



CANADIAN ASSOCIATION
OF PETROLEUM PRODUCERS

BEST MANAGEMENT PRACTICES

Wildfire Prevention

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The Canadian Association of Petroleum Producers (CAPP) represents 140 companies that explore for, develop and produce natural gas, natural gas liquids, crude oil, oil sands, and elemental sulphur throughout Canada. CAPP member companies produce more than 97 per cent of Canada's natural gas and crude oil. CAPP also has 125 associate members that provide a wide range of services that support the upstream crude oil and natural gas industry. Together, these members and associate members are an important part of a \$65-billion-a-year national industry that affects the livelihoods of more than half a million Canadians.

CAPP engaged QSI Quality Service Investigations Inc. (QSI) to develop Best Management Practices for Wildfire Prevention for the upstream oil and gas industry. QSI assembled a team of experts with numerous years of experience and training in wildland fire management. The Team members are: Bill Bereska, Dennis Quintilio, Murray Heinrich and Kelly O'Shea.

Throughout the development of this document, QSI worked with members of the Industrial Wildfire Prevention Working Group who reviewed the document and provided comments and suggestions. CAPP wishes to acknowledge the interest and support from these members and from other stakeholders whose joint efforts have helped make this a more useful document for all.

Review by December 2012

Disclaimer

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Project Scope

Overview

Best Management Practices are to be used collectively by the upstream oil and gas industry to assist them in the prevention of industry caused wildfires, and to mitigate the impact of catastrophic fires on industry infrastructure, operations, liability, personnel safety and the environment.

The project is developed in two phases. Phase I contains an inventory and analysis to identify key issues, fire history of industry related wildfires, current legislation, and some key components that will be considered in developing Best Management Practices. These components include Integrated Land Management, Seasonal and Daily Fire Danger, Emergency Response Planning, and Communications.

The first step in the process was the development and approval of a Best Management Practices Outline (Appendix A). This outline established the criteria for conducting the inventory and analysis. Information and data were collected from industry and government personnel, documents and other publications, and websites relating to wildland fire and the oil and gas industry. A number of case studies of industry-related wildfires have been included to illustrate the magnitude of the problem.

Findings

- A wildfire prevention overview identifies three initiatives that are critical to the oil and gas industry success in wildfire prevention:
 - Regulatory compliance to enhance fire suppression response.
 - Voluntary assessment of wildfire threat and risk to mitigate damage.
 - Standard industry practice that reduces wildfire ignitions and associated liabilities.
- A review of fire history in the Forest Protection Area of the province from 1996 to 2005 revealed there were 987 overall industry-caused fires. Of that number, 327 fires were caused by the oil and gas industry; this was second only to fires caused by electrical transmission lines. Many of these power line fires occurred in the oil and gas fields (see Appendix B Map of Forest Protection Area).
- A review of the legislation that regulates the oil and gas industry showed the *Forest and Prairie Protection Act* and *Regulations* are the most applicable pieces of legislation for wildfire prevention in the Province of Alberta. Other acts, regulations, fire control plans and agreements, guidelines and directives were also reviewed.
- Integrated Land Management is an important consideration, particularly in the planning process. The Area Operating Agreement provides a tool that can be used to incorporate the three initiatives of wildfire prevention.

- The incorporation of seasonal and daily fire danger ratings can be used to modify operations and reduce the risk of wildfire ignition.
- Emergency response planning is a legislated requirement for the oil and gas industry. All companies complete and implement emergency response plans, but few companies identify wildfire as a threat or risk. The incorporation of wildfire risk in emergency response planning is critical as a best management practice in wildfire prevention.
- Without a suitable communications plan, the good intentions of fire prevention will fail. All levels of an organization must be aware, and be able to understand and practice the elements of fire protection. Companies must self regulate and enforce the accepted wildfire prevention practices.

Phase II consists of Best Management Practices for the prevention of the most common causes of the oil and gas industry wildfires, and practices that will mitigate the impacts of escaped wild fires.

1 Introduction

1.1 Context

Wildfire prevention in the oil and gas industry requires a proactive approach based on understanding the corporate liabilities associated with the ignition of a fire, as well as the threat that a catastrophic fire poses to personnel, infrastructure and production. The fundamentals of wildfire prevention include education and awareness, engineering vegetation to reduce flammability, and enforcement of fire prevention regulations.

The Canadian Association of Petroleum Producers (CAPP) has initiated development of Best Management Practices (BMP) to address these fire prevention fundamentals across the industry. This initiative will be a model for industrial operations in forested areas throughout Canada. Implementation of BMP will not only significantly reduce both the risk of fire ignition during routine operations, but also the negative impact of catastrophic fire events on oil and gas developments.

The four leading causes of fire ignition in the oil and gas sector are brush burning, equipment, flaring, and All Terrain Vehicle (ATV) operations. These were determined through analysis of fire history in the Forest Protection Area of the province, which is included as a component of this report. The BMP program will provide mitigating options that may significantly reduce ignitions in all four categories, and concurrently decrease the associated liability with each activity that may cause a wildfire to ignite. Coinciding with this is the need for vegetation management on dispositions to reduce the threat of wildfire during annual fire seasons.

The combination of reducing liability and wildfire threat across the oil and gas industry will have a positive impact on safety, financial and legal issues. A historical review of a number of high profile industry related fires has been included as part of the introduction as a contribution to the education and awareness component of fire prevention, and a reminder of the seriousness of wildfire impacts.

1.2 Case Studies of Selected Industry-Related Fires

Christmas Fire, 1997

The Christmas fire occurred on December 14, 1997, adjacent to Highway 40 south of Hinton after strong Chinook winds had removed snow cover from the area. Highway 40 construction and subsequent contract burning of over 200 brush piles preceded the fire event, and the fire cause was determined to be holdover fire in two of the brush piles. Such fires occur when glowing or smoldering combustion persists for lengthy periods, particularly when forest fuels are mixed with soil from clearing operations.

The following day, the fire spread to 2800 hectares under the influence of westerly winds in excess of 140 kilometres per hour. Occurring at the same time was a power line fire north of Hinton that was threatening rural residential developments, as well as the wood decks at the Weldwood mill site on the Athabasca River. The gale force winds limited air attack and both fires were fought primarily by hand with ground crews, bulldozers and water trucks. Holdover fires commonly escape during high velocity wind events, as was the case with the Christmas fire, and fire suppression operations are challenged.

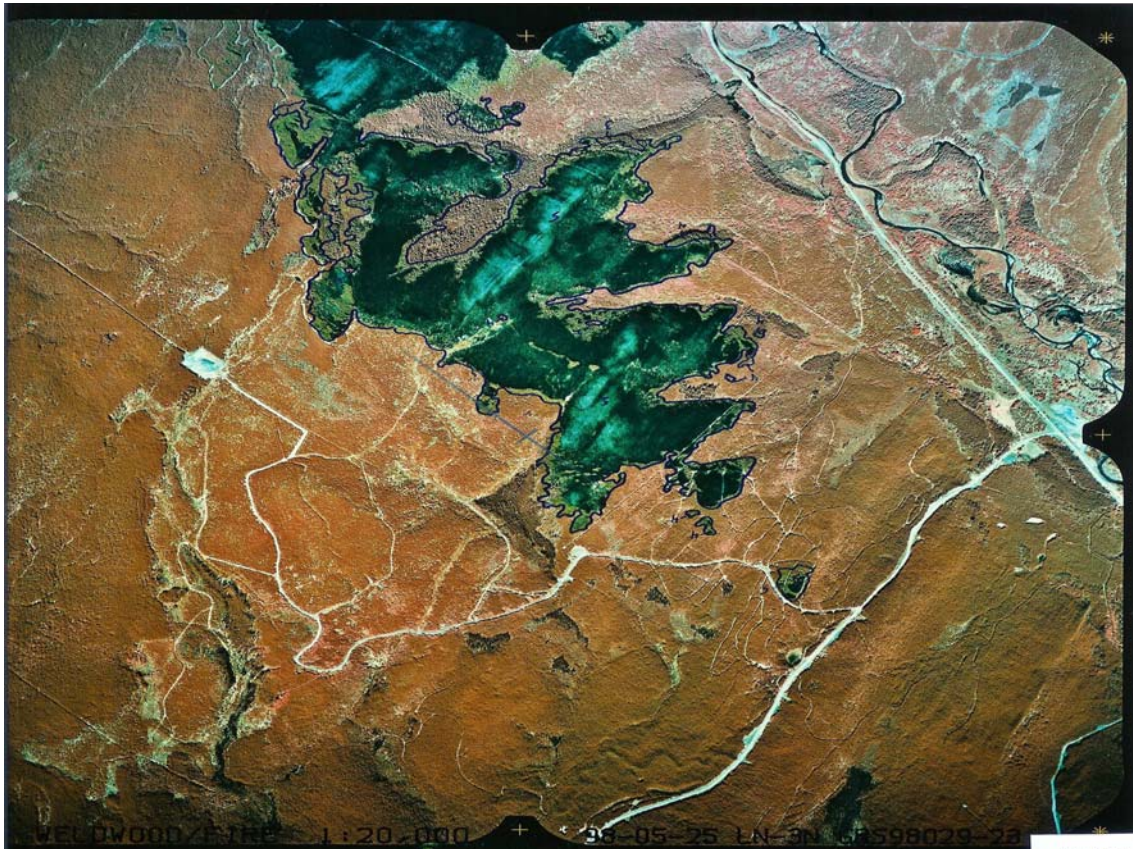


Figure 1. Wind-driven fire on December 14, 1997, originating from previous brush pile burning on Highway 40 right-of-way clearing.

Chisholm Fire, 2001

The Chisholm fire burned 120,000 hectares of forested area in May 2001, following a three-year drought and a winter with very little snowfall. During the peak fire activity, 224 firefighters, 24 helicopters, three air tanker groups and 111 bulldozers were committed to the fire suppression operation. The fire was reported at 21:35 hours on May 23, and was 10 hectares in size at that time. Aircraft were grounded due to darkness; by the next morning, the fire had grown to 4,000 hectares despite ground crews and bulldozer initial attack efforts overnight.

On May 28, the fire exploded as a result of a low level jet wind, and the communities of Chisholm, Honda and Smith were evacuated and the Town of Slave Lake was put on evacuation alert. In the early afternoon of May 28 the fire overran Chisholm, burning 10 homes. This was the first major community loss in Alberta since 1919 when Lac La Biche burned to the ground. The impacts on industry were unprecedented in Alberta, as land use activities in the area were suspended and community protection priorities prevailed.

Local forest industry companies (Vanderwell, Slave Lake Pulp and Weyerhaeuser) lost 4,587,269 m³ of timber, as well as the cut blocks that were reforested as a result of the 1998 Mitsue fire. The oil and gas companies in the area (Anderson Exploration, Chevron, CNRL, Conoco, Fortune Energy, Husky Energy, Northstar Energy and Sabre Energy) lost production ranging from three hours to 10 days. Atco Electric facility and structural loss and service disruption were estimated at \$1,000,000. Fire suppression expenditures on the Chisholm Fire exceeded \$30,000,000.



Figure 2. Chisholm fire convection column recorded by Edmonton radar at 45,000 ft on May 28th, 2001.

House River Fire, 2002

The House River Fire was reported on May 17, 2002. When it was declared under control on June 17, 2002, it was the second largest fire in Alberta's history (243,200 hectares). At the time of the House River fire, record fire events were

occurring in Saskatchewan, Quebec, Arizona and Colorado, and fire impacts on communities and industry operations were unprecedented in North America.

Oil and gas operations in the area were shut-in for up to three weeks, and a number of companies experienced facility losses and infrastructure damage. Companies affected by the fire included Rio Alta, Talisman, Stylus Energy, Devon, EnCana, Paramount Resources, Husky, Simmons Group, Enbridge and TransCanada.

Atco Electric and Aquila lost over \$1,000,000 of transmission line poles and power outage for 25 days. The forest industry (Al-Pac, Millar Western and Vanderwell) lost \$2,000,000 of timber which included silvicultural costs and program disruptions. Fire suppression expenditures on the House River Fire exceeded \$40,000,000.



Figure 3. Close call for oil and gas facility in the House River Fire.

Lost Creek Fire, 2003

The Lost Creek Fire started on the afternoon of July 23, 2003, in a cut block near the Lynx Creek Recreation Area approximately 24 kilometres south of the Crowsnest Pass. When the fire was finally brought under control on August 22, 2003, it had consumed 18,966 hectares of forested land in the Castle River

Watershed, threatened communities in the Crowsnest Pass area, and caused the evacuation of over 2,000 people.

The fire burned beyond the wildlands and entered the urban interface on August 12. Fortunately no homes were lost. The fire affected local area residents and impacted natural resources, local industries and businesses. The area in which the fire occurred had not been exposed to any major fire event since 1910.

The extreme behaviour experienced by this fire resulted from a combination of drought, hot, dry and windy weather, contiguous coniferous fuels and rugged topography. On July 23 the drought code was 378, and it continued to climb until it reached 600 by August 22. Firefighters had little help in the way of moisture, with less than 5.0 mm of rain recorded during that time. The average daily high temperature for the 31-day period was 28.3°C; the average daily low relative humidity was 21%. Crossover of temperature and relative humidity occurred on day 21 of the 31 days in which the fire burned out of control. Winds influenced by the rugged terrain were variable in direction and speed.

At the peak of fire suppression operations (August 12), there were 671 firefighters and overhead personnel, three air tanker groups, 22 rotor wing, 12 dozer units, and 54 water tenders and engines. The municipal districts also deployed a number of firefighters, water tenders and engines.

A total of 18,966 hectares of the fire were within the timber harvest land base and this affected the timber quotas of four timber companies and one community timber program. The Castle River grazing allotment (18 individual ranchers) were directly affected by the fire as were a number of private recreation developments.

Oil and gas and utility companies affected were Shell Oil, Devon Canada Ltd, Hunt Oil of Canada, ATCO Pipelines, ATCO Gas, TransCanada Pipelines and Fortis Alberta. Shell Canada was affected the most, with the closure of two producing gas wells, suspension of drilling operations on one site and suspension of a seismic program in the fire area. Fire suppression expenditures were approximately \$30 million.



Figure 4. Lost Creek fire threatens forestry lookout and the communities of Hillcrest and Blairmore.

Freeman River Fire, 2004

The Freeman River Fire started along a power line in the Pen West Oil Field approximately 13 kilometres southwest of the Town of Swan Hills and five kilometres north of the Pengrowth Corporation Judy Creek Gas Plant. The fire was ignited at approximately 15:20 hours on May 18, 2004, and consumed 993 hectares.

At the time the fire started, fire weather indices were extreme and strong northwest winds pushed the fire toward the Pengrowth Corporation Judy Creek Gas Plant. The gas plant was evacuated and the Pen West Oil Field was shut in. The gas plant was situated in a large clearing and the fire passed by without causing damage to the facilities. A downturn in weather (light rain and high humidity) slowed the fire spread and allowed Sustainable Resource Development (SRD) to control the fire that evening.

The Swan Hills area has experienced a number of large catastrophic fires in recent years and the Freeman River Fire had the potential to be another. ATCO suffered serious losses to infrastructure in the fire area; in turn, this affected production activities in the gas field and plant. The fire was located in West Frazer's Forest Management Area and timber and growing stock were lost in the fire. The Freeman River fire suppression costs were \$1.7 million.



