LACES versus LCES:
Adopting an "A" for "Anchor Points" to Improve Wildland Firefighter Safety

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Abstract. "LCES" stands for Lookouts – Communications - Escape routes - Safety zones. The elements of LCES form a safety system used by wildland firefighters to protect themselves from entrapment from free-burning wildfires and other fireline hazards. LCES was developed by Paul Gleason as a direct response to the tragic loss of life on wildland fires and a concern for the overload of rules and procedures that had to be remembered by a firefighter at any one time. Alberta Forest Protection has adopted this system but believes that an essential element is missing from LCES, namely the need for an "A" for Anchor points. This need was identified as a direct response to an entrapment and subsequent fatality that occurred in Alberta in 1995. Alberta had a policy for anchor points being implemented, but this may never have happened. This need was further highlighted by a recent entrapment and fire shelter deployment by firefighters who had left the safety of their anchor point. Anchor points serve as a barrier to fire spread and should be designed to minimize the chance of being outflanked by a fire while line is being constructed. If work begins from an anchor point to prevent the burn-over of firefighters, the dependency on following escape routes to safety zones would be minimized due to the lessened chance of a burn-over or entrapment. It is not implied that neither escape routes and safety zones should be ignored, nor the "10 Standard Fire Orders" or the "18 Situations that Shout Watch Out!" Adding the "A" for "Anchor points" to LCES, resulting in LACES, isn't likely to infringe on firefighter memory overload, and on the contrary, may be easier for firefighters to remember.

Introduction

A need for an "A" for "Anchor points" to be added to the LCES firefighting safety system -- denoting Lookouts, Communications, Escape routes and Safety zones -- was identified and adopted by the Alberta Forest Protection agency as a direct response to an entrapment and subsequent fatality that occurred in the province in 1995. Although a number of Canadian wildland fire suppression agencies have considered and support the concept of "LACES" as opposed to "LCES," it has not yet been adopted on a national or international scale. A more recent entrapment and fire shelter deployment by firefighters has highlighted the need for the adoption of a single standard of either LCES or LACES. The purpose of this paper is to provide a rational basis for the adoption of an "A" for "Anchor points" to LCES in the hope that wildland fire suppression agencies worldwide will consider a move to adopt LACES rather than LCES as their fundamental firefighter safety system.

LCES described

LCES stands for Lookout(s), Communication(s), Escape routes, and Safety zone(s) – an interconnection each firefighter must know. LCES is viewed as a system for operational safety in the wildland fire environment where four basic natural safety hazards confront the firefighter (Fuquay

1984; Beighley 1995; Valdez and Style 1996; Leuschen and Frederick 1999; Alexander and Stam 2001):

- lightning;
- rolling rocks;
- fire-weakened timber; and
- entrapment by running fires.

Together the elements of LCES form a safety system used by firefighters to protect themselves. LCES is a procedure that is put in place

before fighting the fire. It is built on two basic guidelines: (1) each firefighter must know how the LCES system will be implemented on a given incident, and (2) the LCES system must be re-evaluated continuously as the fire environment changes (see also: http://www.fs.fed.us/fire/safety/lces.shtml).

The LCES system was developed by Paul Gleason (1991) as a direct response to the firefighter fatalities that occurred on the Dude Fire in Arizona in 1990 (Chamberlin 2000). When someone is injured on a fire, agencies are quick to respond, committing full attention to safety and adding yet another mix of rules and procedures into over 60 that exist today. These include the 10 Standard Fire Orders and the 18 Situations that Shout Watch Out! (here after referred to as the "10 Orders" and "18 Situations"), which wildland firefighters have pursued in the name of safety for many years.

Based on his previous involvement with and study of several fatality fires, veteran firefighter Paul Gleason analyzed the many firefighter safety rules and procedures (Harris 1998). He determined that firefighters were very overloaded with all that had to be remembered at any one time. His solution was the development and introduction of his LCES concept, a concept that is currently adopted by many firefighting agencies worldwide.

In supporting Paul Gleason's concern, Ted Putnam (1995), a fire safety and equipment specialist with the U.S. Forest Service's Missoula Technology Development Center, pointed out that the research conducted cockpit management indicated that no matter how many factors are important, the human mind normally can handle only about seven factors. He suggests that this number is even lower when the situation becomes intense.

As Gleason (1991) points out, "LCES refocuses on the essential elements of the 10 Orders and 18 Situations." Its simplicity is a welcome solution to the problem of having to manage many elements at one time.

Alberta Forest Protection adopts/modifies LCES concept

Alberta Forest Protection (AFP) has also adopted Paul Gleason's (1991) LCES firefighter safety system. However AFP staff believe that one element is missing from LCES, namely an "A" for "Anchor points."

In Alberta, anchor points MUST be an essential component of LCES when the potential burning conditions reach a critical point. This policy slowly evolved over time within the AFP after a fatality that occurred on June 2, 1995: Rappel crew members became entrapped and had to be extracted using a helicopter mounted static line. The process of extraction resulted in the death of one crew member and the injury of another. A review of this incident concluded that had the crew been "anchored," they would have had a safety zone to go to when the fire blew up, thus avoiding entrapment.

Further rationale regarding the recommendation to add an "A" for anchor points to LCES thus resulting in the acronym "LACES," is provided in the following section.

