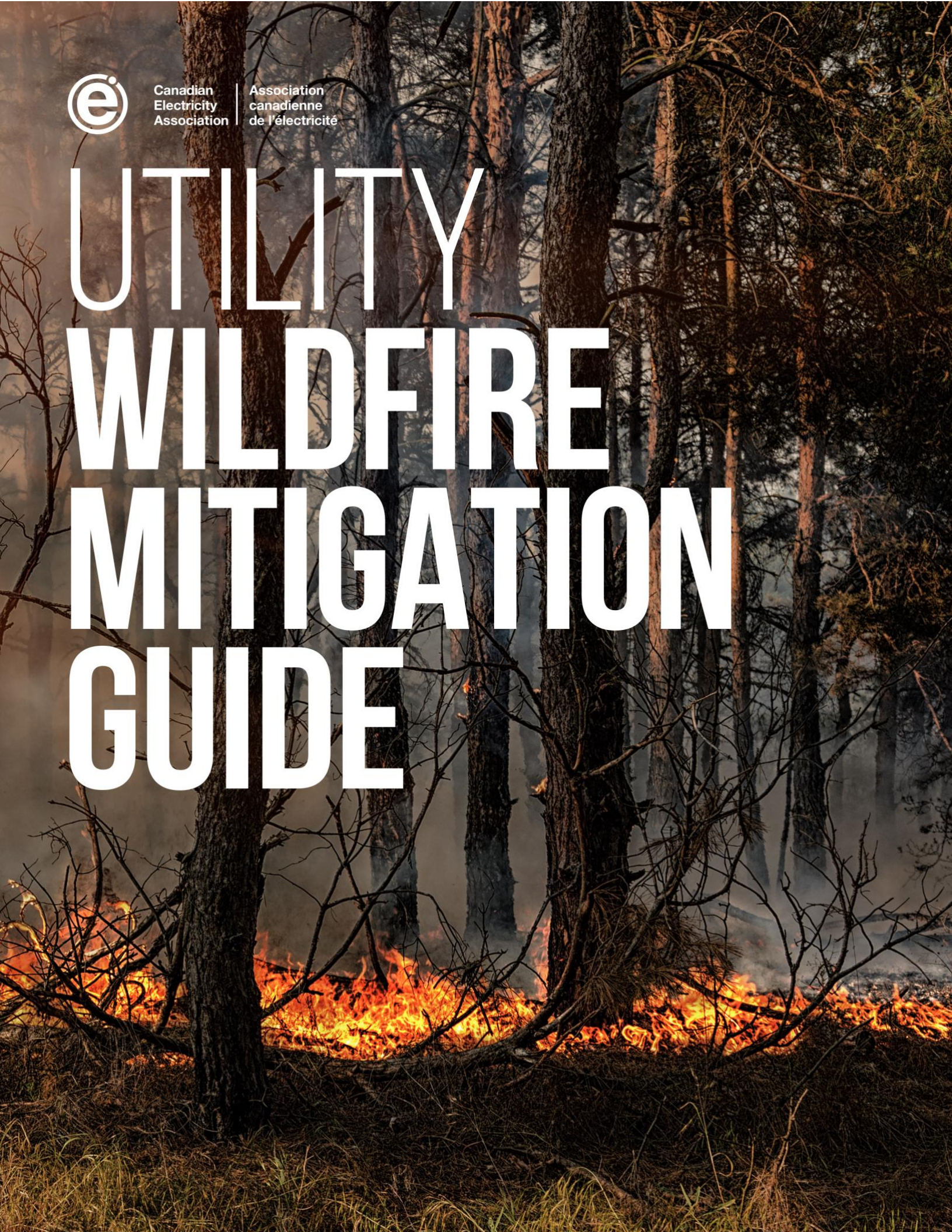

Canadian Electricity Association | Association canadienne de l'électricité

UTILITY WILDFIRE MITIGATION GUIDE

Canadian Electricity Association | Association canadienne de l'électricité

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Governance

The Transmission Council and its related committee the Best Practices Transmission Committee (BPTC) will review this document every 3 years with appropriate partners and or consulting entities in the field of wildfire mitigation to identify any best practice gaps that may arise with new procedures or technology. Those gaps and/or new practices will then be incorporated into the document. At which point the chairs of the Best Practices Transmission Committee and the Transmission Council will approve the document stating that the document has been reviewed and approved by both CEA entities.

Approved by	Chair of	Date
Gary Hart, AltaLink Management	Transmission Council	May 22, 2020
Paul Lee, AltaLink Management	Best Practices Transmission Committee	May 22, 2020

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Introduction

This Best Practice guide applies to all electricity transmission and distribution utilities that have assets in areas of wildfire risk.

The Best Practices document outlines activities that utilities should consider to:

- Prevent and mitigate the risk of utility assets igniting a wildfire
- Prevent and mitigate the risk of utility assets being impacted by a wildfire

Power industry assets are a possible source of wildfire ignition, as well as a receptor of potential negative fire impacts or damage. This document provides guidance for the electricity industry in Canada with the aim of reducing or eliminating ignitions and promoting industry resilience to wildfires while maintaining safe and reliable service to customers.

Fire Risk Drivers

Wildfire Trends

Wildfire seasons are getting longer due to climate change. There are more people than ever before living and working in fire-prone areas, and Canada's forests are becoming increasingly flammable as a result of forest management, forest insect and disease, and fire suppression. [i]

Research conducted by Natural Resources Canada, identified a significant increase in the area burned since 1959. At the same time, the number of large fires has doubled over the past 57 years in Canada.[ii] These large fires represent just 3% of all wildfires but they account for 97% of the total area burned.[iii]

Utility assets and standard operations are capable of generating wildfire ignitions in some situations, under some conditions. Damaging fires typically occur under the most extreme fire weather conditions, often generalized as "hot, dry and windy". High wind speeds are a well-known factor in major fire disasters, which is important for powerline failures and wildfire starts, as they are both more likely under extreme high wind speeds. As a result of climate change, we expect more extreme conditions including more high wind speed events. [iv]

Wildfires can create significant threats to public safety, forest resources and other landscape values. Proactive prevention, mitigation, and preparedness will help protect utilities from liability for wildfire damages and protect their assets from being damaged or destroyed. Recent wildfires and wildfire seasons have demonstrated just how damaging wildfires can be to utility assets.

One of the most recent wildfires that significantly impacted a utility is the Horse River wildfire in 2016 that impacted the Fort McMurray and other communities in the Regional Municipality of Wood Buffalo (RMWB). This wildfire damaged over 7,536 km of distribution and transmission powerlines and 560 electric transmission poles.

ATCO Gas and Electric reported $35 million in capital costs. The entire fire reported an overall $9.5 billion in direct and indirect costs, to families, businesses and governments.[v]

During the 2017 fire season in British Columbia, a single wildfire damaged over 15 kilometers of powerlines. In 2015, Saskatchewan replaced 85 poles due to damage from wildfires.

In 2002, the House River fire impacted multiple utilities and created over $1,000,000 in transmission pole damages and outages that lasted 25 days.[vi]

Figure 1.0: Area burned and number of fires (Source: National Forestry Database)

