Chapter 25
SaskPower—Maintaining Above-Ground Distribution Assets

1.0 Main Points

Both industry and households rely on the availability of power. Power helps us communicate, heat our homes, cook our food, and enjoy technology. Power is also critical to economic growth and security.

SaskPower maintains one of the largest electricity transmission and distribution systems in Canada. Effective maintenance is key to providing customers with a safe, reliable source of power. It reduces the risk of unplanned power outages, higher costs of supplying power, or power blackouts during peak times.

This chapter reports on the results of our audit of SaskPower's processes to maintain above-ground assets used to distribute electricity. Above-ground assets used to distribute electricity include wood poles, power line conductors, voltage regulators, reclosers, overhead switches, poletop transformers, and capacitor banks.[1] In this report, we refer to these assets as above-ground distribution assets.

SaskPower's processes to maintain its most significant above-ground distribution asset, wood poles, were more mature than its processes for its other above-ground distribution assets. This experience may help it to improve processes for maintaining its other above-ground distribution assets. To improve its maintenance processes for those other assets, SaskPower needs to:

- Complete formal risk assessments to support its strategies for inspections and preventative maintenance. Formal evidence-based risk assessments would help SaskPower determine the optimal type and timing of maintenance.

- Gather complete information about asset condition needed for risk-informed asset planning. Such information would help SaskPower focus its resources on assets with the highest risk of significant failure, or posing the greatest safety risks.

- Formally prioritize maintenance to support a risk-informed allocation of resources over the longer term. Prioritizing would help SaskPower use its maintenance resources wisely by scheduling the right maintenance at the optimal time.

- Formally determine the consequences of not maintaining assets as planned, and report them regularly to senior management. Knowing the consequences of deferring maintenance would help SaskPower assess the risks of asset failure and safety incidents, and anticipate increased costs.

[1] Above-ground assets to distribute electricity do not include power substations or streetlights and related assets that SaskPower is responsible for maintaining.

2.0 INTRODUCTION

2.1 Providing Power in Saskatchewan

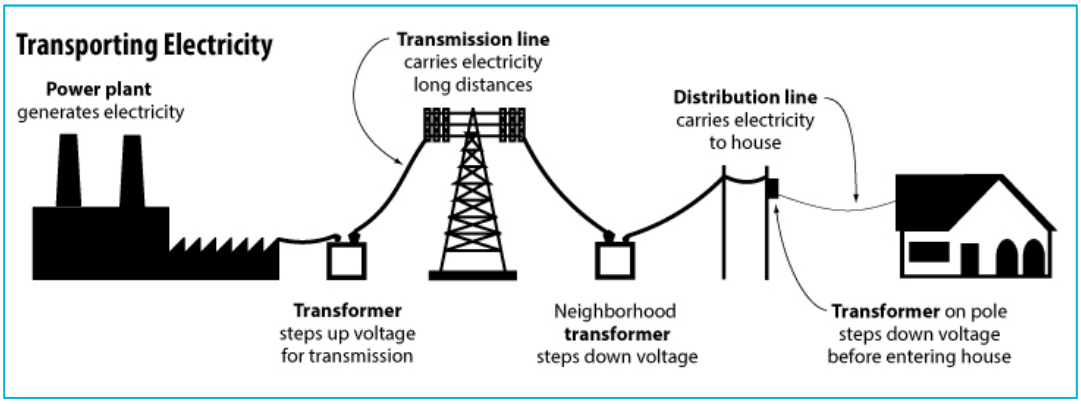
SaskPower is the principal supplier of electricity in Saskatchewan. SaskPower operates primarily under the mandate and authority of *The Power Corporation Act*. Its corporate mission is to ensure reliable, sustainable, and cost-effective power for its customers and the communities it serves.[2]

Each year, it generates, transmits, and distributes power to nearly 533,000 customers over approximately 652,000 square kilometres.[3] Its customer base has grown by nearly 32,000 customers (or 6%) during the past five years (i.e., from 2013 to 2018).[4]

As shown in **Figure 1**, SaskPower generates electricity in power plants (using generation assets), transmits this electricity at high voltages on transmission lines (using transmission assets), and then lowers the voltage and distributes the electricity to consumers through a series of distribution lines (using distribution assets).[5] At March 31, 2018, SaskPower owned $2.4 billion of assets used to distribute electricity including above-ground distribution assets.[6]

See glossary in **Section 5.0** for technical terms used.

Figure 1—Transporting Electricity (Generation, Transmission, Distribution)



Source: Adapted from National Energy Education Development Project graphics library (public domain).

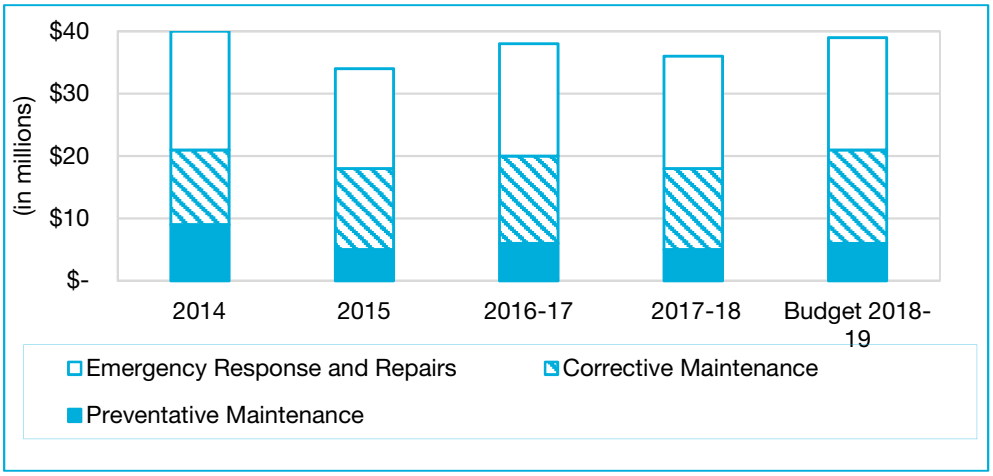
SaskPower makes one of its nine divisions—the Asset Management, Planning and Sustainability Division—responsible for planning and prioritizing SaskPower's investment needs for core assets including power generation, transmission, and distribution assets. Its Distribution Asset Management and Planning Group is comprised of over 30 full-time equivalent positions whose responsibilities include planning maintenance of above-ground distribution assets.

SaskPower makes staff within its Operations and Maintenance group responsible for carrying out maintenance of distribution assets.