Rationale for LACES

In the Canadian *Glossary of Forest Fire Management Terms* an "anchor point" as illustrated in Figure 1 is defined as (from CIFFC 2000):

> *An advantageous location, usually a barrier to fire spread, from which to start or finish construction of a control line.*

The definition given in the U.S. *Glossary of Wildland Fire Terminology* is similar in that it defines an anchor point as (from NWCG 1996b):

> *An advantageous location, usually a barrier to fire spread, from which to start constructing a fireline. The anchor point is used to minimize the chance of being outflanked by the fire while the line is being constructed.*

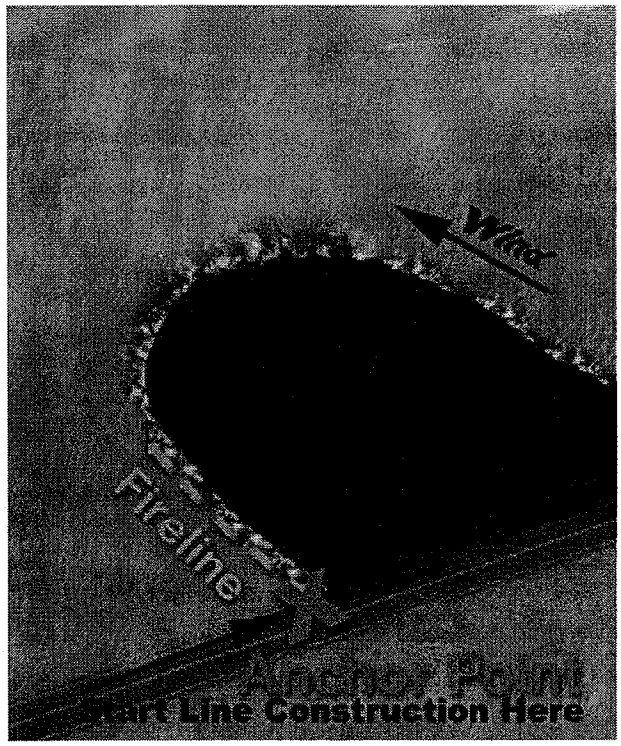


Fig. 1. *Graphic representation of an anchor point defining the logical position from which wildland firefighting operations must begin (from ETC and CIFFC 2000).*

The descriptors "*barrier to fire spread,*" and "*minimize the chance of being outflanked by the fire,*" found in the above definitions, should be noted, and are key to the rationale for adding an "A" for "Anchor points" to LCES. Interestingly, neither LCES nor LACES is mentioned or defined in either glossary.

If the intent of an anchor point is to serve as a barrier to fire spread and thus minimize the chance of being outflanked by the fire while line is being constructed, would it not seem appropriate to include an "A" for "Anchor point(s)" to LCES? When arriving at a conclusion, keep in mind that anchor points are indeed established to prevent circumstances that result in wildland fire entrapments. An additional benefit of including the "A" would be to suggest that tactics and a review thereof must be considered carefully when engaged in suppression operations on a wildland fire.

Furthermore, the selection of an anchor point is normally dictated by the assurance that a barrier to fire exists, thus avoiding a burn-over or entrapment that would likely threaten a crew while working on the line. The likelihood that firefighters would be forced into a compromising position where one would have to depend on the use of escape routes and safety zones would therefore be minimized by lessening the chances of a burn-over incident.

Escape routes often utilize the fireguard leading to safety zones that often use the black or suitably burned-over area. To avoid compromising firefighter safety by seeking out escape routes and safety zones when time is of the essence, it makes good sense to establish anchor points that can also use by default the fireline and suitably adjacent burned-over area. Both the fireguard and burnt-over area may be used as possible escape routes and safety zones. This is not to imply that escape routes and safety zones can be ignored in the presence of an anchor point. An anchor point selected as an escape route can be obstructed by falling trees that have been weakened by fire, making escape slow and difficult. A burned over area that has had an anchor point established against it may not necessarily be a safety zone due to falling trees or rolling rocks, for example. Alternate suitable escape routes and safety zones must be established as insurance.

Arguments for the addition of an "A" to LCES come from a review of the 10 Orders and 18 Situations by order #1 on the list – "Fight fire aggressively but provide for **safety first"** [bolding added for emphasis], and situation #8 – "Constructing line without a safe anchor point." It is argued that because anchor points are addressed in the 10 Orders and 18 Situations, and, as LCES attempts to manage the essential elements of the 10 Orders and 18 Situations, an "A" for anchor points could be incorporated into a condensed safety model or mnemonic device such as LACES.

In Alberta, the adoption of LACES does not imply that the 10 Orders and 18 Situations should be ignored. They are still a very important component of wildland firefighter safety training. If a wildland firefighter injury or fatality were to occur, the usage and/or breakage of the 10 Orders and 18 Situations would certainly be a component of any subsequent investigation.

Considering what was stated earlier about adding to the mix of rules and procedures, it can be strongly argued that the addition of a fifth component to the LCES abbreviation (thus changing it to LACES), still falls within the range of seven factors that Ted Putnam (1995) has pointed out that we can manage successfully.

Furthermore, it is believed that as an acronym, LACES fits more easily into the firefighter's lexicon, given that one periodically looks down to their boot "LACES." This should serve as a reminder that line staff need to address and re-assess the situation as required. As a result, LACES may be far easier to remember or recall than LCES.

Jim Cook, currently the Training Projects Coordinator for the USFS Fire Safety Program and the author of a four step risk management model for wildland firefighting (Cook 1995), also has a concern for the numerous rules and procedures that exist. In one of his four steps, risk management, he associates the establishment of anchor points and LCES in a single task. This relationship suggests that perhaps anchor points and LCES should be combined.