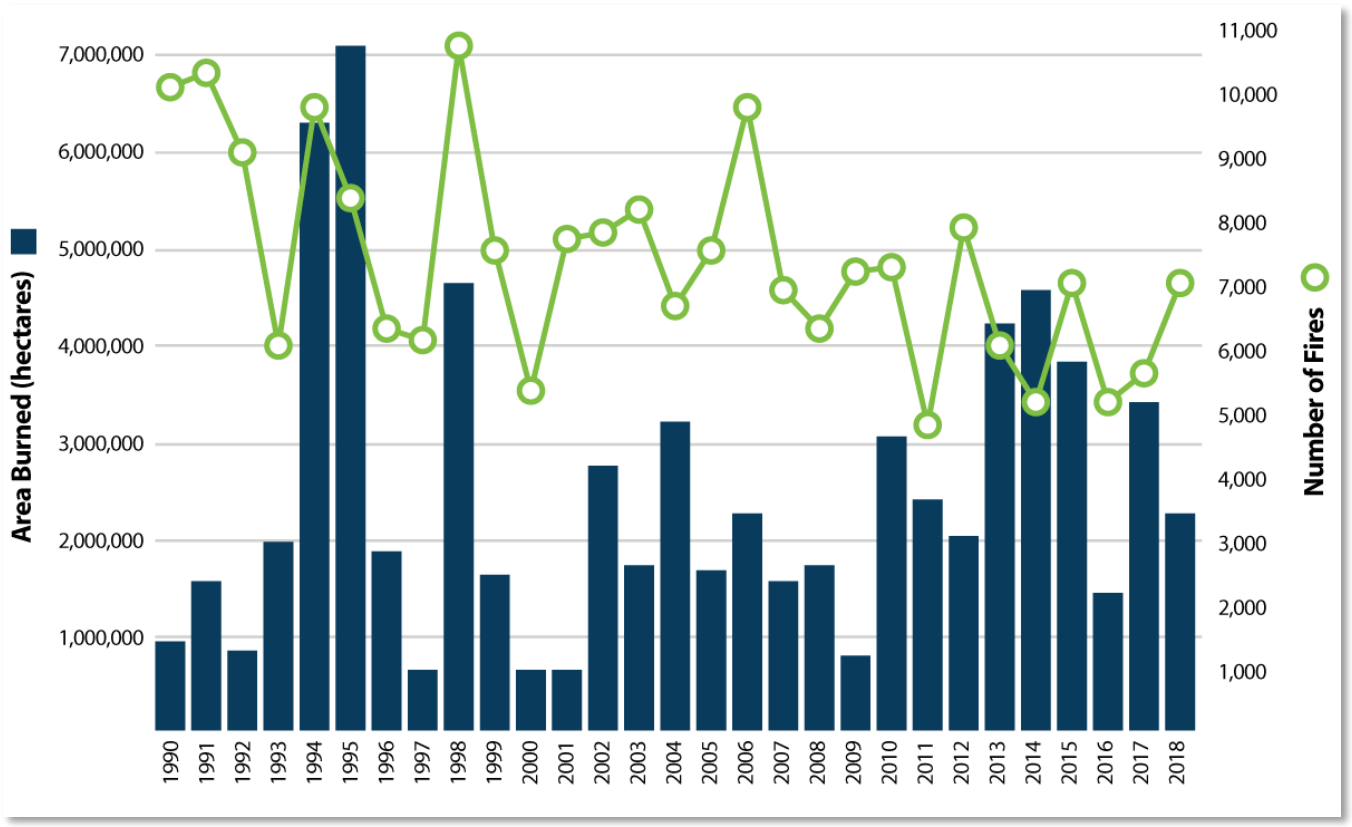
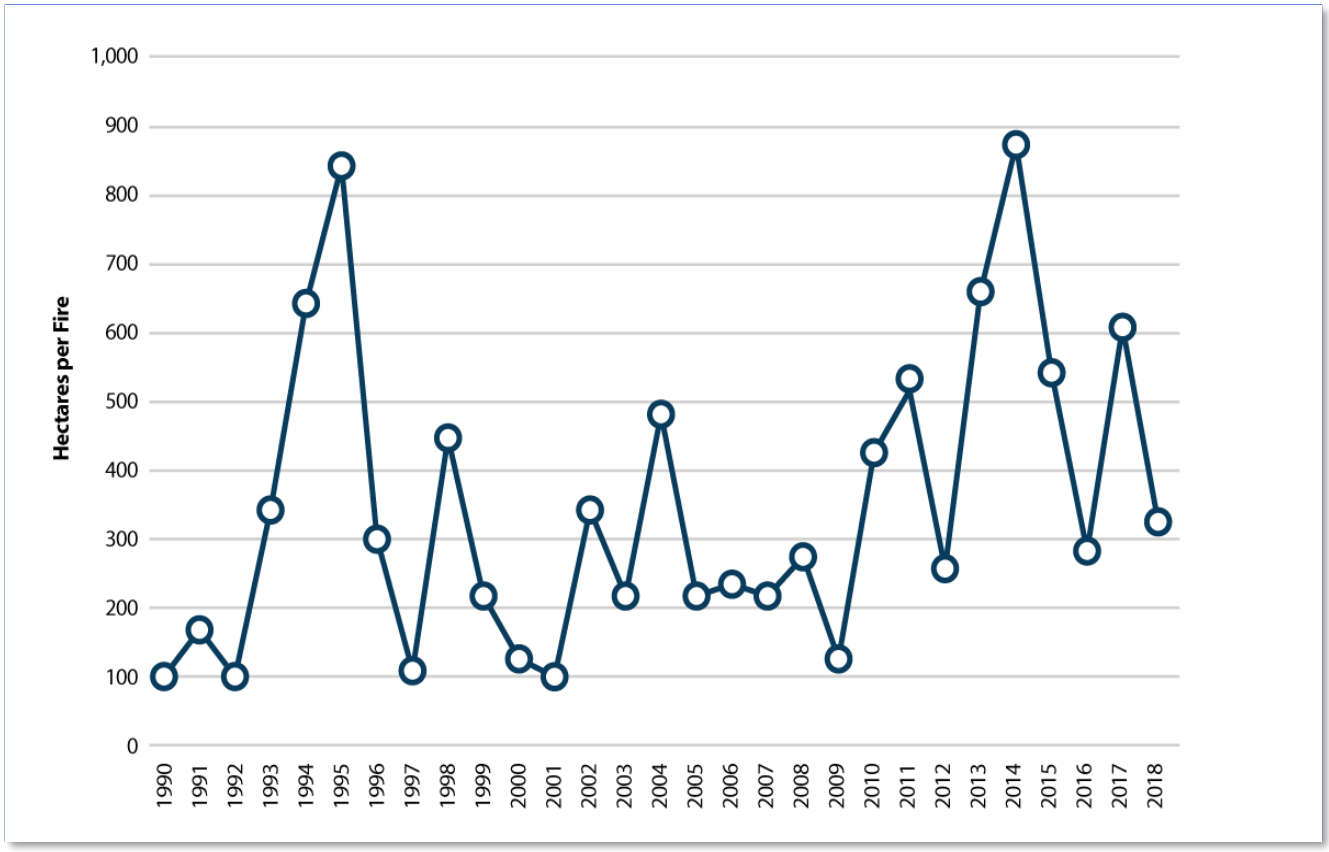


Figure 1.0 identifies the number fires and are burned in hectares, while Figure 2.0 highlights a growing trend towards intensity of each fire, with a consistent increase in area burned per fire.

Figure 2.0 1990-2018 Fire intensity (Data Source: National Forestry Database)



Wildfire Season

Wildfires are natural disturbances and are influenced by complex ecological processes. The nature of wildfire activity in a given area is dependent on the fuels, weather topography, and ignition sources in a region. Characteristic fire activity in an area is called the “fire regime”. Fire regimes are typically described using historical fire data to summarize standard characteristics including, fire season and cause; fire size, intensity and type; fire frequency of occurrence; and severity of fire effects. Fire regimes vary across Canada and utilities will benefit from an understanding of the specific fire regime characteristics to the areas they operate. However, fire regimes are just one piece of information and may not always be relevant to current conditions due to climate change and evolving landscape conditions.

Wildfire Season and Cause

Awareness of wildfire seasons and related fire causes is important for utilities to prepare and establish their mitigation practices and training schedules for the year. Table 1 lists officially-recognized start and end dates for provincial and territorial wildfire seasons. These dates are strictly administrative. The wildfire season may start earlier in a given year due to a lack of snowfall during the preceding winter and/or limited precipitation in the spring. Utilities should consider applying wildfire mitigation practices whenever fuels are receptive to fire irrespective of the date.

Table 1.0 Official Start and end dates of the wildfire season, by Canadian jurisdiction

	Season
British Columbia	March to November
Alberta	March to November
Saskatchewan	April to November
Manitoba	April to October
Ontario	April to November
Quebec	April to November
New Brunswick	April to November
Prince Edward Island	March to December
Nova Scotia	April to October
Newfoundland and Labrador	May to October
Yukon	May to October
Northwest Territories	May to October
Nunavut	May to October

Wildfires in Canada are caused by either human activities or lightning, which are closely tied to seasonal conditions. Spring and fall fires are predominantly caused by people. During summer conditions, when grass and leaves are green, the forest is less flammable and human ignition sources tend to be less effective. For this reason, summer fire ignitions result primarily from lightning that occurs almost exclusively during the core summer months.

Wildfire Size, Intensity and Type

Fire size is often described with a distribution of historical fire sizes in an area. In Canada, these distributions are typically heavily skewed towards the low-end, with many very small fires (< 1 ha) and only very rare and infrequent large fires (> 200 ha). Large fires typically occur under extreme fire weather conditions that produce very intense, fast-spreading fires that move from the ground into the forest canopy (i.e., tree crowns). In this way, fire size, intensity and type (i.e., ground, surface or crown fire) are all very much related. Most fires in Canada are very small, low intensity surface or ground fires, but when conditions are extreme, less common large, high-intensity crown fires can also occur.

Fire Frequency

Fire frequency is how often fires occur in an area. The fire cycle is a measure of frequency that describes the average time between fires at a location or the number of years it would take to burn an area, given the average annual area burned observed historically.

