WILDLAND INCIDENT RESPONSE GUIDE

Alberta Wildfire

Fire Safety Alert/Survival Checklist

The following list of **10 Fire Orders and 17 Watch Out** situations were developed over the years as a result of actual experiences and/or conditions that have led to firefighter fatalities mainly in the United States.

ANY VIOLATION OF EVEN ONE ORDER OR SITUATION CAN PROVE DEADLY.

Fire Orders

1 Know what your fire is doing at all times.
2 Keep informed on FIRE WEATHER conditions and obtain forecasts.
3 Base all actions on current and expected fire behavior.
4 Give clear INSTRUCTIONS and be sure they are understood.
5 Post lookouts in potentially hazardous situations.
6 Establish safety zones, escape routes for everyone, and make sure they are known.
7 Be Alert. Keep Calm. Think Clearly. Act Defensively.
8 Maintain control at all times.
9 Remain in communication with your crew members, supervisors and adjoining forces.
10 Fight fire aggressively but provide for safety first.

17 Watchout Situations

1. You are in country not seen in the daylight.
2. You are constructing line without a safe anchor point.
3. You are attempting a frontal assault on a fire.
4. There is unburned fuel between you and the fire.
5. You are building fire line downhill with fire below.
6. You are on a hillside where rolling material can ignite fuel below.
7. The weather is getting hotter and drier.
8. The wind increases and/or changes direction.
9. You are getting frequent spot fires across the line.
10. The terrain and fuels make escape to safety zones difficult.
11. You feel like taking a nap near the fireline.
12. You are unfamiliar with local factors including fire behavior
13. You are working in an area where numerous snags and hazard trees are present.
14. The management of the fire is transitioning.
15. You are driving when fatigued and/or in conditions where darkness, dust and/or smoke make visibility difficult.
16. The fire is in the urban interface.
17. You have significantly exceeded the 2:1 work/rest ratio or you have been operating at the 2:1 ratio for an extended period.

Safe Work Procedures - LACES

Lookouts

- Lookouts must be trained wildland firefighters capable of assessing wildland fire hazards.
- The Crew Leader will determine the number of lookouts used.
- When fireline hazards endanger the crew, lookouts warn wildland firefighters and notify the Unit Leader.
- Wildland firefighters should remove themselves from any immediate danger and await further instructions from their Crew Leader.

Anchor Points

- An advantageous location, usually a barrier to fire spread, from which to start or finish construction of a control line.
- Used to minimize the chance of being flanked (or outflanked) by the fire while the line is being constructed.

Communications

- Crew Leaders are trained to give clear instructions and to ensure that they are understood.
- Wildland firefighters must understand all instructions or ask for clarification when uncertain.
- Every wildland firefighter must be in communication with the crew. ***Working alone or out of earshot of other crew members is not allowed.***
- Communications must be prompt and clear, whether by radio or verbal.

Escape Routes

- Escape routes are retreat paths that provide rapid access to safety zones.
- Safety zones are locations where wildland firefighters can find shelter from threatening wildfire.
- The most common escape route, or part of one, is the fireline.
- Escape routes should lead away from the fire: downhill or opposite the fire's direction of spread.
- There should **always** be more than one escape route that leads to an effective safety zone. A single escape route may be cut off. All wildland firefighters are responsible for knowing the locations of escape routes and safety zones.

Safety Zones

- Safety zones are locations where firefighters can find shelter from threatening wildfire
- Safety zones should be big enough to be 8x the distance from the height of the surrounding vegetation on flat ground.
- Water sources (rivers/creeks/ponds).
- Marshy or boggy sites.
- Large, rocky areas or cliff bands.
- Large clearing or areas of sparse fuel, particularly deciduous.
- The burned area.
- Down slope from the fire.
- Lease sites

Note: Avoid using caves. Fire outside the cave will pull the cool air from the cave and replace it with smoke and hot gases.

Rules of Thumb

- When temp exceeds or is near RH then FFMC = 92
- When FFMC is in the low 90’s, the ISI is equal to the wind speed
- ISI doubles for every 13km/hr of wind speed at a constant FFMC
- For DC values above 100, rain of 10mm + will reduce DC by the rainfall amount in % before drying
- If the difference between the temperature and the dew point = 10 then RH = 50%
- If the difference between the temperature and the dew point = 20 then RH = 25%
- If the difference between the temperature and the dew point = 30 then RH = 13%
- FFMC has a significant effect on ignition potential and rate of spread
- FFMC reacts very quickly in drying and saturating
- Threshold for ignition is FFMC 75
- DMC has a significant effect on depth of burn, holdover potential, and ignition potential from lightning
- DMC requires 1.6mm precipitation\ to effect it
- DMC of 20+ is considered to be the threshold for lightning starts
- Holdovers may occur if RH under 45% and DMC is 20+
- DC has a significant effect on the depth of burn, resistance to control, and amounts of large fuels available for combustion

- DC is effected with rains over 2.9mm and can become a factor in long periods of drought
- Large fuels become available for consumption at a DC above 300
- BUI is an indicator of fuel available for combustion
- When BUI is high fires burn deep, when low fires burn shallow
- BUI and ISI are used to determine HFI
- ISI has a significant effect on rate of spread and crowning potential
- ISI of 5 is the threshold for intermittent crown fire in C2 and ISI 10 for continuous crown fire
- Direct attack is difficult or likely to be unsuccessful at HFI values of above 4000 kW/m
- Aerial ignition should be considered at HFI 5 and 6
- Support resources are required at HFI 4
- Fire Regime – the total pattern of fires in vegetation, over time, characteristic of a natural region or ecosystem and includes variation in the characteristics of fire frequency, intensity, severity, size and the season and source of the ignition.
- Dew point = Temperature to which air must be cooled to become saturated
- Back to the wind; Low pressure on your left
- Winds are counter-clockwise around a low pressure and clockwise around a high pressure
- The closer the isobars the faster the wind speed
- The atmosphere is stable if vertical motion is suppressed and unstable if vertical motion is promoted

- Air cools 3 degrees Celsius per 1000 ft for dry air and 1.5 degrees Celsius for wet air
- 500 mb chart is a chart indicating whether 500mb heights are above or below climatological averages. It indicates upper ridging or upper trough and is usually around 18000ft in elevation
- Backfire – a fire spreading or set to spread into or against the wind
- Burning Out – a fire suppression operation where fire is set along the inside edge of a control line or a natural barrier to consume unburned fuel between the line and the fire perimeter, thereby reinforcing, the existing line and speeding up the control effort.

Values at Risk

Values-at-risk are a specific or collective set of natural resources and man made improvements and/or developments that have measurable or intrinsic worth, and which could potentially be destroyed or otherwise altered by fire in any given area.

Provincial Priorities in Fire Suppression:

- **Human life** (For example: Occupied industrial plant sites, construction camps, commercial lodges, campgrounds including private and municipal, etc.).
- **Communities** (For example: cities, towns, villages, hamlets, subdivisions within Indian Reserves (IR), subdivisions within Metis lands, etc.).
- **Watersheds/soils** (For example: critical fish habitat, areas of possible erosion and siltation, sensitive soils, critical basins for water production, etc.).
- **Natural resources** (For example: terrestrial and aquatic vegetation, wildlife, fisheries, insects and disease, threatened/rare/endangered species, critical age classes, research plots and enhanced treatments, recreation and tourism, protected areas/significant features, visual quality, historical/cultural areas, range opportunities, wood product opportunities, hydrocarbon and in situ resource opportunities, etc.).
- **Infrastructure** (For example: major roads, major transmission lines, major railways, major telecom sites, major navigational sites, main public travel corridors, buildings, etc.).

Wildland Urban Interface

A popular term used to describe an area where various structures (most notably private homes) and other human development meet or are intermingled with forest and other vegetative fuel types. Simply put, Wildland Urban Interface is where the urban lifestyles meet the forested area. In forest fire terms, any vegetative type (forest or grassland) is a potential fuel that can pose a serious risk to human life and property in this "interface zone". By choosing to extend our lifestyle and communities further into forested area, we become more exposed to the danger of a wildfire.

Requesting WUI Resources

WUI resources can be deployed inside or outside the FPA, and the Authority Having Jurisdiction is responsible for requesting WUI resources. A municipality can start the deployment process independently if a resource request is outside the FPA. Once they have depleted all local and mutual aid resources, they can contact the PECC, and a WUI Field Officer will help them acquire resources for their incident (see Figure 2 WUI Resource Request).
The process is the same if a municipality is inside the FPA and requires WUI resources for protection within its borders. The Municipality should contact the Forest Area and gather as much information as possible on weather, fire probability, and fire predictability. The Municipality should also inform the Forest Area of any resources they have requested and deployed so that the Forest Area can maintain situational awareness.

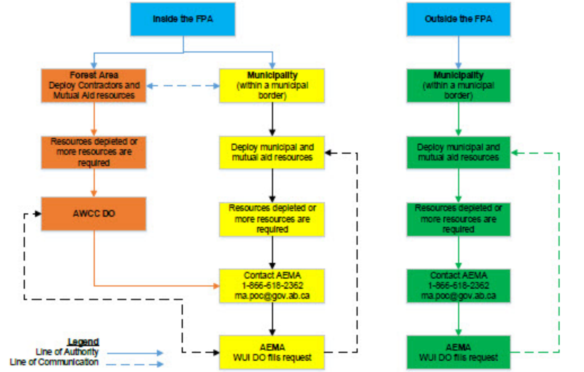
The Forest Area will handle a resource request inside the FPA. Should the Forest Area require assistance, they can contact the PECC, and a WUI Field Officer will help them acquire resources for their incident (see Figure 2 WUI Resource Request).

If a Municipality, Forest Area, AWCC, or an IMT is requesting WUI resources from the Province

(through the PECC), the following information needs to be included:

- Requesting party, contact name, and phone number
- Incident name, number, and location
- Resources requested; kind, type, and quantity
- Expected task(s)
- Required arrival date and time for each resource
- The approximate duration the resource will be required
- Reporting location
- Any special requirements

FIGURE 2 WUI RESOURCE REQUEST



WUI Personnel and Training

The WUI positions required for an incident are based on the type and level of activation, and the WUI positions are filled based on the individual's qualifications, training, and experience. To be considered for a WUI deployment, personnel must be trained in at least one of the WUIM, WUIB, WUIL, or STPS levels

WUI Protection Specialist (STPS)

An STPS may be employed in either the Operations Section or Planning Section.

Operations Section - When activated as a Branch Director, Division or Group Supervisor, the STPS helps manage all tactical WUI operations at an incident. This includes direction, coordination, and implementation of WUI resources to meet the objectives of the Incident Action Plan. The WUI Protection Branch Director reports to the Operations Chief, and a WUI Division or Group Supervisor reports to the Branch Director or the Operations Section Chief.

Planning Section - When activated as a Technical Specialist, the STPS coordinates site assessments and determines the resources required to achieve desired strategies and tactics. The STPS Technical Specialist reports to the Planning Section Chief.

WUI Strike Team or Task Force Leader (WUIL)

A WUIL performs tactical missions on a division or segment of a division and is responsible for directing different kinds and types of multiple resources assigned to them (i.e. engine, ground or sprinkler crews; heavy equipment, water tenders) during the pre-impingement, impingement, and post-impingement phases. This also includes reports on work progress and resource status as well as maintaining work records on assigned personnel. The WUIL may report to the WUI Branch Director, a Division, or a Group Supervisor, depending on the organizational structure of an incident.

WUI Crew Boss (WUIB)

A WUIB is responsible for supervising and performing tactical assignments of a single resource assigned to them (i.e. engine operations and site preparation activities) during the pre-impingement, impingement and post-impingement phases of an incident. This also includes providing reports on work progress and resource status and maintaining work records on assigned apparatus and personnel. The WUIB may report to a WUIL or the WUI Branch Director, a Division, or a Group Supervisor, depending on the organizational structure of an incident.

WUI Crew Member (WUIM)

Responsible for performing tactical assignments during the pre-impingement, impingement and post-impingement phases. They must be proficient in engine operations and site preparation activities (i.e. sprinkler setup, pumps, hose deployment, and triage). The WUIM reports to a WUIB.