[2] SaskPower, *SaskPower 2017-18 Annual Report*, p. 9.
[3] Ibid.
[4] Ibid., p. 125.
[5] Distribution lines use a combination of above-ground and below-ground assets to distribute power.
[6] SaskPower, *SaskPower 2017-18 Annual Report*, p. 89.

As shown in **Figure 2**, SaskPower's spending on maintenance of its existing distribution assets fluctuated slightly over the past four years. In 2018-19, SaskPower expects to spend about $39 million maintaining its existing distribution assets, and $197 million for capital projects to sustain, improve, and connect new customers to SaskPower's distribution infrastructure.[7]

Figure 2—Five-year Trend of Distribution Asset Maintenance Expense from 2014 to 2019[A]



Source: SaskPower financial records.
[A] In common with other CIC Crowns, SaskPower changed its fiscal year to March 31 from December 31 effective January 1, 2016. For 2015, results are for the 12-month period January 1, 2015 to December 31, 2015. For 2016-17, results are for the 12-month period April 1, 2016 to March 31, 2017.

2.2 Importance of Maintaining Power Distribution Infrastructure

SaskPower maintains one of the largest transmission and distribution systems in Canada, but, relative to other power utility companies, has relatively few customer accounts.[8] Saskatchewan has about 3.5 customer accounts per circuit kilometre as compared to the Canadian average of 18.0 customer accounts per circuit kilometre.[9] This means that it must spread the cost to sustain and maintain this system across a modest number of customers.

In 2017, the Saskatchewan Rate Review Panel recommended SaskPower limit its growth in Operations, Maintenance and Administration expense per customer account to less than the annual growth of Saskatchewan's consumer price index.[10] This puts greater pressure on SaskPower to spend its maintenance dollars in the right place at the right time.

Much of SaskPower's distribution infrastructure is aging (i.e., built between 1950 and 1965).[11] Over the past five years, aging infrastructure caused 34% of SaskPower's unplanned power outages.[12]

[7] SaskPower financial records.
[8] Saskatchewan Rate Review Panel, *Review of SaskPower's 2018 Rate Application*, p. 12-1.
[9] SaskPower records.
[10] The Saskatchewan Rate Review Panel made this recommendation in its November 7, 2017 *Report to the Minister Responsible for Crown Investments Corporation of Saskatchewan Regarding the SaskPower 2016 and 2017 Rate Application*, p. 22.
[11] SaskPower, *SaskPower 2018 Rate Application*, p. 11.
[12] SaskPower records.

SaskPower has identified the risk that the rate at which its power transmission and distribution infrastructure is aging could be outpacing its sustainment and maintenance activities. This risk can result in unplanned power outages, higher costs, or power blackouts during peak times.[13]

Planning for and completing required maintenance is essential for providing customers with a reliable source of power. Unplanned power outages resulting from unplanned repairs can be disruptive and costly. Improper or untimely maintenance could result in unplanned outages negatively affecting businesses who need power to operate, or public safety. Excessive deferred maintenance can reduce asset value or service life (e.g., having to replace earlier than intended), and cause high-cost major repairs.

3.0 Audit Conclusion

We conclude that, for the period March 1, 2017 to April 30, 2018, Saskatchewan Power Corporation had effective processes, other than in the following areas, to maintain its above-ground assets used to distribute electricity. With respect to these assets, SaskPower needs to:

- **Complete formal risk assessments to support its strategies for inspections and preventative maintenance**
- **Gather complete information about asset condition needed for risk-informed asset planning**
- **Formally prioritize maintenance to support a risk-informed allocation of resources over the longer term**
- **Formally determine the consequences of not maintaining assets as planned**
- **Report regularly to senior management the consequences of not completing planned maintenance**

SaskPower identified wood poles as its most significant above-ground distribution asset. SaskPower's processes to maintain wood poles were more mature than its processes for other above-ground distribution assets—it may be able to use its experience in maintaining wood poles to help it improve its processes for maintaining its other above-ground distribution assets.

Figure 3—Audit Objective, Criteria, and Approach

Audit Objective:

The objective of this audit was to assess the effectiveness of Saskatchewan Power Corporation's processes, for the period March 1, 2017 to April 30, 2018, to maintain above-ground assets used to distribute electricity.

Above-ground distribution assets include wood poles, power line conductors, voltage regulators, reclosers, overhead switches, poletop transformers, and capacitor banks. See **Figure 4** for a description of each of these assets.

[13] SaskPower, *SaskPower 2016-17 Annual Report*, p. 65.

Audit Criteria:

Processes to:

1. Keep reliable information on significant assets
   1.1 Identify significant assets, including components, that must be maintained
   1.2 Determine long-term performance requirements (e.g., expected service life, acceptable asset condition)
   1.3 Maintain current, reliable information needed to manage maintenance (e.g., asset condition, remaining service potential, estimated maintenance costs, estimated replacement costs)
   1.4 Assess risk that significant assets will not meet long-term performance requirements
2. Develop a maintenance plan
   2.1 Establish specific maintenance strategies and performance measures
   2.2 Set maintenance priorities (short, medium, and long term)
   2.3 Evaluate strategies against available resources (short, medium, and long term costs)
3. Carry out maintenance effectively
   3.1 Use recognized maintenance standards
   3.2 Implement maintenance procedures consistent with standards
   3.3 Provide staff with guidance on use of maintenance procedures
   3.4 Track maintenance activities
4. Monitor performance of maintenance
   4.1 Analyze progress in carrying out maintenance plan
   4.2 Periodically report on maintenance activities (e.g., progress against maintenance plan, total deferred maintenance) to internal and external stakeholders (i.e., Board, CIC, public)
   4.3 Adjust plans as new information becomes available

Audit Approach:

To conduct this audit, we followed the standards for assurance engagements published in the *CPA Canada Handbook – Assurance* (CSAE 3001). To evaluate SaskPower's processes, we used the above criteria based on our related work, reviews of literature including reports of other auditors, and consultations with management. SaskPower's management agreed with the above criteria.

We examined SaskPower's policies and procedures that relate to maintaining above-ground assets used to distribute electricity. We interviewed SaskPower staff responsible for planning, carrying out, and reporting on maintenance. In addition, we reviewed related documentation (e.g., asset plans, maintenance strategies, contracts, monitoring reports). We consulted with an expert to help assess if SaskPower's processes aligned with best practice guidance (e.g., maintenance strategies, forms used to collect information on assets). We tested key aspects of SaskPower's processes, including samples of work orders, maintenance records, and staff training records.