Fire Severity

Fire severity generally refers to the effects or impacts of a wildfire. Severity can be measured from many different perspectives including but not limited to, impacts to vegetation (e.g., tree mortality); water quality; economic activity; buildings; infrastructure; and suppression expenditures.

Key Elements of Wildfire Prevention and Mitigation Practices

Utilities are advised to develop a comprehensive **Wildfire Prevention, Preparedness and Mitigation Plan**[1] to support implementation of best practices over strategic, seasonal and daily/weekly horizons. The Best Practices contained in this guide are intended to assist with plan development. In addition, each utility must respect the legal requirements of their respective provincial wildfire acts and related regulations, as outlined in Appendix A.

The elements of effective wildfire mitigation are as follows:

Table 2.0 Elements of mitigation guide

Elements	Type
Wildfire Risk Modeling/Mapping	Strategic
System Hardening	Strategic
Inspections and Corrections	Seasonal Practices
Vegetation Management	Seasonal Practices
Rights-of-Way and Substation Maintenance and Preparedness	Seasonal Practices
Personnel Training	Seasonal Practices
Performance Metrics and Monitoring	Seasonal Practices
Situational Awareness	Operational
General Operational Practices	Operational
Proactive De-energization	Operational
Emergency Response (Personnel Safety and Evacuation)	Operational

[1] Utilities with transmission and distribution lines that go through densely populated forests will need a comprehensive plan as compared to a utility whose assets are not in high risk areas. Each utility must weigh the risks of their assets in conjunction with starting wildfires and being exposed to them and therefore build a plan accordingly.

Strategic Practices

Wildfire Risk Modeling and Mapping

Mapping wildfire risk in the vicinity of utility assets is essential for informing many of the other best practices that follow in this guide. There is no single accepted definition of wildfire risk. An insurance industry approach is to define risk as the product of fire likelihood and potential impact. Utilities can assess potential impacts of lost or damaged assets using a contingency planning or scenario approach that asks, for example, “What would be the consequences of a fire destroying this particular segment of a powerline?”.

To assess the likelihood of a fire occurring in a particular location, utilities may consider enlisting wildfire experts to conduct comprehensive risk assessments for their assets. The specific type of assessment required will depend on a number of factors. Fire likelihood is not constant. It varies over space, but it will also fluctuate in any given location from day to day due to weather conditions and resulting changes in fuel moisture. These daily changes in fire risk should be monitored by utilities and are covered in the section on situation awareness.

Over longer strategic planning horizons, likelihood can be assessed using a wide range of approaches. Fire risk assessment is a rapidly developing field and new models and methods are being developed on a continuous basis. Provincial fire management agencies typically conduct risk assessments for their jurisdictions and may have readily available risk maps or standards and recommended modeling techniques for the fire regimes characteristic of their management areas. A common approach is to analyze historical fire records to develop predictive statistical models that can be used to map variation in fire likelihood across a region in relation to influential factors such as fuel type, slope, and weather conditions. Computer simulations offer an alternate avenue that lets the modeler systematically vary conditions to see how the growth of the simulated fire is affected. Probabilistic models are very popular and more accessible due to advances in desktop computing but, may not be informative in situations where probabilities are relatively low but fires could result in catastrophic impacts. In these low-probability, high consequence situations, contingency planning is recommended. All fire risk modeling approaches have limitations and will generate predictions that have uncertain accuracy. Use of multiple approaches is highly recommended.

Once fire likelihood has been estimated, a utilities’ assets can be overlaid on the map to identify locations where strategic prevention and mitigation efforts can be expected to have the most benefit.

To assess wildfire risk, each utility should consider the burn likelihood and burn impact of wildfires. As an example, in Alberta, wildfires are modeled from regulator intervals along Alberta transmission lines.

The resulting burned areas from modeling were intersected with known values on the landscape, such as human activities, communities and infrastructure in order to understand potential impacts. The impacts associated with the highest risk wildfires are identified as high-risk fire areas.

Table 3.0 Risk Modelling/Mapping Inputs

Risk Modelling/Mapping Inputs	Description
Asset Health and Asset Condition	A risk model identifying the condition of assets from good to poor. Assets in poor condition or health should be considered higher risk as an ignition source.
Asset Locations	The coordinates of the asset.
Asset Types	Identification of the type of asset (i.e., pad mounted transformer vs. pole mounted; composite pole vs. wood pole).
Fire Weather Index	As described in the Situational Awareness section, the Fire Weather Index is an input model based on conditions for ignition risk.
Topography	Land surface and features, valleys, mountains, hills, rivers and lakes.
Identification of Fuel sources and high flammability forest make-up	Identification of low to extreme flammable fuel sources based on tree type, biowaste, and tree density.
Precipitation levels of the past 30 days	Historical understanding of drought levels through lack of precipitation. Utilities should take note that 30 days is a recommended minimum.
Live Weather Mapping	Live weather mapping will facilitate operational activities based on a complete model assessment/ decisions.
Satellite imagery	Live satellite imagery will provide imagery of the utility territory and that around their territory in terms of monitoring existing or nascent wildfires, and related risks to their assets.

System Monitoring, Maintenance and Hardening

Components in poor asset health may be frayed, worn down, or contaminated and should be prioritized for replacement or upgrade. Investment in upgrading line components and insulating assets will reduce the potential for powerlines to cause wildfire ignition. Established practices for monitoring, maintenance and hardening include:

- Implement systematic monitoring plans to assess equipment condition (health levels) at regularly timed intervals or informed by risk.
- Consider and expedite equipment for maintenance, replacement or upgrade prior to the fire season based on the results of strategic fire risk assessments.
- Implement systematic monitoring plans to assess equipment condition (health levels) at regular time intervals.
- Replace wood poles that have deteriorated due to wear and/or pose a risk as an ignition source if they are subject to weather conditions that exceed their operating design standards.
- Identify lines that require rebuilds. Old lines need to be replaced to ensure safety and meet new operating standards and fire mitigation standards.
- Undertake ongoing upgrades throughout the fire season on high risk equipment, provided those activities themselves do not pose a threat of ignition.

Utilities should consider hardening, where applicable:

Table 4.0 Hardening Practices for Ignition Prevention

Hardening Activity	Examples
Pole type	Replacing wooden poles with steel, concrete, or composite material
Pole Loading	Increasing wind loading of structures
Conductors and components	Install insulated conductor, utilize stronger clamps, check splices
System Protection (relays and line reclosers)	SCADA for substation relays, recloser technology, fault location data from relays
Fuses and Arrestors	Installing non-expulsion fuses
Wildlife Protection	Install bird and wildlife deterrent on structures and assets
Undergrounding	Underground distribution and transmission lines
Design Standards	New design standards in elevated fire risk areas, such as more insulation, pole loading, RoW width, etc.

Table 4.1 Hardening Practices for Fire Damage Mitigation

Hardening Activity	Examples
Poles	Encourage the use of fire proofing practices at construction stage
Insulator Types	Ceramic and Glass insulators may be preferred
Line accessories	Limit the use of rubber/polymer
Right-of-Ways (RoW)	Apply standard recommendations and prevent trees falling on conductors
Minimum Distance	With new construction builds establish a minimum distance between lines, 25km has been recommended
Number of circuits in RoW	Establish a maximum number of circuits per RoWs based on strategic importance of the RoW.

Asset Management

Many organizations use a structured approach to Asset Management in order to resolve competing priorities and ensure that long-term benefits are not sacrificed for more immediate needs. An Asset Management System (AMS) based on the ISO 55000 family of standards helps an organization to establish a coherent approach and coordinate delivery of appropriate resources and activities. It also incorporates monitoring and continual improvement elements to assure sustained achievement of the strategic objectives.

Asset Management realizes value by optimizing combinations of financial, environmental, social impact, risk management, quality of service and performance criteria throughout an asset's life. It also includes the adaptation to climate change and strategies for mitigating ignition risk through asset failure. Asset Management provides assurance that assets will fulfill an organization's corporate social responsibility due to the following:

- Developing and implementing processes that connect the required purposes and performance of the assets to organizational objectives.
- Implementing processes for assurance of capability across all life cycle stages.
- Implementing processes for monitoring and continual improvement.
- Providing the necessary resources and competent personnel to succeed.

Inspections and Corrections

Seasonal Practices

Summary Checklist[1]

Prior to the fire season, the following activities are recommended:

- ☐ Conduct pre-fire season inspection patrols on transmission lines in risk areas.
- ☐ Ensure all new worksites, (construction projects, substations, rights-of-way, etc.) have undergone a fire assessment (situational awareness).
- ☐ Conduct annual full training or refresher sessions for all relevant staff.
- ☐ Ensure emergency contact numbers and names are up-to-date.
- ☐ Establish a communication plan or update the communication plan.
- ☐ Conduct a review of the Emergency Response Plan (ERP).