TABLE 2 ENGINE TYPES

Minimum Requirements	Engine Type						
	E1	E2	E3	E4	E5	E6	E7
Tank minimum capacity (litres)	1130	1130	1890	2830	1510	560	180
Pump minimum flow (LPM)	3780	1890	568	189	189	189	38
At rated pressure (kPa)	1034	1034	1724	689	689	689	689
Hose: 65 mm (meters)	360	300					
Hose: 38 mm (meters)	150	150	300	90	90	90	
Hose: 25 mm (meters)			150	90	90	90	60
Ladders per NFPA 1901	Yes	Yes					
Master stream: 1893 LPM	Yes						
Pump and roll			Yes	Yes	Yes	Yes	Yes
Maximum GVWR (kg)					11793	8845	6350
Personnel Maximum (minimum)	4 (4)	4 (4)	4 (4)	4 (3)	4 (3)	4 (3)	4 (2)

Note: Crews, as a minimum, can consist of 1 WIUB and 1 WUIM and up to 1 WUIB with 3 WUIMs. Also, an apparatus will not carry any personnel with out the proper number of seatbelts.

TABLE 4 TENDERS

Minimum Requirements	Tender Type				
	Support			Tactical	
	S1	S2	S3	T1	T2
Tank capacity (litres)	15142	9464	3785	7571	3785
Pump flow (LPM)	1136	757	757	946	946
At rated pressure (kPa)	350	350	350	1050	1050
Maximum refill time (minutes)	30	20	15		
Pump & roll				Yes	Yes
Personnel	1	1	1	2	2

Note: Tender personnel are considered to be a WUIMs.

FIRELINE ORGANIZATION

Wildfire Types and Size Class

Type 1

- Most complex type of incident to safely and effectively manage and operate
- All Command and General Staff and required support positions are activated
- The incident complexity analysis, agency administrative briefings and agency delegation of authority must be completed and monitored and updated as required
- Multiple agencies will be involved and there may be a declaration of emergency by the appropriate authority
- A written IAP is required for each operational period

Type 2

- Incident will extend into multiple operational periods
- This type of incident may exceed the capabilities of local fire management resources
- Most or all Command and General staff positions are filled

- The Agency Administrator or official is responsible for the incident complexity analysis, agency administrative briefings and agency delegation of authority
- Multiple agencies may be involved
- A written IAP is required for each operational period

<u>Type 3</u>

- The incident normally extends into multiple operational periods
- The appropriate ICS positions should be added to match the complexity of the incident. Some of the Command/General Staff positions (Division Supervisor, Unit Leader) may be filled.
- A written IAP may be required for each operational period.

<u>Type 4</u>

- Limited to one operational period in the out-of-control stage
- Incident Commander is activated, and other operational positions activated as required
- No written Incident Action Plan (IAP) is required, but an operational briefing

will be completed for all incoming resources

Type 5

- Incident is normally under control or out within the first operational period
- Incident Commander is the only overhead position activated
- Include “A verbal Incident Action Plan is required, no written IAP is needed”
- Include ICS characteristic “Little complexity”

The size class of a fire is defined as follows:

A class = 0 to 0.1 ha
B class > 0.1 ha to 4.0 ha
C class > 4.0 ha to 40.0 ha
D class > 40.0 ha to 200 ha
E class > 200 ha

Incident Check In and Check out

Every resource must check in and check out of an incident. When you arrive the first thing you should do is go to check in. If you do not have a crew manifest or dispatch form be ready to provide the following information at checkin;

- Your name
- The position you are filing on the incident
- Your last day off duty and length of deployment
- Vehicle make, model and license plate
- Food allergies or restrictions
- List of equipment you are bringing to the incident

At Checkin you should be given the following minimum information;

- P number assignment
- Accommodation assignment
- Overall incident briefing
- Incident assignment and direct supervisor contact

All resources must check out before leaving the incident.

P	**RIORITIES**	LIFE SAFETY, INCIDENT STABILIZATION, P&E CONSERVATION
P	**ROBLEMS**	WHAT YOU KNOW AND OBSERVE OF INCIDENT?
O	**BJECTIVES**	WHAT YOU ARE GOING TO DO?
S	**TRATEGIES**	HOW (METHODS) YOU ARE GOING TO DO IT?
T	**ACTICS**	RESOURCES ASSIGNED TO TASKS

ICS

S.M.A.R.T

OBJECTIVES

S PECIFIC
Is the wording precise and unambiguous?

M EASURABLE
How will achievements be measured?

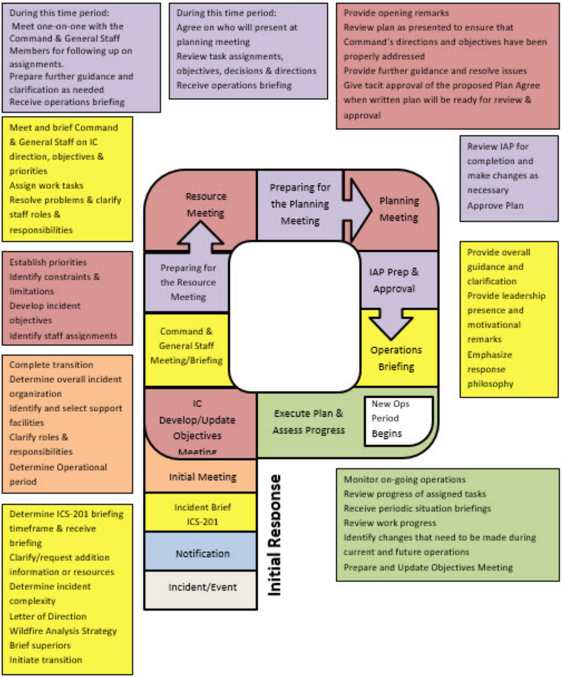
A CTION ORIENTED
Is an action verb used to describe expected accomplishments?

R EALISTIC
Is the outcome achievable with given available resources?

T IME SENSITIVE
What is the timeframe? (if applicable)

ICS

Operational Planning "P" Command Activities



Incident Command and General Staff

There will always be an Incident Commander in charge of the fire.

The Incident Commander is responsible for the overall management of the fire. The Incident Commander:

- Evaluates the known circumstances.
- Assesses the situation or obtains briefing from the prior IC.
- Establishes immediate priorities and anticipates future developments.
- Develops objectives and strategies.
- Executes this strategy in the most satisfactory and effective manner possible.
- Establishes an Incident Command Post.
- Ensures planning meetings are scheduled as required.
- Ensures adequate safety measures are in place.
- Approves and authorizes the Incident Action Plan.
- Coordinates all Command and General staff.
- Approves requests for additional resources or for the release of existing resources.
- Authorizes information released to the media.

- Orders the Demobilization of the fire.
- Authorizes change of fire's status.

The Incident Commander co-ordinates and directs the Command Staff and the General Staff. The General Staff is made up of an Operations Section Chief, Planning Section Chief, Logistics Section Chief, and the Finance/Administration Section Chief. The IC may assign personnel to assist, known as Command staff they consist of the: Information Officer, Safety Officer, and Liaison Officer and provide services to the entire fire. The IC may have a deputy. A deputy must have the same qualifications as the IC. The IC ensures the most effective use of personnel and equipment to safely suppress wildfire. If the fire is small the IC may perform any or all of the IC team's functions or roles. If the fire increases in size and complexity, the Incident Commander of the small fire may be replaced with an individual of higher certification, experience and suppression knowledge. As the fire grows, so may the command team personnel as indicated in the organization build-up portion of this section.

Operations Section

The Operations Section is responsible for implementing strategic and tactical firefighting operations. Operations Section duties include:

- Management of Tactical Operations.
- Supervision of all suppression personnel.
- Assisting in development of the Incident Action Plan (IAP).
- Ensuring Safe Tactical Operations
- Requesting resources needed to implement IAP.
- Approving the release of resources for assigned status (not release from the fire).
- Maintaining close communication with the IC.
- Managing all Staging Areas.
- Maintaining the Unit Log.

Within the Operations Section, two (2) additional levels of organization can be used as necessary. These are Divisions/Groups and Branches. A **Division** is established to divide the fire geographically into manageable compartments. **Groups** can be developed for specific functions on the incident and are not geographical. If the

number of Divisions exceeds the recommended Span of Control, Branches may be established.
Air Operations is activated at the Branch level to meet complex needs for the use of aircraft in both tactical and logistical operations.

Resources are organized into Strike Teams that are teams of the same kind and type of resource or into Task Forces that are teams of various kinds and types of resources.

Operational Briefing Checklist

Situation

- Introduce yourself and your position
- Fire name, location, and other incidents in the area
- Terrain influences
- Fuel type and conditions
- Fire weather (previous, current, and expected)
- Wind, RH, temperature, precipitation
- Fire behavior (previous, current, and expected)
- Time of day, alignment of slope and wind etc.

Mission/Execution

- Command (Incident Commander/immediate Supervisor)
- Leader's intent
- SMART objectives and strategy
- Specific tactical assignments
- Aviation operations (crew moves, how do you request bucket drops/tankers etc.)
- Contingency plans
- Medivac plan: personnel, equipment, transport options, contingency plans

Communications

- Communications Plan (tactical, command, air/ground frequencies, cell phone numbers, etc.)
- How will non-radio communication be used (e.g. group text to all resources etc.)
- Communication timelines (are there specific times that resources should communicate)

Services/Support

- Other resources that may be working adjacent to you and those available to order
- Logistics (e.g. transportation, supplies, equipment)

Risk Management

- Identify known hazards and risks
- Identify control measures to eliminate hazards and reduce risk
- Include LACES
- Identify trigger points for tactical withdrawal or re-evaluation of operational plan
- Any questions or concerns?

Plans Function

The Planning Section is responsible for:

- Collecting, evaluating, processing and disseminating information pertinent to the fire.
- Developing and disseminating an Incident Action plan from the information and information from the Operations Section Chief, the plan is approved by the IC.
- Documenting the suppression effort for legal, analytical and historical purposes.
- Oversees checking in/out of resources.
- Maintaining a master list of all resources.
- Time Unit functions.
- Developing and implementing Incident Demobilization plan.
- Reassigning out-of-service personnel to operational positions.
- Determining any special equipment needs.
- Assembling information on alternative strategies.
- Providing period fire predictions, forecasts fire behaviour, and weather forecasts.
- Providing maps and intelligence information.

There are four units within the Planning Section:

1. Resources Unit
2. Situation Unit
3. Documentation Unit
4. Demobilization Unit

Good communication and accurate information are vital to proper planning

Logistics Section:

The Logistics Section is responsible for:

- Managing all incident support and service needs, with the exception of Aviation support.
- Obtaining and maintaining essential personnel, facilities, equipment and supplies.
- Expediting and procuring additional resources as requested by the Operation Section Chief.
- Reviewing and inputting into Communication Plan, Medical Plan and Traffic Plan
- Servicing reusable equipment.
- Providing security and medical services.
- Managing established contracts, and overseeing lodging and meals.

- Assisting in the development, approval and implementation of the Incident Demobilization Plan.