Figure 4—Description of Above-ground Distribution Assets

Asset Type	Purpose
Wood Pole	➢ Provides structural support for above-ground distribution assets (e.g., power line conductors)
Voltage Regulator	➢ Continually adjusts (raises or lowers) the voltage on the distribution system to ensure that customers receive power within acceptable limits
Recloser	➢ Automatically isolates the distribution system to protect the public and prevent irreparable damage to assets from a sustained short circuit ➢ Improves service continuity by automatically isolating and restoring power to powerlines during momentary interruptions, such as lightning or wildlife contacts
Overhead Switch	➢ Enables isolation of a section of power line resulting in fewer customers being affected when an outage is required for scheduled maintenance or repairs; allows customers to be serviced from different feeders during a power outage so power can be restored while repairs are ongoing
Capacitor Bank	➢ Stores electrical energy to help tune and optimize the operation of the distribution network, thereby deferring the need and expense of additional capacity on the electrical delivery system

Asset Type	Purpose
Poletop Transformer	➢ Transforms higher voltages from distribution power lines down to a useable voltage that end users can utilize; provided as close to customers' sites as possible to avoid energy losses that are amplified at lower voltages
Power-line conductor	➢ Electrical wires and associated hardware that transmit electrical energy along long distances; consists of one or more conductors (i.e., physical wire) suspended by towers or poles, often in groups of three.

Source: Developed by Provincial Auditor based on research and SaskPower's records.

4.0 Findings and Recommendations

4.1 Adoption of Asset Management Strategy Underway

In the spring of 2018, SaskPower was in the early stages of adopting a new corporate-wide asset management strategy.[14] Maintenance is one aspect of asset management.

The asset management strategy takes a risk- and evidence-based approach to managing assets through their entire life cycle (from purchase to disposal or decommission). This strategy requires linkage between decisions about asset management to SaskPower's overall strategic direction.

SaskPower's corporate-wide policy, the Power Operations Asset Management Policy, supports its move towards this new asset management strategy. The objectives of the Policy are to:

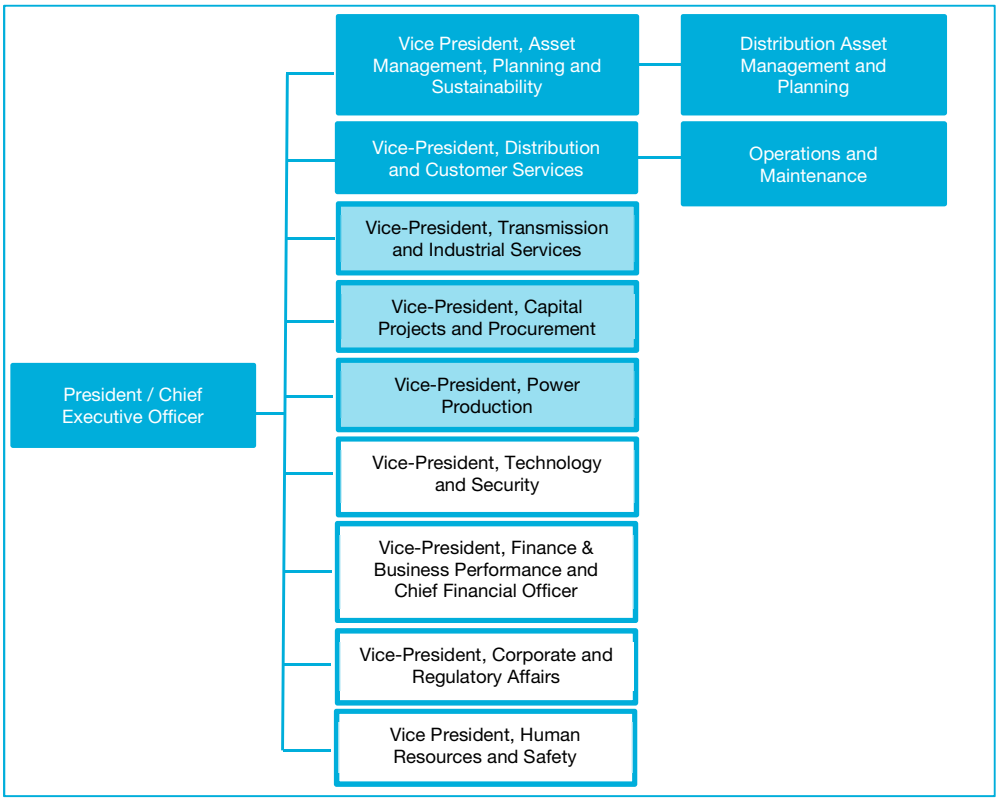
- Understand the risk profile associated with assets and how this changes over time
- Determine the business consequences of reducing or increasing the capital or maintenance budgets today and in the years ahead
- Justify planned asset expenditures to internal and external stakeholders
- Ensure that employees have the right competencies and capabilities for managing the organization's assets
- Ensure continuous improvement

Implementing the asset management strategy requires a co-ordinated approach and sharing of information between various parts of SaskPower.

As shown in **Figure 5**, most of SaskPower's divisions actively manage different aspects of SaskPower's power infrastructure and related assets. They make decisions about sustaining or maintaining it, and about using it to generate or deliver power. In addition, they provide support to do so (e.g., financial budgeting, costing, and IT systems).

[14] SaskPower, *SaskPower 2017-18 Annual Report*, p. 63.

Figure 5—SaskPower Organization Structure and Responsibilities for Asset Management



Source: SaskPower Records.
Blue shaded cells are actively involved in managing power infrastructure and assets. Darker blue shading indicates units that are directly involved in maintenance of above-ground distribution assets.

SaskPower's Asset Management, Planning and Sustainability Division is leading the adoption of the corporate-wide asset management policy. Its Distribution Asset Management and Planning Group plans for the maintenance of power distribution assets including above-ground distribution assets, which its Operations and Maintenance group carries out.

We found members of its Distribution Asset Management and Planning Group had a clear understanding of their responsibilities about planning for the maintenance of above-ground distribution assets, and the Group's role in contributing towards the implementation of the new Asset Management Policy. For example, as part of implementing the new policy in 2017-18, the Group began creating written asset management plans for significant types of distribution assets (e.g., wood poles, voltage regulators).

In general, the asset management plans or other maintenance planning documents set out the following:

- Importance of the asset type to the power supply system (e.g., integral to the reliability of the distribution of power)
- General risk if SaskPower does not sufficiently maintain the assets (e.g., more or longer outages, reduced customer experience, more employee safety incidents, and higher costs)
- Broad maintenance strategy (preventative maintenance, run-to-failure)[15]

[15] Run-to-failure strategy means staff do not actively carry out preventative maintenance, but only replace assets when they fail (no longer work).