ERP's act as quick reference for critical information and may typical perform the following:

- ☐ Coordinates activities amongst responders, emergency services; local authorities, government agencies and others;
- ☐ Defines roles and responsibilities;
- ☐ Identifies predetermined resources;
- ☐ Identifies evacuation procedures.

In locations where strategic assessments indicate wildfire risk is high, utilities should consider incremental inspections of its assets prior to and during the fire season. Frayed lines, or damaged assets pose a risk for ignition in the field. Regular maintenance and inspection of transmission and distribution lines will help ensure proper operation of such assets.

Each utility should analyze its assets and classify conditions that have the potential of igniting a wildfire. The incremental inspections should consider and target those types of asset conditions for accelerated corrections.

As an example, rotting cross arms or leaking insulators can cause an ignition from a flashover.

The correction timeframes of asset deficiencies that can lead to fire ignitions should be prioritized based on risk and completed within a tolerable timeframe.

The timing is dependent on the current conditions of the environment, utilities may wish to take action sooner if the area is facing a drought and at risk of entering into a high risk fire zone.

Utilities should consider an asset health indexing program that will identify poor conditioned equipment. Combining this information with the areas of heightened fire risk will help identify assets that pose the greatest threat of ignition in high risk fire zone.

Visual Inspection of assets, (using helicopters, fixed-wing aircrafts, drones or field crews) in forested areas should be conducted frequency commensurate with the wildfire and asset risk. Utilities should consider more frequent inspections of assets in high risk fire areas.[vii] Furthermore, more detailed inspections may occur more frequently if there is an increased risk of ignition due to external conditions such as lower fuel moisture.

Ad hoc inspections should occur in response to equipment failures such as open or tripped equipment. When equipment trips or other damage occurs (i.e., blown fuses), a visual inspection of the fault location is recommended as soon as possible, and with priority dependent on the level of risk.

Development of formal monitoring programs and inspection policies, standards and procedures are recommended to ensure the utilities' effort to monitor equipment, identify issues, and proactively mitigate risks are well-documented.

Vegetation Management on Rights-of-Ways

Rights-of-way should be maintained through vegetation management and on regular intervals. Vegetation or other material coming in contact with transmission and distribution lines create ignition risk as they may ignite and/or cause flashover electrical charges.

Utilities should use strategic wildfire risk assessments to identify priority areas for near term and incremental vegetation management.

Right-of-ways and other open spaces should be gravel, mineral soil, frequently mowed grass or maintained vegetation (ground-cover shrubs) and therefore act as firebreaks - an obstacle to the spread of a fire. In the event of ground cover in rights-of-way, utilities may choose to introduce engineered low flammability ground cover, provided it is not an invasive species to that geographic area or rock-filled culverts to maintain erosion and act as fire barriers.

All facilities including right-of-ways, should ideally have adequate space for vehicles and personnel to operate in a safe area.

The following activities are recommended to reduce the ignition of fuel sources and prevent ignition of wildfires due to vegetation management activities in high risk fire zones.

Table 5.0 Vegetation Management Activities

Activities
Widen antiquated rights-of-way to modern standards where appropriate.
Near substations, prune dead or diseased tree branches within two meters of the ground.
Establish erosion control where appropriate on poles and or nearby tree-lines.
Perform grubbing up to a minimum of three meters away from wooden pole; and apply fire retardant up to 4m away when a wildfire is approaching.
Tree trimming should occur to prevent trees from growing up into the lines; falling onto the lines or coming in contact with lines.
Fuel hazards (tree trimmings/slash) should be removed from rights-of-way.
Remove hazardous trees that pose risks to transmission or distribution lines.
Tree trimming should occur on appropriate intervals based on vegetation growth rates as growth rates will vary by region due to tree types, precipitation and soil content. Tree trimming should occur and be maintained at a minimum distance as identified in “NERC FAC-003-4 Transmission Vegetation Management” and “ANSI A300 Standard for Integrated Vegetation Management” or greater distance as appropriate.
Prohibit open burning of vegetation debris during the wildfire season.
Consider the flammability of different tree types, see table 6.0 below and avoid or limit construction projects in areas with high populations of black spruce and other extremely flammable fuel types.

Table 6.0 Tree species flammability levels

Tree Species[viii]	Flammability
Black Spruce	Extreme
Cured /dead grass and slash (biowaste)	Extreme
Fir	Extreme
Pine	Extreme
Cedar	High
Lodgepole or Jackpine	High
White Spruce	High
Western Larch	Low
Alders	Very Low
Ash	Very Low
Birch	Very Low
Cherry	Very Low
Cottonwood	Very Low
Maple	Very Low
Poplar	Very Low
Young and mature aspen	Very Low

Removal of Vegetation Waste

Burning vegetation waste on-site during the fire season is not recommended nor should it ever take place within a high wildfire risk zone or when daily fire danger is rated as moderate or higher (see the Situational Awareness section on page 17 and related background on the Canadian Forest Fire Weather Index [FWI] System) .

Recommended precautionary steps for on-site burning of vegetation waste are identified in Table 7.0:

Table7.0 Burning mitigation practices

Burning Practices
Winter conditions with snow cover are ideal for incinerating vegetation waste on-site.
Burn sites should be on sites with shallow organic soil (less than 15cm duff).
Fire-fighting equipment with appropriate personnel and available water source must be present during the burning operation.
Burn activities must be actively monitored at all times.
Burn piles (windrows) must not exceed 60 meters in length or 1 meter in height and never be within 15 meters of an uncleared area (forest edge).
When burning debris, a fire permit is required in many jurisdictions, and must be obtained in advance of burning activities where applicable.
Burn piles must be physically inspected to ensure they are fully extinguished. Infrared scanning of burn piles is not considered an appropriate form of confirming extinguishment.

Mowing/Mulching

Due to the production of highly flammable fine fuels, mulching should be avoided in high-risk areas identified by strategic risk assessments.

Removal

To avoid the need for on-site incineration, waste vegetation can be physically removed by transporting it to a biofuel facility or other location for incineration or handling off-site. Partnerships with generation plants that consume biofuels could be developed to accommodate ongoing vegetation waste production by utilities.

Substation Maintenance and Preparedness

The following activities have been identified to facilitate both mitigation of wildfires starting and protection of assets in high risk fire zones:

Table 8.0 Substation mitigation and protection activities

Mitigation and Protection Activities	
Animal Management	Wildlife can ignite when they come in contact with specific equipment in substations and become an ignition source. Installation of animal deterrence gear can reduce wildlife contact with equipment.
Manage Hazardous Materials	Manage hazardous materials within the substations by following WHMIS standards.
Building Standards	Roofing materials are a major determinant of whether or not a wildfire will ignite a nearby structure. To protect building assets, ensure the roof classification is “A”, “B” or “C” where Fire Rating Classification “A” is recognized as the best in class, which includes metal roofs. Incorporating roof sprinkler systems on flammable roofs and maintaining internal building sprinkler systems in high-risk fire areas is recommended.
Vegetation Management	Near substations, prune dead or diseased tree branches within 2 meters of the ground. Maintain bare ground conditions within the substation site. Ensure that vegetation is mowed or brushed along the perimeter immediately adjacent to the site perimeter fence to a recommended distance of 12 to 14 meters.

Personnel Training

Utility personnel are a potential source of ignition however, they can also assist with the protection of physical assets. It is important to note that even the smallest action is relevant and due diligence must be taken to mitigate wildfires. Structured training and education on prevention and mitigation practices should be conducted annually prior to the fire season.

Recommended annual training components are summarized in Table 9.0.

Table 9.0 Personnel Training

Training Component	Description
Fire extinguisher deployment	Train staff on how to use extinguishers safely and effectively for extinguishing and containing small, nascent fires.
Wildfire prevention	Train staff on practices for preventing fire ignition such as ensuring equipment is in proper operating order, refueling on asphalt, or conducting visual inspections of known faults.
Wildfire suppression	Field crews and site crews must be trained on fire behavior basics and proper use of fire suppressing equipment as well as techniques for preventing the spread of wildfires, such as grubbing, or the use and application or fire retardant.
Wildfire Safety	Staff must be informed of emergency response plans, evacuation procedures and the required actions to take when a wildfire is within the area.
Communication Protocols	All staff must be informed of the proper communication channels. In addition, the utility should ensure that communication channels are up-to-date and posted at all facilities and are easily accessible to all field crews.