The Logistics Sections is divided into two (2) branches and six (6) units:

Support Branch

Supply Unit
Facilities Unit
Ground Support Unit

Service Branch

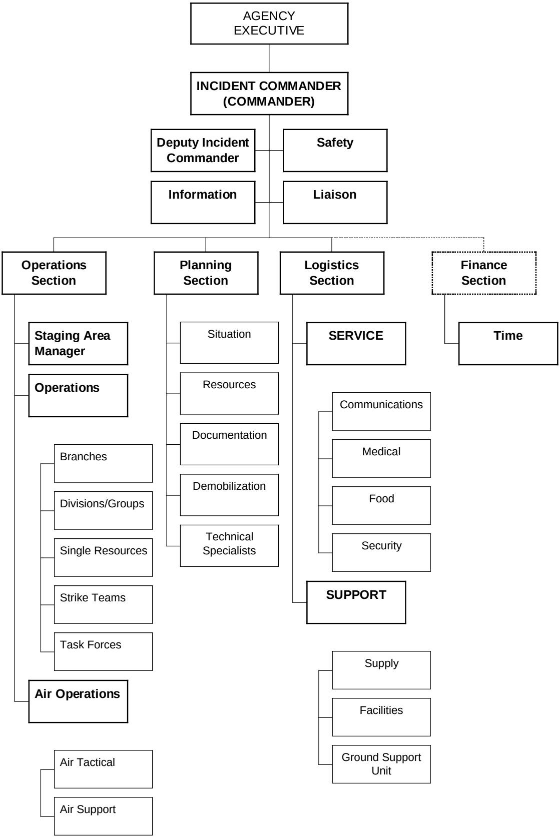
Food Unit
Medical Unit
Communication Unit

Finance/Administration Section

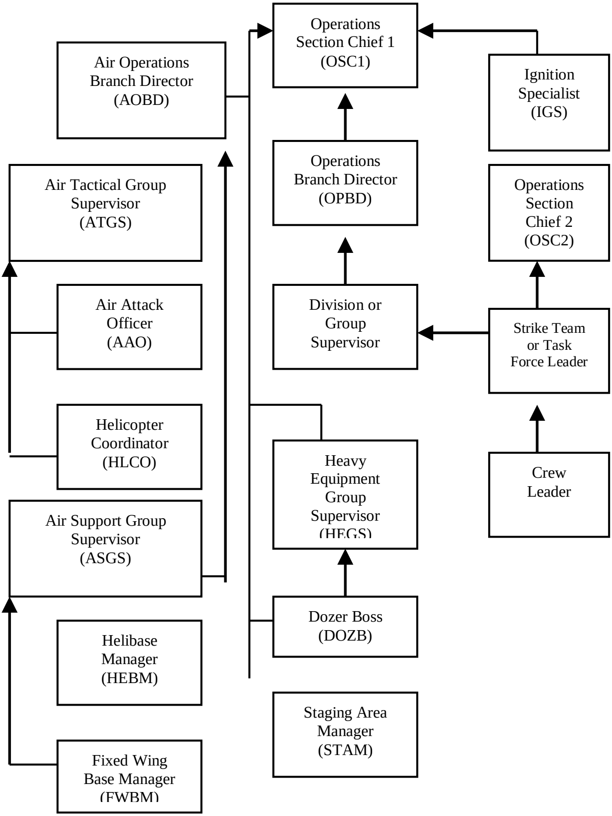
The Finance/Administration section, if activated, is responsible for:

- Maintaining accurate and complete records of the fiscal expenditures accrued on the fire.
- Monitoring costs, providing accounting, procurement, and cost analysis.

INCIDENT COMMAND SYSTEM ORGANIZATION



Operations Section Organization Chart



CIFFC 2022 Mnemonic Table

Section	Mnemonic	Function	Section	Mnemonic	Function
Operations	AAON	Air Attack Officer Nationally Certified	Operations	HESM	Helispot Manager
Command	ACDR	Area Commander	Operations	HLCO	Helicopter Coordinator
Logistics	ACLC	Assistant Area Commander, Logistics	Operations	HTMM	Helitorch Mixmaster
Operations	AOBD	Air Operations Branch Director	Command	ICT *	Incident Commander (Type 1,2,3,4 or 5)
Command	AREP	Agency Representative	Operations	IGSP	Ignition Specialist
Operations	ASGS	Air Support Group Supervisor	Planning	IMET	Incident Meteorologist
Operations	ATGS	Air Tactical Group supervisor	Command	INLO	International Liaison Officer
Logistics	BCMG	Base/Camp Manager	Command	IOF *	Information Officer (Type 1 or 2)
Finance	CLMS	Claims Specialist	Planning	IRIN	Infrared Interpreter
Various	CLRK	Clerk	Planning	IROP	Infrared Operator
Finance	CMSY	Commissary Manager	Operations	LOAD	Loadmaster
Logistics	COML	Communications Unit Leader	Command	LOFR	Liaison Officer
Finance	COMP	Compensation / Claims Unit Leader	Logistics	LSC*	Logistics Section Chief (Type 1 or 2)
Logistics	COMT	Communications Technician	Operations	LSCT	Line Scout
Finance	COST	Cost Unit Leader	Logistics	MEDL	Medical Unit Leader
Operations	CRW *	Crew (Type 1,2, or 3)	Operations	MXMS	Mixmaster (retardant)
Operations	CRL *	Crew Leader (Type 1,2, or 3)	Operations	OPBD	Operations Branch Director
Operations	CRM *	Crew Member (Type 1,2, or 3)	Operations	OSC *	Operations Section Chief (Type 1 or 2)
Logistics	DISP	Dispatcher	Operations	PBSP	Prescribed Fire Specialist
Operations	DIVS	Division/Group Supervisor	Operations	PLDO	Plastic Sphere Dispenser Operator
Planning	DMOB	Demobilization Unit Leader	Finance	PROC	Procurement Unit Leader
Planning	DOCL	Documentation Unit Leader	Planning	PSC *	Planning Section Chief (Type 1 or 2)
Operations	DOZB	Dozer Boss	Finance	PTRC	Personnel Time Recorder
Operations	ENGB	Engine Boss	Logistics	RADO	Radio Operator
Operations	ENOP	Engine Operator	Logistics	RCDM	Receiving and Distribution Manager
Finance	EQTR	Equipment Time Recorder	Planning	RESC	Resource Clerk
Logistics	FACL	Facilities Unit Leader	Planning	RESL	Resource Unit Leader
Operations	FALL	Faller	Planning	SCKN	Status / Check-In Recorder
Planning	FBAN	Fire Behaviour Analyst	Operations	SCLD	Sector Leader
Logistics	FCMG	Fire Cache Manager	Planning	SITL	Situation Unit Leader
Logistics	FDUL	Food Unit Leader	Logistics	SMEC	Small Engine Mechanic
Planning	FINV	Fire Investigator	Operations	SMKJ	Smoke Jumper
Operations	FIRB	Firing Boss	Command	SOF *	Safety Officer (Type 1 or 2)
Operations	FOBS	Field Observer	Logistics	SPUC	Supply Unit Clerk
Finance	FSC *	Finance/Admin Section Chief (Type 1 or 2)	Logistics	SPUL	Supply Unit Leader
Operations	FWBM	Fixed Wing Base Manager	Command	SREP	Senior Agency Representative
Planning	GISS	Geospatial Information System Specialist	Operations	STAM	Staging Area Manager
Logistics	GSUL	Ground Support Unit Leader	Operations	STLD	Strike Team Leader
Operations	HEBD	Heavy Equipment Branch Director	Logistics	SUBD	Support Branch Director
Operations	HEBM	Helibase Manager	Logistics	SVBD	Service Branch Director
Operations	HEGS	Heavy Equipment Group Supervisor	Operations	TFLD	Task Force Leader
Operations	HENG	Helicopter Engineer	Various	THSP	Technical Specialist
Operations	HEOP	Heavy Equipment Operator	Finance	TIME	Time Unit Leader

NOTE: * indicates type used nationally

Alberta Crew Configurations

Crews are configured as follows;

Helitack Crew (HAC) – 4 or 8 person Type 1 trained crew used primarily for initial attack and occasionally for sustained action with 1 leader and 3 members or 1 leader, 1 subleader and 6 members. These crews may come with an intermediate aircraft and 1-2 pickup trucks, radios and an allotment of pumps, hose and hand tools.

Unit Crew (UNIT) – 20 person Type 1 trained crew used primarily for sustained action and occasionally initial attack with 1 leader, 5 subleaders and 14 members. These crews come with five heavy duty pickup trucks, radios and an allotment of pumps, hose and hand tools.

Firetack Crew (FTAC) – 8 person contract crew used primarily for sustained action with 1 leader, 1 subleader and 6 members. These crews come with two pickup trucks, radios and an allotment of pumps, hose and hand tools.

AIR OPERATIONS

Definitions

The following definitions are general guidelines for determining which type of occurrence may have taken place. If uncertainty still exists as to whether the event requires reporting, contact the Forest Area or Alberta Wildfire Coordination Centre Duty Officer for further clarification.

Aircraft Accident

A reportable aircraft accident is one resulting from the operation of an aircraft where:

- A person sustains a serious injury or is killed as a result of:
  - being on-board the aircraft,
  - coming into contact with any part of the aircraft or its contents, or
  - being directly exposed to the jet blast or rotor down wash of the aircraft;
- The aircraft sustains damage or failure that adversely affects the structural strength, performance or flight characteristics of the

aircraft, and requires major repair or replacement of any affected component; or
- The aircraft is missing or inaccessible.

In case of any of the above, report the occurrence immediately, following the procedures outlined in Schedules “A” and “C”.

Aircraft Incident

An incident is an occurrence (other than an accident or hazard) that is associated with the operation of an aircraft, which affects or could affect the safety of operations. Some examples of incidents are:

- An engine fails or is shut down as a precautionary measure.
- Smoke or fire occurs, other than an engine fire, and is contained within the engine, not resulting in engine failure or damage to other components of the aircraft.
- Difficulties in controlling the aircraft in flight due to operations outside the flight envelope, or to an aircraft system malfunction, weather phenomena, wake turbulence or uncontrolled vibrations.

- A near-miss (narrow escape) brought about by a communication systems failure or a lack of adequate communications equipment.
- The aircraft fails to remain within the intended landing or take-off area, lands with one or more landing gear retracted, or drags a wing tip or engine pod.
- Any unit member incapacitated and unable to perform his/her flight duties.
- Decompression, explosive or otherwise, occurs that requires an emergency descent and/or landing.
- A fuel shortage occurs that requires the aircraft to be diverted or makes it a priority for approach and landing at its destination point.
- The aircraft is refuelled with the wrong type of fuel or contaminated fuel that was not detected prior to departure from the ramp.
- A collision or risk of collision with any vehicle, terrain or obstacle occurs, including a collision or risk of collision that may be related to air traffic control procedures or equipment failure. This includes wire strikes or rotor strikes.
- An emergency declared by a flight unit member, or any degree of emergency that

requires priority handling by an air traffic control unit, or crash, fire fighting or rescue services on standby.

- Toxic gases or corrosive materials leaking from any cargo aboard the aircraft.
- Precautionary or emergency landings.
- Bird strikes, resulting in damage to any component.
- Lightning strikes.
- Jettisoning or loss of cargo, sling loads, or retardants that are released unintentionally or as a precautionary or emergency measure.
- Violation of pilot flight/duty day limitations.
- Flying aircraft outside of daylight flight restrictions.
- Rotor blade strikes.

If doubt exists as to whether or not an occurrence should be classified as an incident, contact the Forest Area or Alberta Wildfire Coordination Centre Duty Officer for clarification.

Hazard

A hazard is a danger or risk that is often foreseeable, which can affect the safety/operations of an aircraft. This can range from an improperly closed cargo door to a leaning snag near a helipad. If uncertainty exists as to what constitutes a hazard, contact the Forest Area or Alberta Wildfire Coordination Centre Duty Officer for clarification.

Air Traffic Control (All Incidents)

The Air Attack Officer/Air Tactical Group Supervisor is responsible for air traffic control over and in the immediate vicinity of any incident during the initial attack and support action role. This individual will assign a theatre of operations by time, sector, branch, division, route or holding area, to each aircraft or group of aircraft. In the absence of both the Air Attack Officer and the Air Tactical Group Supervisor this responsibility will be assumed by the Operations Section Chief or in his/her absence, the Incident Commander.

All incoming aircraft must receive clearance from the person controlling air traffic before entering within 8 km (5 miles) of the fire perimeter, or as amended by issuance of a NOTAM. This also will advise the assigned theatre of operations. The air advisory frequencies are as follows:

- 129.800 MHZ (primary)
- 128.950 MHZ (alternate)
- As per ICS215 on campaign fires

- **All aircraft**, especially fixed-wing and airtankers going to an incident, will call for clearance instructions from a minimum of **32 km (20 miles)** out. If an aircraft has not received clearance instructions by the time it has reached **16 km** (**10 miles)** out, or from a distance predetermined by the Air Attack Officer or Incident Commander, it will discontinue its inbound track and enter into a safe holding pattern above the designated flight corridor elevation. The aircraft shall not proceed until it receives its clearance instructions.
- Where helicopters and/or fixed-wings are on the ground within the controlled space

zone, they must contact the Air Attack Officer/Air Tactical Group Supervisor on the air advisory frequency for clearance instructions into or out of the area before they lift off or move.

- Once aircraft land and have completed a specific assignment in a designated location, or are leaving the area, they must contact the Air Attack Officer/Air Tactical Group Supervisor and advise him/her:
  - they are at a specific location;
  - they have completed their assignment and want clearance to another location; or
  - they are leaving the area and will call from **32 km (20 miles)** out as a final clearance.