- Expected frequency (i.e., timing) of inspections and preventative maintenance (see **Figure 6**)

- Key specific maintenance activities to undertake in conjunction with inspections, and estimated number of labour hours to complete each activity

While the Group had drafted some asset management plans, it had not completed any of them as of April 30, 2018. It expected to complete them by early 2019.

4.2 Formal Risk Assessments Needed to Support Inspection and Preventative Maintenance Strategies

While SaskPower had broad maintenance strategies for each of the above-ground distribution asset types, it had not completed formal (evidence-based) risk assessments to support its decisions to use these strategies and how often.

As shown in **Figure 6**, SaskPower expects to do preventative maintenance for five of the seven types of these assets at the same time as it inspects the condition of the asset.

Figure 6—Above-ground Distribution Assets

Asset description	Number of Assets in Use at February 2018	Estimated Replacement Value (in millions)	Uses a Preventative Maintenance Strategy	Inspection and Preventative Maintenance Cycle	Average Age (years)[B]	Average Life for Accounting Purposes (in years)
Wood Poles	1,121,739	$ 2,650.0	Yes	10 years[D]	37.5	35
Voltage Regulators	1,217	$ 32.2	Yes	4 weeks	Unavailable[E]	35
Reclosers	2,572	Unavailable[C]	Yes	Annual	Unavailable[E]	35
Overhead Switches	3,769	$ 74.0	Yes	5 years	Unavailable[E]	35
Capacitors[A]	1,015	$ 2.0	Yes	Annual	9.7	35
Poletop Transformers	123,835	$550.0	No	Not Applicable – run to failure	23.5	35
Power-line conductors (circuit kilometres of power lines and associated hardware)	89,019 km	Unavailable[C]	No	Not Applicable – run to failure	Unavailable[E]	35

Source: Developed by Provincial Auditor Saskatchewan based on information available in SaskPower's asset management records and asset management plans.
[A] Capacitors are normally operated in banks of three assets (i.e., a capacitor bank typically has three unique assets).
[B] Information in SaskPower records. SaskPower is aware its records do not always include the age of individual assets, so the average age may not accurately represent the fleet.
[C] This information was not available at October 1, 2018, as SaskPower had not completed an asset management plan for these assets (this information is typically maintained within the asset management plans).
[D] SaskPower's initial strategy was to complete the maintenance over a 10-year cycle. SaskPower extended the current inspection cycle from 10 to 11 years due to budget constraints.
[E] This information was not available at October 1, 2018, as SaskPower did not have complete data.

We found these broad maintenance strategies (e.g., preventative maintenance, run-to-failure) are generally consistent with industry practice. Industry practice can vary based on assessments of risk (i.e., comparing the cost of inspections and preventative maintenance to the benefits). In addition to deciding whether to complete preventative maintenance, industry practice supports differing preventative maintenance intervals if the cost of maintaining individual assets exceeds the benefits (e.g., safety, less frequent or shorter outages).

We found SaskPower informally assessed risks that support its strategies not to actively maintain power line conductors (due to Saskatchewan's low corrosive environment) and poletop transformers (as replacement is cheaper than preventative maintenance). SaskPower did not use formal risk assessments to validate its broad maintenance strategies for the other assets. Rather it based its decisions on expertise and experience of management.

We found SaskPower had determined a preventative maintenance interval for wood poles of 11 years—an interval supported by industry practice.[16] Industry practice supports a 5 to 12 year preventative maintenance interval for wood poles.

SaskPower outsourced the inspection and maintenance of its wood poles. Its two-year maintenance contract with a service provider was robust. It clearly set out the inspection cycle and timing of maintenance for wood poles.

For the other asset types with planned preventative maintenance, industry practice sometimes provided ranges for routine inspection intervals, but it generally indicated that preventative-maintenance cycles should be based on asset activities and issues (i.e., evidence-based risk assessments). For example, industry practice suggests inspection of voltage regulators could be from every month to every five years, while for reclosers inspection frequency could be based on operation counts or oil sample trends. SaskPower's strategy required voltage regulators be inspected every four weeks and reclosers annually.

As noted in **Section 4.6**, SaskPower inspected above-ground distribution assets less often than it planned.

We found that SaskPower had not completed formal risk assessments to determine whether the expected frequency of its inspection cycle for each type of asset was cost-effective (whether it was inspecting too often or not enough) other than the following. SaskPower adjusted its planned inspections to inspect assets at higher risk of polychlorinated biphenyl, or PCB, contamination (e.g., capacitor banks in 2016-17, poletop transformers) to meet environmental regulatory requirements.

Risk assessments include identifying risks associated with decisions, determining the likelihood and impact of those risks on an organization`s business, and using strategies to mitigate those risks.

Without formal risk assessments to support the frequency of inspections and preventative maintenance, SaskPower is at greater risk of not doing the right maintenance at the right time to limit the risk of asset failure or safety issues, or not using its resources effectively.

[16] While SaskPower's initial strategy was to complete the maintenance over a 10-year cycle, SaskPower extended the current inspection cycle from 10 to 11 years due to budget constraints.

1. **We recommend that Saskatchewan Power Corporation formally assess the risks associated with its inspection and preventative maintenance strategies for above-ground assets used to distribute electricity.**

Preventative Maintenance Activities in Accordance with Best Practice

We found SaskPower used industry best practice guidance and manufacturer recommendations to outline the preventative maintenance activities it expected its staff to complete during inspections. For example, it expected staff to apply chemical treatment to prevent further decay of wood poles and to replace recloser batteries.

Consistent with industry best practice, SaskPower expected staff to vary maintenance activities depending on factors such as the assessed condition of the asset, expected timing of asset replacement, and cost of maintenance. SaskPower expects staff to use their knowledge and experience to decide what specific maintenance to undertake at the time of the inspection, and what maintenance or repairs to defer to a later date.

4.3 Desired Acceptable Asset Condition Not Yet Determined for All Above-Ground Distribution Assets

SaskPower had not determined the condition at which it expected to keep most of its above-ground distribution assets, to guide the nature and extent of maintenance activities to undertake. This is commonly referred to as a health index or condition rating.

SaskPower had a clear condition rating for wood poles. The condition rating considered factors such as the estimated remaining pole strength, the condition of pole top and cross arms, the age of the pole, the pole treatment type, and the overall pole condition. SaskPower used the condition rating to assess the condition, required maintenance, and prioritization of maintenance for wood poles.