The following education videos should be considered in the training package for specified staff:

i. An Introduction to the Canadian Fire Weather Index System (https://www.youtube.com/watch?v=mdeM-cBCQJA);
ii. Introduction to Fire Behavior (https://www.youtube.com/watch?v=SB4pk91yq24);

Smoking

Employees who smoke should dispose of cigarette butts and matches in fire-safe receptacles. Smoking should be strictly prohibited in high fire risk zones.

All smoking materials must be removed from all worksites and employees should ensure they do not dispose of ashes or smoking waste in any forested location.

Personal Cooking or Warming

On rare occasions field crews have created small campfires to remain warm or to cook meals. It is recommended that crews find alternate sources of heat, especially in high risk areas. Open fires should be prohibited within high risk fire zones. In the event where campfires may be required, they should be attended to at all times; placed on mineral soil, gravel or rock; surrounded by a fire barrier (i.e., rocks), and fully extinguished when no longer in use.

Contractors

Any utility employing contractors should ensure that the contractors adhere to the same wildfire mitigation practices that the utility would follow for their own staff. Contractors may be hired for vegetation management and/or power restoration, and in either case the utility should ask the contractor for relevant documented mitigation practices or perform an audit of their wildfire mitigation practices.

Utility management should request that wildfire practices are followed within the contractor agreement before engaging with any relevant contractor.

Performance Metrics and Monitoring

All utilities should develop performance metrics and monitor programs to document their wildfire prevention and mitigation activities.

For example, if asset hardening is the primary focus for mitigating wildfires, the utility should track and measure how many assets have been upgraded in high risk fire areas.

Suggested metrics could include but are not limited to:

- Number of burn permits obtained.
- Quantity of vegetation waste removed (kg).
- Installed hardening measures (i.e., poles, insulators, etc.).
- Days/hours of field work rescheduled due to fire bans or high-risk fire.
- Number of completed inspections in response to trips.
- Number of trained staff.
- Number of outreach events (e.g. to educate community regarding de-energization practices).
- Customer satisfaction with company wildfire mitigation efforts.

All utilities should also record and investigate any wildfires initiated by its power lines and assets to prevent future occurrences. A reduction in fires may illustrate a positive trend based on the implementation of the utility mitigation plan.

Operational Practices

All operational practices should be in alignment with the wildfire mitigation plan developed for the utility.

Situational Awareness

When conditions are extreme, fast moving wildfires driven by strong winds can travel extended distances of up to 60 kilometers in a single day in Canada. Most wildfires will travel at much slower speeds due to the constraints imposed by local fire environment conditions (topography, weather and fuel). However, utilities must be prepared for worst-case scenarios when fast moving fires demand immediate reaction.

For this reason, daily and weekly preparedness planning and situational and awareness among utility staff is critical for preventing and mitigating negative fire impacts.

Table 10.0 Situational Awareness Activities

Summary of Situational Awareness Activities
Conduct a daily consultation session to distribute updates on fire risk and any fire bans or area closures to key personnel and any personnel leaving for the field that day.
Undertake review and real-time monitoring of fire weather and fuel moisture (see below) before crews are sent out into the field.
Advise field crews of any local fires, and potential fire threats to assets and crew safety
Limit non-critical work and access in areas with active fire bans or area closures.
When Fire Weather Index (FWI) System indicators reach moderate to extreme levels, advise field crews and implement modified hours as needed.
When work ceases in a high fire risk area, a fire watch should remain in effect for a minimum of 45 minutes after work concludes, to ensure no spark ups.
Use of infrared equipment to identify properly extinguished fires is recommended, however should not be the sole confirmation that a fire is extinguished.
During a drought, ensure insulators are washed, clean and operational.
If a nascent fire or larger wildfire is contained and extinguished by utility personnel, staff should remain on site until the proper authorities have arrived provided there is no safety risk. Wildfire agencies will determine if a wildfire is fully extinguished on public lands.

Real-time Monitoring of Fire Weather and Fuel Moisture

To inform operational activities, utilities should combine their strategic fire risk assessments with current information about fire weather and fuel moisture in their operating areas. For example, high-risk zones identified in strategic assessments may not be a concern if the area has received ongoing precipitation for several weeks. When fuels have high moisture contents reaching 30% or more, they are effectively neutralized as a wildfire hazard because they cannot ignite or sustain combustion. Ongoing monitoring of fuel moisture conditions is therefore, a recommended activity for understanding the receptivity of vegetative fuel to wildfire ignition and spread.

The primary tool used in Canada by all fire management agencies to track and map fuel moisture conditions across their jurisdictions is the Canadian Forest Fire Weather Index (FWI) System. This system generates a set of six daily indicators (i.e., three codes and three indexes) that provide relative ratings of fuel moisture and potential fire behaviour based solely on weather variables tracked each day during the fire season (i.e., precipitation, wind speed, temperature, and relative humidity).

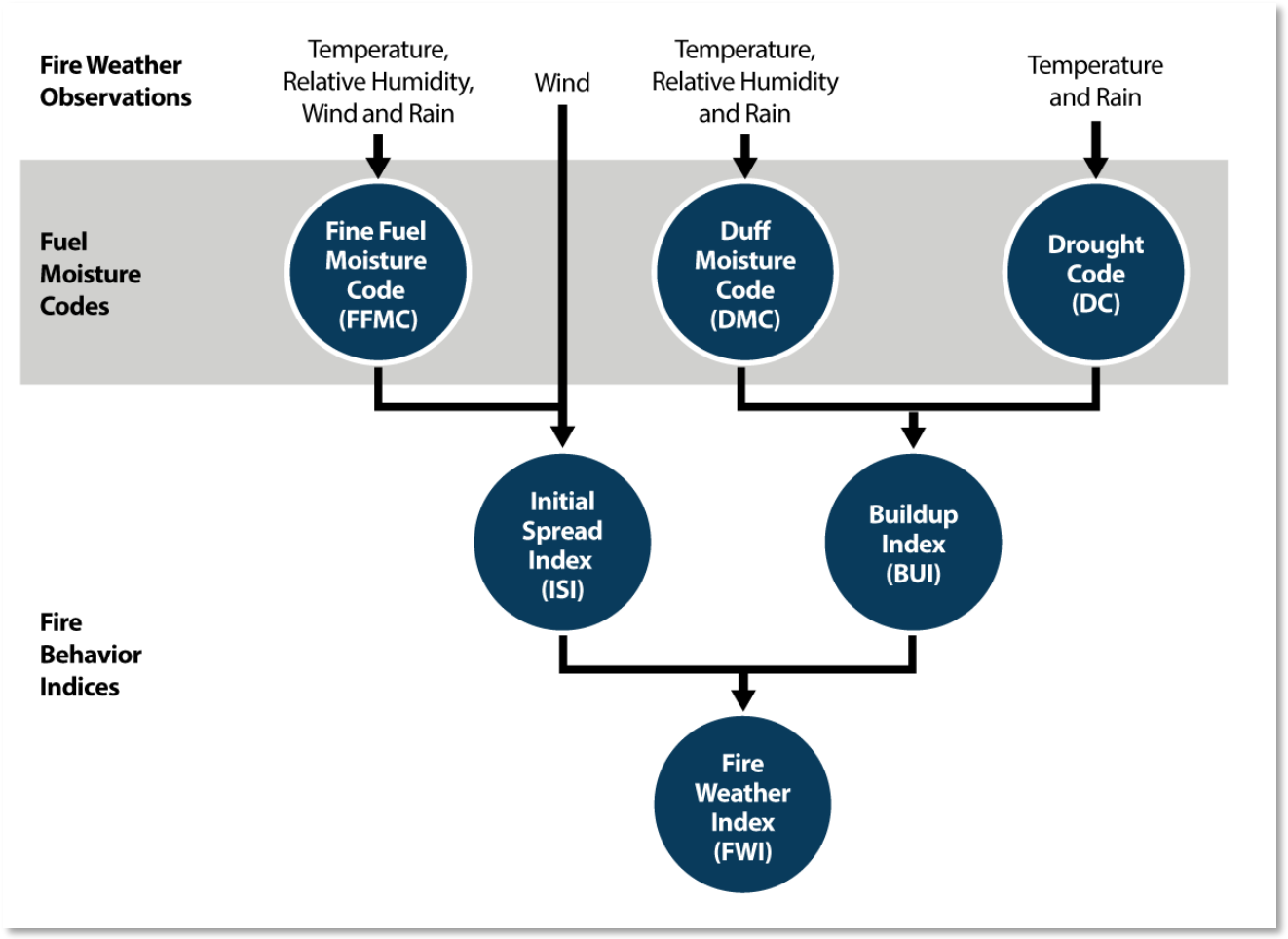
The Fine Fuel Moisture Code (FFMC) is considered the primary indicator of fuel receptivity to human ignition sources, which by nature tend to be more short-lived or more transient than lightning ignitions. For lightning ignition or more sustained ignition sources, the Duff Moisture Code (DMC) is considered the primary indicator of fuel receptivity. Fire management agencies across Canada generate daily maps of FFMC and DMC values for their jurisdictions and release both observed and predicted maps on their agency websites. These maps are used to make decisions such as, where to position fire response resources and when to impose forest area closures and campfire bans. Utilities can easily access provincial online maps of FWI System indicators and can also view online national maps generated by the Canadian Forest Service. An FFMC score of 86-89 begins the high potential for fire ignition.[ix]

Reliability of FWI System maps depends on the density or coverage of provincial fire weather stations in a region. Utilities can enhance the quality of the FWI System maps they use by helping to expand the provincial weather station network and installing their own weather station instruments in high-risk zones identified in strategic assessments and at any asset locations that are far-removed from existing weather stations in the provincial network.