Placement of Personnel in Aircraft

Only essential flight crew will fly in an airtanker or other fire bombing aircraft.

Alberta Wildfire personnel are ***not*** to be on-board a helicopter during external load operations (slinging, bucketing and long lining). Three exceptions to this are given below.

During Backfire Operations

It is imperative that a Fire Behaviour Analyst either be on-board the helitorch, helicopter or birddog the operation from another helicopter. This procedure is required because of obvious safety concerns and the fact that Crown Land is being ignited, with the Alberta Wildfire being accountable for this decision. To make the pilot solely responsible for this operation is unreasonable.

During Initial Attack Fires Using Medium Rotary-wing

When medium rotary-wings are used, the Incident Commander or STLD/TFLD may be on-board during bucketing operations only during initial attack, providing the rotary-wing pilot is authorized to do so in his/her operations certificate (Sec. 702.16 of Canadian Aircraft Regulation Standard). Once the forward spread of the fire has been stopped and a safe zone established, there is no need for any of these personnel to remain on-board during bucketing operations.

Audio/Visual Signals Air-To-Ground (All Incidents)

On initial attack and during sustained action or follow-up action, the birddog aircraft approaching the target will:

- Activate the siren in "yelp" (intermittent) mode followed by a sharp pull-up, meaning the airtanker will approach the target from the same direction and make the drop at the point indicated at pull-up. *"CLEAR THE DROP AREA."*

> The “yelp” siren will not be repeated for each drop if using the same line sequence and as long as the drops are being made on the same target. When the target is changed, the “yelp” siren will be reactivated.

- Pass over the previously indicated target with the siren operating in "wail" mode, meaning "*ALL CLEAR. RETURN TO FIRELINE."*

- Circle an area with siren operating in "yelp" mode, meaning *"SITUATION REQUIRES IMMEDIATE ATTENTION."*

Helicopter Safety

General

- All operations must comply with all MOT and WCB Safety Regulations and Air Operations Policy.
- All ground personnel must be trained in safety practices in and around helicopters.
- Pilots are ultimately responsible for the safe operation of the helicopter.
- Helicopter operations must only be earned out in daylight hours. The STLD/TFLD must be aware of, and use official grounding times.
- All crews must **be briefed on helicopter** safety prior to approaching or leaving the helicopter. This operation must always be carried out under direction of trained personnel.
- Watch for pilot fatigue. Fatigue may be caused by long hours of duty days, type of flying, camp conditions or weather.

Ground

- Keep clear of rotors (main and tail) when in operation or until directed to approach the helicopter. Stay at least 30 meters from all helicopters.
- Approach from the downhill **front or side** in full view of the pilot. Do not move toward the helicopter until directed.
- Approach and depart in a slight crouch with head and eyes up. If you must exit on the uphill side, remain crouched at the side of the helicopter until it lifts off and is clear.
- Chin straps must be used if hard hats are worn when working around helicopter. They must be carried in the hand if not worn in a chin strap. Secure all rain gear, coats, packs, etc. prior to approaching or departing.
- All tools must be carried parallel to the ground below the waist and loaded only with the pilot's approval. Never throw objects to or from the helicopter.
- All landing areas should be marked and kept free of litter and debris (i.e., tarps, ropes, cans, lids).

- Fuel storage and refueling areas must be separate from the general landing area and marked as such.
- All communication types and methods (i.e., hand signals, radios) must be established prior to any operation and utilized.
- Adjust seat belts and shoulder harnesses prior to takeoff.
- Never duck under the tail boom or walk toward rear of the machine.

Air

- All doors must be finally latched and seat belts adjusted prior to takeoff. Take care in closing doors.
- Test radios to ensure communications are being maintained.
- No smoking on takeoff or landing. Pilots have their own preference and will let you know if it is permissible to smoke while in flight.
- Keep your feet, equipment, maps, etc. clear of all controls and glass.

- Scan area for hazards. Inform pilot of their presence; he/she may not be familiar with power lines, cable crossing, etc. in the area.
- Keep oriented; know where you are. Use your maps. Report in at designated intervals, i.e. give 30 minutes position reports.
- After landing stay in the machine until pilot gives the signal to depart.
- Ensure radios assigned **to the helicopter** stay with it and are not accidentally off-loaded.
- Don't push the pilot into situations where he/she is not comfortable. Conversely, pull him/her off if you are not comfortable in any situation.

Helicopter Bucket or Helicopter with a Fixed Tank

The use of helicopter buckets or helicopters with a fixed tank **(helitankers) is confined to the following** procedures and guidelines.

- On initial attack, a helicopter equipped with a bucket or fixed tank is to be used to control the forward spread of the fire, stopping it and establishing safe zones. After **this has been achieved,** alternative water delivery systems should take over (i.e. power pumps, backpacks).

- After initial attack, the use of buckets or helitankers is restricted to supporting units in holding the active perimeter and/or hot-spotting. On follow-up **action, buckets or helitankers should be used** only for hot-spotting critical and potential areas where control of the fire is threatened.
- When buckets or helitankers are used in follow-up action, the aircraft operations plan **must specify** assignments based on real need. Buckets and helitankers can be used only with direct supervision, and their use is to be curtailed after the objective has been met.
- Direct use of buckets or helitankers should not occur in mop-up operations. **Other, more economical** and effective water delivery methods should be used (i.e. holding tanks and pumps).
- Buckets or helitankers should not be used to action targets inside the burn unless hot **spots pose a** definite threat to control by spotting out.
- A specific position must be assigned the responsibility for **supervising a helicopter bucket or** helitanker operation.

Heliports and Helispots

Heliport: This is a permanent landing area for helicopters where fuel, service and supplies are generally /available. These landing areas must conform to Transport Canada design criteria, which includes such - items as markers and wind socks provided by the Alberta Wildfire.

Helispots: These are temporary areas prepared for helicopter landings. When constructing helispots, the following criteria should be considered:

- The opening is at least two rotor lengths in diameter or larger in steep terrain or heavy timber.
- The location provides for two directions of take-off as close to 180 degrees apart as possible, with one direction being into the prevailing wind.
- A slight curve in the take-off corridor is present to avoid obstructions.
- Take-off and approach corridors are cleared of all obstructions to a minimum width of 25 meters (75 feet).
- The take-off corridor is not into rising terrain.

- The slope of the landing area does not exceed 2%.
- Snags within striking distance of the helispot are removed.
- All hung-up branches or dead tops around the perimeter of the helispot are removed.
- The helispot is located to help facilitate easy approach and departure, taking into consideration the local weather and terrain in the immediate area.

Helispot Construction (Level Terrain)

1. Selecting the Site

- Size at least **2x rotor diameter** (approx. 40m or 120 ft.) in diameter (light and medium RWs).
- Flight paths good approach and departure paths in direction of prevailing winds. A clearing beside a river, lake or road might be good.
- Obstacles avoid clearings beside cliffs or stands of tall trees which can cause dangerous downdrafts.
    - Clear of power lines, wires, cables.

- Site improvement minimal, if possible, i.e. relatively free of stumps, dead falls, brush, rocks.
- Surface-level for landing.

2. Improving the site.

- Cut down tree hazards on approach and departure paths, particularly if slinging external loads.
- Clear the maneuvering area within 15 meters (50 feet) of the landing spot of hazards such as stumps, brush, dead fall and loose debris.
- Clear the landing area to the surface within 8 meters (30 feet) of the helipad.
- Provide the pilot with a wind indicator a windsock of flagging attached to a tree.
- Keep equipment and personnel well clear during flying activity.

Helispot Construction on Slopes

- Same as for level ground helispots except leveling considerations.
- The downhill side must be built up to level the helispot. Often a larger log on the downhill side will suffice. On steep

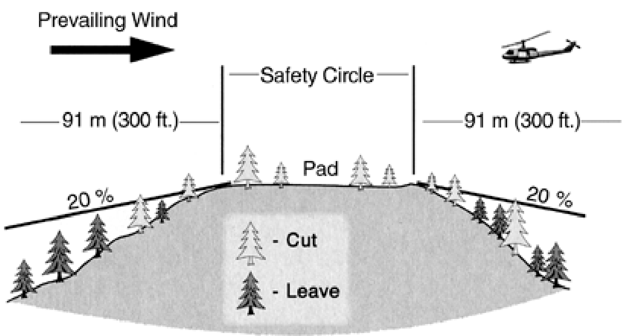
slopes, ensure the pad is securely braced so it won't slide or roll under loading.

- Lay the cross-logs at 60 cm (15 inches) intervals in the same direction as the slope. The helicopter will approach on a track along the side of the hill and land with one side towards the slope.
- A wind indicator is particularly important because of variable winds around hills and down slopes.

The following diagrams outline procedures to follow when constructing helispots and heliports under variable terrain considerations.

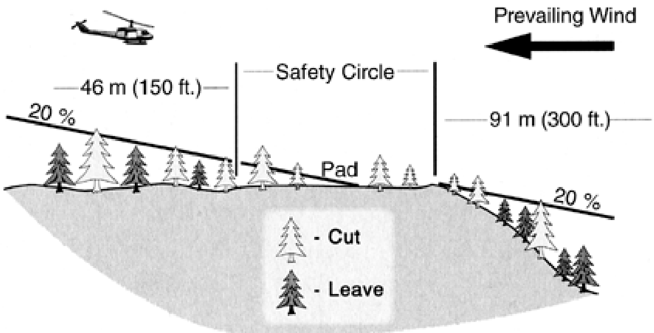
TWO-WAY RIDGE HELISPOT

Approach & Takeoff Depending on Wind Direction



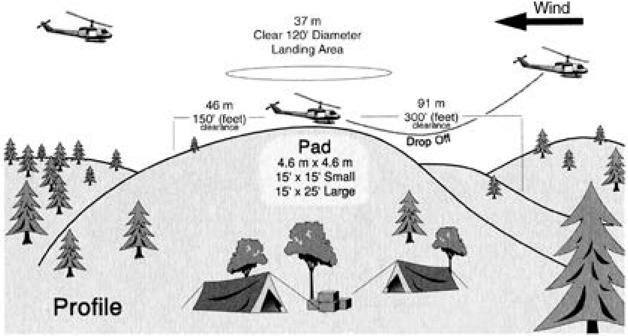
ONE-WAY HELISPOT

Adjacent to DownSlope



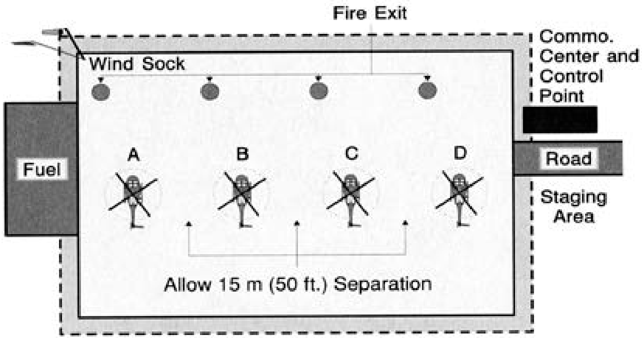
HELISPOT LOCATION - HILLTOP

Ideal Situation



BASE HELIPORT

Multi-Helicopter



Refueling Aircraft

No person operating an aircraft shall permit it to be refuelled if passengers are on board, embarking or disembarking.

Unless a third person is present to act as a visual link between the pilot and refueller during hot refuelling operations, rotor-wing with a filler neck for the fuel tank located on the opposite side from the pilot must be shut down and the pilot must exit the machine to supervise the refuelling.

Hot refuelling aircraft on Alberta Wildfire projects will be allowed only if:

1. There are no passengers on board, embarking or disembarking,
2. The pilot’s seat must be occupied by a person who is competent in controlling the aircraft, and
3. Refuelling is carried out by a trained company engineer and/or a person who is trained and certified in refuelling aircraft as per the CAN/CSA Standard for Storage, Handling and Dispensing Fuels at Aerodromes.

Refuelling aircraft can be carried out from:

- Commercial outlets,
- Alberta Wildfire under- ground tanks,
- Alberta Wildfire bowsers,
- Contract portable fuelling systems/ bowsers for field operations, or
- Alberta Wildfire drums (purchased fuel).