Additional background information

This has not been the first attempt to add an "A" to LCES. According to the *Firefighter's Handbook on Wildland Firefighting* (Teie 1994), the "A" in LACES stands for "Awareness." It is also believed that some agencies have dedicated the letter "A" to denote "Attitude," amongst other labels. It is unfortunate that the lack of a national/international standard exists for the use of LCES versus LACES. It only confuses the issue and introduces the need to train imported personnel from other agencies before they can begin firefighting. One close call in Alberta this year has already occurred, perhaps due in part to the interpretation by different agencies of LCES versus LACES. It is time to move to adopt one national or international standard for firefighters exported outside of their jurisdictions.

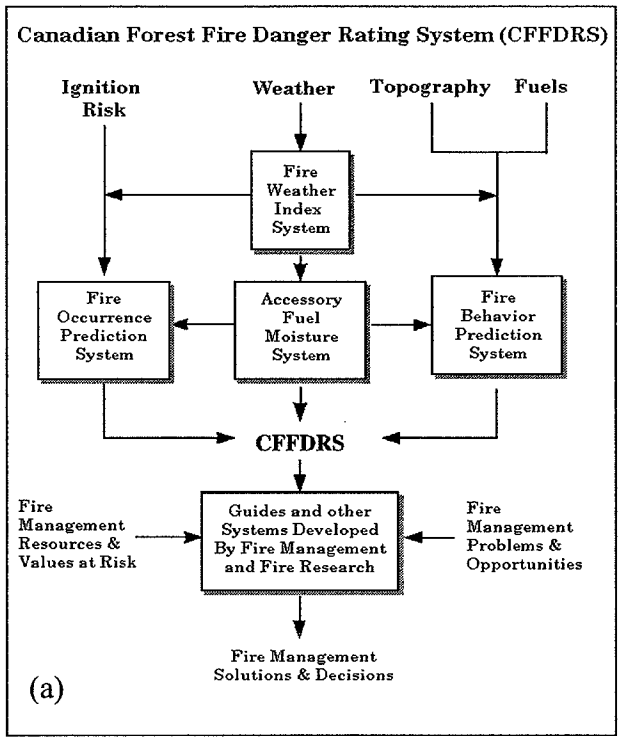
As an adjunct to this issue, in Alberta, anchor points are not always implemented. For example, when rapid initial attack on small fires is conducted and a "hot-spotting" style of attack is used, anchor points may not be feasible. Hot-spotting is a suppression method or technique used to check the spread and intensity of a fire at those points that exhibit the most rapid spread or that otherwise pose some special threat to control of the situation. This is in contrast to systematically working all parts of the fire at the same time, or progressively, in a step-by-step manner (CIFFC 2000). This is largely due to the small size of fires being actioned during initial attack, which also results in minimal opportunities to "anchor." One example is, a lightning strike in the middle of a continuous fuel type. The necessity to go in and without delay, knock down flames in areas of greatest threat to the immediate escape of the fire preclude the immediate establishment of anchor points. However, during hot-spotting tactics, the other four components of LACES are strictly observed without prejudice. The following guidelines, documented in the province's forest protection policy manual (Anon. 2001) govern when anchor points must be established:

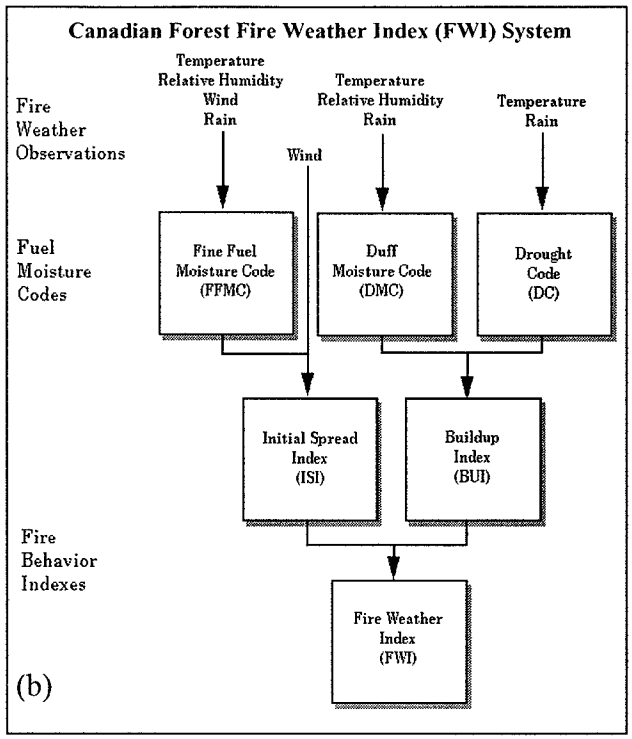
- When fire behavior potential indicates that head fire intensity (HFI) is up to an HFI Class 3 (i.e., 500-2000 kW/m), wildfire resources **should** work from an anchor point.
- At head fire intensity (HFI) equal to or greater than HFI Class 4 (i.e., 2001-4000 kW/m), wildfire resources **must** work from an anchor point.