In addition, utilities using a regional agency's (i.e., provincial forestry services) indicators must be aware of the potential for differences between the national and provincial FWI. Operations should be making decisions based on the higher risk scenario.

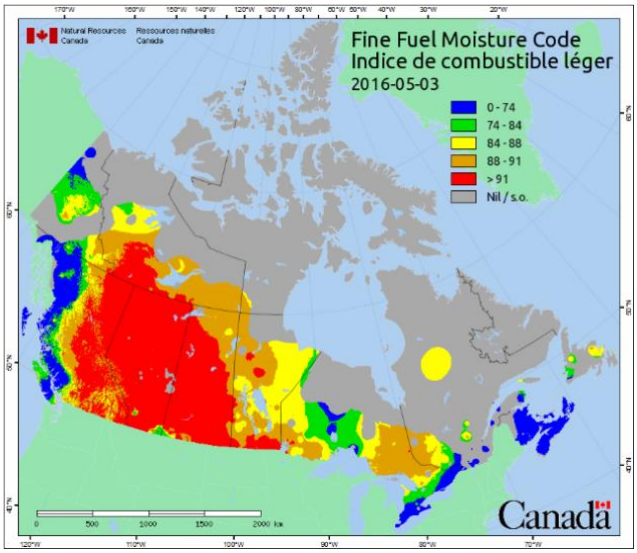
A schematic of the FWI System structure and some example map products generated by the system are shown below. Figure 3.0 and Figure 4.0 respectively.

Figure 3.0 Canadian Fire Weather Index Structure



Source: Government of Canada website, NRCAN

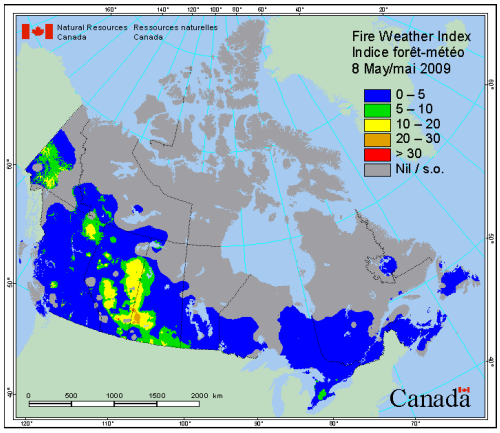
Figure 4.0 Fine Fuel Moisture Code (FFMC) on May 3rd , 2016 – Fort McMurray wildfire impacts



FFMC is a relative rating of the receptivity of fuels to ignitions caused by people.

The following FWI map, Figure 6.0, provide a visual on the FWI changes during the same day of the year in a ten year timespan. The FWI indicator combines the other five indicators generated by the FWI System and is a general rating of potential fire intensity.

Figure 5.0 10-year comparison May 8th, 2009 vs. May 8th 2019



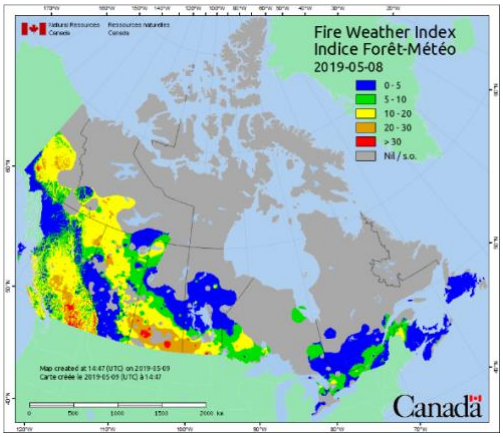
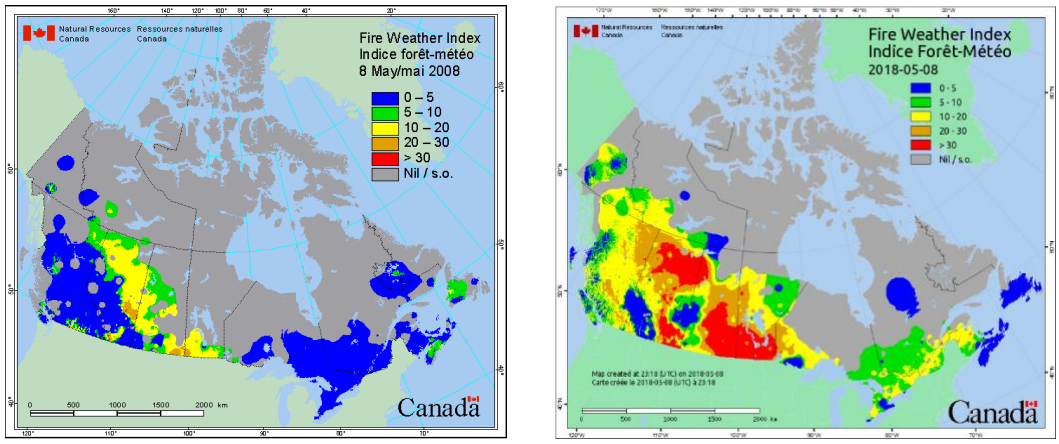


Figure 6.0 10-year comparison May 8th, 2008 vs. May 8th 2018



Source: Natural Resources Canada

FWI System values should be interpreted using the regional standard in a utility's operating area. Table 11.0 shows the FWI System classes used by Canadian jurisdictions to define low to extreme conditions. For example, an FWI of 20 is classified as very high in Alberta, but only 'moderate' in Manitoba. Utility personnel should become familiar with their provincial FWI classes to evaluate the risk of ignition on any given day.

Additional daily situational updates and reports can be accessed from the Canadian Interagency Forest Fire Centre (CIFFC) and by liaising with individual provincial fire management jurisdictions. These daily situation reports contain summary information about ongoing fires, fire weather and fuel moisture conditions, predicted fire behaviour on a given day, fire bans and area closures, as well as resource commitments and anticipated resource limitations for fire response.

Note: Advanced modeling methods could also be pursued for predicting daily fire occurrence. These modeling methods are still in development and in need of validation to ensure they are reliable. For this reason, most fire occurrence prediction models have been used primarily for research studies. However, some fire management agencies in Canada have collaborated with fire researchers to develop operational daily fire occurrence prediction models. These are based on analysis of historical fire records and could potentially be used by utilities through collaborations with fire researchers.

