did not require regulator approval.

Robust processes to plan, conduct, and complete timely repairs increases pipeline integrity and safety, and reduces risk of pipeline failures.

5.0 Transmission Pipeline by Class

SaskEnergy classifies its transmission pipelines based on the CSA Z662 standard requirements using population density in a specified geographical area.

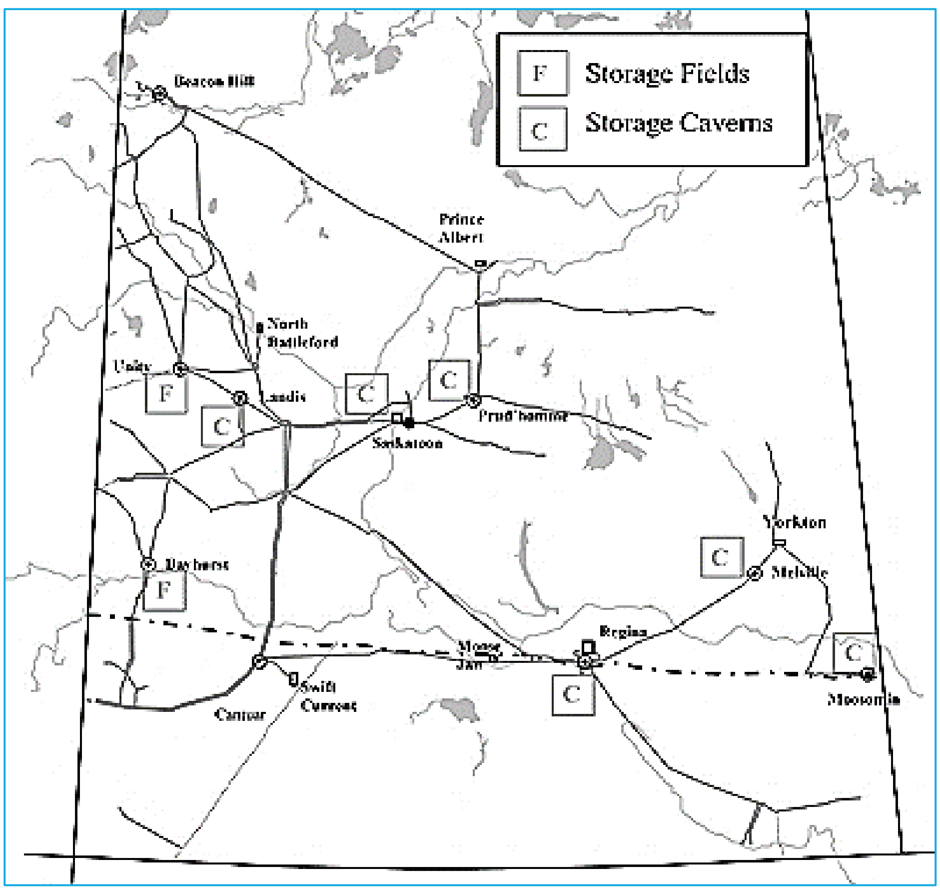
SaskEnergy's Transmission Pipeline by Class

Class	Description	Number of Kilometers	% of Total Kilometers
1	10 or less residences	14,880	99.20
2	11-45 residences, a building or outside area with 20 or more people during normal use (e.g., playground or recreation area), and /or an industry such as a chemical plant	92	.6
3	46 or more residences	30	.2
4	Mostly apartments and condominiums with four or more stories	0	.0
		15,002	**100**

Source: Adapted from www.cer-rec.gc.ca/bts/ctrg/gnnb/flngmnl/archive/2017gd-e-cnslttn/bckgrndr-eng.html (25 March 2020) and SaskEnergy records.

SaskEnergy monitors the class location for each section of its transmission pipeline for development and environmental changes. It also plans some of its inspection activities based on the class of the pipeline. If a pipeline's class changes (e.g., development near a class 1 pipeline causes it to become a class 2 pipeline), SaskEnergy may need to adjust how often it performs its inspection activities.

6.0 Transmission Pipeline Map



Source: Adapted from SaskEnergy records.

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