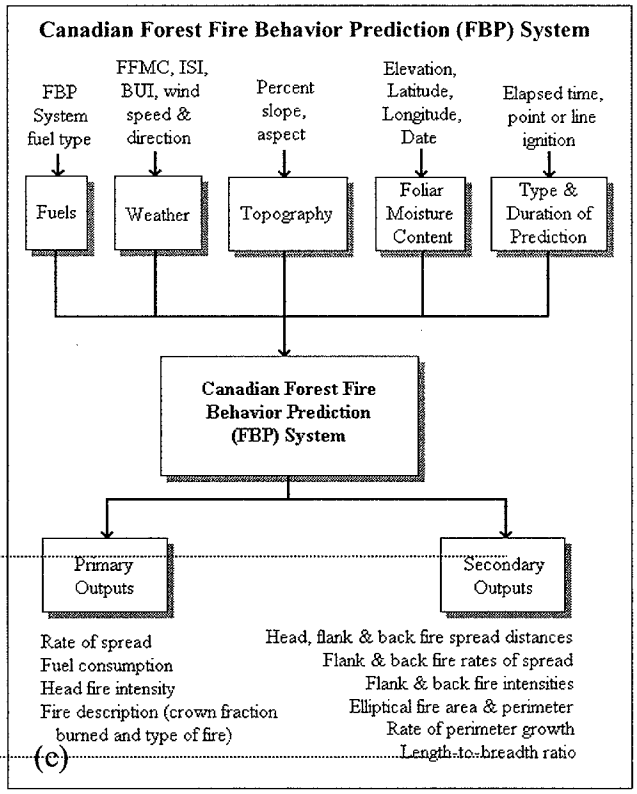
Beck, Alexander, Harvey and Beaver (2001) have outlined how HFI forecasts are undertaken on an operational basis in the province of British Columbia.

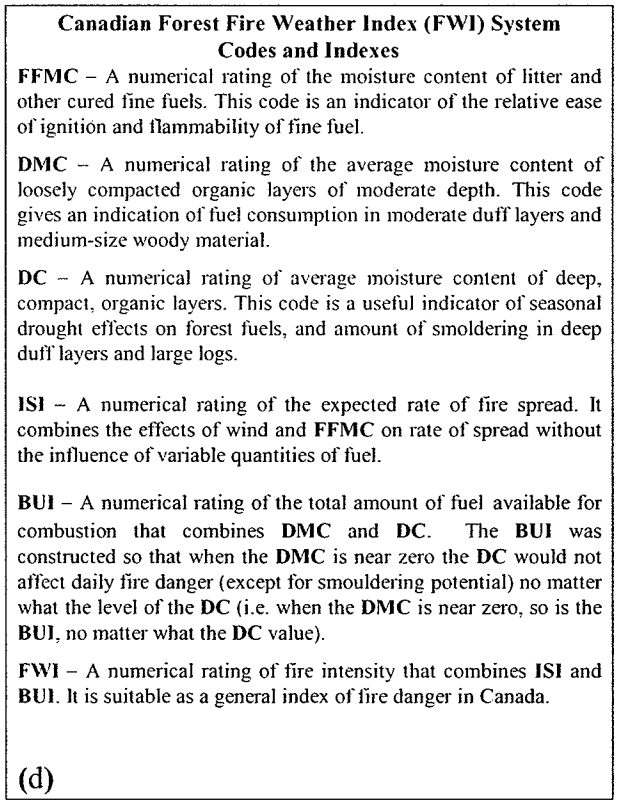
In considering the above policy guidelines, one should keep in mind that certain cautions need to be observed in determining anchor points. **One should not assume that anchor points are necessarily safety zones.** They are similar in that both must offer protection from a burn-over. However, the "black," burned over area directly against an anchor point, although offering protection from a burn-over, may not serve as a safety zone due to the presence of other basic safety hazards, especially falling trees or rolling rocks. And of course, the effectiveness of a burned area will depend on the degree and completeness of the fuel consumption.

Finally of note is the LCES training initiative developed by Paul Chamberlin (2000) which is delivered in the form a workshop. Paul facilitated a LCES workshop at the Environmental Training Centre, Hinton, Alberta, in January 2001, which was very well received . While he did acknowledge that the addition of an "A" to LCES was a worthy addition, he didn't formally sanction it.









Canadian Forest Fire Weather Index (FWI) System Codes and Indexes

FFMC – A numerical rating of the moisture content of litter and other cured fine fuels. This code is an indicator of the relative ease of ignition and flammability of fine fuel.

DMC – A numerical rating of the average moisture content of loosely compacted organic layers of moderate depth. This code gives an indication of fuel consumption in moderate duff layers and medium-size woody material.

DC – A numerical rating of average moisture content of deep, compact, organic layers. This code is a useful indicator of seasonal drought effects on forest fuels, and amount of smoldering in deep duff layers and large logs.

ISI – A numerical rating of the expected rate of fire spread. It combines the effects of wind and **FFMC** on rate of spread without the influence of variable quantities of fuel.

BUI – A numerical rating of the total amount of fuel available for combustion that combines **DMC** and **DC**. The **BUI** was constructed so that when the **DMC** is near zero the **DC** would not affect daily fire danger (except for smouldering potential) no matter what the level of the **DC** (i.e. when the **DMC** is near zero, so is the **BUI**, no matter what the **DC** value).

FWI – A numerical rating of fire intensity that combines **ISI** and **BUI**. It is suitable as a general index of fire danger in Canada.