The wood-pole condition rating used a rating system of very good, good, fair, poor, and very poor to define if maintenance should continue. For example, a wood pole in good condition requires normal maintenance, whereas, a pole in fair condition may require increased monitoring and possible remedial work, or replacement.

Although SaskPower determined expected service life for its other above-ground distribution assets, it had not documented what it considers an acceptable condition rating. As noted previously, SaskPower expected staff to vary maintenance activities depending on factors such as the assessed condition of the asset. About 429 full-time positions located throughout Saskatchewan were responsible for inspecting and maintaining these assets. Not having guidance increases the risk of staff making inconsistent decisions about unplanned maintenance identified during similar situations.

Management advised us that it plans to develop condition-rating systems for the other assets in conjunction with its implementation of the asset management policy.

For assets it plans to maintain, not determining desired acceptable condition for each type of above-ground distribution asset increases the risk that SaskPower will not focus its

maintenance resources on assets with the highest risk of significant failure or posing safety risks. In addition, not having a desired acceptable asset condition makes monitoring the effectiveness of maintenance strategies more challenging.

2. **We recommend, for above-ground assets used to distribute electricity that Saskatchewan Power Corporation plans to maintain, it determine the condition to which it expects to maintain each type of those assets.**

4.4 Complete and Consistent Information Needed to Develop Risk-informed Maintenance Plans

SaskPower did not have complete and consistent key data about all of its above-ground distribution assets to support the development of risk-informed maintenance plans.

Other than wood poles, it did not have complete and consistent data about its assets (e.g., number, age, name of manufacturer, model number), their condition, and completed maintenance activities (e.g., repair history, date of last inspection, results of inspections). In addition, it did not always keep up-to-date information about some of its above-ground distribution assets. It also did not have a ready way to do broader analysis of asset information across its various IT systems to support maintenance planning.

Inconsistent Asset Information Across IT Systems

Above-ground distribution assets (other than wood poles) were not consistently tracked among SaskPower's different IT systems that it used to manage those assets.

SaskPower used a number of different IT systems to track its distribution assets and related key information. These IT systems can track the same asset in more than one system, with each system tracking different types of information about that asset. For example, for an individual asset:

- Asset system (Electric Office) tracks the nameplate (e.g., manufacturer, model number, serial number, certifications, voltage, frequency), spatial and network data, and certain operational settings (e.g., tap position on a regulator controller matches the tap position on the voltage regulator).[17] It used this system as the main information source for all of its assets in use as it contains the detailed information on each asset.

- Work order system (module within SAP) tracks nameplate and financial information.[18] SaskPower used this system to issue work orders for inspections and preventative maintenance automatically for individual voltage regulators and reclosers and manually for groups of its other assets. It also used it to manually order repairs for problems identified during inspections. The work order system also tracks spare equipment and parts.

[17] Tap position is used to indicate the current position of the motor-drive unit or tap changer in any location (usually in the control room). Adapted from www.reinhausen.com/desktopdefault.aspx/tabid-1922/2772_read-7849/ (27 September 2018).
[18] SAP stands for Systems, Applications and Products in data processing. It is a multi-functional system that SaskPower utilizes for its business.

- Inspection system (FSII) tracks the detailed inspection and preventative maintenance records for assets. SaskPower used this system to record the detailed results of inspections and preventative maintenance, including the condition of the inspected assets.

SaskPower uses information in its IT systems to determine when to inspect certain asset types (i.e., voltage regulators and reclosers), track maintenance completed, and track power outages caused by failure of assets.

To support issuing work orders automatically, SaskPower expected the individual voltage regulators and reclosers included in its work order system and in its asset system to match. It uses work orders to direct maintenance staff when to inspect these assets, and when to complete corrective maintenance. As shown in **Figure 7**, in February 2018, the number of voltage regulators in its work order system was 30% more than in its asset system; similarly, the number of reclosers in its work orders system was 57% more than in its asset system.

Figure 7—Difference in Number of Regulators and Reclosers in IT Systems at February 2018

# of assets	Voltage Regulators	Reclosers
Asset system (Electric Office)	1,217	2,572
Work order system (SAP)	1,580	4,035
% difference	30%	57%

Source: Provincial Auditor Saskatchewan based on information available in SaskPower's IT systems.

We found that SaskPower was aware that information in these key IT systems did not agree.[19] It did not have an efficient way to reconcile information between these systems, or compare information on the same asset(s) from them because these systems did not have a common identifier.

A common identifier enables linking or matching of key information between the systems. For example, a common identifier could be a unique identification number for each asset. Without a common identifier, management needs to use manual processes to analyze data across IT systems to make asset planning decisions, which is labour intensive (i.e., slower, costs more). For example, asset condition from the inspection system and time of last inspection from the work order system can help SaskPower decide when to next inspect an asset. A common identifier would allow the IT systems to share this type of information so that SaskPower could issue work orders automatically for more assets and efficiently analyze data to support evidence-based asset planning.

SaskPower adjusted its corrective maintenance order form to collect identifiers (e.g., circuit number of asset, asset identifier like equipment code) to allow tracking of maintenance completed and the related cost in its systems. Since 2012, it has requested staff completing maintenance to provide this when completing the work orders. However, we found staff completing the maintenance often omitted completing these parts of the form.

[19] Management advised us that the differences between the number of assets between the systems may be partly due to the following. The work order system tracks spare equipment and parts not in use along with assets in use; whereas, the asset system only tracks assets in use.

Our analysis of corrective maintenance orders issued for the month of February 2018 found 95% of them did not record a circuit number, and 99% of them did not record an asset identifier.

Without consistently maintaining key information about above-ground distribution assets within its IT systems, and the ability to link data across these systems, SaskPower will not have sufficient information to support evidence-based maintenance planning for these assets. This includes formally assessing risks associated with its inspection and preventative maintenance strategies. Evidence-based planning helps determine the optimal type and timing of maintenance.

3. **We recommend that Saskatchewan Power Corporation consistently maintain in its IT systems key information about its above-ground assets used to distribute electricity to support evidence-based decision-making.**

Information on Asset Location, Circuit, Voltage Rating Generally Complete and Accurate

SaskPower collected and maintained generally complete and accurate information in its IT systems about individual above-ground distribution asset's location, circuit, and voltage rating. It collected and then tracked this information when it either installed the asset, or inspected an existing asset where it had previously missed collecting this information.

Information on Condition of Above-Ground Distribution Assets Not Always Kept Up-to-date

Because SaskPower did not inspect above-ground distribution assets (other than wood poles) as frequently as it expected, it did not always have up-to-date information about their condition.