Figure 5. Judy Creek Gas Plant threatened by the Freeman River Fire

1.3 Forest Fire Prevention Overview for the Oil and Gas Industry

The preceding case studies illustrate the potential for catastrophic fires in Alberta to impact both community safety and industry operations. In 2003, an Alberta-based coalition dedicated to raising awareness and providing information that would reduce the risk of wildfire losses in the wildland/urban interface, published an internationally recognized report titled “FireSmart—Protecting Your Community From Wildfire”. This publication introduces the concept of community protection zones (Figure 6) that define priorities associated with wildfires.

Building on the success of a “Partners in Protection” concept, a proactive government/industry task force initiated discussions for a similar project focused on industrial developments in forested areas of the province. The formal title of the task force is the *Wildfire Prevention Strategy Group*, and comprises representatives from the oil and gas, forestry and utilities industries.

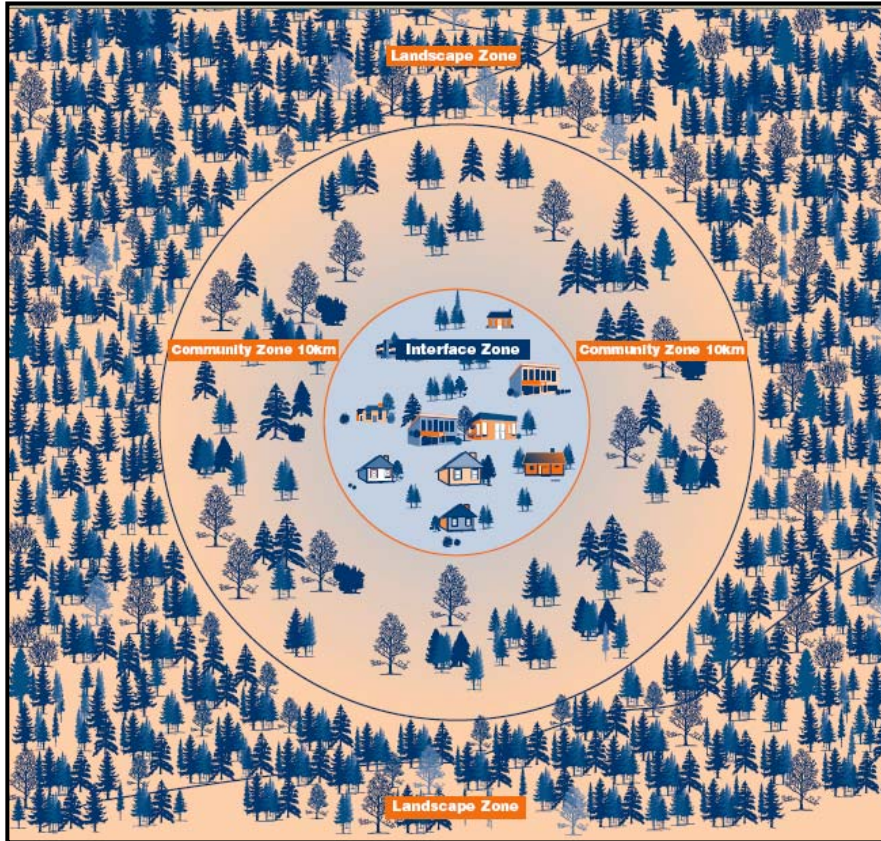


Figure 6. FireSmart Zones. Partners in Protection July 2003, 2nd Edition.

The oil and gas industry BMP need to link to the community zone strategies for dealing with brush disposal, fuel modification, provision of water sources for wildfire suppression, and development of containment lines within the community zones.

The *Wildfire Prevention Strategy Group* issued a final report in July 2005 with three concerns to be addressed jointly by government and industry:

- Risk to people and facilities from wildfires,
- Production facility shut-ins associated with wildfires, and
- Liability exposure to wildfire suppression costs, and stakeholder or third party damages that could potentially be incurred from industry-caused fires.

Since 2005, three initiatives have been identified as critical to industry-wide fire prevention. A strategy is being considered by SRD to link the initiatives, eliminate duplication, and clearly separate regulatory and non-regulatory actions. The following summary of the initiatives and contribution to fire prevention has been approved by SRD.

Annual Industrial Wildfire Control and Prevention Plan*

- Mandatory under the Forest and Prairie Protection Act.

- Provides an important update of information for local Forest Protection Branch staff of SRD.
- Used for enhancing SRD's ability to quickly respond to and successfully suppress wildfires that may threaten oil and gas personnel, infrastructure and production.

FireSmart Assessment Guidebook for the Oil and Gas Sector**

- Introduces three industrial zones for assessing wildfire threat based on forest vegetation and facility developments.
- Enhances emergency response on dispositions that are at risk during wildfire.
- Is linked to the *FireSmart Manual for Community Protection in Alberta* and the Oil and Gas Best Management Practices.

Best Management Practice for Fire Prevention in the Oil and Gas Sector***

- Linked to other industrial fire prevention practices on the same land base.
- Identifies forest fire ignition liabilities associated with industrial operations in the oil and gas sector based on fire history analysis.
- Presents mitigation practices to reduce the risk of wildfire and the liability associated with fire ignitions that can be attributed to the oil and gas industry.

*Regulatory requirement to enhance fire suppression response.

**Voluntary assessment of wildfire threat and risk at the disposition level.

***Standard industry practice that reduces wildfire ignitions and associated liability.

1.4 Historical Industry-Related Fires in Alberta

Phase 1 of this project required a historical summary of industry-related fires in Alberta, including an analysis of general and specific causes. A 10-year period from 1996 to 2005 was used for the summary and analysis. This period represents the current boom of land use activities and reflects a number of the most extreme fire seasons in Alberta's history.

Wildfire data obtained from the Forest Protection Branch of SRD applies only to the Forest Protection Area (FPA) of Alberta (see Appendix C Forest Protection Area Map). The Fire Commissioner's office maintains fire statistics for the Non-Protection Area (NPA) of Alberta (White Area); however, data on wildland fires are not accurate because not all wildland fires are reported.

There are a number of wildfires each year within the NPA and the majority of these fires occur during the early spring or late fall. The data within the FPA indicates that industry is ranked as the third highest human-caused ignition source. Some of these fires become very large and expensive to extinguish.

The primary objective of this data analysis was to identify the five most common activities that take place in industrial operations which have a high liability of starting a wildfire. The second objective is to recommend the best management

practice for industrial operations that will limit the liability of starting wildfires, and offer positive wildfire prevention options.

The wildfire ignition cause was also reviewed for other industry that operates on the same land base as the oil and gas industry. This review is necessary to ensure that any best management practices developed for oil and gas industry wildfire prevention are consistent with what is being done by other industries.

1.4.1 Historical Oil and Gas Industry Wildfires

A review of Alberta wildfire data indicates there are five oil and gas industry operation activities that rank the highest in contributing to the wildfire ignition. These are:

- - Brush burning,
- - Flaring,
- - Use of all terrain vehicles in forested areas,
- - Abandoned cooking and warming fires, and
- - Heavy equipment.

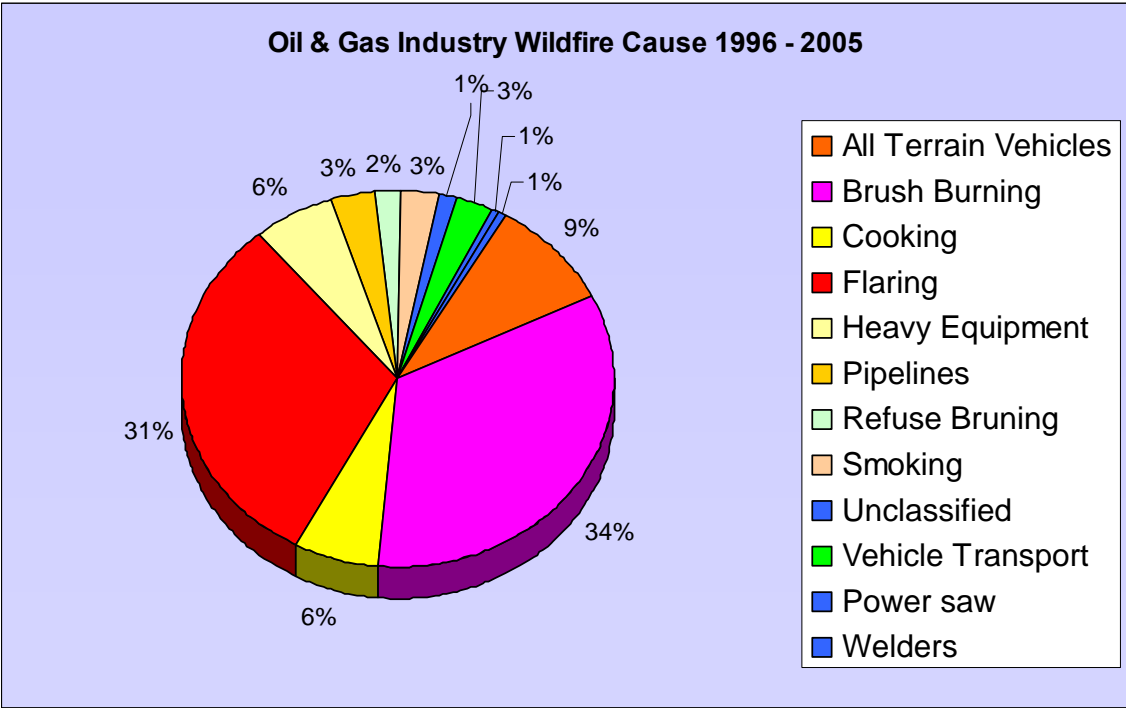


Figure 7 and Table 1. Summary of oil and gas industry activities and associated number of wildfire starts for the period of 1996 – 2005.

Table 1.

Activity Class	Number of Wildfires
All Terrain Vehicles	31
Brush Burning	110
Cooking	21
Flaring	101
Heavy equipment	20
Pipelines	11
Refuse Burning	7
Smoking	9
Unclassified	4
Vehicle Transport	9
Power Saws	2
Welding	2
Total Fires	327

Brush Burning

The majority of wildfire ignitions from brush burning are a result of improperly extinguished fires or holdover fires in deep duff layers or within large brush piles that contain fibrous top soil. These piles should be spread and checked with infrared equipment to ensure fires are properly extinguished.

Flaring

There are a number of operational activities, both mechanical and human, that lead to wildfire caused through flaring. Some of the more common causes are the use of flare guns, flare stack burps that send hot carbon to the forest floor, insufficient expanse of mineral soil between the flare stack and surrounding forest vegetation, and flaring during high and extreme wildfire burning periods.

Flaring is a routine operation in the oil and gas sector that can potentially ignite a wildfire under high and extreme fire hazards. During the period of 1996 to 2005, a total of 101 fires were caused by flaring operations in the Alberta. These fires are preventable.

Regulations determine the distance from flammable fuels for permanent and portable flaring operations; therefore, the key to mitigating flare fires is the seasonal and diurnal timing of flare events. More than 50% of the wildfires caused by flaring in the 10-year period that was analyzed ignited in grass fuels that were cured (spring and fall) or in slash fuels following clearing operations. The fires over this 10-year period were contained at 608 hectares or less owing to the fortunate circumstance of light winds that were associated with each fire event. The wind velocities of the case studies included in this report indicate the potential for catastrophic flaring fires.

All Terrain Vehicles

The use of all terrain vehicles in forested areas causes a build up of wet or dry fibrous material from grass and moss to accumulate around the exhaust system. This material is then ignited by the high exhaust temperature and falls off as burning material on dry forest fuels where it can spark a wildfire.

Cooking and Warming Fires

Wildfires caused by abandoned cooking and warming fires have declined in the last five years. This maybe attributed to the oil and gas Industry using fewer crews for brush pile burning and slashing.

Heavy Equipment

Heavy equipment triggers fires mainly in two ways. The first is by hot exhaust carbon landing in dry surface fuels; the second cause is from an accumulation of fine fiber particles from grass and trees collecting on hot exhaust systems, igniting and then falling onto dry surface fuels.

1.4.2 Historical Forest Industry Wildfires

A review of the Alberta wildfire data indicates the four forest industry operation activities that are the biggest contributors to wildfire are:

- Brush pile burning,
- Heavy equipment,
- Refuse burning, and
- Use of all terrain vehicles in forested areas.

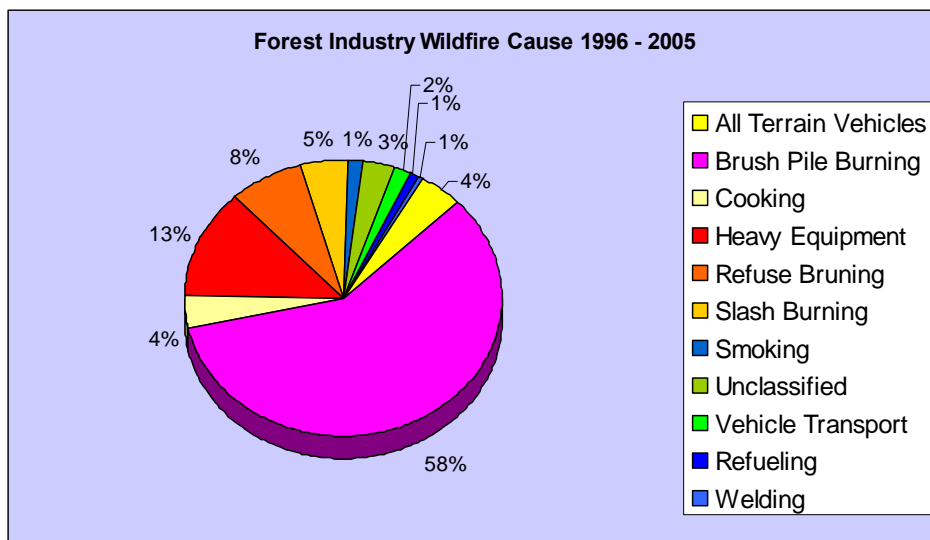


Figure 8 and Table 2. Summary of forest industry activities and associated number of wildfire starts for the period of 1996 – 2005.

Table 2.

Activity Class	Number of Wildfires
All Terrain Vehicles	7
Brush Pile Burning	92
Cooking	6
Heavy equipment	20
Refuse Burning	12
Slash Burning	8
Smoking	2
Unclassified	5
Vehicle Transport	3
Refueling	1
Welding	1
Total Fires	157

Refuse Burning

Refuse burning is the burning of small amounts of debris or garbage or other materials. Wildfire can occur when the fire is not properly extinguished, or burning occurs under conditions where the fire quickly escapes the individual’s control.

1.4.3 Historical Railroad Wildfires

A review of the Alberta wildfire data indicates the three railroad operation activities that contribute to the highest wildfire causes are:

- Burning substances,
- Unpredictable event, and
- Hot exhaust.