(d)

Fig. 2. *Simplified structure diagrams for* (**a**) *the Canadian Forest Fire Danger Rating System illustrating the linkages to fire management actions,* (**b**) *the Canadian Forest Fire Weather Index (FWI) System,* (**c**) *the Canadian Forest Fire Behavior Prediction (FBP) System, and* (**d**) *the definitions of the six standard components of the FWI System (adapted from CFS 1984; Alexander et al. 1996; Forestry Canada Fire Danger Group 1992).*

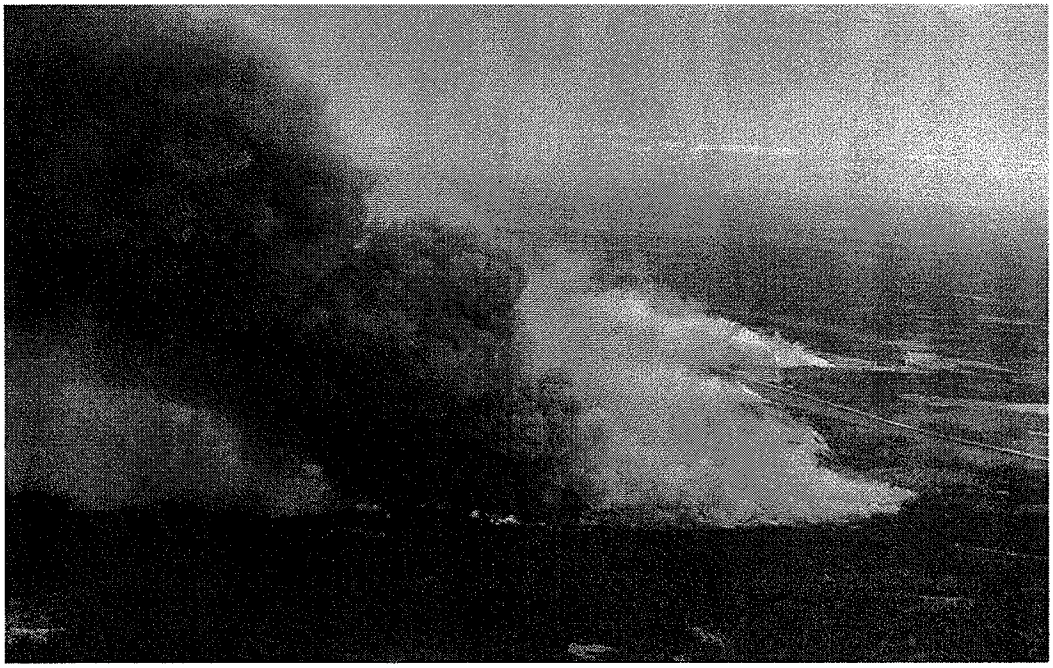


Fig 3. *Chisholm Fire during the late afternoon of May 25, 2001.*

Wildfire case studies in support of LACES

A number of past incidents lend support to the adoption of LACES in lieu of LCES as a basic wildland fire safety system. Points made in the previous sections of this paper are reflected in two recent incidents that have occurred in Alberta, one involving a "close call" and the other a fatality. Every letter of LCES was compromised, resulting in firefighters being either killed, injured or threatened. Had an anchor point been established or had the safety advantage afforded by an anchor point not been abandoned, these incidents may not have occurred at all.

In reviewing these two case studies, some familiarity with the Canadian Forest Fire Danger Rating System (Alexander et al. 1996) and its two major subsystems (Fig. 2), the Canadian Forest Fire Weather Index (FWI) System (CFS 1984; Van Wagner 1987) and the Canadian Forest Fire Behavior Prediction (FBP) System (Forestry Canada Fire Danger Group 1992; Taylor et al. 1997) on the part of the reader is presumed.

Chisholm wildfire entrapment/fire shelter deployment

Analysis of the fire entrapment that occurred on the Chisholm Fire supports the argument for advocating LACES over LCES. On May 27, 2001 at approximately 1600 hours, fire shelters were deployed as a precautionary measure to protect a crew of 14 firefighters working on a large fire just north of the community of Flatbush in central Alberta (Fig. 3). Key elements of the investigation of this fire incident are reported elsewhere (Beck, Van Nest, Hutchinson and Bachop 2001) and are included herein and for the most part, verbatim, with permission from the authors.

Fire LWF-063 or the Chisholm Fire, as it is commonly called, started during the evening of May 23, 2001. Over a period of three days the fire grew to approximately 15,000 ha in size due to extremely dry, volatile fuels and strong winds.
The fire exhibited very aggressive behavior during its early stages. Numerous resources were requested and assigned to the fire, including fire suppression crews from British Columbia.

Fire environment summary

Fuels. Fuels in the incident area consisted of a mixture of mature black and white spruce conifer and deciduous timber types. The foliar moisture content in conifers was at its annual spring low. Of note is the fact that the understory herbaceous plants and grasses were still in a dormant cured stage even though overstory green-up had occurred in the deciduous timber. Dozer guard construction had resulted in heavy slash
accumulations, and significant pockets of partially burned fuels existed along the dozer guard in the vicinity of the incident. The entire forest floor was very dry, which resulted in deep burning and almost complete duff consumption at the base of standing trees.

Weather. The weather that preceded the incident included below normal over-winter precipitation followed by a very dry spring. The weather conditions that were forecasted for the fire site on May 27, 2001 included high temperatures (27°C), low relative humidities (25%) and winds were forecast to increase to 25 km/h (gusting to 50 km/h) from the east-southeast. A fire weather advisory was in effect for May 27.

Topography. Terrain in the area of the incident was flat.