SaskPower used inspections of individual assets to verify the accuracy and completeness of information in its IT systems, and to determine the current condition of each asset. As shown in **Figure 6**, SaskPower expected to inspect most of its above-ground distribution assets at routine intervals (e.g., every four weeks, annually).

SaskPower used work orders and inspection or collection forms to guide staff as to what information to collect and how often. We found these orders and forms supported collection of information as required by the maintenance plans.

SaskPower completed inspections of its wood poles as planned. It had reasonably up-to-date information about their condition. We noted that SaskPower outsourced their inspection and maintenance. Its two-year maintenance contract with a service provider was robust. The contract clearly set out the inspection cycle for wood poles, processes to assess the condition of poles (condition rating), acceptable condition, expected maintenance activities based on assessed condition, and timing of maintenance to complete.

SaskPower did not always inspect other types of above-ground distribution assets as often as expected for the last few years. For example, from our analysis of information in

its IT systems, we determined SaskPower had never inspected 71% of its switches (it expects to inspect them every five years). We also found that, during 2017-18, it completed less than two-thirds of planned inspections (see **Recommendation 6**).

Management is considering the use of remote monitoring to efficiently collect data about the condition of certain assets (e.g., number of times a switch is operated, overload events).

Without asset condition information about above-ground distribution assets, SaskPower cannot analyze if it is completing the right maintenance at the right time to achieve desired asset condition levels. SaskPower needs this analysis to inform its risk assessments for planning maintenance of assets throughout their lives.

4. **We recommend that Saskatchewan Power Corporation maintain up-to-date information about the condition of its above-ground assets used to distribute electricity to support risk-informed asset planning.**

4.5 Formal Processes to Prioritize Maintenance Needed

SaskPower did not document its basis for prioritizing maintenance of above-ground distribution assets, including allocation of its maintenance budget.

We found that SaskPower's contract with its service provider sets out the budget and maintenance work for wood poles for the upcoming two years.

For other above-ground distribution assets, the Distribution Asset Management Planning Group used an informal process to prioritize specific maintenance activities (e.g., voltage regulator inspections and ground grid tests) for the upcoming year. It used its knowledge and experience to decide which specific maintenance activities to do first by ranking them from low to very high priority. It did not document the basis of its prioritization decisions.

To estimate the cost of specific maintenance activities for other above-ground distribution assets, the Group used budgeted labour hours for power line technicians, and estimated labour hours required for that maintenance activity.[20] Using these estimated costs, the Group allocated the maintenance budget for the upcoming year to the highest priority maintenance activities.

We found that in 2017-18, SaskPower identified that it did not have enough resources to complete all maintenance tasks assessed as very high or high priority.

We also found that SaskPower did not formally assess the implications of its maintenance prioritization decisions, including if it would have sufficient resources to complete maintenance deferred to the next year. Also, it did not determine if deferring maintenance activities would:

- Affect the nature and timing of future maintenance activities
- Pose increased safety risks

[20] Asset maintenance plans for most assets set out estimated labour hours for each maintenance activity.

- Contribute to a higher number of unplanned power outages
- Result in higher future maintenance costs

In addition, we found SaskPower did not have mid- to longer-term maintenance forecasts linked to its maintenance and capital plans. It did not estimate resources necessary to complete key maintenance tasks beyond the upcoming year, or the consequences where desired resources exceeded resources available (see **Recommendation 6**). As a result, it did not have this information to inform its maintenance prioritization decisions.

Not documenting the basis of prioritization, including allocation decisions, makes it difficult to assess if judgments made and assumptions used when making those decisions are reasonable and sufficiently based on evidence (e.g., current condition of assets, assets posing highest safety or disruption of power risks).

5. **We recommend that Saskatchewan Power Corporation formally prioritize its maintenance of above-ground assets used to distribute electricity to support risk-informed allocation of resources over the longer term.**

4.6 Maintenance of Most Above-Ground Distribution Assets Not Completed As Planned

SaskPower did not complete preventative maintenance of most of its above-ground distribution assets as it had planned. Also, it did not actively monitor the completion of corrective maintenance identified as needed during inspections.

Wood Pole Maintenance Completed as Planned

SaskPower completed maintenance of its wood poles as planned. At April 2018, SaskPower was in year 7 of 11 of its wood pole maintenance cycle. It actively monitored maintenance work completed by its contractor. It reviewed weekly activity reports to monitor progress. It hired an independent third party to check the quality of the maintenance performed.

In 2017-18, SaskPower completed planned maintenance for 94% of wood poles. We found the reason for not completing the remaining inspections reasonable (e.g., new pole; restricted access to the pole due to private property, safety concerns, or environmental restrictions; plan existed for replacing the pole).

Related Facts

Wood pole maintenance costs approximately $50 per pole on average, while replacement costs are about $2,500 per pole. Without maintenance, the life expectancy of a wood power pole may be as short as 25 to 30 years. Through SaskPower's maintenance program, that life expectancy can extend to more than 65 years.

Source: www.saskpower.com/our-power.../distribution-wood-pole-replacement-program/ (October 2018).

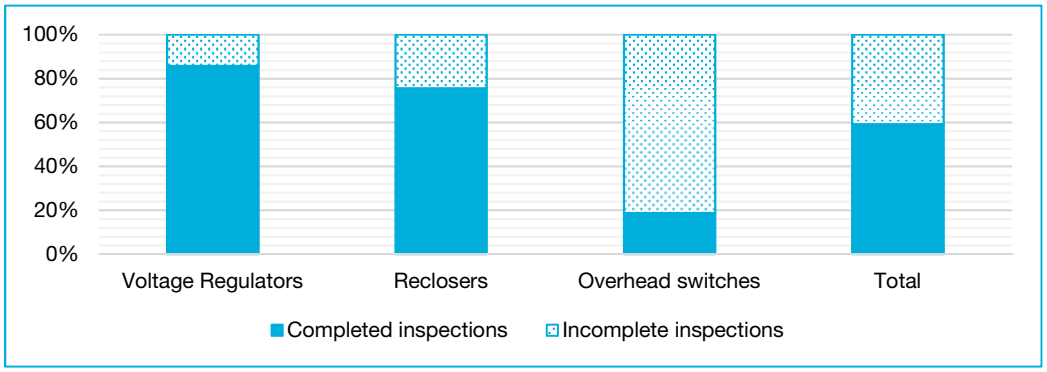
Maintenance Not Completed as Planned for Other Assets

SaskPower had not determined the consequences of not completing inspections and related preventative maintenance as often as it expected, or the impact of not scheduling corrective maintenance within the near term.