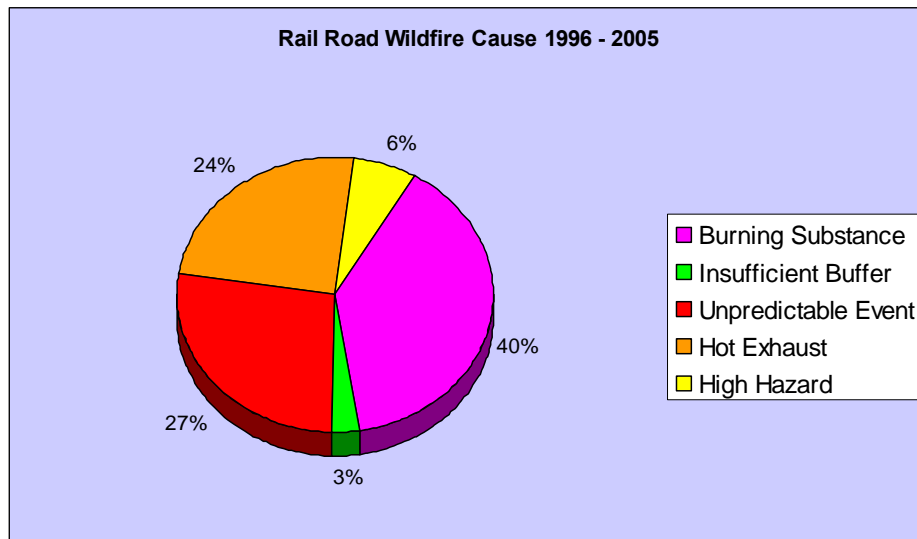


Figure 9 and Table 3. Summary of railroad activities and associated number of wildfire starts for the period of 1996 – 2005.

Table 3.

Activity Class	Number of Wildfires
Burning substance	56
Insufficient buffer	4
Unpredictable event	39
Hot exhaust	35
High Hazard	9
Total Fires	143

Burning Substance

Burning substances are usually hot metal pieces of brakes or bearings that are expelled from the train wheels as it moves.

1.4.4 Historical Power Line Wildfires

A review of the Alberta wildfire data for the FPA indicates that trees falling on power lines contribute to the highest number of wildfire causes on power lines right-of-ways. This usually occurs when fire hazards are high and strong winds cause off right-of-way trees to fall on conductors. The second major cause of power line fires is burning substance, such as fuses, molten metal, or burning wildlife falling into dry grass.

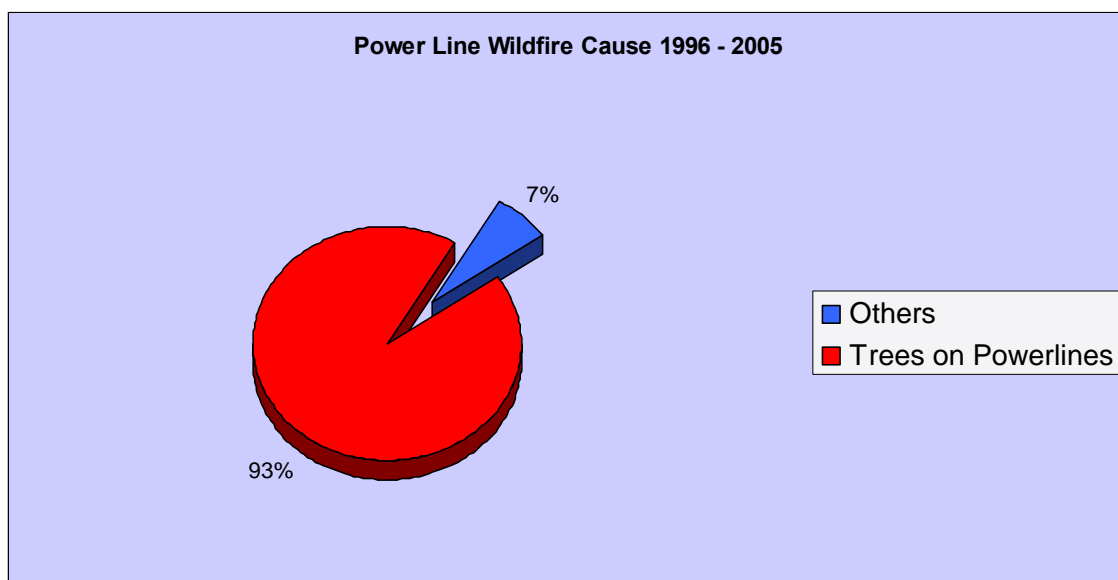


Figure 10 and Table 4. Summary of power line activities and associated number of wildfire starts for the period of 1996 – 2005.

Table 4.

Activity Class	Number of Wildfires
Power Lines	335
Others	25

- Power lines – include trees falling on power lines and burning substances falling into dry grass.
- Others – includes all terrain vehicles, brush burning, heavy equipment, smoking, and unknown.

1.5 Timing of Industry Related Wildfires

Most industry related fires occur during the months of April, May and June. SRD statistics of human caused fires from 1997 to 2006 indicate that 64% of human caused fires occurred during this time. The statistics hold true for oil and gas related fires with April, May, and June (31, 32, 29 respectively) accounting for the highest monthly fire occurrence.

During these months grass and other fine fuels are very dry and easily ignited. The spring months April, May, and June can also account for some of the most extreme fire behavior due to low moisture content of fine fuels and critical fire weather. The Chisholm Fire of May 2001, the House River Fire of May 2002, and the Freeman River Fire of 2004 are examples of spring fires.

2 Regulatory Aspects

The Canadian Association of Petroleum Producers has initiated the development of Best Management Practices (BMP) that addresses the fundamentals of wildfire prevention, including education and awareness, engineering to manage vegetation flammability, emergency response and communications. These practices are aimed at significantly reducing the risk of fire ignition during routine operations and the negative impact of catastrophic wildfire events on the oil and gas industry.

BMP will be implemented by the oil and gas industry on a voluntary basis to reduce the potential for liability to the industry from wildfire. The BMP will provide a guide for the industry to operate within a FireSmart environment, and will provide the industry with a self-regulating method of wildfire prevention. Regulatory agencies may support the practices and encourage their implementation; however, the practices remain largely voluntary as a benchmark for the oil and gas industry.

The BMP will form a performance standard that is acceptable to the industry. They will form the basis for self audits or peer audits which can be carried out by industry to ensure they are meeting the appropriate benchmarks. Compliance with the practices will result in a reduced number of fires and the significant impact that such fires have on the industry.

Although the BMP are primarily voluntary, provincial legislation is in place that pertains to wildfire prevention and response. This section considers industry's compliance with this legislation.

2.1 Legislation, Codes, Directives, Guidelines And Agreements

2.1.1 Forest and Prairie Protection Act and Regulations

There are a number of national and provincial statutes that regulate the oil and gas industry. In Alberta, the one most applicable to wildland fire management is the *Forest and Prairie Protection Act (FPPA)*. Under the *Government Organization Act*, the Minister of Sustainable Resource Development is responsible for the *FPPA*. This Act provides for the prevention, detection and suppression of all wildland fires within the Province of Alberta except on land within the boundaries of an urban municipality and on land owned by the Government of Canada wherein a fire control agreement with the Minister is not in place.

The Forest Protection Area Regulation designates the forested area of the province as the Forest Protection Area (FPA). The Department of Sustainable Resource Development (SRD), Forest Protection Branch (FPB), is responsible for the prevention, detection and suppression of wildfire within the FPA. The prevention, detection and suppression of wildfire outside the FPA are the responsibility of the local municipality.

The *FPPA Regulations Part I* regulates the size of clearing and distance to standing timber required for any industrial operation, including flare pits and flare stacks, either on public land or within one kilometre of public land. *Part I* also regulates the use of flares and incinerators. *FPPA Regulations Part II* prescribes the disposal of debris for fire hazard reduction, which has resulted from the clearing of all oil and gas land use dispositions, including geophysical exploration.

The *FPPA* allows the Minister to enter into a fire control agreement with any person conducting an industrial or commercial operation on or adjacent to public land. It is a requirement of the Act that anyone conducting an industrial or commercial operation on public land or within one kilometre of public land (may) be required to submit a fire control plan. Failure to obtain an approved fire control plan could result in the suspension of operations. The *FPPA* also requires that any industrial or commercial operation on public land or within one kilometre of public land must have fire fighting equipment on hand, as identified in the *Regulation Part I*.

The *FPPA* authorizes the Minister to determine responsibility for the cause of wildland fires, and entitles the Minister or a municipality to reimbursement for the cost and expenses of fighting the fire from the person or agency responsible for causing the fire.

General provisions of the act and regulations applicable to the oil and gas industry include:

- designation of fire seasons,
- lighting of outdoor fires,
- requirements for fire permits, and
- fire control orders.

Fire permits are required for the fire season (generally April 1 to October 31 unless otherwise designated by the Minister). In addition to the Act and Regulations, fire permits may contain fire control conditions with which the permittee must comply, and the permits may be suspended or cancelled at any time. The permittee must then immediately extinguish any fire set pursuant to the permit.

Other general provisions of the Act and Regulations that are applicable to the oil and gas industry include: requirements for spark arrestors on equipment, power saw precautions, pipeline precautions, and liability of directors, officers and agents of a corporation.

2.1.2 Occupational Health and Safety Code 2006

The revised 2006 Code came into effect on February 1, 2007. It is referenced here for the purposes of determining requirements for the BMP.

Hazard Assessment, Elimination and Control

In Part 2 of the Code, it is stated that an employer must assess a worksite and identify existing and potential hazards before on-site work begins or prior to the construction of a new worksite. The employer must prepare a report on the results of a hazard assessment and the methods used to control or eliminate the hazards identified.

This section of the Code could refer to a worksite that is constructed in a forested environment and which is subject to wildfire. The remedy is assessment, elimination and control of the hazards.

Emergency Preparedness and Response

Part 7 of the Code states an employer must establish an emergency response plan for responding to an emergency that may require rescue or evacuation. The contents of the plan are described in Section 116, and rescue and evacuation requirements are described in Section 117. Equipment and Personnel Protective Equipment appropriate to the worksite and potential emergencies is described in Section 118.

2.1.3 EUB Directive 060 Upstream Petroleum Industry Flaring, Incinerating, and Venting.

The Alberta Energy and Utilities Board (EUB) Directive 060 provides regulatory requirements and guidelines for flaring, incinerating, and venting in Alberta, as well as procedural information for flare permit requests, dispersion modeling, and the measuring and reporting of flared, incinerated, and vented gas. In addition to upstream petroleum industry facilities, the directive also applies to gas transmission facilities licensed by the EUB.

Section 7 describes performance requirements for flares and incinerators in all upstream oil and gas systems. Section 7.8 (3) and (4) identifies compliance with the *Forest and Prairie Protection Regulations*, and Section 7.9 identifies with compliance with fire bans. Section 7.11 addresses flare pits. The EUB recommends that operators phase out flare pits used for routine gas flaring and will not be used at facilities constructed after 1996. Section 7.11 also provides requirements for pit flaring at facilities constructed prior to 1996.

2.1.4 EUB Directive 071 Emergency Preparedness and Response Requirements for the Upstream Petroleum Industry.

This directive provides the minimum EUB emergency preparedness and response requirement for the upstream petroleum industry. It is the responsibility of the licensee to determine when an emergency response plan is required and the type of plan required. The directive details common emergency preparedness and response requirements that apply to any hazard related to upstream petroleum

operations. A key component of emergency preparedness and response is the development of an Emergency Response Plan, which is defined as a document developed to ensure quick access to critical information necessary to effectively respond to an emergency. The directive clearly identifies the requirements of the Emergency Response Plan.

2.1.5 Alberta Building Code

The Alberta Building Code is a prescriptive document that regulates the construction of buildings in the Province. Architects and engineers are compelled to plan buildings that comply with Code. The Code includes many fire safety aspects such as exits, smoke and heat detection, and emergency lighting. Building permits pursuant to the Code are required for new construction throughout Alberta.

Although there are no specific FireSmart inclusions in the Building Code, the firefighting water supply components of the Code can be crucial in not only providing the resources to deal with the structural fires for which it was intended, but also wildland fires. The requirements for water supply are based on the size and occupancy of the buildings. Water supply systems must meet standards which are established by the National Fire Protection Association.

2.1.6 Alberta Fire Code

The Alberta Fire Code is primarily concerned with building and occupant safety in existing buildings. It contains requirements for operational exits, smoke detection, alarm systems and handling of flammable materials and processes.

The Alberta Fire Code has a requirement of a three metre fuel-free zone around flammable liquid storage sites.

2.1.7 Municipal Government Act

All land developments in Alberta are conducted within a municipal jurisdiction which is governed by the *Municipal Government Act*. The Act establishes the municipalities' authority for municipal planning, subdivision and development control. Municipalities have the ability to create FireSmart requirements within their Land Use Bylaw. These types of requirements are being implemented for residential subdivisions across Alberta, and in the future they may be extended to non-residential developments.

2.1.8 Other Acts and Regulations

A number of other acts and regulations governing the oil and gas industry were reviewed to ensure there was no overlap or contradiction. These include:

- *Public Lands Act*
- *Forest Act/Timber Management Regulations*

- *Environmental Protection and Enhancement Act*
- *Water Act*
- *Special Areas Act*
- *Mines and Minerals Act*
- *Alberta Energy and Utilities Board Act and Regulations.*

2.1.9 Fire Control Plans and Agreements

The following fire control plans and agreements were reviewed:

- Forest Management Agreements
 - Forest Management Fire Control Agreement and Fire Control Plan
- Annual Wildfire Control and Prevention Plan
- Canadian National Wildfire Control Plan
- Power Line Hazard Assessment Plan (draft)
- Indian Reserves Fire Control Agreement
- Area Operating Agreement
- Environmental Field Report.

2.1.10 Guidelines and Directives

The following guidelines and directives were reviewed:

- Public Lands Operational Handbook, SRD
- FireSmart Guidebook for Oil and Gas Dispositions (draft)
- Debris Management Standards For timber Harvesting Operations, SRD
- Evolving Approaches to Minimize the Footprint of the Canadian Oil and Natural Gas Industry, Canadian Association of Petroleum Producers, June 2004
- Integrated Land Management (ILM), Alberta Chamber of Resources
- Reclamation Standards, DOE

3 Integrated Land Management

For upstream oil and gas producers, Integrated Land Management (ILM) involves working with other oil and gas producing companies and with other resource users to minimize the footprint of activities on the landscape. The advantages of ILM include:

- shared resource data and planning,
- cost reduction,
- shared technology and research, and
- reduction of cumulative effects associated with increased access.

ILM can also reduce the risk of wildland fire by reducing the amount of clearing necessary and subsequent debris disposal by burning. Windrows along seismic lines can act as a wick and increase the spread of a wildfire. One method to eliminate windrows and reduce timber damage fees (through negotiation with the FMA holder) is the implementation of low impact seismic. Consultation with other users may result in a sharing of emergency services planning and resources. Coordinated planning with other resource users can reduce access which in turn can reduce the risk of human-caused fires by other users.

Alberta Sustainable Resource Development, Land Management Branch (LMB), in conjunction with natural resources users, has developed a template for Area Operating Agreements (AOA). An AOA is an agreement between the Lands Division and an oil and gas company for areas where multiple land use dispositions will be located. The AOA provides for stewardship over the entire life of a disposition, as well as for greater integration and common use with others. The AOA also provides an opportunity for participating companies to integrate wildfire prevention into their development and operating practices.

4 Seasonal and Daily Fire Danger

The Canadian Forest Fire Danger Rating System (CFFDRS) is internationally recognized as a daily and seasonal indicator of wildfire potential in forested areas. It is based on weather and forest fuel flammability. In Alberta, over 130 weather stations provide input for the CFFDRS on a daily basis, and outputs of the system include potential fire intensity and fire spread rates.

In order to conduct oil and gas operations during the fire season in the forested and prairie regions of Alberta and Canada, industry needs to adopt best management practices to mitigate the liability and accompanied risk of wildfire ignition during high and extreme wildfire danger periods. To accomplish this with minimal cost, the oil and gas industry needs access to tools that will provide accurate information for decision making. The CFFDRS should be used to identify days when operational activities such as flaring, welding or other activities need to be restricted due to the high risk of wildfire.