Although the Alberta Wildfire makes every attempt to keep fuel clean and current, pilots should always check the fuel to make sure it is the appropriate type for the aircraft and is free from foreign material.

Alberta Wildfire personnel who refuel rotor-wing aircraft must be properly trained and certified in refuelling aircraft as per course outline found in the CAN/CSA Standard for Storage, Handling and Dispensing Fuels at Aerodromes. People doing aircraft fuelling must take a refresher-training course annually to maintain their certification.

Helicopters – Suppression and Presuppression Assignments

- Ten hours maximum for the first three (3) days of continuous activity, and
- Eight (8) hours maximum for every consecutive day thereafter.

The Forest Area Duty Officer, Incident Commander or the Air Operations Branch Director may allow a pilot who has been flying to start the first of his/her ten-hour days providing:

- Pilot has been on continuous ‘light duty’ such as man-up, day basing, or flying patrols, and
- In the previous three (3) days pilot has flown less than four (4) hours per day.

To reset to a ten-hour day the pilot must not fly for a 24-hour period.

The Air Operations Branch Director, Forest Area Duty Officer or their designate must monitor pilot flying times and when required ask a company to rotate flight crew or change aircraft assignments.

Helicopter Sling Loads

Personal gear is easily lost in a sling load and therefore:

- **Under no circumstances are personal items to be placed in sling loads for transportation under helicopters.**
- The Alberta Wildfire will not replace or pay for any personal items of value that have been lost or damaged through being transported in sling loads.
- To alleviate the problem of transporting bulky, heavy personal gear, and to comply with aircraft safety standards and maximum load capacity, the following shall apply:
- Personal gear, including a sleeping bag for firefighters and overhead shall not exceed 40 pounds.
- Supervisors should ensure these weight restrictions are not exceeded.

Government Equipment

The guidelines below are to be followed when dealing with government equipment:

- Sling loads shall not be lifted from or onto a vehicle.
- Items of high value (garden tractors, quads) can be carried in a sling, if no other "in cabin" transport is available and rotor-wing is of an adequate size and capacity to safely carry item.

Environmental Considerations for Retardant and Foam

Protection of the environmental must be considered in all operations.

NOTE: As strategy is normally pre-determined by the incident command team (except on initial attack), the Air Attack Officer should alert the team to alternative plans or methods where the possibility of environmental damage exists.

Long-term fire retardants depend on the interaction between fuels and chemicals, and the ammonium sulphates and phosphates common to fire retardants could cause serious ecological damage to marine life/habitat when dropped on or near lakes or streams. In addition, they can migrate easily into water courses when placed on land surfaces in confined drainage systems. Therefore, caution must be exercised when tying fire retardant lines into lakes and rivers. Where ground crews are present, the fire retardant line can be tied into lakes and streams with a hand line.

When building fireline in an area of unstable soil, steep hills, etc., it may be more desirable to build a line with fire retardant rather than strip the ground to mineral soil with a hand or equipment line.

Due to the sensitivity of aquatic life to chemicals fire foam should not be dropped within 30 meters (100 feet) of any water source.

Pocket Guide to Ground Application of Class A Foam - Pt. 1

Foam 'Solution'	Wet Foam
Description	**Description**
• A clear milky fluid • No bubble structure • Mostly water (wet water) • Immediately runs on vertical surfaces	• Watery • Very runny on vertical surfaces • Bubble size varies from large to small • More water than air • No 'body'
Characteristics	**Characteristics**
• Foam 'solution' has no bubble structure. Air may be present if foam solution produced with CAFS unit. Secondary bubble formation may occur due to agitation and impact.	• The bubbles of 'wet' foams are spherical and evenly dispersed throughout the solution. The bubbles are separated by a large amount of solution, relative to other types of foams. Wet foams have very fast drainage rates.
Typical Uses	**Typical Uses**
• Areas requiring immediate penetration • Thick fuel beds like sawdust piles, peat tundra and muskeg • Tall grass • Deep seated fuels • Mop-up	• Direct attack on fine or desert fuels • Mop-up • Deep duff and fuel penetration • Tall grass or deep fine fuels • Muskeg, tundra, sawdust piles, peat, and deep seated fuels
Typical Equip. Required to Produce	**Typical Equip. Required to Produce**
• Conventional nozzles • Eductor or injection units	• Aspirating nozzles • Eduction or injection units • CAFS units

Taken from Wildfire Foam Manual, British Columbia Forest Service

Wet Foam	'Dripping' Foam
Description	Description
• Watery • Very runny on vertical surfaces • Bubble size varies from large to small • More water than air • No 'body'	• Watery shaving cream • Does not hold peaks • Immediately runs on vertical surfaces • Medium to small bubbles
Characteristics	Characteristics
• The bubbles of 'wet' foams are spherical and evenly dispersed throughout the solution. The bubbles are separated by a large amount of solution, relative to other types of foams. Wet foams have very fast drainage rates.	• The bubbles of 'dripping' foam are still spherical; the bubble walls are not touching. There are a great number of paths around the bubbles in the foam. Dripping foams have a medium to fast drainage rate.
Typical Uses	Typical Uses
• Aspirating nozzles • Education or injection units • CAFS units	• Eductor or injection units • CAFS units • Aspirating nozzles (low and medium expansion)

Leaving a Hovering Helicopter

Exiting and boarding a hovering helicopter can be done safely provided the personnel are trained in the maneuver. The movement of personnel and equipment must be preplanned and practiced, and personnel must understand why these moves are made and the resulting effects of movement on a hovering helicopter.

All hover exit operations shall conform with the conditions and guidelines of the Hover Exit Training Manual.

All certified hover exit personnel must be recertified every 60 days. Transport Canada (Canadian Aviation Regulations Part VII, Sections 702.19, 702.21, and Part VI, Sections 602.15, 602.17 and 602.25) allows helicopter companies to apply for authorization to exit/board persons from helicopters while in flight.

For the purpose of Alberta Wildfire operations, hover is defined as follows:

1. ***Hover Exit***: Exiting and emergency boarding of a helicopter where the pilot is maintaining an altitude above the ground surface and the person's weight is transferred smoothly between the helicopter and the ground.

2. ***Ground Hover Exit:*** Exiting or boarding a helicopter when both skids (full length) are in complete contact with the ground surface, and power and flight controls are maintained by the pilot. This covers open muskeg and snow operations.

Average Field Use Aircraft Specifications
Fixed Wing - Cargo

Average Field Use Aircraft Specifications - Fixed Wing - Cargo

Aircraft Type	Avg Cruise Speed	Pax/ Cargo	Fuel Type	Hourly Consumption	Fue Quantity	Min. Runway
CESSNA 185	257 km/h (160 mph)	5/542 kg (1195 lbs)	Avgas	56.8 L (12.5 gal)	235 L (52 gal)	732 m (2400 ft)
CESSNA 206	249 km/h (155 mph)	5/400 kg (883 lbs)	Avgas	54 L (12 gal)	300 L (66 gal)	732 m (2400 ft)
CESSNA 210	290 km/h (180 mph)	5/246 kg (543 lbs)	Avgas	55 L (12 gal)	300 L (66 gal)	619 m (2030 ft)
DHC2 BEAVER	230 km/h (143 mph)	6/517 kg (1140 lbs)	Avgas	82 L (18 gal)	586 L (129 gal)	335 m (1100 ft)
DHC-2 MARK III TURBO BEAVER	241 km/h (150 mph)	8/515 kg (1135 lbs)	Turbo	145 L (32 gal)	727 L (160 gal)	355 m (1200 ft)
DHC-3 OTTER	177 km/h (110 mph)	8/1003 kg (2194 lbs)	Avgas	118 L (26 gal)	723 L (159 gal)	355 m (1200 ft)
BRITTON-NORMAN ISLANDER	257 km/h (160 mph)	9/367 kg (810 lbs)	Avgas	105 L (23 gal)	700 L (154 gal)	457 m (1500 ft)
DHC-6 TWIN OTTER	257 km/h (160 mph)	14-18/1165kg (2570 lbs)	Turbo	273 L (60 gal)	1446 L (318 gal)	396 (1300 ft)
SHORTS SKYVAN	257 km/h (160 mph)	12/2086 kg (4600 lbs)	Turbo	364 L (80 gal)	2500 L (550 gal)	300 m (1000 ft)

Aircraft Type	Average Cruise Speed	Pax/Cargo	Fuel Type	Hourly Consumption	Fuel Quantity	Minimum Runway
Cessna 185	257 km/h (160 mph)	5/542 kg (1195 lbs)	Avgas	56.8 L (12.5 gal)	235 L (52 gal)	732 m (2400 ft)
Cessna 206	249 km/h 155 mph)	5/400kg (883 lbs)	Avgas	54 L (12 gal)	300 L (66 gal)	732 m (2400 ft)
Cessna 120	290 km/h (543.mph)	5/246 kg (543 lbs)	Avgas	55 L (12 gal)	300 L (66 gal)	619m (2030 ft)
DHC2 Beaver	230 km/h (143.mph)	6/517 kg (1140 lbs)	Avgas	82 L (18 gal)	586 L (129 gal)	335 m (1100 ft)
DHC2 Mark III Turbo Beaver	241 km/h (150.mph)	8/515 kg (1135 lbs)	Avgas	145 L (32 gal)	727 L (160 gal)	355 m (1200 ft)
DHC-3 Otter	177 km/h (110.mph)	8/1003 kg (2194 lbs)	Avgas	118 L (26 gal)	723 L (159gal)	355 m (1200 ft)
Britton-Norman Islander	257 km/h (160.mph)	9/367 kg (810 lbs)	Avgas	105 L (23 gal)	700 L (154 gal)	457 m (1500 ft)
DHC-6 Twin Otter	257 km/h (160.mph)	14-18/1165 kg (2570 lbs)	Avgas	273 L (60 gal)	1146 L (318 gal)	396 m (1300 ft)
Shorts Skyvan	257 km/h (160.mph)	12/2086 kg (4600 lbs)	Turbo	364 L (80 gal)	2500 L (550 gal)	300m (1000 ft)

Average Field Use Aircraft Specifications – Rotary Wing

Aircraft Type	Average Cruise Speed	Pax/Cargo	Fuel Type	Hourly Consumption	Fuel Quantity	Bambi Bucket Capacity
Robinson R-22	178 km/h (110 mph)	1/247 kg (546 lbs)	Avgas	32 L (19 gal)	72 L (19 gal)	none
Robinson R-44	210 km/h (130 mph)	3/363 kg (800 lbs)	Avgas	64 L (14 gal)	151 L (33 gal)	none
Bell 206B Jet Ranger	215 km/h (116.mph)	4/727 kg (1600 lbs)	Turbo	114L (25 gal)	286L (63 gal)	409 L (90 gal)
Bell 206L-3 Long Ranger	202 km/h (125.mph)	6/550 kg (1213 lbs)	Turbo	159 L (35 gal)	416 L (92 gal)	681 L (150 gal)
Astar AS350B	224 km/h (139.mph)	5/685 kg (1510 lbs)	Turbo	163 L (36 gal)	520 L (114 gal)	545 L (120 gal)
Hughes 500 D	217 km/h (135.mph)	4/525 kg (1157 lbs)	Turbo	136 L (30 gal)	272 L (60 gal)	409 L (90 gal)
Bell 204B	177km/h (110.mph)	9/944 kg (2081 lbs)	Turbo	318 L (70 gal)	916 L (200 gal)	1226 L (270 gal)
Bell 205A	177 km/h (110.mph)	14/1241 kg (2736 lbs)	Turbo	314 L (75 gal)	818 L (180 gal)	1589 L (350 gal)
Bell 212	202 km/h (125.mph)	14/1560 kg (14/3430 lbs)	Turbo	360 L (80 gal)	820 L (180 gal)	1800 L (400 gal)