For its other above-ground distribution assets, our analysis of 2017-18 data found SaskPower did not complete almost one-half of its preventative maintenance.[21]

As shown in **Figure 8**, SaskPower's work order system indicated that it completed 86% of voltage regulators, 76% of reclosers, and 19% of overhead switch inspections as planned.[22] However, the information in these systems about completion of inspections and preventative maintenance was not always accurate.

Figure 8—2017-18 Inspection/Preventative Maintenance Completion Rates of Above-Ground Distribution Assets



Source: Developed by Provincial Auditor Saskatchewan based on information available in SaskPower's asset management records.

We found work orders were incorrectly recorded as completed in the work order IT system, and maintenance records were not updated as expected in its inspection system (i.e., the IT system that tracks details of inspections and maintenance completed). We found:

- Of the preventative maintenance recorded as completed in its work order system, only 35% of voltage regulators and 89% of reclosers had an electronic record detailing maintenance done. As a result, for those assets, SaskPower did not have record of what specific preventative maintenance staff did, if any.

- Management advised us that SaskPower sometimes recorded maintenance as completed in its work order IT system even though it did not have record of maintenance done. They also indicated that, in these cases, SaskPower informally decided to defer the maintenance to the next cycle, as they felt SaskPower did not have sufficient resources available to complete that maintenance activity.

Not correctly documenting completion of preventative maintenance results in SaskPower using inaccurate information about its assets (e.g., condition data, historical maintenance completed) to assess risks and make decisions about its assets.

We also found SaskPower often did not issue work orders to schedule corrective maintenance or know the impact of not doing corrective maintenance in the near term (e.g., within the next six months). SaskPower expects its Distribution Asset Management and Planning Group staff to issue work orders to schedule corrective maintenance identified during inspections. We found:

[21] We determined that based on information in its IT systems, it did not complete 41% of its preventative maintenance.
[22] SaskPower did not plan to do inspections/preventative maintenance on capacitor banks in 2017-18. This decision was based on all capacitor banks being recently inspected and/or replaced in 2016-17 or 2017-18 as a result of work to ensure compliance with federal environmental standards for PCB.

- For four of nineteen inspections that we tested, staff identified, during the inspection, items that require corrective maintenance (e.g., repairs), and, as expected, recorded this information in SaskPower's inspection system.[23] However, only one of four inspections that identified a need for repairs resulted in a work order to complete the repairs.

- Our analysis of SaskPower's inspection IT system found SaskPower, as of February 2018, did not issue work orders for about 96% of corrective maintenance identified through inspections.[24] For example, SaskPower did not issue work orders for some overhead switches that were inoperable, and some reclosers that had missing or broken counters, which could lead to equipment failures that result in an unexpected power outage.

  While management advised us that it looks at these corrective maintenance items on an ad hoc basis, we did not find evidence of it doing so. Also, we did not find evidence where it formally assessed the risk or documented its rationale for not completing the corrective maintenance.

Not formally and routinely determining the consequences of not completing planned maintenance, including identified corrective maintenance, increases the risk of failure of distribution assets. Failure of these assets in turn can contribute to more and/or longer unplanned power outages, and higher costs for repairing or replacing assets.

6. We recommend that where Saskatchewan Power Corporation does not follow its plan for maintaining above-ground assets used to distribute electricity, it formally assess the consequences of not completing such maintenance.

4.7 Qualified Employees Completed Maintenance

SaskPower hired and contracted qualified staff to maintain above-ground assets used to distribute electricity.

SaskPower used a combination of staff and external contractors to maintain distribution assets. Its maintenance staff are journeyperson or apprentice power-line technicians. SaskPower provided staff with training to help them maintain their expertise. In its contract for wood-pole maintenance, it set education and experience requirements of the contractors, and required they attend start-up training and pass a written exam prior to working for SaskPower.

The 11 staff responsible for maintaining assets that we tested had the required education and experience and attended expected training. We also found that all 42 staff of the contractor successfully passed the competency exam in 2017-18.

4.8 Reporting of Maintenance Results Needed

While SaskPower periodically reports some information about the completion of maintenance for its above-ground assets used to distribute electricity, the reports did not

[23] As noted in **Section 4.2**, SaskPower expects to do preventative maintenance for five of the seven types of these assets at the same time as it inspects the condition of the asset.
[24] Corrective maintenance is also identified in other ways, such as customers calling to report malfunctioning or damaged equipment.

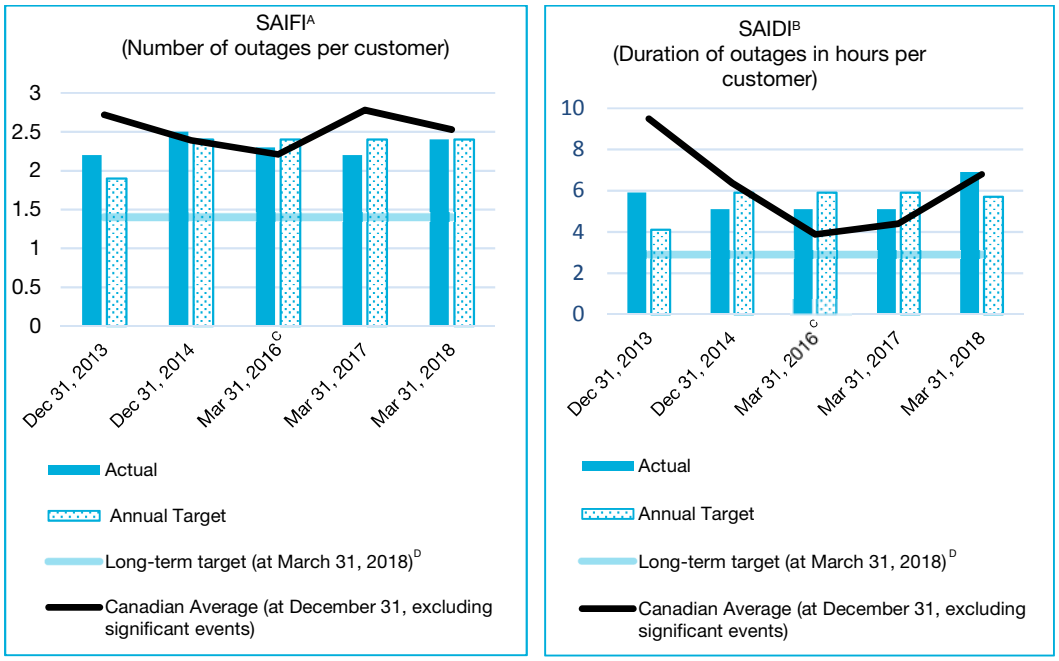
include a robust analysis of its progress in carrying out the maintenance plan to allow risk-informed decision-making.