Figure 11. Forest Protection Branch website image.

The oil and gas industry needs to have access to daily fire danger ratings to optimize prevention results and reduce the wildfire ignition liability. By reviewing the daily and forecasted fire danger ratings for specific areas, standard operating procedures can be modified to reduce the risk of wildfire ignition. This information is provided daily on websites by Natural Resources Canada and by SRD Forest Protection Branch. SRD also provides a number of maps showing current and forecast fire danger and fire behavior conditions; <http://www.srd.gov.ab.ca/wildfires/fpd/maps.cfm>. Through the development of special operating procedures and best management practices, daily operations can

continue and wildfire prevention objectives can be achieved. This will also provide for the highest level of safety to personnel working in flammable forests.

In addition to what the Forest Protection Branch provides on their website relating to current and forecasted fire danger, a map could be included of the provincial FPA ignition probability for each day of the wildfire season. During high and extreme fire danger periods, this would allow the oil and gas and other industry to restrict certain high risk operations during periods of the day when the ignition probability is highest.

The Natural Resources Canada Canadian Wildland Fire Information System website should be reviewed for daily wildfire danger and fire behavior maps and reports for wildfire danger information in the non-protection area of Alberta and other provinces.

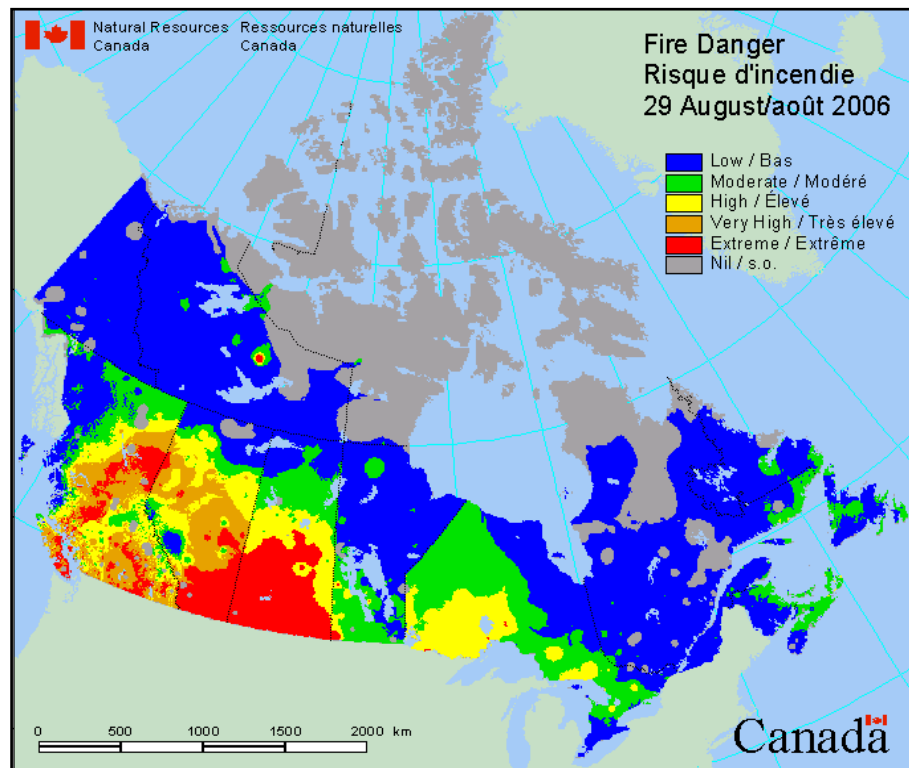


Figure 12. Natural Resources Canada website image

The Natural Resources Canada website provides excellent examples of fire behavior in jack pine fuel types, and gives a description of fire behavior fuel types which include photos. These examples and other information can be found under the heading *Background*, http://cwfis.cfs.nrcan.gc.ca/en/current/cc_fdr_e.php

5 Emergency Response Planning

Wildfire is a dynamic, natural, and seasonal phenomenon that can have a dramatic impact on the environment, people and infrastructure. It must be understood that despite wildfire prevention activities and the best efforts of industry and fire professionals, fires will occur. Wildfire behavior can be amplified by drought, global climate change, extreme weather conditions (particularly wind), landscape changes, and insect and disease infestations.

The oil and gas industry must consider wildfire when developing their local Emergency Response Plans. Emergency planning must address FireSmart and fire prevention issues that focus on:

- Enhancing personnel safety while working in flammable forests,
- Managing operations during evacuation alerts and orders,
- Enhancing the emergency response capability,
- Mitigating economic impact during shutdown,
- Reducing liability for industry-caused ignitions.



Figure 13. Talbot Lake fire 2002.



Figure 14. Chisholm Fire 2001 near an oil field.

Globally, wildfire has been responsible for thousands of fatalities and billions of dollars of infrastructure damage, as well as interruption of community services and industrial operations. An extreme fire event in Alberta has the potential to spread over 60 kilometres in a single day, producing the energy equivalent to 1000 barrels of oil in that same period. The combination of rapid and unpredictable fire spread and high energy release rates produces super heated air currents, ember transport and smoke columns that can impact human health and safety many kilometres from the actual fire front.

On average, over 1000 wildfires will occur throughout Alberta each year. Therefore, the next logical step is to implement an effective planning process to respond to the fire that will inevitably impact the oil and gas industry.

5.1 Industrial Wildfire Control and Prevention Plan (IWCPP)

The Forest Protection Branch (FPB) is responsible for wildfire suppression in the Forest Protection area in Alberta. The planning and prevention process with the FPB starts with the development of an Industrial Wildfire Control and Prevention Plan, which is updated annually. The intent of this plan is to proactively identify and update industrial values at risk and wildfire prevention strategies to reduce the negative impacts of wildfire. It is used by FPB to enhance their ability to respond quickly and suppress wildfires that may threaten personnel and infrastructure. It serves as the basis for an exchange of information and communication between industry and government for their mutual benefit.

Emergency Preparedness and Response Requirements for the Upstream Petroleum Industry, EUB Directive 071

Directive 071 provides the minimum EUB emergency preparedness and response requirement for the upstream petroleum industry. It is the responsibility of the licensee to determine when an emergency response plan is required and the type of plan required. The directive details common emergency preparedness and response requirements that apply to any hazard related to upstream petroleum operations.

A key component of emergency preparedness and response is the development of an Emergency Response Plan, which is defined as a document developed to ensure quick access to critical information necessary to effectively respond to an emergency. A comprehensive Emergency Response Plan:

- Must be well organized to ensure quick access to critical information,
- Coordinates activities among industry responders, emergency services, local authorities, governments and others who have a role in providing an effective response,
- Ensures communications with all parties involved in or potentially affected by the emergency,
- Assists personnel in determining and performing remedial actions,
- Clearly establishes roles and responsibilities for all responders,
- Identifies response organizations and command control structures,
- Identifies predetermined resources, required personnel, equipment and services; and
- Increases public confidence in the ability of industry to handle emergencies.

The source for the above information is Directive 071. For consistency and convenience, emergency planning for wildfires that impact the oil and gas industry shall be included in existing Emergency Response Plans or be in the same format as required by the EUB.

5.2 Incident Command System

Organizations use a variety of systems to manage emergencies, including Emergency Site Management (municipalities) and Fire Ground Command (Fire Departments). The oil and gas industry uses various forms of the Incident Command System (ICS), which is the emergency management system used by all provincial and federal wildfire agencies in North America. It is quickly being adopted as the preferred model for emergency management.

ICS is a standard for on-scene emergency management. It is specifically designed to allow users to adopt and integrate an organization structure equal to the complexity and demands of single or multiple incidents without being hindered by jurisdictional boundaries. A wide spectrum of ICS training is currently available to meet the needs of emergency responders. BMP for the oil and gas industry should be based on the adoption of ICS. This may prove to be a challenge for some organizations; however, the benefits are worthy of the challenges.

5.3 Personnel Safety

The development of a FireSmart environment will lead to enhancements in the safety of personnel in the event of a wildfire. All stakeholders clearly understand that life safety is their top priority. Neither emergency response agencies nor industry will sacrifice safety for infrastructure.

BMP must include criteria and plans for the termination of operations and the evacuation of personnel to meet the threat of an approaching wildfire. The practices need to consider the use of evacuation trigger points, safety zones and sheltering in place which may be necessary in extreme events.

The effects of wildfire on personnel in the oil and gas industry can be from smoke, heat and direct flame impingement. The smoke from a wildfire may impact the industry for several days up to several weeks. Smoke will cause low visibility and have a multitude of physiological impacts depending on the smoke concentration. The heat from an approaching fire will impact personnel and infrastructure, depending on the distance from the burning fuel. Direct flame impingement would have a grave impact on persons and infrastructure.

5.4 Training

The most effective tool in maintaining a safe workplace in the wildfire environment is education and training. Staff is trained to extinguish incipient fires at their worksite with fire extinguishers as a “first aid” measure, but is not expected to attempt fighting larger fires. With the appropriate training, staff can be trained to extinguish small wildfires without compromising their safety.

BMP will address the need to provide an appropriate level of wildfire training for the oil and gas industry. The Wildfire Orientation Course is a one-day seminar

that could easily be adopted for use in the oil and gas industry. Another consideration would be the use of self-study learning aids such as the “Safety on the Fireline” CD which is available from FPB.

5.5 Municipal Emergency Plan

All lands in Alberta are under the jurisdiction of a municipality. Each municipality must have a Municipal Emergency Plan (MEP) in compliance with the Alberta Disaster Services Act. The MEP is designed to provide a prompt and coordinated response to major emergencies such as wildfire. First responders from the fire department and FPB conduct an initial assessment to determine the extent and potential impact of a wildfire, and then provide appropriate advice to the municipal Director of Disaster Services on implementation of the MEP. The director may declare a state of local emergency in order to assist in the management of the emergency. The mandatory evacuation of an affected area is only possible under such declaration. BMP must be considered which develop strong linkages with municipalities and their Municipal Emergency Plans.

5.6 Infrastructure Protection

The development of a FireSmart environment will lead to enhancements in the ability of infrastructure to survive and even maintain operations during a wildfire event. If developments in the wildland/urban interface are FireSmart and consistent with BMP, and resources are available and operations will not compromise personnel safety, it may not be necessary to evacuate during a wildfire.

5.7 Resources

During periods of high hazard, provincial fire managers are faced with assigning resources to a multitude of fires across their jurisdiction. In today’s wildfire environment, the necessary resources may not be available provincially or nationally.

Best Management Practices will be developed and incorporated by the oil and gas industry and will provide direction to determine the resources necessary to protect their facilities. These resources may include the development of water supplies and the provision of sprinklers and gel systems. Such resources could be deployed by the oil and gas industry staff to protect infrastructure before leaving an endangered site, or to enhance a safe zone to put sheltering in place. It must be noted that new developments constructed under BMP may be able to survive a wildfire without extraordinary assignment of resources.

It would be advantageous for the oil and gas industry to cooperate on a regional basis to provide the resources to protect facilities. Mutual aid agreements could be developed between companies and other industrial sectors such as the forest industry.

6 Communications

The development of an effective communications strategy is likely the single most critical component of any new program and BMP for wildfire prevention in the oil and gas industry is no exception. The FireSmart manual, *Protecting your Community From Wildfire*, stated the following: “Effective education and communication is the key to preventing or minimizing fire risk in the wildland/urban interface. Political leaders, community planners, and people in the public and private sectors need to work together. But to do that, they need the knowledge to make informed decisions.”

6.1 Internal Communications

It will not suffice to simply issue BMP to staff and expect the contents to be implemented. Protecting the industry from wildfire and preventing wildfires will require effective communication at all levels within the organizational structure of a company, starting with direction from upper management. All facets of a company’s organization will be part of the wildfire solution.

Communications and education must extend from management to head office to field offices, and then to field staff and ultimately to operators and contractors, each of whom will have a distinct role in wildfire prevention. Delivering this level of communications will be a challenge for any organization, and will be conducted according to their standard operating procedures.

BMP will be developed for the primary functions of the oil and gas industry:

- Exploration
- Drilling and completion
- Production
- Pipeline transportation.

The BMP will recognize the unique operations which are conducted within each of the primary functions to ensure the practices are applicable to the function.

6.2 External Communications

The forested lands of Canada are used by multitude of stakeholders who are impacted by wildfire prevention activities. Prevention of wildfire in the wildland/urban interface will only prove to be successful when integrated solutions are implemented. In this context, *integrate* refers to the oil and gas industry, railroads, power transmission, forest industry, municipalities, landowners, governments and agencies. Each member must understand its role in wildfire prevention. The BMP for the oil and gas industry must be consistent with those of other stakeholders, and there must be strong communication linkages between them.

Oil and gas industry solutions are further enhanced by placing wildfire prevention as a cornerstone in the development of Annual Operating Plans which should provide an open forum with other industries and regulators.

The Forest Protection Branch is responsible for wildfire suppression on forested lands in Alberta. The communication process with the FPB starts with the development of an Industrial Wildfire Control Plan, updated annually. The intent of this plan is to proactively identify and update industrial values at risk and wildfire prevention strategies to reduce the negative impacts of wildfire. It is used by FPB to enhance their ability to quickly respond to and suppress wildfires that may threaten personnel and infrastructure. It also serves as the basis for an exchange of information and communication between industry and government for their mutual benefit.

Alberta has adopted a proactive approach to addressing the serious and recurring threat of wildfires to communities and industrial developments. The program, known as FireSmart, is one of several wildfire management initiatives developed in Alberta. FireSmart has received national and international recognition and is now being adopted by other jurisdictions worldwide. The philosophy behind FireSmart recognizes that:

- Through assessments, the level of wildfire threat can be quantified to provide priority setting at various spatial scales.
- FireSmart mitigation options can be identified and applied to manage liability and reduce wildfire impacts based on those priorities.
- Linkages to wildfire suppression activities can be integrated through pre-suppression plans developed by SRD.
- Linkages to land management activities can be integrated through best management practices.

Regular communications with FPB during the fire season will be part of the BMP. The oil and gas industry will use the Canadian Forest Fire Danger Rating as a guide for responsible operations in forested regions. By reviewing the daily fire danger rating for specific areas, standard operating procedures can be modified to reduce the risk of wildfire ignition. This information is obtained on a daily basis from the FPB website and is described in detail in the Seasonal and Daily Fire Danger portion of this document.

6.3 Delivery and Format

The BMP will have application to all sectors within an individual company; however, they must be in a format consistent with the end user which will vary from head office to field staff to contractors. The BMP must be applicable to the task at hand and must be concise and easily understood. They must also avoid the use of industry jargon and technical terms, and should assume the user has a limited knowledge of fire and industry operations. The documents should include pictures, diagrams, vegetation types, typical facility layouts and plans, checklists

and mitigation strategies. The approach of the BMP must be consistent with the philosophy of the oil and gas industry.

In order to meet the requirements of the industry, the BM should be developed so they can be formatted to meet the needs of the different user groups. Head office staff may use an individual BMP in its entirety, whereas the same BMP in the hands of a contractor may be in a condensed or even a checklist format. A good example of this approach is the *FireSmart–Protecting Your Community from Wildfire* manual, which is a comprehensive guide that has been used as the source for several brochures and short manuals aimed at very specific audiences.