Table 11.0 Fire danger classes for Fire Weather Index (FWI) System by province

Fire Danger
Provincil/Territorial Classifications

Agency	Region		Low	Moderate	High	Very High	Extreme
Alberta			FWI < 4	4 < FWI <10	10 < FWI <18	18 < FWI <29	FWI > 29
British Columbia	Coastal, Prince George and Northwest	FWI < 1 1 < FWI < 7 7 < FWI < 16 16 < FWI < 31 FWI > 31	BUI < 19	19 < BUI < 118 BUI < 42 BUI < 19	BUI > 118 BUI > 42 19 < BUI < 69 BUI < 42 BUI < 19	BUI > 69 42 < BUI < 118 19 < BUI < 69	BUI > 118 BUI > 69
	Cariboo	FWI < 5 5 < FWI < 17 17 < FWI < 27 27 < FWI < 38 FWI > 38	BUI < 49	49 < BUI < 159 BUI < 86 BUI < 49	BUI > 159 BUI > 86 49 < BUI < 119 BUI < 86 BUI < 49	BUI > 119 86 < BUI < 159 49 < BUI < 119	BUI > 159 BUI > 119
	Kamloops, Southeast	FWI < 5 5 < FWI < 17 17 < FWI < 28 28 < FWI < 47 FWI > 47	BUI < 51	51< BUI < 201 BUI < 91 BUI < 51	BUI > 201 BUI > 91 51 < BUI < 141 BUI < 91 BUI < 51	BUI > 141 BUI < 91 51 < BUI < 91	BUI > 91
Manitoba			FWI < 14	14 < FWI < 24	24 < FWI < 33		FWI > 33
New Brunswick			FWI < 4	4 < FWI < 11	11 < FWI < 23		FWI > 23
Newfoundland			FWI < 5	5 < FWI < 13	13 < FWI < 20		FWI > 20
NWT			FWI < 4	4 < FWI < 12	12 < FWI < 18	18 < FWI < 23	FWI > 23
Nova Scotia			FWI < 3	3 < FWI < 10	10 < FWI < 23		FWI > 23
Nunavut			FWI < 4	4 < FWI < 12	12 < FWI < 18	18 < FWI < 23	FWI > 23
Ontario			FWI < 3	3 < FWI < 10	10 < FWI < 22		FWI > 22
Parks Canada			Uses Provincial FDR Scheme				
PEI			FWI < 1	1 < FWI < 8	8 < FWI < 15	15 < FWI < 21	FWI > 21
Quebec			FWI < 4	4 < FWI < 10	10 < FWI < 20		FWI > 20
Saskatchewan			FWI < 5	5 < FWI < 16	16 < FWI < 30		FWI > 30
Yukon			FWI < 13	13 < FWI < 23	23 < FWI < 28		FWI > 28

Real-time Monitoring for Detection and Response

Timely detection and response to asset-caused wildfires is essential for avoiding and limiting damage. Fires are easily suppressed when they are small and burning at a low intensity. Under extreme hot, dry and windy conditions, wildfires quickly achieve large sizes and high intensities that exceed fire suppression capabilities. Utilities should consider installing fire detection cameras on high risk assets to facilitate early notification to first responders and other partners.

All ignition incidents should be tracked and documented for future analysis to determine key influential factors. Development of an ignition incident reporting template could help to ensure that key information is noted and recorded at the time of the event.

General Operational Practices

Large vehicles, ATVs, and Light Equipment

Lift trucks, borers and other large equipment performing vegetation management or other operational functions in and around forested areas can generate highly flammable fine organic material. This material combined with vehicle exhaust system heat poses an ignition risk. [x]

Likewise, organic material that accumulates around the exhaust of ATVs can overheat and fall off the exhaust system and ignite dry grass or other highly flammable vegetation. Use of ATVs is not recommended in high-fire risk zones when fuels are receptive to ignition due to low fuel moisture.

Chainsaws, cutting tools, mowers, welding tools and other equipment can create sparks during regular use. Proper handling and maintenance of such equipment is critical for preventing wildfire ignitions and mitigating fire impacts.

The following activities, listed in Table 12.0, are recommended to prevent and mitigate wildfire ignitions from equipment:

Table 12.0 Large vehicles, ATVs and Light Equipment

Activity	When Operating
Clear debris from exhaust system prior to daily use.	Large vehicles and ATVs
Install heat shields.	Large vehicles and ATVs
Do not park vehicles in dry fine fuel zones, if not possible; spray the area with water to create an acceptable parking location.	Large vehicles and ATVs
Refuel at designated locations and not in forested areas whenever possible.	Large vehicles and ATVs
Heavy equipment and vehicles must be equipped with onboard firefighting equipment as outlined in the fire suppression section and/or regulated provincial acts.	Large vehicles and ATVs
Maintain equipment to manufacturers specifications.	Large vehicles and ATVs
Install spark arrestors on exhaust systems	ATVs
Refuel on mineral soil or asphalt/concrete surfaces whenever possible and ensure fire suppression equipment is available when refueling.	Large vehicles, ATVs, chainsaws, other gasoline operated equipment
Check for metal wires, nails or other similar items that may be imbedded in vegetation or the immediate area and remove to avoid sparks or arc flashed during chainsaw operation.	Chainsaws, other vegetation removal equipment.
Remove or pre-wet flammable fuels from operating areas where sparks or arc flashes are a threat.	Large vehicles, ATVs, chainsaws, other gasoline operated equipment

Fire Suppression Equipment

Utility staff are not firefighters nor are they expected to fight wildfires. Nonetheless, utilities may be in a position to take early fire suppression action in some circumstances. Utilities can be prepared by keeping equipment on hand to extinguish or contain a small nascent fire before it becomes a problem. Utilities should be aware that wildfire agencies may have provincial regulations allowing them to conscript suppression equipment as needed. In addition, utilities may be in a position to maintain and\or host emergency response crews at specified remote sites, dependent on each utility's situation, available resources and operational risk management framework.

Recommended on-site firefighting equipment in high-risk fire locations is listed in Table 13.0. This equipment should be considered mandatory for operations involving crews of three or more people. In several jurisdictions on-site fire suppression equipment is mandated by law when operating in or near forested and public lands. Utilities must be familiar with regulatory requirements for fire suppression equipment in their operating areas and follow these regulations as a minimum requirement.

Table 13.0 Fire suppression equipment list

Equipment type and capacity
200 Gallons of water with pump per 4-5 crew members
1 shovel per two people
1 pail per three people
1 axe or Pulaski per five people
1 grub hoe per five people
1 Dry chemical extinguisher per travelling vehicle

Through contract agreements, utilities are recommended to require contractors to keep this equipment on hand when performing vegetation management.

In the event of an approaching wildfire, utilities should consider performing the following activities:

Table 14.0 Approaching fire activities

Activities:
Apply fire retardant on all wood assets in the path of the approaching wildfire.
Remove hazardous material from worksites (i.e., gasoline, oil diesel, etc.).
Remove combustible material from the worksite such as bio-waste.
Contact required utility personnel and/or first responders at the wildfire command centre.
Provide location of critical assets to incident command centre personnel.

Hazardous Material

Hazardous materials (i.e., chemical agents, gasoline, oil, etc.) may accelerate the spread of an existing fire or facilitate the start of a new fire. All utilities must be familiar with hazardous products on their worksites and the *Hazardous Product Act (HPA)* and the *Workplace Hazardous Materials Information System (WHMIS).* Hazardous materials should always be stored in a safe and secure location, in accordance with regulatory requirements governing the handling, use and storage of such materials. Inventories of all hazardous materials are recommended so that locations of PCB related transformers or oil cooling transformers can be relayed to the responsible authority in command of fire suppression activities.

Communications

Communications take two main forms within a utility: internal, where staff are informed of internal operating procedures; and external, which involve information exchanges with stakeholder groups (i.e., municipal fire departments, provincial forestry services). Internal and external communications are essential for preventing and mitigating wildfire damage.

Daily situation reports should contain information summaries critical to effective communication about wildfire threats:

- Summaries of Fire Weather Index (FWI) System indicators and area restrictions or fire bans;
- Identification of current at-risk assets determined through inspection of daily FWI System maps and strategic risk assessment maps;
- Locations where operations must be limited due to the high risk of ignition;
- Communication channels for utility personnel, fire services and/or the Incident Command.

Table 15.0 Communications

Internal	External
Communication of daily wildfire monitoring and activities including outage areas, availability of assets, etc.	Perform outreach with communities that will be impacted by preventive de-energization, and communities that have lost power due to a wildfire event providing an estimated time to restoration (ETR).
Field crews must have emergency contacts, supervisor and control center numbers available at all times.	Transmission system operators must be informed of affected regions that contain transmission assets.
All utility crews operating in the field must have a form of communication (i.e., cell phones or satellite phones).	Any identified fires must be reported to your transmission system operator and the appropriate wildfire agencies.
Create a communications plan internally to establish the proper chain of command for specific activities, such as de-energization.	Identify and explain mitigation plans to communities from system hardening to vegetation management and how they can assist from legal actions to support of initiatives.
	Create a communications plan for how wildfire agencies will interact and communicate with the utility for mitigation and for existing fires that threaten physical assets.
	Inform mutual aid partners of events, and likelihood of outreach.

Control Center Operations

Utilities should consider incremental or tailored operational practices during times of high fire risk in its control centre operations, such as disabling of automatic reclosing. If the fire risk increases, the control room should evaluate and re-evaluate the situation and adjust operational activities to mitigate ignition risk.

If a trip occurs on a transmission or distribution line in a high-risk fire area, the operator should consider proactively disabling any automatic reclosing and dispatch utility personnel to visually confirm the situation. Once confirmed there are no issues, the operator may then re-enable automatic reclosing as appropriate.

Stakeholders

Utilities should communicate with stakeholder groups, including partners about their operational procedures during wildfires and the prevention of wildfires.
Utilities should form partnerships with governments and wildfire service departments in their jurisdiction to build plans that protect utility assets and mitigate wildfires. They should maintain detailed communication plans to inform both wildfire services and/or at-risk communities or approaching fires and/or de-energization.