On a corporate-wide basis, SaskPower monitors for how often and how long power outages occur in its transmission and distribution systems. Management responsible for distribution asset maintenance, senior management, and the Board each receive monthly reports with the following information. Monthly reports compare actual rates to short- (annual), medium-, and long-term targets, as well as the Canadian annual averages. SaskPower provides this information to the public in SaskPower's annual report.

In addition, SaskPower tracks factors that contribute to power outages (e.g., scheduled/planned outages, weather, and equipment faults). It uses this information to help understand general trends in outages.

For distribution, as shown in **Figure 9**, between 2013 to 2018, SaskPower`s results remained well below its related long-term targets. In general, SaskPower had fewer outages in its distribution system than the Canadian average, but the outages lasted longer. In 2017-18, SaskPower noted significant improvements in service levels depend upon making long-term increases in capital investment and enhancing maintenance activities.[25]

Figure 9—Distribution Outage Frequency (SAIFI) and Duration (SAIDI) Results Compared to Targets and Canadian Average from 2013 to 2018



Source: SaskPower Annual Reports; Canadian Electrical Association, CEA Outage Stats – SAIDI and SAIFI for Canadian Utilities.
[A] SAIFI - System Average Interruption Frequency Index represents the number of outages that an average customer experiences in one year (i.e., lower is better).
[B] SAIDI - System Average Interruption Duration Index measures the service interruption length in hours that an average customer experiences in one year (i.e., lower is better).
[C] The annual target for 2015-16 is the 2015 calendar year target. The actuals at March 31, 2016, were restated to match SaskPower's fiscal year.
[D] The long-term target for each measure has changed slightly over time; SaskPower has not met its long-term target in any year.

[25] SaskPower, *SaskPower 2017-18 Annual Report*, p. 33.

Management advised us that it does not have sufficient information to link changes in the System Average Interruption Frequency Index and System Average Interruption Duration Index directly to its maintenance activities to help determine if it is doing the right amount of maintenance in the right areas. SaskPower noted that it is improving its outage management IT system to better collect the reasons for unplanned outages to support decision-making.

In addition to monitoring frequency and duration of power outages, SaskPower monitored on a corporate-wide basis the percentage of planned maintenance completed (Planned Maintenance %), and, up to 2017-18, publicly reported on this measure in its annual report.[26] SaskPower met its target for 59% of its maintenance being planned/corrective as opposed to an emergency response for the period ending December 31, 2017.[27]

SaskPower also provided information about maintaining its distribution assets to management responsible for distribution asset maintenance through several ways:

- Receiving weekly reports on the status of maintenance and inspection of wood poles, to monitor its contractor, and determine whether inspection and maintenance activities were on schedule. SaskPower pays its contractor based on extent of work completed as determined by these reports.

- Receiving bi-weekly and monthly reports showing outstanding work orders and actual maintenance hours and labour costs by location and type of maintenance (e.g., planned, corrective, emergency).

- Holding bi-weekly leadership team meetings and quarterly meetings with district staff to discuss maintenance progress and operational issues

- Receiving monthly reports comparing actual to budgeted labour costs (monthly; year to date by location, crew, region, and overall) to monitor spending on maintenance activities.

We found these reports did not take into account the consequences of not having accurate information about its maintenance in its systems (e.g., missing inspection records to support that staff completed inspections).

We found, for above-ground distribution assets (other than wood poles), none of these reports clearly identified whether maintenance was behind or ahead of schedule. In addition, reports did not compare planned versus actual costs of key maintenance activities or set out the consequences of not completing preventative or identified corrective maintenance for those assets. See **Recommendations 3** and **4** about SaskPower needing consistent and up-to-date information about its above-ground distribution assets.

In April 2018, SaskPower gave its senior management a report that included information about completion of preventative maintenance, including preventative maintenance with no detailed record of maintenance done. While this report clearly showed that SaskPower completed preventative maintenance of its distribution assets less often than it expected, the report did not set out the consequences of not doing so.

[26] SaskPower decided to discontinue using Planned Maintenance % as a publicly reported measure starting in 2018-19.
[27] SaskPower, *SaskPower 2017-18 Annual Report*, p. 34.

Not reporting regularly to senior management if expected maintenance was completed for above-ground distribution assets increases the risk that senior management will not be able to correctly assess if the right maintenance is being done at the right time to prevent power outages and safety issues and manage costs. This analysis would also help SaskPower to decide when to replace assets.

7. **We recommend that Saskatchewan Power Corporation regularly report to its senior management on the status of its maintenance activities and, if applicable, the consequences of not completing planned maintenance for above-ground assets used to distribute electricity.**

5.0 Glossary

Asset Management — a formal, methodical, and holistic risk management business model that will convert corporate strategic priorities into business plans and actions that optimize the competing priorities of cost and performance at an acceptable level of risk in a sustained manner.[28]

Deferred Maintenance — maintenance work that has been postponed or phased for future action.

Distribution — from a sub-station, voltage is lowered through a series of smaller substations and transformers to reach customers in a safe low-voltage form along distribution lines.[29]

Maintenance — the processes of keeping existing assets in good condition to meet long-term performance requirements.

Preventative Maintenance — repairs and inspections intended to assist in systematic correction of emerging failures before they occur or before they develop into major defects.

Reactionary Maintenance — repairs that are in response to service requests and are completed as issues arise. This includes corrective and emergency maintenance.

Transmission — electricity leaves a generating plant and is raised to a high voltage to travel efficiently over long-distance transmission lines to a sub-station.

System Average Interruption Duration Index (SAIDI) Distribution — a measure of the service interruption length in hours that an average customer experiences in one year. SAIDI is influenced by a number of factors, including adverse weather, equipment condition, line contacts, extent of outage, travel time to the trouble point, as well as line staff availability, familiarity with facilities and level of experience.

System Average Interruption Frequency Index (SAIFI) Distribution — represents the number of outages that an average customer experiences in one year. Both controllable and uncontrollable interruptions are taken into account. Outages with controllable elements include infrastructure failures, tree contacts, scheduled outages, or loss of supply. Uncontrollable factors include lightning and other adverse weather conditions.

[28] SaskPower, *Power Operations Asset Management Policy*, p. 1.
[29] Adapted from SaskPower's *2017-18 Annual Report*, p. 127.

6.0 Selected References

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