The BMP developed for CAPP shall be used by individual companies as the basis for the implementation of BMP that are directly suited to that company. It is understood that all companies are unique in their operations and management style, and it is expected that their BMP format will be a reflection of the company. The BMP will stress linkages to other industries and other reference materials such as the *FireSmart–Protecting Your Community from Wildfire* manual and the [*Oil and Gas FireSmart Guidebook*](#).

7 Best Management Practices For Fire Prevention

Fire risk can be described as the probability and consequence of a fire occurring at a specified location under specific conditions. The historical review of industry related fires has identified the most common causes of the oil and gas industry fires. By focusing on fire prevention strategies and implementation of best management practices for each cause the oil and gas industry can effectively reduce wildland fire ignitions.

7.1 Brush Burning

7.1.1 Issue

Approximately 34% of the wildfires attributed to the oil and gas industry are linked to burning of woody debris. Fire escapes commonly occur after the initial burning operation as smoldering combustion that can persist for days and even months. These fires are preventable through the implementation of Best Management Practices that address proper burning sites and complete extinguishment.

Total disposal of woody debris by burning at a safe time is a regulated requirement on most Oil and Gas industry dispositions. Burning brush piles is a standard method of total disposal however escaped fires from these piles are a liability for the industry and burning operations often contravene the Forest and Prairie Protection Act.

7.1.2 Background

Unsafe burning practices range from burning without adequate buffers between the burn piles and forest vegetation, burning while unsafe to do so during windy conditions and or high to extreme fire danger periods, and not properly extinguishing burnt piles. The majority of wildfire ignitions result from improperly extinguished fires or holdover fires that reside in deep duff layers or within large brush piles that contain fibrous organic top soil. These holdover fires can surface during dry windy conditions and spread rapidly to the flammable forest vegetation. These fires are often not discovered until they are well developed and under fire behavior conditions that make them difficult to contain.

7.1.3 Best Management Practices

- 1) Brush disposal on all Oil & Gas dispositions will be in accordance with *THE FOREST AND PRAIRIE PROTECTION REGULATIONS PART II*:
 - For fire hazard reduction and total debris disposal refer to Section 3
 - For debris disposal on Geophysical Exploration refer to Sections 15, 16, and 17
 - For miscellaneous debris disposal refer to Section 18 which states,

“the partial debris disposal methods set out in section 17 also apply in the forest protection area to survey lines, fence lines, winter use roads, airstrips constructed for winter use that are not accessible by road during the fire season and pipe line rights-of-way of less than 8 m”.

- 2) Within the FireSmart Community Zone (approximately 10 kilometre radius from the community) debris management strategies, for any purpose, must not include the retention of debris piles.
- 3) Where economically feasible and in consultation with the FMA or Quota Holder pre-log and salvage all merchantable timber. This reduces the amount of large fuels and allows for a more efficient burn.
- 4) Consider mulching instead of burning to dispose of all non-salvaged woody debris. This will also aid site reclamation by providing a fiber cover over the disturbed soil.

If cost is a concern, mulch only muskeg and willow sites with high organic soils as these sites present high risk for ground fires from brush burning,

- 5) If disposal by burning is chosen:
 - (a) Debris piles scheduled for burning should be placed on sites with shallow organic soils (Deciduous or mixed wood forest vegetation sites of less than 15 cm of duff) rather than deep duff layers such as those found in muskeg and coniferous forest vegetation sites.
 - (b) On rights-of-way less than 30 metre width, the windrows or piles shall be located and burned along the centre of the rights-of-way and on other cleared areas the windrows or piles shall not be placed and burned less than 15 metre from adjacent un-cleared areas
 - (c) Windrows should be no more than 60 metres in length, with a minimum of 8 metres break between windrows. Round piles should be at least 15 metres apart.
 - (d) Debris should be piled in a manner that allows for clean, efficient burning of all material. Avoid mixing soil into the woody debris.
 - (e) To reduce the liability for causing poor visibility on highways that could potentially lead to traffic accidents, consider alternatives before burning debris piles next to highways.
 - (f) The best time for burning brush and debris piles is during the winter months when sites are snow covered. Fire permits are not required in the Forest Protection Area between November 1 and March 31. Some municipalities require fire permits all year. These dates are subject to change and it is advisable to check with the nearest SRD or municipal office.
 - (g) When possible and with the approval of a Forest Officer (in the FPA) allow piles to cure for one season before burning. This will result in a cleaner, more efficient burn.

- (h) An option to piling debris for burning is to utilize burning sleds, towed by heavy equipment. This is particularly effective for burning green woody debris.
 - (i) Winter burn sites should be reported to the local SRD or municipal office, and included on the Annual Industrial Wildfire Control and Prevention Plan.
 - (j) Piles located near habitation or roads should only be burned when weather conditions are favorable to ensure a safe dispersal of smoke. Avoid burning when temperature inversions are present or predicted.
 - (k) If a pile is still burning past April 1st it must be immediately extinguished or covered by permit.
 - (l) Obtain a fire permit if burning during the fire season (generally April 1 to October 31) and/or if in a permit area, check with the local SRD or municipal office. Ensure all conditions on the permit are followed.
 - (m) Ensure precautions are taken to keep the fire under control at all times. Monitor burning and have adequate water sources, pumps, manpower and equipment on site to deal with the potential for escape fires.
 - (n) Burn piles must be spread and mixed with water or snow to ensure they are properly extinguished.
 - (o) Use Infrared technology to scan burn sites to ensure no residual fire is left un-extinguished.
- 6) Form a partnership with a co-generation company to use all woody material from the clearing and convert it into a co-generation product.

7.2 Flaring

7.2.1 Issue

Flaring of petroleum by-products is performed as a routine part of various operations throughout the oil and gas industry. When flaring is conducted in a wildland environment there is a risk of the ignition of surrounding vegetation. Approximately 31% of wildfires attributed to the oil and gas industry are ignited from flaring. The use of flaring by the oil and gas industry is diminishing; however the number of flaring caused fires is not.

The majority of fires originating from flaring occur during windy conditions in the afternoon during the seasons with cured grass and vegetation.

7.2.2 Background

According to the EUB, there are four main reasons for flaring:

- Completion and testing of natural gas wells to access a well's capability and determine the appropriate gathering and processing systems needed to handle the wells production.
- Routine maintenance at gas processing facilities to safely dispose of gas from the depressurizing of equipment.

- To remove very small amounts of solution gas at oil wells that is uneconomical to produce.
- During emergency situations when there is an uncontrolled release of gas from a well or pipeline the gas may be ignited and burned. Flaring may also be necessary at processing facilities when the facility must be depressurized during operational upsets (equipment failure, power outages, and pipeline problems).

Flaring can be accomplished in a safe manner by ensuring that burning materials from a flaring operation do not come in contact with flammable vegetation.

There are a number of operational activities, both mechanical and human, that lead to wildfires caused through flaring. Some of the more common causes are the use of flare guns that over shoot flare stacks or pits and flare stack burps that send hot carbon to flammable vegetation. Many fires are caused by an insufficient expanse of mineral soil between the flare stack and surrounding wildland vegetation and flaring during high and extreme wildfire burning periods.

The Energy Utilities Board Directive 060 provides regulatory requirements and guidelines for flaring, incinerating, and venting for all upstream oil and gas facilities in Alberta. The Alberta Forest and Prairie Protection Regulations include provisions restricting the use of flare devices, the distance from a flare stack to vegetation and vegetation control surrounding a flare pit.

7.2.3 Best Management Practices

- 1) All flaring operations must meet the requirements of EUB Directive 060.
- 2) Compliance with the Forest and Prairie Regulations requires that the area 8 metres around a **flare pit** shall be vegetation (fuel) free and the area 30 metres around the flare pit shall be free of all combustible debris. Operators should inspect this area on a semi annual basis to ensure that the Regulations are being met.
- 3) Compliance with the Forest and Prairie Regulations requires that the distance from the base of a **flare stack** used for flaring sour gas be at least 2.5 times the length of the vertical pipe to the closest forest vegetation. For example, a 5-metre vertical pipe must be 12.5 metres away from the closest forest vegetation. This area can be maintained through mechanical, chemical or engineering means. Where there are extremely high flare stacks, removal of all forest vegetation may not be practical. In these instances fire proofing through removal of ladder fuels, thinning to provide an open canopy, and removal of ground fuels and shrubs should be considered.
- 4) Flare pits must not be used at any facilities constructed after July 1, 1996.
- 5) When conducting flaring operations in flare pits at facilities constructed after 1996 operators must follow the requirements of *EUB 060, Section 7.11*. In

addition; the flare pit must be constructed to restrict flare materials from discharging beyond the pit and the discharge tip of the flare line is directed into the flare pit at an angle of not less than thirty (30°) degrees below horizontal.

- 6) The Flare pit must be constructed to restrict flare materials from discharging beyond the pit and the discharge tip of the flare line is directed into the flare pit at an angle of not less than thirty (30°) degrees below horizontal.
- 7) Maintain the area around a flare pit free of flammable vegetation through mechanical, chemical or engineering means.
- 8) Operators will perform regular maintenance of flare stacks and pipes to reduce buildup of carbon. The ignition devices shall be inspected and maintained to ensure operation is within appropriate parameters.
- 9) Operators will perform regular maintenance of any associated fluid tanks at the base of flare stacks to avoid burping.
- 10) Operators shall develop an inspection program whereby all flare devices in an operating area are inspected on a regular basis to ensure that vegetation control and the devices are being maintained. The results of this program shall be maintained for internal audit purposes.
- 11) Compliance with the Forest and Prairie Protection Regulation requires that in order to ignite gas at a flare, a flare device may be used on public land **only in the event of an emergency** and all residue from such flares shall be extinguished by the user before he leaves the site thereof.
- 12) In accordance with the Industrial Wildfire Prevention Plan and to avoid the unnecessary dispatch of firefighting resources, the operator shall provide the following notifications to the Forest Protection Branch during the Fire season:
 - The operator will provide ASRD annually a list of permanent flare stack locations where continuous or daily flaring may occur. The operator is **not** required to notify the Branch prior to flaring at these locations.
 - For those operations with intermittent flaring for testing or maintenance procedures, the operator **shall** advise the local Fire Centre at least one hour prior to ignition of the flare.
 - For those operations where unexpected or emergency flaring is necessary, the operator **shall** advise the local Fire Centre as soon as is practical given the situation.
 - Prior to routine flaring, obtain fire weather and hazard information from the Sustainable Resource Development website to ensure the fire danger rating and ignition potential is not high or extreme;
<http://www.srd.gov.ab.ca/wildfires/fpd/maps.cfm>.
- 13) Flaring should not be conducted during periods of high or extreme fire hazard.

- 14) Operators shall endeavor to complete flaring operations during the evening or early morning when the vegetation ignition risk is at the lowest due to higher relative humidity and lower temperatures. Flaring should be avoided during the spring and fall when there is an abundance of cured grass and other vegetation.

7.3 All Terrain Vehicles

7.3.1 Issue

All Terrain Vehicles (ATV) are utilized by all sectors of the oil and gas industry for transportation of personnel and equipment. Approximately 10% of wildfires attributed to the oil and gas industry have been ignited by ATVs. Fires caused by ATVs are preventable with the implementation of Best Management Practices. The use of ATVs by all sectors of the industry is increasing dramatically.

7.3.2 Background

The operations of ATVs in wildland areas pose a significant liability for the ignition of a wildfire. These types of fires typically originate from a component of the exhaust system coming into contact with flammable organic material or vegetation. During the operation of an ATV organic material such as grass and moss can accumulate around the exhaust system. The material is dried and heated to its ignition temperature by the hot exhaust system. Smoldering materials can then fall to the ground and ignite dry grass or vegetation which in turn can result in a wildfire. Recent studies by FERIC have determined that this process can occur within 15 minutes from the time the material comes into contact with the hot exhaust system.

The risk of wildfires caused by ATVs is highest in the spring of the year (April/May) when natural fine fuels such as grass is in its cured state and highly flammable. Wildland fire hazards during this time of the year are generally high to extreme due to low moisture content of forest fuels, low relative humidity and strong winds.

Many ATV operators are unaware of the potential for ATVs to ignite a wildfire. The problem posed by fires caused by ATVs may be compounded by a lack of firefighting equipment carried on the vehicle and the operator's inability to report a fire should it occur.

7.3.3 Best Management Practices

- 1) Operators of ATVs need to stop on a regular basis and remove accumulations of organic material and vegetation from around all components of the exhaust system. The frequency of this cleaning will be dependant on the terrain and weather conditions. For example, the operator must frequently stop and clean the exhaust after traveling through a muskeg area during the spring.

- 2) ATVs should be equipped with an appropriate tool according to the type of ATV to assist the operator in the removal of accumulations of debris from around the exhaust system. Hot or burning materials that are removed from the ATV must be cooled or extinguished with water or by burying in mineral soil.
- 3) ATVs should be parked on sites that contain bare mineral soil. Avoid parking in areas with cured grass or other fine fuels which are highly flammable.
- 4) Operators need to be particularly vigilant during the spring of the year when grass and other fine fuels will quickly ignite and spread to heavier fuels.
- 5) Restrict or limit the use of ATVs during prolonged periods of extreme fire danger, particularly in the spring of the year. The potential for an ATV to ignite a fire early in the
- 6) The exhaust system should be inspected by the operator on a regular basis to identify and remedy any malfunctions which may further contribute to the ignition of a wildfire. The Forest and Prairie Protection Regulations and the Off Highway Vehicle Regulations require that ATVs be equipped with a spark arrestor.
- 7) During the fire season, ATVs should be equipped with basic firefighting tools which may include: a canvas or plastic water pail, water, back pack water bag (full of water), shovel, Pulaski, fire extinguisher. Tools will be restricted by the amount of space available on the ATV but must include a container of water and a fire extinguisher.
- 8) Operators must be familiar with the protocol for reporting a wildfire in their area of operation. They must have the communication equipment and technology necessary to contact fire authorities. To report a wildfire in the Forest Protection Area call 310-FIRE. To report a wildfire in other areas call your local fire authority at 9-1-1.
- 9) Prior to operating an ATV at the start of a work day, the operator should ensure that there are **not** any accumulations of organic material or vegetation surrounding any components of the exhaust system.
- 10) Oil company personnel and contractors utilizing ATVs should be educated about the potential of ATVs to start fires and what they can do to prevent fires from occurring and what to do should a fire occur. Daily safety briefings could include awareness of fire potential and mitigation.

7.4 Heavy Equipment

7.4.1 Issue

The oil and Gas industry in Alberta relies on heavy equipment for the construction of pipelines, access roads, well and plant sites. During the process of clearing forest vegetation wildfires often result from flammable materials igniting on exhaust systems or hot carbon particles being expelled from a diesel engine exhaust after idling for long periods of time.

7.4.2 Background

Using heavy equipment in forest areas for clearing forest vegetation, or working in tall cured grass or in very fibrous soils, can result in an accumulation of fine, highly flammable organic material on or near the exhaust systems. This flammable material dries and if heated on exhaust systems to temperatures greater than 240 to 260° C it will ignite. Through vibrations caused by the equipment the ignited materials often fall to the forest floor and cause a wildfire or the materials are carried to maintenance sites that are not fire proof. Diesel engines that idle for long periods of time build up carbon in the exhaust system and when throttled up and placed under load can expel small very hot carbon particles that are capable of igniting dry forest vegetation and becoming a wildfire. Woodlands Operating Learning Foundation offers training in equipment maintenance specifically directed at lowering the number of equipment fires.