Potential fire behavior

On Sunday, May 27, 2001 the fire behavior specialist working as a member of the overhead team assigned to the Chisholm Fire noted that all fuels were at a critical state of dryness. Strong winds were expected to cause the fire to make significant excursions, display erratic behavior and produce long range spotting. The six
standard 1300 hour FWI System components for May 27 were as follows:

Fine Fuel Moisture Code (FFMC) - 90
Duff Moisture Code (DMC) - 95
Drought Code (DC) - 380
Initial Spread Index (ISI) - 15
Buildup Index (BUI) - 117
Fire Weather Index (FWI) – 43

The head fire rate of spread in FBP System fuel type 0-1b (standing grass) was predicted to be 54 m/min. The head fire intensity was predicted to be ~30,000 kW/m in FBP System
fuel type C-2 (boreal spruce) and involve continuous crowning.

Incident description

On the morning of May 27, 2001, fourteen people were instructed to mop-up 30 – 50 meters inside a dozer guard that had been established along the eastern flank of Sector 5, Division 2, Fire #63. The fourteen personnel were comprised of the following: a single three-person initial attack crew from British Columbia, eight Type III emergency firefighters from Alberta, and three equipment operators (i.e., two Nodwells and one buggy ground tanker). Only the three initial attack firefighters from British Columbia were carrying fire shelters. The dozer guard the firefighters were working on had been "tight-lined" and it had not yet been secured.

Bucketing commenced on the sector at approximately 0730 hours and spots were noted outside the dozer guard at approximately 0846 hours. These spot fires were actioned by helicopters with buckets. As the day progressed, firefighters proceeded south along the dozer guard carrying out their assignment. Between 1130 and 1200 hours, the division boss contacted the crew boss and instructed him to proceed approximately one kilometer further south along the dozer guard to evaluate hotspots at that location. The crew then left the safety of their anchor point and proceeded south to the hotspots. Safety zones and escape routes were discussed over the radio by the sector boss and the crew boss. By 1400 hours the sector boss and crew boss realized that the burned area could no longer be considered a "safety zone" due to the risk of falling trees as a result of strong winds and complete duff consumption around the bases of trees.

At approximately 1432 hours, a flare-up to the north of the crew blocked access to their original anchor point. By this time, the ground water tankers being used by the crew were nearly empty and unable to return north to be refilled. By 1500 hours, the crew had traveled south and established a new safety zone. Trees laying across the guard to the south prevented the sector boss from reaching the crew via ground transportation, and he requested a helicopter bird dog officer (BDO) to check on the crew between 1532 and 1535 hours.

The BDO assessed the situation and advised the sector boss that the crews were in a safe area. A further radio transmission from the BDO to Chisholm Fire base camp at 1555 hours indicated that the crew was trapped between two smokes and a helicopter with bucket was requested to assist. The division boss then called the BDO for a report on the status of the crew. The BDO informed the division boss that the crew was in no immediate danger but needed bucket support. The BDO then instructed the crew to stay where they were, and not to head north. Discussions between the BDO and crew boss resulted in the construction of a helipad for evacuation. At approximately 1600 hours, fire shelters were deployed in the helipad area (Fig. 4) as a precautionary measure to protect the crew from radiant heat, and were shared amongst fourteen personnel on the ground. Following the deployment, five of the crew were evacuated from the site by helicopter (at approximately 1615 hours). The remaining nine personnel were guided through a burned area (i.e., the "black") to a designated helicopter pick-up site (1635 hours).

None of the individuals involved in the incident were physically injured, and all willing participants received critical incident stress counseling following the incident. An investigation of this entrapment was requested by the fire boss
and both Alberta and British Columbia agencies immediately following the incident.

Fig. 4. *Fire shelter deployment site on the Chisholm Fire shortly after the incident.*

Evaluation of firefighter actions

Question # 1. How did the crew end up in their predicament given the message issued by the fire boss at the strategy team meeting the evening prior, stressing the severity of the burning conditions anticipated and that the safety of firefighters was paramount and that crews should remove themselves given any uncomfortable situation? Other crews within the sector and division did so safely. *Findings.* The crew left the safety of their Anchor Point. Fire crew members discussed safety concerns regularly, but continued to work despite having knowingly breached the safe work practices and guidelines advocated by both LCES and LACES. The crew did not designate a Lookout to ensure that their primary Escape Route was maintained. Contrary to training, the crew's primary escape route was not flagged or effectively Communicated to all crew members and equipment operators, and a secondary Escape Route was not scouted. British Columbia initial attack crew were being used for sustained action with inexperienced Alberta Type III firefighters.

The message issued by the fire boss (incident commander) at the strategy team meeting the evening prior to the entrapment stressed the severity of the burning conditions anticipated and that the safety of firefighters was paramount. He stated that "Tomorrow's fire behavior will be very extreme and violent, every firefighter must have two feet in the black and there should not be any 'green' between any firefighter and the fire. No fire is worth the life of a firefighter and if anyone feels at all uncomfortable with the situation they should pull themselves off. Use your LACES." Unfortunately, this safety message was not received at the crew level. General safety messages were issued from the line down without full analysis of the situation at hand and without field audits to ensure that crews had implemented what was required on the ground. The firefighters involved did not offer a concern that they were out of their element and did not assert themselves to take any immediate action to address their concerns.