Average Field Use Aircraft Specifications – Airtankers

Average Field Use Aircraft Specifications - Rotary Wing

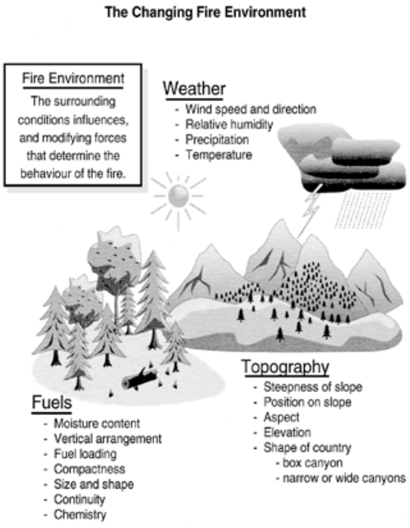
Aircraft Type	Avg Cruise Speed	Pax/ Cargo	Fuel Type	Hourly Consumption	Fuel Quantity	Bambi Bucket Capacity
ROBINSON R-22	178 km/h (110 mph)	1/247 kg (546 lbs)	Avgas	32 L (7 gal)	72 L (19 gal)	none
ROBINSON R-44	210 km/h (130 mph)	3/363 kg (800 lbs)	Avgas	64 L (14 gal)	151 L (33 gal)	none
BELL 206B JET RANGER	215 km/h (116 mph)	4/727 kg (1600 lbs)	Turbo	114 L (25 gal)	286 L (63 gal)	409 L (90 gal)
BELL 206L-3 LONG RANGER	202 km/h (125 mph)	6/550 kg (1213 lbs)	Turbo	159 L (35 gal)	416 L (92 gal)	681 L (150 gal)
ASTAR A5350B	224 km/h (139 mph)	5/685 kg (1510 lbs)	Turbo	163 L (36 gal)	520 L (114 gal)	545 L (120 gal)
HUGHES 500 D	217 km/h (135 mph)	4/525 kg (1157 lbs)	Turbo	136 L (30 gal)	272 L (60 gal)	409 L (90 gal)
BELL 204B	177 km/h (110 mph)	9/944 kg (2081 lbs)	Turbo	318 L (70 gal)	916 L (200 gal)	1226 L (270 gal)
BELL 205A	177 km/h (110 mph)	14/1241 kg (2736 lbs)	Turbo	341 L (75 gal)	818 L (180 gal)	1589 L (350 gal)
BELL 212	202 km/h (125 mph)	14/1560 kg (14/3430 lbs)	Turbo	360 L (80 gal)	820 L (180 gal)	1800 L (400 gal)

Aircraft Type	Average Cruise Speed	Pax/Cargo	Fuel Type	Hourly Consumption	Fuel Quantity	Minimum Runway
Douglas B26	402 km/h (250 mph)	3373 L (830 gal)	Avgas	636 L (140 gal)	3637 L (800 gal)	1524 m (5000 ft)
Canadair CL-215	257 km/h (160 mph)	5346 L (1176 gal)	Avgas	568 L (125 gal)	4319 L (950 gal)	808 m (2650 ft)
Douglas DC-6B	434 km/h (270 mph)	11,365 L (2500 gal)	Avgas	1455 L (320 gal)	10,092 L (2220 gal)	1798 m (5900 ft)

Aircraft Type	Average Cruise Speed	Comp	Total Cap.	Fuel Type	Hourly Consumption	Fuel Quantity	Minimum Runway
Electra (L 188)	560 km/h (350 mph)	2	10,896 L (2400 gal)	Jet B (Turbo)	2260 L (497 gal)	79,103 L (17,400 gal)	1524 m (5000 ft)
Air Tractor	299 km/h (190 mph)	1	3104 L (683 gal)	Jet B (Turbo)	282 L (62 gal)	11284 L (2482 gal)	379 m (3000 ft)
S2F Tracker (Fire Cat)	368 km/h (230 mph)	4	3295 L (725 gal)	100 LL	385 L (85 gal)	15404 L (3388 gal)	379 m (3000 ft)
Douglas DC-4	296 km/h (185 mph)	8	4530 L (997 gal)	100 LL	1130 L (249 gal)	4530 L (997 gal)	1524 m (5000 ft)
S2F Tracker (Firecat)	368 km/h (230 mph)	4	3295 L (727 gal)	100 LL	385 L (85 gal)	15404 L (3388 gal)	1524 m (5000)

FIRE BEHAVIOUR AND TATICS

The Changing Fire Environment



Weather and its Effects on Fire

Fire behaviour is influenced by the following weather elements:

- Relative humidity
- Temperature
- Wind
- Precipitation

Relative Humidity (RH)

The percentage of moisture in the air compared with the maximum of moisture that air will hold at the same temperature.

- The higher the temperature, the lower the RH, conversely lower temperature higher RH.
- RH of 30% is considered the critical point. Lower RH increases rate of spread and fire intensity while a higher RH inhibits a fire's growth.

Low RH dries out the fuels in the forest and makes more fuel available to burn.

Temperature

Temperature is one of the main elements in the drying of forest fuels. Thus the higher the temperature, the faster a fire will burn.

Wind

Affects the rate of spread and also assists in drying out forest fuels. Direction changes and velocity increases can cause problems in controlling a fire.

Precipitation

Amounts received and their time of occurrence, have both short and long-term affects on fire behaviour. During drought conditions, fuels lose moisture to surrounding air until they become almost as dry as the surrounding air. The fine fuels dry out quickly whereas larger fuels take longer to dry. Precipitation in small amounts affects the fine fuels fairly quickly whereas the larger fuels are affected only slightly.

The effects of weather on forest fuels are measured using the Canadian Forest Fire

Weather index. This FWI represents the intensity of a single spreading fire in a standard fuel complex on level terrain. The six components of the CFFWI are described individually below:

- **Fine Fuel Moisture Code (FFMC)**
  Is a numerical rating of the moisture content of litter and other cured fine fuels. This code is an indication of the relative ease of ignition and flammability of fine fuels. It also integrates weather effects of past several days.

- **Duff Moisture Code (DMC)**
  Is a numerical rating of the average moisture of loosely compacted organic layers of moderate depth. This code gives an indication of the fuel consumption in moderate duff layers and medium sized woody materials. It also integrates weather effects over past couple of weeks

- **Drought Code (DC)**
  Is a numerical rating of the average moisture content of deep, compact, organic layers. This code is a useful indicator of seasonal

drought effects on forest fuels, total fuel consumption and amount of smoldering in deep duff layers and large logs. It integrates temperature and rainfall trend over a period of months.

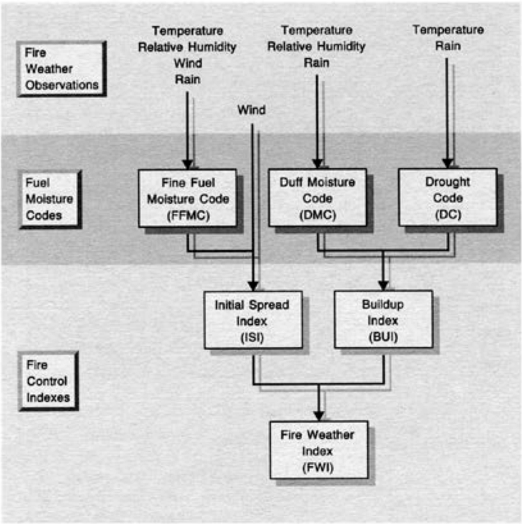
- **Initial Spread Index (ISI)**
  Is a numerical rating of the relative spread of fire that can be expected soon after ignition. It is the combined effect of wind and FFMC on rate-of-spread without the influence of variable quantities of fuel.

- **Build up Index (BUI)**
  Is a numeric rating of the total amount of fuel available for combustion. It integrates medium and long-term weather history.

- **Fire Weather Index (FWI)**
  Is a numerical rating of fire intensity It is suitable as a general index of fire danger throughout the forested areas. It integrates effects of weather history and current weather on fire behaviour.

All fuel moisture codes are arranged so that higher values correspond to lower moisture contents. All index values increase as fire weather severity increases. Except for the FFMC, which has a maximum value of' 101, the scales of the FWI and remaining components are open-ended and a higher value will always be possible if the fire weather worsens.

STRUCTURE OF THE CANADIAN FOREST FIRE WEATHER INDEX SYSTEM



Fire Weather Index Codes - Hazard Levels

Hazard Rating	FFMC	DMC	DC	ISI	BUI	FWI	HFI
Low	0-73	<22	0-79	0-1	0-24	0-4	1
Moderate	74-84	22-27	80-189	2-4	25-40	5-8	2-3
High	85-88	28-40	190-299	5-8	41-60	9-16	3-4
Very High	89-91	41-61	300-424	9-15	61-89	17-29	4-5
Extreme	92+	62+	425+	16+	90+	30+	6

HFI 1-2	HFI 3	HFI 4	HFI 5-6
Flame lengths 0 - 1.5 m	Flame lengths 1.5 - 2.5 m	Flame lengths 2.5 - 3.5 m	Flame lengths 3.5 m+
Direct Attack with handtools.	**Direct Attack** with pump and hose **or** air support.	**Indirect Attack** air attack **successful** on head.	**Indirect Attack** air attack likely to **fail** on head.
Should Anchor	**Should Anchor**	**Must Anchor**	**Must Anchor**

Fire Weather Index Reminders

FFMC
< 74 - little chance of ignition
80 - surface fire continuous spread
85 - increase in fire behaviour
90 - high chance of spot fire development

DMC
20 - lightning fires possible
40 - fuel layer aids in spreading, fire behaviour increases
60 - onset for extreme fire behaviour

DC
<100 - very wet
300 - high chance of holdover fire, mop-up concerns
500 - significant ground fire activity

ISI
5 - vigorous surface fire (will vary between fuel types)
10 - threshold for crowning in most conifer fuel types
20 - extreme fire behaviour

BUI
<30 - low intensity surface litter fires
30 - deeper fuels can burn, increase in fire behaviour
60 - threshold for extreme fire behaviour, mop-up problems

FWI
3 - sustained combustion and fire growth
10 - vigorous surface fire, candling/torching
25-30 - onset of crowning, extreme fire behaviour

Fuel and its Effects on Fire

Fuels influence the ignition, build-up, and overall behaviour of fire more than any other single factor.

A forest profile is made up of three classifications of fuels:

- Ground fuels - duff, roots, punky wood.
- Surface fuels - litter, shrubs, downed logs.
- Aerial fuels - foliage, branches, snags, moss.

The most important characteristic of fuel is its moisture content. The lower the moisture content, the better fuel will burn and vice versa. Aspen stands do not usually burn as readily as coniferous stands. They can be used as a control line for burnout or backfire. However, under severe drought conditions, they have been known to burn readily. Also, there is a two to three day period just after leaf out that they will also burn due to chemical makeup of new leaves.

Young coniferous stands, because of higher moisture content, do not burn as easily as mature stands. Also, older stands have more dead and dying material in them, which adds to available fuel.

Stands with branches all the way to the ground will produce a crown fire more readily than stands that have branches 6 m to 9 m (18 – 30 feet) above the surface.

General rule of thumb for fuel recovery after precipitation.

Fine Fuel (FFMC)	dries in one day.
Medium Fuel (DMC)	dries in 12 days.
Heavy Fuels (DC)	dries in 60 days.

Topography and its Effects on Fire

Slope, elevation, and aspect are the three elements of topography that affect fire behaviour.

Slope A fire will burn uphill faster than downhill under normal situations. The steeper the slope, the faster the rate of speed. This occurs because the slope tilts the fuel towards the flames. Therefore, heat is transferred to the fuels ahead of the fire, which dries them out.

Elevation A fire's position on a mountain side, whether close to the valley floor or higher up the side, will influence its behaviour. As elevation changes, so do the fuel types and quantities. The higher elevations usually have sparse vegetation; therefore, there is less fuel for fire to burn. Weather also changes as you move upward; wind direction is likely the most important factor to affect the fire. Because of elevation, wind will be affected by daytime heating, i.e. upslope winds during heat of day and down-slope winds in evening.

Aspect The direction of slope faces affects a fire's behaviour in the following ways:

- Southeast to southwest facing slopes are drier due to more direct sunshine, which dries out the fuels very quickly.

- North to east facing slopes is moister as they receive less direct sunshine. Vegetation is more abundant and lush requiring longer periods of drought to dry them out.

Slope is particularly important at low wind speeds. At higher wind speeds, the wind can dominate the fire so that slope is not apparent.

Types of Fire	
Smouldering	Making no appreciable spread and burning without flames
Creeping	Spreading slowly without low flame
Running	Spreading rapidly with a well defied head but without spotting or crowning
Spotting	Spreading rapidly with sparks or embers falling ahead and starting new fires (jumping)
Crowning	Spreading primarily from crown to crown

Types of Crown Fires

Passive Are fires in which trees torch individually, reinforcing the spread rate, but are not basically different from surface fires.