7.4.3 Best Management Practices

- 1) To prevent wildfire ignition by heavy equipment establish a practice that requires all contractors to clean their equipment's exhaust systems on a regular basis
 - While cleaning the engines, park the equipment on bare mineral soil if possible or spray the area with water then drive the equipment over the wet areas and clean them.
- 2) Ensure that equipment with diesel engines that idle for long periods of time are throttled up and placed under load to expel any carbon build up over a safe zone of mineral soil or other non flammable material.
- 3) Heavy equipment should also carry a backpack water container (full of water) complete with hand pump, dry chemical extinguisher, shovel, axe or pulaski during the fire season.
- 4) Heavy Equipment operators should consider taking the Woodlands Operating Learning Foundation training on equipment maintenance.

7.5 Light Equipment

7.5.1 Issue

Light equipment such as power saws, power pumps, pick-up trucks, brush saws, mowers, mulchers and graders are used extensively by the oil and gas industry in the agricultural and forest areas of the province. During high and extreme fire danger periods, especially when the grass is in a cured and very dry state, there have been occasions when wildfires are started by light equipment.

7.5.2 Background

Operating power saws for long periods of time will result in very hot exhaust systems and if the power saw exhaust system comes in contact with dry fine forest vegetation it can start a wildfire. Hot power saws and power pumps have been known to ignite fires during refueling.

Gas powered light vehicles usually have catalytic converts that get very hot and if parked where they come in contact with dry grass may result in ignition of a wildfire. Using mowers in ditches or right of ways have on occasion started a wildfire from sparks caused by the mower blades contacting rocks or other metal objects. The sparks may cause an ignition in very dry grass or other fine fuels. Graders operating on gravel roads during very dry periods have also caused ignitions from the sparks that result from the steel blades coming in contact with rocks especially along the edges of the ditch line.

Mulcher heads are steel with carbide tips that rotate at high speeds and when they come in contact with rocks or metal cause a shower of sparks. These sparks can ignite dry grass and fine fuels and when conditions are right will cause wildfire starts. To reduce the risk of wildfires caused by light equipment, the following Best Management Practices should be adopted.

7.5.3 Best Management Practices

- 1) Ensure that contractors and employees conduct operations in accordance with THE FOREST AND PRAIRIE PROTECTION REGULATIONS Part I which states the following:

Section 11 (1) All steam and internal combustion engines used within the forest protection area shall be equipped with spark arresters or mufflers in good working condition, each of a type approved by the forest superintendent

Section 20 requires:

A person who uses a power saw in the forest protection area shall take the following precautions to prevent starting a forest fire:

- (a) *refrain from starting a power saw within 3 metres of the gasoline supply;*
 - (b) *refrain from placing a running or hot power saw engine on any inflammable matter;*
 - (c) *have at the site of operation an approved fire extinguisher in working condition.*
- 2) Ensure vehicles with catalytic converters are not parked in tall dry grassy areas.
 - 3) Evaluate the risks of mowing, mulching or using graders during periods of high and extreme fire danger periods when the grass is cured, the forest fine fuels are dry and the relative humidity is below 30 percent.
 - 4) Allow small engines to cool down before refuelling.
 - 5) If it is essential that these operations are under taken during high and extreme fire danger periods with high probability of wildfire ignitions then a water tanker complete with crew, hose and pump should accompany the operation to patrol behind the operation to detect and extinguish any fires that maybe started.

7.6 Welding

7.6.1 Issue

The oil and gas industry uses welding extensively during pipe line construction for regular maintenance of their facilities and for repairs to on site equipment. Wildfires resulting from welding are rare however the risk of starting a wildfire does exist during high and extreme fire danger periods and prevention measures should be considered.

7.6.2 Background

Welding on pipe line projects or when performing regular maintenance and repairs to equipment during the active fire season especially during the spring and fall cured grass stages, on muskeg sites or other areas with deep organic soil layers during very dry periods does have the potential for starting a wildfire. To prevent the risk of starting a wildfire from welding the oil and gas industry needs to adopt a Best Management Practice.

7.6.3 Best Management Practices

- 1) Establish a practice that requires employees and contractors operating in wildland areas to conduct welding operations on bare mineral soil if possible. As an alternative, during high fire hazard periods, the work area where welding is to take place should be wet down with water or foam.

- 2) Another option is to use a non-flammable shield around the area where welding will take place to confine and prevent the sparks from spreading in all directions.
- 3) If it is essential that if these operations are undertaken during high and extreme fire danger periods with very high probability of wildfire ignitions then a water tanker complete with crew, hose and pump should accompany the welding operation to patrol, detect and extinguish any fires that maybe started.
- 4) Wildfire Foam (Fire Foam 104) should be considered for use when welding on pipelines during high and extreme ignition potential periods to reduce amount of water required and to ensure the water penetrates into the organic layers. Properly mixed foam will expand the volume of water 5 to 20 times, depending on the foam and equipment used. Foam acts as a fire suppressant rather than a fire retardant. A suppressant extinguishes the flaming and glowing phases of combustion when applied directly to forest vegetation.

7.7 Using Fire Safely

7.7.1 Issue

Many sectors of the oil and gas industry routinely utilize fire for cooking, warming, and burning refuse. In addition smoking and improper extinguishment of smoking materials in a forest work site is also a common practice. When fire is carelessly used or smoking material is improperly extinguished and discarded in a wildland environment there is a risk of the ignition of surrounding vegetation. Approximately 11% of wildfires attributed to the oil and gas industry are ignited through the use of fire and smoking however, both causes are likely diminishing with changes in lifestyle and environmental concerns.

7.7.2 Background

Wildfires originating from cooking and warming fires account for 6% of fires caused by the oil and gas industry. Although this activity would be most prevalent in the winter as workers strive to keep warm or have a hot meal. A burning permit is not required throughout the year for fires used for warming or cooking purposes. Occasionally workers ignite cooking or warming fires during the fire season. Wildfires can result from ignition of surrounding vegetation (unsafe fire) or abandoned fires that are not properly extinguished. Winter fires (if placed on deep humus soils) can hold over in the ground and surface when burning conditions are favorable in the spring.

The activities relating to smoking have caused 3% of the fires attributed to the oil and gas industry. These fires are generally caused by careless disposal of smoker's materials including matches, cigarettes or cigars on to flammable forest vegetation. These types of fires would typically occur when the grass is cured

and/or during high to extreme fire danger periods when dry vegetation is combined with very low relative humidity and strong winds.

The activities relating to burning of refuse in incinerators or other receptacles resulted in a further 3% of the fires attributed to the oil and gas industry. Incinerators utilize a burning chamber with a mesh over the chimney to prevent sparks from being discharged from the unit. On occasion glowing embers will dislodge from the mesh as a result of an accumulation of foreign matter on the mesh or pass through the mesh opening and are transported on the convection current created by the incinerator heat and are transported by winds to flammable forest vegetation and cause a wildfire ignition. Other methods of refuse disposal are burning in a pit or barrel. These methods require a fire permit during the fire season.

7.7.3 Best Management Practices

a. Smoking

- 1) Smoker's materials such as cigarettes should be "field stripped" by the user to ensure that all material is extinguished before disposal on bare mineral soil. The material shall be broken up and spread before discarding, or placed in a metal or glass receptacle.
- 2) Matches must be cold to the touch before disposal. The preferred safest method of lighting tobacco materials is with a child proof lighter.
- 3) Smoking in forest areas during periods of high or extreme fire danger conditions should be prohibited
- 4) If personnel must smoke in the wildland they should not be walking while smoking. The preferred location for smoking is in a vehicle
- 5) If smoking in a vehicle use the ash tray to dispose of smoking materials, do not throw these materials onto the ground.

b. Cooking And Warming Fires

- 1) Under the requirements of Alberta's Forest and Prairie Protection Act and *"THE FOREST AND PRAIRIE PROTECTION REGULATIONS Part I of Section 17* states that:
 - "A person who desires to light or maintain an outdoor campfire for cooking or warming purposes during a fire season shall take the following precautions:*
 - (a) set the fire on a flat rock, gravel bar, sand or bare mineral soil at a spot relatively clear of vegetation and located near water;*
 - (b) clear the site of all debris down to mineral soil to a radius of at least one metre from the edge of the fire;*
 - (c) keep the fire under control and attended to at all times, and*
 - (d) extinguish the fire before leaving the site."*

- 2) Open fires should be prohibited during periods of high or extreme fire danger conditions. This can be a voluntary measure taken by the industry or if conditions dictate, Sustainable Resource Development or municipal authorities may issue a Fire Ban which would include all open fires.
- 3) Consider the use of alternative methods for cooking and warming.

c. Refuse Burning

- 1) When using an incinerator at oil and gas industrial sites and camps comply with *THE FOREST AND PRARIE PROTECTION REGULATIONS Part I section 18 and 19* which states:

Section 18 - Burning of non-industrial wastes within the forest protection area shall be carried out in a fully enclosed incinerator constructed of incombustible material and the draft and smoke vents thereof covered with a heavy gauge metal screen of a mesh size not greater than 6 millimetres.

Section 19 - An incinerator used within the forest protection area shall be located over bare rock, gravel, sand, mineral soil or concrete at least 30 metres from a stand of trees or shrubs and the ground surrounding it outward from its base to a distance of at least 3 metres shall be clean mineral soil or be covered by any of the aforesaid materials.

- 2) During periods of high and extreme fire danger and during high winds when the ignition probability in a forest area is high, consider using the incinerator during the late evening when the relative humidity is higher than 45 percent and the wind speed is less than 15 kilometre per hour.
- 3) During the active fire season ensure the mesh on top of the incinerator is free of any carbon or other foreign matter that can turn into a glowing ember, become dislodged and spread to surrounding flammable forest vegetation during high winds.

8 Best Management Practices To Mitigate The Impact Of Wildland Fires

Fire is a natural occurrence in the forests and grasslands of North America. Over 90% of all wildfires occurring in the province of Alberta are contained at initial attack. Under extreme burning conditions escaped fires can have a devastating impact on oil and gas personnel, infrastructure and facilities. By implementing strategies and best management practices the oil and gas industry can reduce the impact of wildland fire.

8.1 Emergency Response

8.1.1 Issue

The oil and gas industry must consider the wildfire threat and employee safety when working and living in a flammable forest and incorporate wildfire into their Emergency Response Plans.

8.1.2 Background

Wildfires are often unpredictable and may exhibit extreme and erratic fire behavior. Under these conditions a wildfire can travel more than 60 kilometres in one day. Therefore, response time during a wildfire emergency will vary. Many incidents that result in tragic and costly losses from wildfire are attributed to delayed initial response times, insufficient resources, substandard water supplies or inadequate access.

Interface fire emergency management plans must recognize that interface fire hazard varies daily or even hourly with weather conditions and forest fuel moisture. Wildfire protection agencies have developed various red flag warnings that link high-fire-danger weather forecasts to operational preparedness and technical considerations. Oil and gas industrial emergency response plans should incorporate flexibility in their daily operations to allow for weather related wildfire danger periods to prevent wildfires and reduce the wildfire threat to facilities.

Using the Oil and Gas Industry Guidebook produced by ASRD and completing a wildfire threat assessment will provide the oil and gas industry officials with a clearer picture of the level of hazard faced by the workers in an area and where that hazard is the greatest.

During extreme wildfire danger periods oil and gas industry safety personnel may review certain operations to determine if special operating procedures are required to protect field personnel and facilities from a potential wildfire threat and to reduce the risk of starting a wildfire.

8.1.3 Best Management Practices

- 1) Incorporate wildfire emergencies and employee safety into the oil and gas industry emergency response plans.
- 2) During high and extreme wildfire danger periods, operations that pose a high risk of ignition should be rescheduled to continue when the wildfire ignition potential is not in the high and extreme range.
- 3) At sites critical to the oil and gas company's economic sustainability the site should have an adequate water supply to protect the structures from airborne embers with sprinkler systems or extinguish wildfires that result from the oil and gas industry operations.
- 4) Incorporate wildfire safety zones and evacuations into the oil and gas industry Emergency Response Plans.

Identify which Oil and gas facilities require to be shut down during a wildfire threat and which ones do not require and operational shut down.

8.2 Incident Command System (ICS)

8.2.1 Issue

The Incident Command System is a management system that can be used on any type or size of incident. It can also be used as a management system for planned non-emergency events. The oil and gas industry must be well informed regarding ICS in order to integrate their operations with fire authorities during a wildfire event. ICS, as a management system, helps to mitigate the risks by providing accurate information, strict accountability, planning, and cost effective operations and logistical support for any incident.

When the wildfire incident threatens an industrial site, the industry should establish contact with the Incident Management Team (IMT). This will allow for access to information from the incident command post, keep industry personnel informed and coordinate evacuation procedures if required. If the site is compliant with Best Management Practices, operations may be able to continue without disruption, despite the fire.

8.2.2 Background

Organizations use a variety of systems to manage emergencies, including Emergency Site Management (municipalities) and Fire Ground Command (Fire Departments). The oil and gas industry uses various forms of the Incident Command System. The Incident Command System is quickly being adopted as the preferred model for emergency management. ICS is the emergency management system used by all provincial and federal wildfire agencies in North America and is a standard for on-scene emergency management. ICS is

specifically designed to allow users to adopt and integrate an organization structure equal to the complexity and demands of single or multiple incidents without being hindered by jurisdictional boundaries. ICS allows different agencies to work together effectively and efficiently toward a common goal. ICS is comprised of five major functions: command, operations, planning, logistics and finance/administration and consists of procedures for managing and controlling personnel, facilities, equipment and communications.

8.2.3 Best Management Practices

- 1) The oil and gas industry and CAPP should encourage members to adopt the Incident Command System as the preferred method of emergency management.
- 2) Specific staff can complete the self study course- ICS 100 which is designed to teach the principles of the ICS system and to acquaint staff with basic ICS structure and terminology. The course is intended for personnel assigned to an incident or event who have a minimum requirement for understanding ICS.
- 3) Specific supervisory staff should complete the ICS 200 course which is delivered in a two day classroom program. This program briefly describes the principal features which constitute the ICS system. Collectively, these features identify the unique quality of the ICS as an incident or event management system.
- 4) ICS should be implemented at the start of any emergency and continued until mitigation of the incident.
- 5) During a wildfire event, the oil and gas industry should establish a communications link with the assigned Branch of the Incident Management Team (IMT). Depending on the situation, this may be the Industrial Liaison, Safety Officer or a Branch Director. This will establish a clear line of authority and communications between the oil and gas industry and the IMT.
- 6) In the event a wildfire threatens facilities or personnel, the oil and gas industry should utilize the Incident Command System and its inherent communication routes to determine if evacuation is necessary or if the people and facilities are able to continue operations despite the wildfire.
- 7) Resources owned, operated or contracted by oil and gas companies may be beneficial to the IMT in mitigating the wildfire or in the protection of facilities. These resources could be assigned to the incident in accordance with ICS principals and supervised by an appropriate position from the IMT.

8.3 Training for Wildfire

8.3.1 Issue

Over the last 10 years, a total of 327 wildfires have been attributed to the oil and gas industry. The most effective tool in maintaining a safe workplace in the wildfire environment is education and training of personnel. The prime components of an effective training program are: wildfire prevention, wildfire safety and in some cases wildfire suppression.