Question #2. Why did the crew leave the safety of their anchor point? *Findings.* British Columbia personnel, although familiar with LCES were unfamiliar with requirements for an Anchor Point (i.e., LACES instead of LCES), and used the term Anchor Point and Safety Zone synonymously. Although fire crew members discussed safety concerns regularly, they continued to work despite having knowingly breached LCES/LACES. The strategies and tactics chosen by the crew boss and sector boss, that were approved by the division and line bosses, were not appropriate given the fuel type and potential fire behavior. Safety messages were not received at the crew level. Crews were not certified for sustained action based on their level of experience and training which resulted in inadequate decision making.

Question # 3. Why was this a case where "two feet in the black" could not be applied or what appeared at first to be possible safety zones, could not be used by the crew? *Findings.* "Two feet in the black" couldn't be applied universally due to dangerous snags and trees, and safety zone and escape route requirements changing depending on the fire behavior conditions. In this case, the winds at the time eliminated the burn as an acceptable safety zone due to falling trees.

The two fire management agencies involved have a number of significantly different policies, procedures and regulations (i.e., Occupational Health and Safety, Workers Compensation Board) that govern safe work practices. Notable differences exist. For example, practices surrounding dangerous trees created by the fire and the use of LACES in Alberta versus LCES in British Columbia.

Question #4. Should we be stressing the need for an "A" (for "Anchor points") to be added to LCES as used in Alberta or continue with LCES as used by the crew boss from British Columbia and other agencies? *Findings.* British Columbia personnel, although familiar with LCES are unfamiliar with LACES, and neither LCES nor LACES are defined in the Canadian *Glossary of Forest Fire Management Terms* (CIFFC 2000). Alberta's standard operating procedures require that an anchor point must be established when head fire intensities are anticipated to exceed 2000 kW/m on the basis of actual or observed fire weather conditions.

Implications for wildland firefighter safety. Given the findings pertaining to questions #1 – 4 above, and in addition to the rationale provided previously for LACES versus LCES, one could easily conclude that the answer to this question is that one

should consider stressing LACES rather than LCES.

Rappel crew member fatality on Lac La Biche Fire

The following account is based on information contained in ETC and CIFFC (2000). On June 2, 1995 about 270 kilometres north of Edmonton, Alberta, three rappel crew members were positioned away from their anchor point, in a green area, some 50 to 75 metres away from the east flank of the fire. Suddenly, the wind switched direction and dramatically increased in strength causing the east flank to then become the head. One member died and another was disabled during an emergency helicopter static line extraction process. The third crew member escaped uninjured by running from the fire.

Fire environment summary

Fuels. Fairly open black spruce (overstory similar to FBP System fuel type C-2 put with a preponderance of sphagnum moss on the ground) with trees less than about eight metres in height with branches extending to the ground surface and heavily draped with oldman's bearded lichen.

Weather. The 1300 hour observations at a nearby weather station were as follows:

Temperature - 25 deg. C
Relative humidity - 43 %
10-m open wind - 7 km/h
Days since rain - 9

Topography. All of the fire area was flat.

Potential fire behavior

The six standard 1300 hour FWI System were as follows:

Fine Fuel Moisture Code (FFMC) - 91
Duff Moisture Code (DMC) - 87
Drought Code (DC) - 360
Initial Spread Index (ISI) - 7
Buildup Index (BUI) - 108
Fire Weather Index (FWI) – 26

The predicted head fire rate of spread and intensity in FBP System fuel type C-2 (boreal spruce), on the basis of the 1300 hour FWI System components, would be 5.2 m/min and about 12,000 kW/m, respectively, and involve nearly continuous crowning.

Incident description

Prior to the fatality on June 2, 1995, a three-person initial attack crew had sized up the lightning-caused fire a little earlier that afternoon. The crew leader decided the fire was