Active Are fires in which a solid flame develops in the crowns, but surface fire and crown fire advance as a linked unit dependent on each other.

Independent: Are fires in which advance in the crown alone. Most crown fires fall into the active class in Alberta.

Criteria determining what class of crown fire will result in a given day in a given stand are:

- Height of crown layer above ground.
- Bulk density of foliage within crown layer.
- Crown foliar moisture content.
- Initial surface intensity.
- Rate of spread after crowning.

Typical Fire Behaviour for C-2 and C-3 FBP Fuel Tupes at Given HFI Ranks

HFI RANK	HFI VALUE (kw/m)	FBP FUEL TYPE	TYPICAL WEATHER VALUES			TYPICAL FIRE BEHAVIOR				
						Equilibrium ROS (m/min.)		TIME TO 2.0 HA.		TIME TO CROWN FIRE
			RH%	Wind (km/h)	TEMP1 (cels.)	Range	Typical	Range	Typicxal	
1	0 to 10	C-2	80-100	0-10	<20	0-0.6	0.3	>3 hrs.	>3 hrs.	N/A
		C-3	70-100	0-20	<20	0-0.2	0.1	>10 hrs.	>10 hrs.	N/A
2	10 to 500	C-2	80	0-10	20	0.1-2.0	1.0	1.5-4.0 hrs.	2.0 hrs.	N/A
		C-3	50	0-25	20	0.1-3.0	1.5	1.5-6.0 hrs.	2.75 hrs.	N/A
3	500 to 2,000	C-2	50	0-15	20	3.0-6.0	4.5	40-55 mins.	55 mins.	14 mins.
		C-3	40	20-35	20	3.0-16.5	10.0	28-95 mins.	40 mins.	N/A
4	2,000 to 4,000	C-2	35	10-15	20-25	6.0-10.0	8.0	29-37 mins.	30 mins.	2-5 mins.
		C-3	30	25-30	20-25	12.5-26.5	18.5	25-40 mins.	30 mins.	15-60 mins.
5	4,000 to 10,000	C-2	30	20	20-25		15.0		25 mins.	2 mins.
		C-3	30	30	20-25	21-26	23.0	19-27 mins.	22 mins.	9-25 mins.
6	>10,000	C-2	<30	>20	25		>20.0		<19 mins.	<2 mins.
		C-3	<25	>25	25		>27.0		<18 mins.	<5 mins.

[1]Temperature is relatively insignificant

(Compiled by Kurt Frederick, PFFC, April/99)

Fire Behavior Related to Relative Humidity and Fuel Moisture Content

RH (%)	FFMC	Relative ease of chance ignition and spotting, general burning conditions
60	86	Very little ignition; some spotting may occur with winds above 9 mph
45-60	86-89	Low ignition hazard; campfires become dangerous; glowing brands cause ignition when relative humidity is 50 percent.
30-45	89-91	Medium ignitability; matches become dangerous; "easy" burning conditions
26-40	92-93	High ignition hazard; matches always angerous; occasional crowning, spotting caused by gusty winds; "moderate" burning conditions
15-30	94-96	Quick ignition, rapid build-up, extensive crowning; any increase in wind causes increased spotting, crowning, loss of control; fire moves up bark of trees igniting aerial fuels; long distance spotting in pine stands; "danger" burning conditions
<15	>96	All sources of ignition dangerous; aggressive burning, spot fires occur often and spread rapidly, extreme fire behavior probable; "critical" burning conditions.

NOTE: Another indicator of extreme fire behavior is when the RH and temperature become equal or when RH becomes lower than temperature, i.e. 27C and RH 25%.

Four Conditions For Blow-Up Fires

- Low fuel moisture.
- Unstable atmosphere.
- Winds greater than 30 km/h just above the level of the fire.
- A low-level jet stream (2,000 to 4,000 ft above ground) and winds decreasing with height above that level.

Methods of Attack

There are four basic methods of attack:

1. Direct
2. Parallel
3. Indirect
4. Limited flanking

Each is adapted to certain fire behaviour conditions. Air attack is used to supplement ground attack. In most cases, a combination of all three methods is used. Which method is used depends on:

- Fire behaviour at the time.
- Safety of manpower.
- Topography and natural fuel breaks.

- Chances of crown fire.
- Weather factors: wind, temperature and RH.
- Type of available equipment.
- Amount of manpower available.

Direct Attack

This method involves working directly on or immediately adjacent to the perimeter of the fire. Attack may be by wetting, cooling or smouldering the fire or by separating the fuel from the fire by constructing a line.

Direct attack can be used in the following situations:

- Smouldering or creeping surface and ground fires.
- During the night or early morning when burning intensity is lower.
- Sometimes when fire is burning against the wind.
- When there are light fuels and the heat is such that men can work directly on the fire edge.

Cold trailing is another direct attack method that can be used to control a fire quickly. With careful inspection of the fire edge, you can quickly pass over areas that are dead and only work on the areas that are hot. You will have to use your hands to make sure spots are completely out so that you do not miss a hot spot that could flare up after you pass. Hot spotting is when you work only on areas that are flaming or showing indication that they may flare up.

Cold trailing or hot spotting can be used in the following situations:

- During initial attack to check spread of small heads or fingers.
- On parts of large fires, in advance of equipment to keep fire within planned limits.
- On dangerous points to control flare-up.

On nine out of ten fires, these methods are used instead of actual line construction. Careful assessment is required before the decision to actually construct a hand line on the fire edge. Hand line construction is very time consuming and in most cases, if you use a combination of hot spotting and cold trailing, you can control a small fire quickly on initial attack without constructing any hand line.

Parallel Method

This method is used when the fire is too hot or there is too much smoke for manpower or equipment to work directly on the fire edge. Also, it is used to shorten the length of fireguard required by cutting across fingers. Usually this method is used when heavy equipment is being used for fireguard construction. The distance between the control line and the fire edge will vary depending on the heat intensity and smoke, location of natural barriers, dangerous fuels, and fire edge regularity. Sufficient distance must be allowed so that the line can be built and burned out in a safe manner. Route must be scouted for the shortest, quickest and safest route.

Parallel method of attack is best used in the following situations:

- On slow to medium-fast running fires.
- When using dozers.
- Where there are numerous spot fires.

- Where the line can be shortened by cutting across fingers.
- Where natural barriers may be used.
- Where resistance to control is less by locating guard away from the fire edge.

Burnout should be considered as part of this method of attack. This is a crew leader's responsibility and should be carried out as soon as line has been properly constructed.
The only safe line is a black line.
This is a good policy to follow in the parallel method of attack.

Indirect Method

This method consists of selecting a control line a considerable distance ahead of the fire head, constructing a fireguard and back-firing the fuels between.

The indirect method can be used on:

- Large crown fires.
- Fast running surface fires where it is not safe to work crews except along natural or artificial barriers.

- Where natural or pre-planned barriers are present.
- In extremely steep or rugged topography where change of slope will favour control.
- When only limited resources are available and values at hand are low (i.e. muskeg areas), large fires can be controlled in this manner.

This method of attack is an Incident Commanders decision and must be considered carefully prior to carrying out. Timing of the ignition of the backfire is very critical to success. Also, the method of ignition can be critical to the success of the indirect method.

Limited Flanking Action

Applies to situations where resource limitations, unfavourable fire behaviour, low priority and high suppression costs or a combination of these factors make aggressive suppression efforts unpractical, ineffective or unsafe.

Under these circumstances a crew or crews may be staged to take advantage of a future change to more favourable circumstances. While crews are staged they would be actively engaged in suppressive action by working rear flanks to remain active and to establish sound anchor points from which to launch future more aggressive action. Such a strategy would apply particularly to establish limited action zones.

Costly support measures such as RW bucket or FW tankers would not generally be acceptable with this strategy.

Air Attack

Air attack (use of airtankers) must always be coordinated with the ground attack. On large fires, this is a Operations Section Chief's responsibility. On small fires, the Incident Commander must ensure that drops are made in the proper place to ensure control of the fire.

It is used:

- On initial attack to knock down and hold until ground forces arrive.
- To check advance of a fire until ground forces arrive.
- On large fires, to support ground forces by

- cooling hot spots for direct attack by ground forces
- cooling spot fires

The airtankers primary and most important role is for initial attack on fires. The support role must be evaluated carefully before it is used.

Fire Tactics

1. Fireline location
    - Locate line as close to fire edge as possible.
    - Make fire line as short as possible.
    - Use existing barriers to fire spread.
    - Avoid sharp angles in the fireguard.
    - If possible, locate fireline to give upslope start for burnout or backfire.
2. Fireline construction
    - Make line no wider than necessary.
    - Clear line to mineral soil.
    - Any charred or burning fuels inside burning area.
    - Ensure unburned fuel is pushed away from fire unless required to ensure success of burnout or backfire.
    - Continue until fireline has been burned out.
3. Mop-up
    - Includes putting the fire out and disposing of fuel either by allowing it to burn or by isolating the fuel so it cannot burn.

- Start mop-up as soon as line construction and burning out are completed. Treat the most threatening situations first.
- Eliminate snags that could throw sparks outside control line to be certain no fire can blow, spot or roll over the fire line under the worst possible conditions.
- Search for spot fires outside the line.
- Feel with bare hands for hot spots.

Visual weather indicators in the field: During the spring fire season, night time inversions usually develop. Often these inversions are topped by an unstable layer. Fires may burn quietly as long as the inversion is present but suddenly show erratic and extreme behaviour when the inversion burns off.

Visual signs of inversions:

- Hazy, with smoke low to ground, poor visibility.
- Smoke layers in lower level of atmosphere.
- Surface winds often light.
- Surface winds generally steady in direction and speed.

Signs of unstable conditions:

- Aircraft experience turbulence aloft.
- Puffy clouds such as CU, Cu+ and CB appear. ACC high in the atmosphere in the early morning indicate instability aloft and may be clue to afternoon thunderstorms activity.
- Visibility generally good.
- If instability extends to surface, surface winds are gusty and erratic.
- If there is a night time inversion capped by an unstable layer, the low-level visibilities and winds may act as in a stable atmosphere but indicators aloft are those of an unstable atmosphere.

Signs of strong winds aloft:

- Strong winds aloft in the morning suggest strong gusty surface winds in the late morning and afternoon.
- There may be a sharp bending of the smoke plume in the downwind direction.
- Pilots can usually give a pretty good indication of wind speed and direction aloft.

- Watch the motion of cumulus-type clouds.

Severe burning conditions usually:

- Occur in late afternoon; the exception is at night when no cooling off occurs and winds remain high.
- Occur when winds are very high.
- Occur when temperatures are high and relative humidity is low i.e. spring of 1980.
- Occur after long periods of drought, i.e. Aug of 1981 and June of 1982.
- Occur in coniferous stands where fuel is the same over large continuity tracts of land, i.e. eastern slopes.

Fatalities usually occur when one of the 10 standard firefighting orders is not obeyed. Statistics from the United States bear this out.

So pay attention to them!

USA statistics show that there are four major areas where fatalities or near misses can occur:

- On relative small fires or deceptively quiet sectors of large hires.

- In relatively light fuels, such as grass, herbs and light brush.
- When there is an unexpected shift in wind direction or in wind speed.
- When fire responds to topographic conditions and runs uphill.

Each set of circumstances has the potential for creating a fatal or near-fatal fire. Human behaviour is often the determining factor. Firefighters who "keeps their cool" when things change rapidly and moves back to a safe area, will survive, whereas those who panic and try to outrun a fire may not survive.

Indicators of Fire-Whirl Potential

Weather Related

- Minimum cloudiness.
- Low humidity.
- Winds below a critical level.
- Temperature lapse rate greater than dry adiabatic.
- Cumulus-type clouds growing vertically.
- Towering cumulus suggest greater extent of instability.
- Rough, bumpy air encountered by aircraft.

- Converging air masses of different winds, direction or temperature.

Topography Related

- Aspect and slope for a large angle of incidence for sunlight.
- Winds across ridge top with heating on leeward slope.
- Canyon winds, either up or down the canyon, when they:
  - flow around a spur ridge
  - flow around a sharp bend in the canyon
  - encounter flow from joining canyons

Fire Related

- Smoke rising to great heights with little spreading.
- Bare exposed soil or burned-over area.
- Strong convection column causing airflow to split around it to form leeward side eddies.
- Intense heat output and turbulent winds extending vertically.