8.3.2 Background

Many members of the oil and gas industry live and work in a flammable wildland environment. Under certain circumstances, this environment may pose a considerable risk to the safety of personnel and the integrity of facilities. To reduce this liability, the industry requires appropriate staff training. The training will concentrate on three main components:

- Wildfire Prevention – A concentration of training and education aimed at Fire Prevention will result in a reduction in the total number of fires. The objective of the Fire Prevention Best Management Practices is to provide this information.
- Wildfire Safety – A necessary component to ensure that employees recognize and react in an appropriate manner if they encounter a wildfire.
- Wildfire Suppression – To a lesser degree than the other training components, since the Forest Protection Branch is responsible for fire suppression in the forested areas. Oil and gas Industry staff are trained to extinguish other kinds of incipient fires at their worksite with fire extinguishers as a “first response” measure, but is not expected to attempt fighting larger fires. With the appropriate training, staff can also be trained to extinguish small wildfires without compromising their safety.

8.3.3 Best Management Practices

a. Fire Prevention Training

- 1) The fundamentals of Fire Prevention are contained within the Best Management Practices which have been developed specifically for the oil and gas industry. In particular, the practices for brush burning, flaring, all terrain vehicles and heavy equipment are aimed at causes which comprise over 80% of wildfires which are attributed to the oil and gas industry. The BMP will be used as the core of an employee training package for fire prevention. This package may be delivered in a time span of 4 – 8 hours depending on the audience.
- 2) Training is available from providers in the private sector. A list of trainers can be made available by contacting the local SRD office or the Hinton Training Center; <http://www.srd.gov.ab.ca/forests/htc/>.

b. Wildfire Safety

- 1) The wildland fire environment poses a risk to personnel. There are misconceptions that such risk only exists in the forested area; however grasslands and brush areas also pose a substantial risk during high or extreme fire danger periods.
- 2) Personnel may attend the one day Wildfire Orientation Course as an introduction to wildfire. This course includes the entry level Incident Command System material which will acquaint students with basic information regarding the management of a wildfire or other emergency. Other topics include: personal preparedness, radio communications, problem wildlife, wildfire safety, introduction to aircraft operations, introduction to fire behavior, weather, fuels, topography and methods of wildfire attack. The course can be provided on a local basis by a qualified instructor. Contact the Forest Protection Branch in your area for instructor information.
- 3) To provide specific field staff with a basic understanding of wildland fire safety, the Canadian Forest Fire Danger Rating System and basic fire behavior the oil and gas industry should make available to their field personnel the following set of interactive CD Rom training programs:
 - Wildland Fire-Safety on the Fireline
 - Fire Weather Index System (FWI)
 - Principals of Fire Behavior

The CD's can be obtained from Georgetown Terminals Warehouse, 34 Armstrong Ave., Georgetown, Ontario, L7G 4R9, toll free 1-877-864-8477, fax toll free 1-877-864-4272 or by email; orders@gtwcanada.com.

- 4) On an annual basis in the spring, field staff will include wildland fire in a regularly scheduled safety meeting to discuss:
 - Review wildfire safety hazards and risks
 - Procedure for reporting wildfires
 - Policies for operations during high or extreme fire hazards
 - Procedure for obtaining information regarding wildfire threat, wildfire hazards, daily fire danger rating and local fire situation reports.
 - Review safety zones and evacuation procedures
 - Review the content of the Industrial Wildfire Control and Prevention Plan
 - Review requirements for shutting down facilities in advance of a wildfire

This is a good opportunity to invite local fire authorities to meet with staff and promote information exchange.

c. Wildfire Suppression

- 1) Wildfire Suppression is the responsibility of the Forest Protection Branch. However, sectors of the oil and gas industry may choose to take a more active

role in the protection of infrastructure by training and equipping their staff in wildfire suppression. In particular this may apply to industries with Emergency Response Teams that may be deployed to protect assets during a wildfire.

- 2) A Basic Firefighter course can be delivered in a four day period. This course would provide Emergency Response Team members with the basics to respond to minor wildfires and would be presented locally. The course is available by contacting your local Forest Protection Branch for instructors in your area.
- 3) Emergency Response Team members with wildfire responsibilities are able to attend the Wildfire for Structural Firefighters course which is presented at the Hinton Training Center on an annual basis. Information on this course is available at; <http://www.srd.gov.ab.ca/forests/htc/> .
- 4) Companies may choose to undertake specialized training to meet specified facility protection goals. The Sprinkler course is a half day course designed to provide students with the information necessary to establish water sprinkler protection of facilities. Sprinklers are a tool which is deployed in advance of a wildfire impacting an area. Training is available by contacting your local Forest Protection Branch for instructors in your area.
- 5) Cross training between Oil and Gas Industry operations staff and the municipal emergency services will ensure that during a wildfire emergency both organizations will have an understanding of the safety issues associated with the operation of the specific site and the training required to deal with wildfire emergencies.

8.4 Ember Transport

8.4.1 Issue

The greatest wildfire threat to Oil and Gas facilities from an advancing fire front will come from airborne embers that can travel long distances on wind currents. The accumulations of embers near vent openings or under eaves, stairs and other areas may cause a fire on an Oil and Gas structure.

8.4.2 Background

High density, short range ember transport (up to 200 metres) is a common feature of free burning wildland fires, especially under critically dry conditions (Alexander 2004). In the Chisholm fire in 2001 and the Kelowna fire in 2003 data indicates a density of 1500 airborne embers per square metre.

8.4.3 Best Management Practice

- 1) Reduce the potential for a structure ignition from airborne embers by equipping all flammable structures with roof sprinkler systems.
- 2) Reduce the potential of a hydrocarbon storage tank ignition, by equipping the tanks with foam sprinkler systems.
- 3) When a wildfire threat is eminent, sprinkler systems should be engaged to extinguish airborne embers as they land on flammable facilities.

8.5 Radiant Heat

8.5.1 Issue

Structures within 10 metres of forest vegetation can be subjected to very high temperatures when a fully involved crown fire front reaches a disposition. These very high temperatures may cause damage to structures generally and can ignite structures that are within 10 metres of a forest edge. To reduce the threat to structures from high intensity fire fronts, increase the size of the clearing to allow the radiant heat and flames to dissipate over the open areas.

8.5.2 Background

A Canadian led research study has documented the effect of crown fires approaching clearings with wooden panels placed at various distances from the forest edge (Cohen 2004). In the 10 metre zone where flame contact occurred, the wooden walls ignited however, without flame contact only scorch occurred. The wood panels at 20 and 30m did not ignite and the panel at 30 m did not scorch (Cohen 2004).

The study data collected 13.8 metres above the ground surface indicates that at the time of arrival of a crown fire front, air temperatures exceeded 1000° C in the upper portion of the forest canopy and maximum radiant energy fluxes occurred in the upper third of the forest stand.

This could be interpreted to indicate that the air temperatures of a flame front at the height of structures and hydrocarbon storage facilities could reach temperatures of 1000° C. If structures or storage facilities are placed within 10m of coniferous forest vegetation then the probability of damage from intense heat is likely.

8.5.3 Best Management Practice

- 1) To reduce the damage from a wildfire threat, ensure there is a minimum of 10 metres and preferably 20 metres between the structures and the flammable forest vegetation with a height greater than 10 metres.

- 2) In grass vegetation ensure a minimum vegetation free zone of 10 metres between structure and grass vegetation.

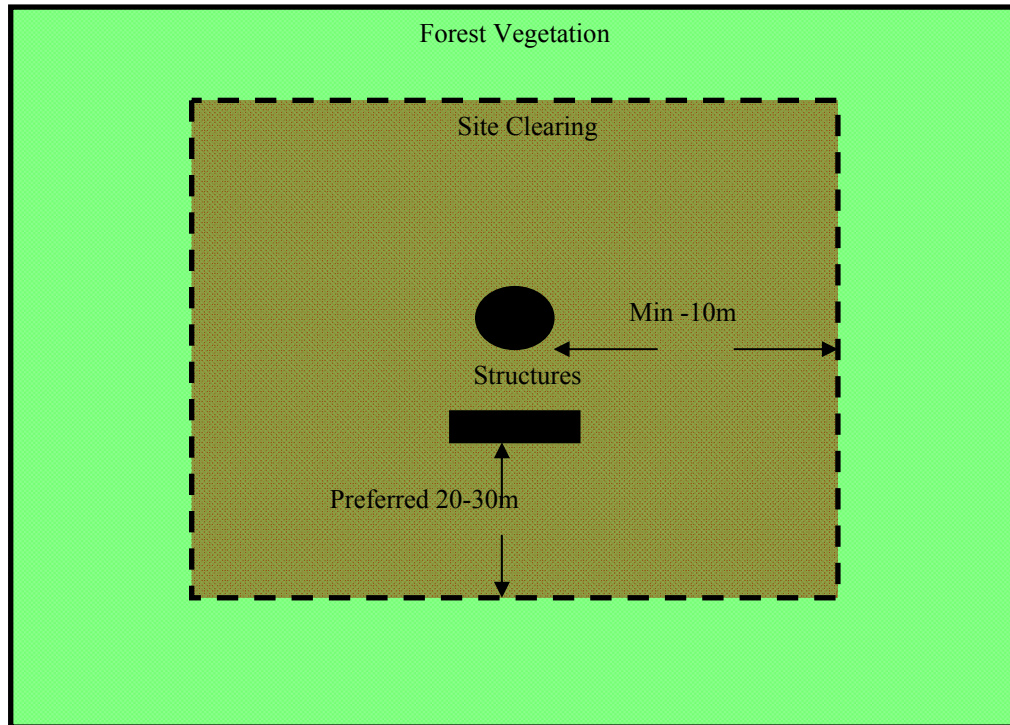


Figure 15. Recommended vegetation free zone around facilities.

- 3) In grass vegetation ensure a propane tank has a minimum of three metres vegetation free around the tank.
- 4) Structures should be placed at the bottom of the slope or on the top of the slope with a minimum of 100 metres set back from the edge of the upper slope to reduce the radiant heat threat associated with topography.

8.6 Safe Areas for Use During Fire Emergencies

8.6.1 Issue

Under high and extreme fire danger levels the behavior of wildland fires is often erratic and difficult to predict, particularly when winds associated with fast moving cold fronts change the direction of fire spread in a matter of minutes. During evacuation alerts or in the event of unavoidable entrapment of personnel the identification of safe areas for evacuation staging or surviving entrapment is critical

8.6.2 Background

The forested area in Alberta is over 34 million hectares and oil and gas operations are a significant feature on the landscape throughout the province. On average, a

thousand wildfires occur each year in Alberta and evacuations and operational shutdowns is a common occurrence. It is prudent to plan for a safe retreat procedure, including the identification of a safe staging area during wildland fire emergencies. At major facilities open and safe areas are generally associated with the development, although not necessarily planned specifically for wildland fire emergency use. The ideal location of an open, safe area is upwind of the approaching fire which will avoid the intense heat and smoke associated with the fire front. Prevailing winds in Alberta during the fire season are either from the west or south quadrant so alternate sites should be identified, particularly for these two common wind directions. The introduction of Best Management Practices will enhance the use of existing open spaces and encourage the incorporation of safe areas during the planning stage for new developments.

8.6.3 Best Management Practices

If using open spaces as barriers to fire spread, they should be at least 30 metres wide on level ground and up to 50 metres when located near slopes.

- 1) The open spaces should be gravel, mineral soil or frequently mowed grass.
- 2) If practical the site should have a water source.
- 3) Ideally the site should have alternate access routes and/or have a heli-pad with fuel available.
- 4) The sites should have a GPS location that is documented in the Emergency Response Plan.
- 5) The site should have adequate space for the personnel, vehicles and equipment that would normally be expected to utilize the safe area.
- 6) The site should be at least five times the height of the highest trees away from the tree line. For example, if the surrounding trees are 10 metres in height, then the buffer between the tree line and the safety zone would be 50 metres.

The sites should have a GPS location that is documented in the ERP.

8.7 Utility Corridors and Access Development

8.7.1 Issue

Services and access to oil and gas plants, well sites and other developments are routinely provided by a common corridor which minimizes the disturbance footprint. Proactive fire prevention planning can avoid fire risk on service corridors and access roads through understanding of the potential fire risk. Power line routing and construction is one operation that can be assessed for level of fire ignition risk, and mitigated at the planning stage. Although the utility company is responsible for the power service it is in the interest of the oil and gas industry to

coordinate the planning to reduce the risk of fire. Access routes, particularly for operating plants and other major facilities, will be used for evacuation during emergency fire situations which requires that a safe escape is certain for workers on site.

8.7.2 Background

Power line fires usually result from adjacent trees falling across the wires during wind events and creating high energy arcing that can ignite dry forest materials. Wind velocities associated with power line fires are also responsible for extreme fire behavior once a fire is established and begins to spread. The risk of power line fires is a function of the power pole height, the slope of the terrain, the height and proximity of the adjacent trees, and the species of trees associated with the power line route. During the construction period these factors can be assessed and Best Management Practices will address mitigation options. Access roads during emergency fire situations must support safe evacuation operations and like power line routes should avoid high flammability forest stands when practical. The Environmental Field Report (EFR) on the Public Lands website <http://www.srd.gov.ab.ca> has a link that is useful in assessing the power line hazard (Power line Hazard Assessment Plan-Application & Procedure, August 1, 2006.doc).

8.7.3 Best Management Practices

a. Utility Corridors

- 1) When practical the power line should be located between the pipeline and the access road; if this is not possible it should be located on the opposite side of the access road and/or pipeline in relation to prevailing winds. This reduces the likelihood of a tree striking the power line if it should blow down.
- 2) Average height and fuel type of the adjacent forest may affect the power pole height.
- 3) When practical the corridor and power line route should avoid the highly flammable forest stands such as black spruce.
- 4) Dangerous trees are removed when new power line corridors are constructed and ongoing maintenance should be completed every five years at a minimum to identify and remove new dangerous trees.

b. Access Roads

- 1) The road surface should provide two-way access with a travel surface of not less than 6.1 metres.
- 2) Fire service access routes should connect to principal roadways.

- 3) Roadway curvature radius should be at least 30 metres, measured from the centerline.
- 4) Road gradient should not exceed 10 percent.
- 5) Dead-end roadways that are more than 90 metres in length should be constructed with a turnaround at the terminus having no less than 18 metres turning radius or a hammerhead “T” alternate turnaround.
- 6) All gates should be located at least 9 metres off the main roads and should not open outward. Gate openings should provide a clear opening of not less than 0.6 metre wider than the traveled way.
- 7) Fire and other emergency service personnel shall be provided with ready access to any locking mechanism.
- 8) Bridges should be designed and built with an all-weather surface capable of supporting heavy pieces of equipment traveling across the bridge. Weight limits should be clearly posted at the approaches to each bridge.
- 9) If the main access could potentially be cut off by a wildfire, alternative emergency routes should be identified.

8.8 Equipment Failure

8.8.1 Issue

There is a potential that the oil and gas industry will experience equipment failure that could result in a fire. If the fire occurs at a plant site it will likely pose a low risk of spreading to the surrounding vegetation. If equipment failure results in a pipeline eruption or a well blowout in a remote area, and results in a fire during high or extreme fire danger periods there will be a high risk for a rapidly spreading wildfire in surrounding vegetation.