- Utilities should develop agreements ensuring there is firefighting support to protect critical infrastructure. These agreements may be with provincial response teams, regional authorities or municipal communities.

- As high-risk fire areas are identified throughout the fire season, communities should be engaged to coordinate response procedures.

- Information sessions should occur in at-risk-communities and information should be maintained in publicly accessible locations to describe the criteria for wildfires and understanding of the potential risks and situations that may result in a de-energization event.

- Ensure utilities have access to the wildfire command centre to be informed or inform the first responders of any critical assets in the path of the fire and/or any assist with mitigation efforts on those assets.

Incident Command System

The Incident Command System[xi] (ICS) is a management system that can be used on any incident and is used by all fire management agencies across Canada.

Standard procedures such as establishing Site Incident Command posts (SIC) for liaising with a wildfire incident, Incident Command Team (ICT) should be established with responsible authorities well in advance of wildfire incidents that could pose a threat to assets to ensure utilities have real-time access to information about the wildfire and potential risks to infrastructure. SIC posts will facilitate support of emergency preparedness and response actions.

Wildfire Investigations

When it is safe to do so, workers should protect the wildfire point of origin, if known and on utility owned property. Protecting the site, will facilitate the wildfire investigation as the site is not compromised. If the point of origin is known but is located on non-utility owned property that information should be communicated to the related fire service authorities.

Proactive De-Energization

Proactive de-energization of powerlines in response to wildfire risk is generally a last resort mitigation strategy and procedures detailing this approach should be outlined and documented for all staff. Staff should undergo training on when de-energization is appropriate.

- Proactive de-energization should occur whenever water-bombers will be dropping water in the immediate area of transmission and distribution lines, and when emergency personnel (first responders) are undertaking wildfire control in the immediate area of powerlines.

De-energization can also occur as a pro-active measure to minimize risk of ignition of a wildfire in order to maintain public safety. Each situation is unique and decision making can be dependent on asset condition or asset health, real-time monitoring of daily fire weather and fuel moisture as well as insights from strategic fire risk assessments.

- If a utility practices proactive de-energization, they should provide information and consultation with potentially affected communities down the line. Consultation with generation providers, stakeholders and major customer groups are critical in the successful adoption and acceptance of such mitigation efforts.

De-energizing lines will ultimately rest with the system operator in most cases and should involve the following personnel:

- On site-assessment of the situation by field personnel; consideration to the de-energization impact will have on customers;
- Approval from the responsible executives of the utility;
- Confirmation that all fire crews are clear of lines; before re-energization takes place an inspection of impacted lines should be undertaken.

De-energization Scenario

The following is an example of when a utility should consider proactively de-energizing. On the utility's asset map, a distribution line has been identified to be in poor health. In that same area, the region is under a fire ban due to lack of rain and the Fire Weather Index is at an extreme level that day. The weather forecast predicts the area will be hit with winds exceeding 90km/hr, a wind speed that exceeds that lines design standard. In addition, the area has suffered multiple trips when high winds have affected the region before. Under such a scenario the utility should investigate whether de-energization is a viable option.

Personnel Safety and Evacuation

It is not the purpose of this document to prescribe evacuation procedures. Each utility maintains evacuation protocols that can be applied to wildfire events.

It is not the purpose of this document to prescribe evacuation procedures. Each utility maintains evacuation protocols that can be applied to wildfire events. As a best practice prior to fire season, it is recommended that each utility review emergency procedures in the event of an approaching wildfire to all staff that may work in fire risk areas or work in a forested environment.

Recommendation

The Best Practice Transmission Committee, recommends that utilities develop a fire prevention and mitigation plan based on the contents of the Utility Wildfire Mitigation Guide. The mitigation guide/plan that is developed for the utility should meet operational and managerial needs from a risk and asset management perspective. In addition, the plan should complement existing processes and should follow the best practice suggestions as outlined in this document.

Appendix A: Regulatory Aspects

Canada has a vast variety of Provincial Regulations on wildfires. Some provinces and territories have industry-specific regulations, particularly in the west, where wildfires have been more prevalent. Other provinces have little to no regulation impacting the electricity sector specifically.

All utilities must follow the laws and requirements under their respective provincial wildfire acts, the following table identifies specific operational impacts to the utility.

Each province also has additional acts that impact of operations in forested areas or public land and each utility must adhere to those rules and regulations.

	Provincial Act	Effective Date	Impact to Industry	Provincial Monitoring Services
British Columbia	BC Wildfire Act Wildfire Regulation, BC Reg 38/2005, s 10	Last Amended: June 2019	•Utility transmission operation, within 300 m of forest or grass land, must reduce the likelihood of producing an ignition source and maintain the site in a manner that prevents any fire from spreading •Additional requirements applying to industrial activities at large include: precautions, fire hazard assessment and abatement, and fire control	BC Wildfire Service

Alberta	Forest and Prairie Protection Act, RSA 2000, c F-19	Last Amended: March 29, 2017	Commercial operation on public land or within one kilometer must: • at the request of a forest officer, submit a satisfactory fire control plan • have firefighting equipment capable of controlling and suppressing any fire that may occur directly or indirectly as a result of the operation on or near (1 km) public lands	Alberta Wildfire
Saskatchewan	The Wildfire Act SS 2014, c W-13.01	Came into force: March 31, 2015	• Industry Liable	Saskatchewan Spatial Fire Management System
Manitoba Hydro	The Wildfires Act CCSM c W128	Last Effective date: March 1, 2019	•May suspend machine-based operations within a Burn Permit area.	Wildfire Program
Ontario	Forest Fires Prevention Act, *R.S.O. 1990, c. F.24*	Came into force: March 16, 2019	•Liable through staff actions •Removal of flammable debris	Ontario Forest Fires
Quebec	Sustainable Forest Development Act, *Forest Protection Regulation*, CQLR, c. A-18.1, r.10.1 sections 5.8	Last Updated: June 1, 2019	Non-Specific	SOPFEU
New Brunswick	Forest Fires Act RSNB 2014, c 110,	Last Updated: March 7, 2018	• Provision and maintenance of firefighting equipment	Forest Fire Watch

Nova Scotia	Forests Act *Forest Fire Protection Regulations* NS, Reg 55/87, 23(2) and 40	Last Amended: April 1st, 2015	• Utilities must have fire-fighting equipment available when operating within 1000 ft. of a forested area	Fire Weather Forecast
Prince Edward Island	Fire Prevention Act RSPEI 1988, c F-11	Last Updated: June 28, 2019	Non-Specific	Fire Information
Newfoundland and Labrador	Forestry Act *Forest Fire Regulations CNLR 11/96*	Came into force: June 9, 2004	Non-Specific	Forest Fires
Yukon	Forest Protection Act *Forest Protection Regulation (2003), YOIC 2003/57*	Came into force: November 24, 2004	Non-Specific	Yukon Forest Fire Report
Northwest Territories	Forest Protection Act, RSNWT 1988, c F-10,	Last Updated: May 20, 2010	• Where directed to do so by the Forest Supervisor, an industrial operation may be required to clear and keep clear of flammable material the space surrounding the site	Wildfire Update
Nunavut	N/A	N/A	N/A	N/A

Appendix B: Glossary

Terminology	Description
BUI	Build-Up Index
DC	Drought Code
DMC	Duff Moisture Code
Emergency Response Plan (ERP)	A document developed to ensure quick access to critical information to effectively and efficiently respond to an emergency.
ETR	Estimated time to restoration
Fine Fuels	Also referred to as slash waste is the remains of wood and vegetation product from vegetation management.
Embers	Heated organic material.
FFMC	Fine Fuel Moisture Code
Fire Weather Index (FWI)	A numerical rating of fire intensity. It is used as an index of fire danger throughout forested and non-urban areas.
Ignition	Source or start of a fire.
ISI	Initial Spread Index
High Fire Risk Area (HRFA)	High Fire Risk Area are defined as areas with heightened wildfire risk where mitigation is required. The high level of risk is determined by government forestry departments and wildfire agencies and/or utility developed risk modelling/mapping.
Mineral Soil	Non-organic soil.
Mitigation	Action that moderates the severity of a fire hazard or risk.
Must	Mandatory
Resilience	The capacity to recover quickly from difficulties.
Risk	Effect of uncertainty on objectives or the organization.
Shall	Mandatory
Should	Recommended
Suppression	Suppression includes the elements that are related in containing a wildfire upon detection in order to protect assets, personnel and equipment.
Tolerable	An acceptable level.
Wildfire	Any unwanted or unplanned fire that burns in forested or grassland areas.

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Appendix C: Recognition

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