Pump Pressures - Limiting Factors

When using power pumps the fire crew must recognize the **"forces"** a pump must overcome to be able to move water from the water source overland and up slope to the fire location.

Lift pressure: is the force required to lift water from its source to the pump body.

Head pressure: is the force required to overcome gravitational pull on water being pushed uphill through a hose.

It takes **0.5 lbs. psi** to lift a column of water **one foot** in vertical elevation.

Therefore, to overcome a 400-foot rise or hill, 200 lbs. psi at the pump would be required to receive water at the top.

Friction Pressure: water passing through a hose under pressure creates turbulence in the hose making contact with the inner lining of the hose. This action causes friction.
The amount of friction is determined by these factors.

- the size or diameter of the hose
- the lining within the hose
- the speed of the water travelling through the hose

Nozzle pressure is the force required to push water through the opening in the nozzle.

All the above forces are referred to as **"pressure losses"** acting on a pump's performance.

To be able to carry out effective fire suppression using water, the pressure at the nozzle must have a minimum of approximately 35 - 50 psi for an effective workable stream.

Water Delivery Systems

A varied number of hook-ups or systems can be initiated to put water/foam on the fire.

Parallel System

The parallel system uses two complete pump setups that feed into the same hose lay (to a siamese one or two hose lengths from the pumps). It is used primarily as a precaution against pump failure as water pressure loss, or as a means to increase water volume at the fire. Very limited pressure increase is created.

Short Tandem System

In this method the two pumps used are set up very close to one another with usually one short length of hose (can be the suction hose) connecting them. The output of the first pump is fed into the intake of the second. The "remote foam system" may be used at the nozzle with this pump system.

Caution must be used in this operation and all aspects of pump care and **safety** must be exercised when using this method.

Relay Tank System

The relay tank is a system whereby water is moved to a point where a single or parallel pump system has exhausted their pressure capability.

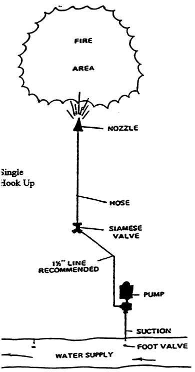
A portable tank or excavation dug into the ground and lined with plastic can be used to hold the water being pumped by the initial pump set up.

Another pump complete with foam system is then set up at the relay tank to transport water or foam solution to the fire.

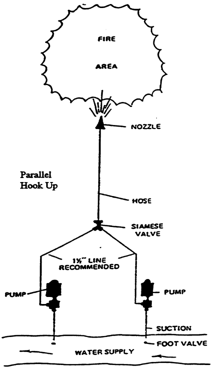
- Fill suction hose with water by submerging hose in water and depressing foot valve. Attach suction hose to foam suction tee on pump intake, open pump primary cap and fill pump with water; or
- Connect suction base to foam section tee, prime pump by using a stroking action until water is discharged through priming cap or appears in discharge line or port; or
- Pail priming of the pump may be done after suction hose is attached to foam suction tee by pouring water into the pump primary opening with pail until water is level with opening.
- Replace cap.

All connections on the suction side of the pump must be wrench tight as these are air seals.

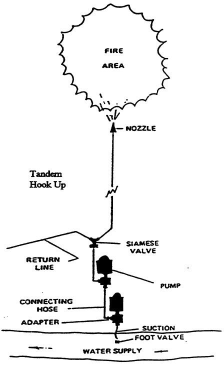
Water Delivery Systems



A single pump set up.



A parallel pump set up.



A short-couple pump set up.

Gravity Funnel System

This system employs the use of a gravity funnel placed into a small running stream at a location higher in elevation than the fire itself. This is a very inexpensive but efficient system that uses nature at work. No pumps are required; therefore, there is no wear and tear on equipment and no fuel being used. Criteria required is a minimum of 25 – 33 meters (75 - 100 feet) of elevation above the fire where the funnel is to be deployed.

Caution: Be careful when using this system, as pressure can be excessive.

Failure to Start/Trouble-Shooting Cautions

- If pump fails to start after several attempts to crank, double check position of over speed cut-out switch. Reset.
- If pump starts but immediately revs up and shuts down, this is usually a sure sign of a pump loss of prime. Check water level in the pump and airtight seals at suction hose connection and top filler cap connection.
- If pump shuts down after several minutes of running, check gas tank venting. Make sure cap or vent is open.
- If flooding occurs when starting, remove fuel line from engine, open choke and throttle, remove spark plug, dry plug by heating or change plug, crank engine with spark plug

removed to clear cylinder of extra fuel. Check plug for spark and replace in engine. Return throttle to fast idle position and crank engine with fuel line detached. Engine should start; if unsuccessful, repeat procedure. When engine starts, attach fuel line and pump should continue to operate.

- Ensure water is pumping once engine starts or damage to pump will occur. Failure of water being pumped usually involves loss of pump prime.
- All pumps on initial start-up require “warm-up” period for no less than two minutes “at idle speed” to warm up and sufficiently lubricate the moving parts.

NOTE: No additional warm up is required after initial start-up for the day.

- Be aware of pump requirement in regards to grease. Some require greasing, some don't.
- Install "back pressure/check valve" to prevent high pressure return on your suction foot valve when pump(s) are stopped.
- When laying out hose lay on steep slopes, secure hose lines to anchors - trees, to prevent hoses sliding downhill.

- During cool/cold overnight seasonal conditions, all hoses and pumps must be drained to prevent damage from freezing.
- Pump shut down: when shutting pump down, engine should be slowed to an idle, fuel lines disconnected and engine allowed to run until fuel is used up and engine is cooled down

Dozer Units on the Fireline

A complete unit or team of dozers and Sustained Action Crews will be seen to fall naturally into two sections:

- The machines themselves and a CREW working directly with or ahead of them
- The CREW that follows them.

Line Building Principles

- Fire guard **location** is of prime importance, i.e. its distance from the fires edge, the amount or volume of timber and debris it will go through, the steepness of the ground, use of natural breaks.
- When the fireguard is built some distance back from the fire edge, the fuel between guard and fire must be burned out by the CREW, so the main fire will not run the guard. (Fireguards do not stop running fires.)
- Speed of guard construction must be closely related to the probable speed of the fire spread.
- Fireguards should be built to add as little extra fuel as possible to the fire.

- Fireguards on steep slopes above and ahead of the fire front are difficult to build and difficult to hold.
- Width of fireguard built should bear some relationship to the volume of fuel that will burn out inside the guard, i.e. heat transfer by radiation and convection.
- The wider the guard the more debris created.

Width of Guard

The width of dozer guard to be built on direct attack is usually fairly simple to decide. As a rule, most of the following conditions are present:

- The fire is quiet (otherwise dozers couldn't work direct attack).
- The guard is so close to the fire edge that there is little, if any, fire likely to run the guard.
- The Incident Commander wants to control the fire before the heat of the day or heavy winds bring the fire to life.

Thus the aim of direct attack is to get lots of safe guard built in as short a time as possible around the whole perimeter of the fire. The Incident

Commander wants distance not width. In order to do this, the Incident Commander should carefully consider the following points:

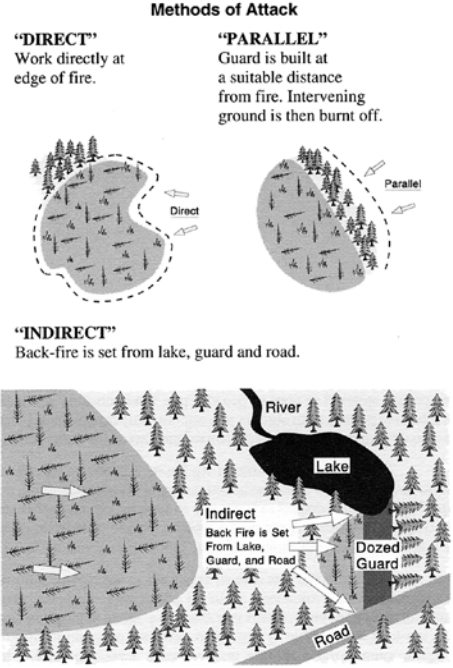
Width of Guard on Direct Attack

To decide, size up these three things.

- The amount and character of the fuel along the inside edges of the guard which may yet burn.
- The height and density of the canopy. Where the trees are tall and the canopy dense and where there is a likelihood of crown fire flare-ups or "candling", it is often necessary to widen the guard.
- The steepness of the slope on which the fire is burning. When a direct guard is put across a hillside to cut the head or front of the fire, something must be done to cope with the problem of heat and sparks, which may be carried up the slope by convection current as the fire burns itself out within the guard. A wider guard is seldom the answer. This only compounds the problem because so often on the steeper slopes, the dozer has to push the trees

and debris downhill, and thus add fuel to the fire.

In general, and only as a guide, it is suggested that **on direct attack never build a guard more than two dozer blades wide**. The guiding principle is to build the narrowest guard that will contain the fire.



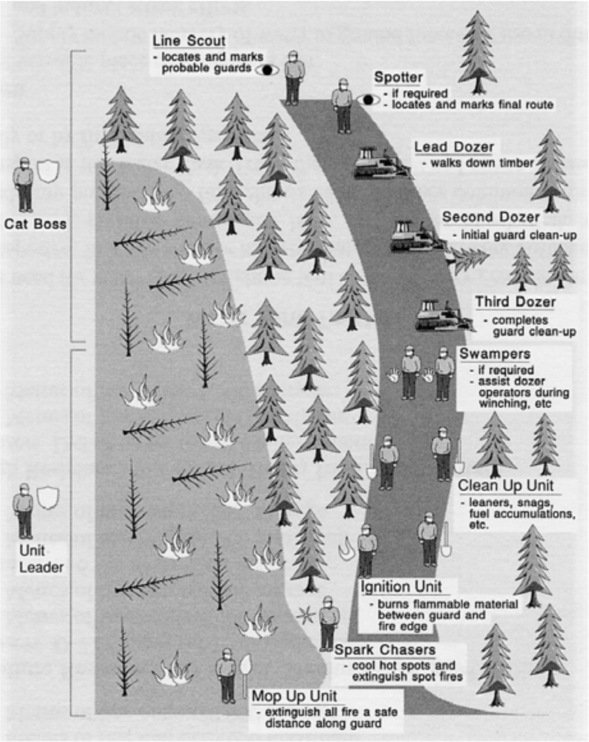
Dozer Operations on Larger Incidents

On larger incidents multiple dozer groups will be required to cut guard efficiently.

A heavy equipment group supervisor (HEGS) can be established to coordinate guard construction and equipment supports like fuel delivery. The dozer boss of each equipment group would report to the HEGS.

Dozers will construct guard with the support of aircraft to establish working areas for crews to follow up with suppression and burnout operations to support the cut guard.

Dozers should be establishing helipads in areas with restricted access as they progressively cut fire guard for crew access.



Line Scout
- locates and marks probable guards
Spotter
- if required
- locates and marks final route
Lead Dozer
- walks down timber
Cat Boss
Second Dozer
- initial guard clean-up
Third Dozer
- completes guard clean-up
Swampers
- if required
- assist dozer operators during winching, etc
Clean Up Unit
- leaners, snags, fuel accumulations, etc.
Unit Leader
Ignition Unit
- burns flammable material between guard and fire edge
Spark Chasers
- cool hot spots and extinguish spot fires
Mop Up Unit
- extinguish all fire a safe distance along guard

Equipment Production Guide by Fuel Type

The following guidelines must be tempered with experience and judgment.

Low Resistance to Control (Light fuels good footing)

2 dozers — D-6 or larger for 10 daylight hours

Meters of line output—15,000 maximum

Meters of line output—10,000 average

Medium Resistance to Control (Medium fuels good footing)

2 dozers — D-7 or larger for 10 daylight hours

Meters of line output—7,000 maximum

Meters of line output—3,500 average

2 dozers — D-6 for 10 daylight hours

Meters of line output—4,000 maximum

Meters of line output—2,500 average

High Resistance to Control (Heavy fuels good footing)

2 dozers — D-8 or larger for 10 daylight hours

Meters of line output—3,000 maximum

Meters of line output—1,500 average