8.8.2 Background

Fires occurring at Oil and Gas Industry plant sites are normally confined within the plant site because of the accessibility by emergency response units on hand or close by. The spread to surrounding forest vegetation would be infrequent. There have been instances when under ground pipelines have erupted and resulted in hydrocarbon ignitions. This type of situation poses a high risk to ignition of surrounding forest vegetation and if this occurs during high fire danger periods, may result in a wildfire. There have been documented cases of ignitions of petroleum storage tanks located at tank farms. Isolated well site storage tanks are at risk of ignition during lightning storms. If the situation occurs at an isolated site the risk of fire spread to surrounding forest vegetation is high because emergency response resources are often long distances away and response times could be delayed. An equipment failure at a sour gas well during the fire season might

require the ignition of the sour gas to reduce the impact to surrounding values at risk which may include human life. An on site assessment should determine which case will pose the highest risk to human life the sour gas or a potential wildfire if the escaping gas is ignited.

8.8.3 Best Management Practices

- 1) At the first sign of any equipment failure immediately report the incident to all responsible agencies as required by legislation for each specific facility.
- 2) During the fire season at the first sign of any fire that occurs within the Forest Protection Area of Alberta, report the fire immediately to the responsible emergency response agency and or the responsible wildfire agency depending on where the incident occurs.
- 3) Notify the appropriate Emergency Response Agency and recommend an evacuation of all personnel and the public in the path of potential danger from the release of hydrocarbons or a resulting wildfire.
- 4) Set up and incident command post at a safe distance from the incident and stop all entry into the area except for emergency response units.
- 5) During the fire season if a sour gas ignition is required and ignition can be delayed, consider ignition during light winds and when relative humidity values are higher then 40 to 50 percent which normally occurs during the night or very early in the morning. Ignition during this period will reduce the potential for vegetation ignition and should be the period of lowest fire spread.

8.9 Reclamation

8.9.1 Issue

Section 137 of the Environmental Protection and Enhancement Act requires that an operator must reclaim all dispositions according to the terms and conditions of approval. The reclamation process can affect the future potential for wildfire in two ways:

- 1) The establishment of vegetation growth on disturbed sites, and
- 2) The windrowing of woody debris along the edge of linear disturbances.

8.9.2 Background

Over the past years the normal reclamation process started with the establishment of grass vegetation on the disturbed site. The practice normally involved the use of non-native plants that grew very dense and tall producing flash fuels which during periods of high to extreme fire hazards are ideal for very rapid build up and spread of wildfires. The grass vegetation especially on linear disturbances can

act like a wick for wildfire, and can spread for long distances along the linear disturbance. These wicks can be picked up by a change in wind direction and become large fire fronts which are difficult to control. Research and approval is being considered to determine if shorter less dense growing grass that produce and spread by rhizomes is acceptable for reclamation purposes. The Forest and Prairie Protection Regulations Part II allows for partial disposal of woody debris from clearing of seismic lines, survey lines, winter use roads and pipelines less than 8 metres in width. Windrowing of the debris is permitted, however improper piling and reclamation of the windrows can result in the windrows acting as a wick along the linear disturbance. Once a windrow becomes involved in fire it is difficult to extinguish without the support of heavy equipment.

8.9.3 Best Management Practices

- 1) Consider the use of shorter less dense grass growth supplemented with the planting of deciduous shrubs on disturbed areas. The deciduous shrub growth when established provides shade to the disturbed areas and will reduce grass density over time. Deciduous forest vegetation, except during the spring, will not normally sustain high intensity wildfires and are easier to control.
- 2) Consider planting a short growing deciduous species where height of forest vegetation needs to be kept to a minimum. By using short growing deciduous species vegetation management may only be required once every 15 to 20 years (check latest reclamation standards to ensure site and ecological conditions allow planting of deciduous).
- 3) Wherever possible, use mulching on all exploration and winter access roads to eliminate the debris windrows and reduce the wicking during wildfires, increase the probability of containment of fires on linear disturbances, and enhance reclamation by spreading the mulched debris over the clearing which promotes vegetation growth and reduces erosion.
- 4) If windrowing of debris is used, ensure that windrows are not piled against standing forest cover, are no more than 60 metres in length and separated from adjacent windrows by a minimum clearing of eight metres.
- 5) Where ever possible, during the reclamation process windrows should be scattered and crushed with heavy machinery, and made to lie flat. This not only reduces the potential of wicking but also allows the woody debris to decompose more rapidly.
- 6) Leaning trees resulting from clearing operations can provide a ladder for fire to reach the crowns of adjacent trees. All leaners should be felled and made to lie flat.

8.10 Water Sources

8.10.1 Issue

Timely initial attack during the fire season results in containment of 90% of fire starts in Alberta. One of the key factors determining the success of initial attack is the availability of a water source that is accessible and capable of supplying a continuous volume for the initial attack operation. If initial attack fails the importance of dependable water source increases as the protection of facilities and structures is usually contingent on water availability.

8.10.2 Background

Generally there are many opportunities to either identify or develop dependable water sources adjacent to oil and gas facilities. These can be used for pump and hose operations, sprinkler lines, water trucks or helicopter bucketing operations. The water sources do not necessarily have to be on site but should be in the general vicinity of the value at risk

8.10.3 Best Management Practices

- 1) Identify natural water sources such as streams and small lakes in the immediate area.
- 2) Ensure access to natural water sources for tanker trucks and/or portable pump set-ups are developed and identified.
- 3) Have a water supply for the purpose of firefighting, which meets the requirements of either the *Fire Underwriters Survey Guide* or the *National Fire Protection Association (1231) Standard on Water Supplies for Suburban and Rural Firefighting*.
- 4) If natural water sources are not available, consider developing a water storage facility on the site. Non-draining borrow pits or tanks may be used for storing large volumes of water.
- 5) Identify the availability of large water tankers in the region.
- 6) Consider the use of agricultural water delivery systems to move water long distances for the protection of facilities.
- 7) Development of water sources must confirm to the Water Act and associated Code of Practice.

Appendix A CAPP Best Management Practices Outline

A.1 CAPP Best Management Practices Outline

A.1.1 Best Management Practices for the Oil and Gas Industry

- Best Management Practices will focus on conducting operations within FireSmart principles to ensure the safety of industry personnel, minimize the economic losses associated with a wildfire threat and reduce a company's liability by taking necessary measures to prevent a wildfire.
 - Practices for the oil and gas industry must be integrated with other industries that are utilizing the same land base. There must be consistency and co-operation among industries in developing FireSmart landscapes to reduce wildfire threat and maximize effectiveness of wildfire prevention programs and Industry Wildfire Control Agreements.
 - The practices need to be central to the development of Oil and Gas Area Operating Agreements, which are developed with other industries and regulators.
 - Practices need to allow flexibility for established facilities, which may be classified as existing non-conforming facilities.
- Practices shall be implemented in the development of all new facilities and operations.

A.1.2 Scope of the Project

- Best Management Practices will be developed for the primary functions of the Oil and Gas industry:
 - Oil and Gas Exploration
 - Drilling and Completion Operations
 - Production Operations
 - Transportation of products by pipeline
- The practices will recognize the unique operations, which are conducted within each of the primary functions to ensure that the Practices match the function. The practices must also recognize the diversity of the oil and gas industry and provide direction to both management and field staffs.

A.1.3 Fire History

- The fire history will be reviewed to describe the fire problem which is attributed to the oil and gas industry. The fire statistics will be compared to other industries including utilities, rail and forest industries.
- Fire history will reveal the general and specific causes of fires related to the oil and gas industry.

A.1.4 Wildfire Liabilities Associated with the Oil and Gas Industry

- The fire history will be linked to the liabilities which are associated with operations by the oil and gas industry including the following:
 - Flaring
 - Brush disposal
 - Use of all terrain vehicles

- Smoking and open fires
- Welding
- Incinerators
- Vehicles
- Power lines
- Structure and facility fires
- Equipment failure
- Catastrophic events

A.1.5 Mitigation of the Wildfire Threat within the Oil and Gas Industry

Following the determination of the liability of wildfire, the next step is the consideration of mitigative measures which will eliminate or reduce the wildfire hazard posed by the Industry. This will include the following:

- Site Clearing
 - Brush Disposal (burning, mulching etc.)
 - Scanning
 - Size of clearing
 - Hazard assessment
- Facility Development
 - Building construction materials
 - Structure distance from forest vegetation
 - Incinerators
 - Water Supply
- Wildfire Liabilities
 - Flaring
 - Use of ATV's
 - Power line ignitions
 - Other operations (welding, equipment malfunction)
- Personal Safety
 - Safety Zones
 - Access Roads
 - Hazards posed by smoke
- Hazards to Facilities
 - Airborne Embers
- Wildfire Suppression and Facility Protection Capability
 - Emergency response plan
 - Suppression capability
 - Water Supply
- Reclamation of Land

A.1.6 The Oil and Gas Industry as a Partner in Protection

- The development of oil and gas operations and facilities that meet *FireSmart* standards will result in an industry that is able to co-operate with other industries and government agencies to prevent fires from occurring and minimizing the impact of fires that do occur. The continuation of business during and after a fire event will be expedited in this type environment.

A.1.7 The Regulatory Aspects of Fire Prevention

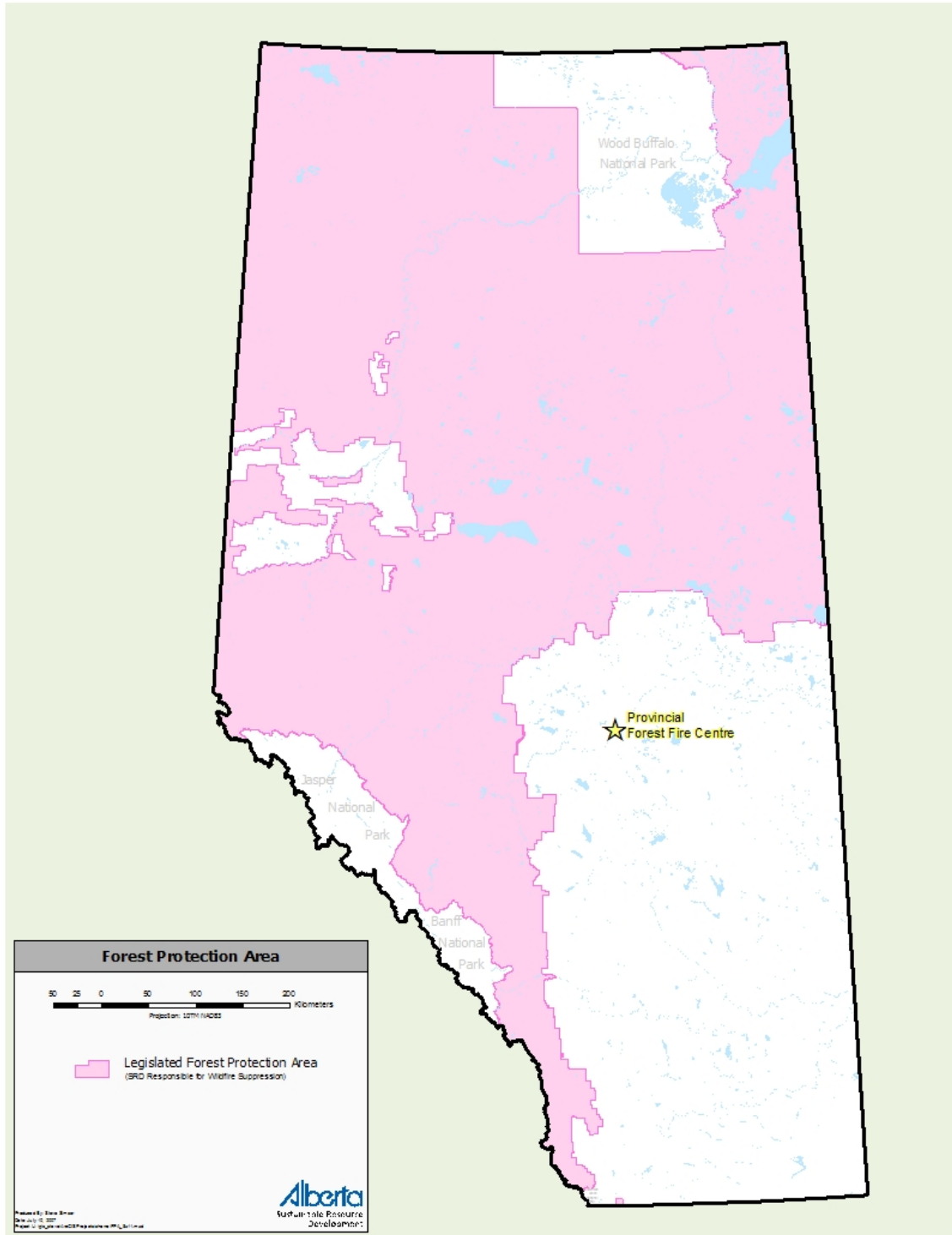
- The current provincial legislation and policy will be provided as a basis for Fire Prevention activities. A self-audit template for regulatory compliance will be developed.
- Trends in Fire Prevention legislation will be considered.
- Current trends in fire control agreements will be considered.
- A review the industrial annual fire plans will be completed.
- Development of self audit tools to promote regulatory compliance.

A.1.8 Best Management Practices for the Oil and Gas Industry

- Best Management Practices for Fire Prevention in the Oil and Gas Industry will be developed for the following primary functions performed by the Industry:
 - Oil and Gas Exploration (Seismic, clearing, brush disposal, drilling, energy sources, camps, helicopter operations, all terrain vehicles, etc.)
 - Drilling and Completion Operations (Survey, size, distance to vegetation, emergencies, camps, etc.)
 - Production Operations including battery sites, small tanks, compressor stations, tank farms, waste facilities, gas plants, etc.
 - Transportation of products by pipeline including valves and stations, etc.

Appendix B Map of Frest Protection Area

B.1 Map of Forest Protection Area



Appendix C List of References

C.1 List of References

A number of references were used to assemble the information required to complete a thorough and detail analysis of wildfire prevention issues relevant to the oil and gas industry. References included personal contact with individuals in government and industry, legislation, company policies and directives, research papers and web searches. The following references are in addition to those references mentioned in the report.

Individuals

Hugh Boyd, Forest Protection Branch, SRD
Rod Houle, Forest Protection Branch, SRD
Murray Anderson, Land Management Branch, SRD
Bob Demaulder, Alberta Chamber of Resources
Neil Shelly, Alberta Forest Products
Warren Kehr, West Fraser Mills Ltd
Don Pope, Alberta Pacific Forest Industries
Keith Branter, Limestone Consulting, (previously with Sunpine Forest Products)
Leanna Davies, EnCana Corporation
Darin Quintilio, PetroCanada
Gordon Bisgrove, PetroCanada
Keith Moore, Anadarko
Mike Murias, Fortis Alberta
Rick Clevette, FireSmart Solutions (a B.C. company)

Research

The following research documents were reviewed:

- In 2001 Alberta alone had 3742 solution gas flares operating. Flare Research Project University of Alberta.
- Fire Hazard Reduction for Linear Disturbances. Wildland Fire Operations Research Group, Forest Engineering Institute of Canada.
- Evaluating the Fire Ignition Potential of All Terrain Vehicles in Alberta. Wildland Fire Operations Research Group, Forest Engineering Institute of Canada.

Web Sites

Canadian Association of Petroleum Producers
SRD Land Management Branch
SRD Forest Protection Branch
Energy Utilities Board
Alberta Department of Energy
Alberta Chamber of Resources
Alberta Fire Commissioners Office
British Columbia Oil and Gas Commission
British Columbia Ministry of Forests, Forest Protection Division
Ontario Ministry of Natural Resources, Forest Fire Management
Natural Resources Canada, Canadian Wildland Fire Information System
U.S. Forest Service Wildfire Management Policy
Australian Government Emergency Management Bushfires Community Safety