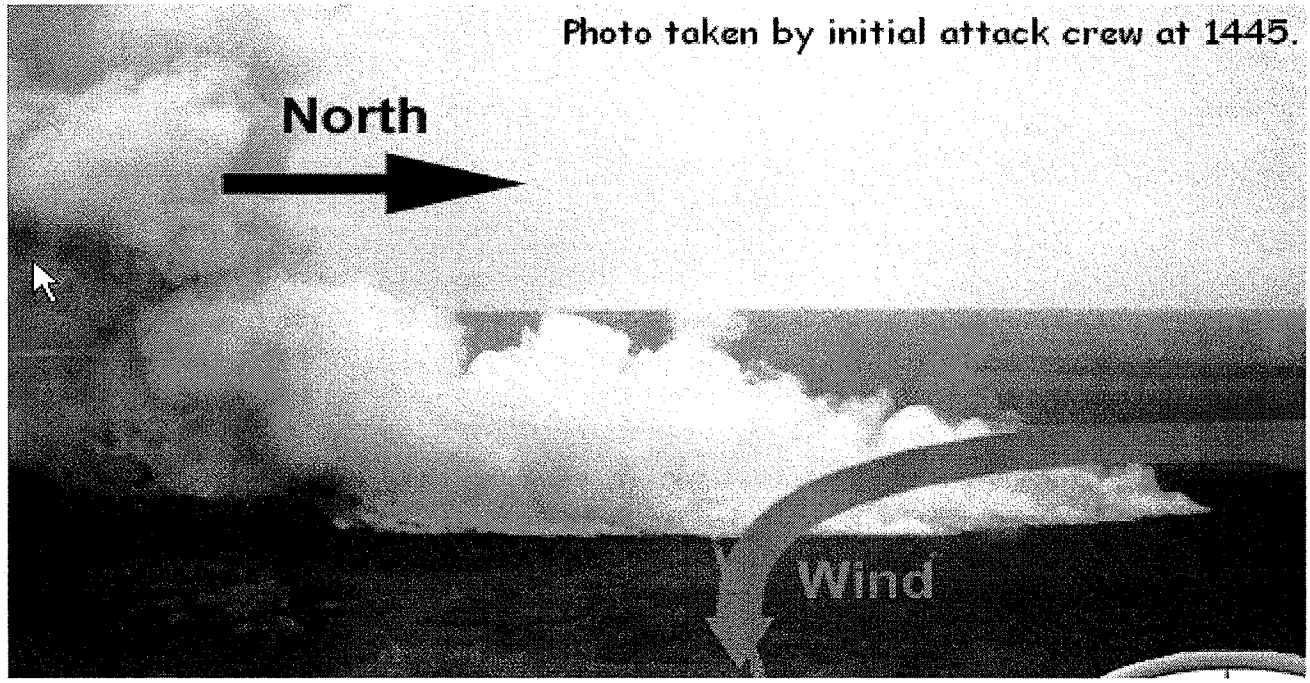


Fig. 5. *View of Fire DL3-18-95 looking west at the east flank of the fire some time prior to wind shifting from the north to the west (from ETC and CIFFC 2000).*

too big and intense for three people to action (Fig. 5), so he reported his findings to the local district office and moved on to the next reported fire. Roughly an hour or so later, air tankers arrived and began retardant drops. The fire was about 40 hectares in size and relatively quiet along the flanks when a seven-person rapattack crew began to take action towards the rear of the fire. The work included cutting a helipad, scouting the fire and some bucket work.

The crew was very conscious of thunderstorm activity in the surrounding area. However, rather suddenly, a wind shift occurred and coupled with the associated increase in wind strength caused the east flank to rapidly change from a low intensity ground fire to a high intensity crown fire, which then became the head.

Three crew members were positioned east of the east flank, some 50 to 75 meters away from the flank. Given the situation, the crew leader elected to use an emergency extraction with static line retrieval for the three crew members.

The assistant crew leader helped the two other crew members get into the harnesses lowered from the helicopter. The assistant crew leader did not have time to hook himself up to the helicopter. He therefore had no other choice but to leave the extraction point because of the proximity of the advancing flame front and convection column.

The assistant crew leader ran out along the seismic line and escaped uninjured. Later, his footprints were measured at distances up to 3 meters apart. He said that he never looked back, but he could see the firebrands landing around him while he was running. In exiting the extraction point, with very low visibility because of smoke, the helicopter inadvertently encountered a very distinct fuel type change, from 8-m high black spruce to 25-30 m tall mixedwood forest. The two crew members were dragged through
the tops of the trees. One crew member eventually died from his injuries and the other sustained disabling injuries.

Evaluation of firefighter actions

Question. Why did the rappel members not establish an anchor point? *Findings.* No standard operating procedures for the observance of LACES (with the "A" standing for "Anchor points") existed at that time. Prior to arrival at the fire, the crews had experienced some precipitation at their point of dispatch. They believed the fire would be relatively benign in nature. As witnessed a slow moving fire upon arrival at the fire scene, which appeared to substantiate their feelings of mild burning conditions. The possibility of a threat to safety by entrapment or a burn-over was not an immediate concern.

Conclusions

It is not the intent of this paper to imply that simply by adding an "A" for Anchor Points to LCES would serve as a "sure-fire" solution to the prevention of all wildland firefighter injuries and fatalities. There are many other factors that enter into the equation when one examines past incidents involving injuries or fatalities. For example, the burn injuries sustained by California firefighter Kelly York during a burn-over,

highlighted the fact that it was not just the lack of an anchor point that contributed to her accident but the lack of proper personal protective equipment and a lack of communications (Anon. 1996).

It's readily acknowledged that the addition of an "A" to LCES for "Anchor point(s)" may simply lead to a plethora of logical additions to LCES. There is already a myriad of well intentioned wildland fire safety acronyms and guidelines (e.g., Queen 1993) in addition to the long standing ones. However, "anchor and flank" is viewed by many as a basic safe work practice in wildland firefighting operations (e.g., Alexander and Fogarty 2000).

Fire suppression actions that are based on observed or perceived fire behavior versus a potential fire behavior relative to an assessment of the fire environment has in the past, and will in the future, continue to lure wildland firefighters into a false sense of security. Perhaps as a few members of the wildland fire community have suggested (e.g., Morse 1990), we should look to adopt some measure of fuel dryness to gauge whether we put firefighters on the line or not and if so where and for what purpose. In Canada at least, such criteria would logically be based on critical threshold values of the Fine Fuel Moisture Code and Buildup Index components of the FWI System for a given fuel type along the lines of the generalized fire suppression guidelines developed by Alexander and Cole (1995). This would enable fire suppression personnel to determine more objectively whether firefighters can continue to work safely on the line.

The next logical step would be to formally and rigorously debate the issues and rationale that have been put forward in this paper to amend "LCES" to "LACES" by the inclusion of an "A" for "Anchor Point(s)." The 2001 Wildland Fire Safety Conference is seen as an appropriate venue for just such an undertaking. Hopefully, a collective recommendation to the global wildland fire community from the participants at this conference would result in such an amendment. Even if consensus is reached at this conference, implementation will undoubtedly be difficult as LCES is a well entrenched concept in the wildland fire community (e.g., Anon. 1996a; Goodson and Adams 1998).

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