WSPP-WFF-1 Wildland Fire Operations & Safety – Student Manual

Wildland Fire Operations and Safety

for the Structural Fire Fighter

BCWS WSPP-WFF-1 Student Manual

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WSPP-WFF-1 Welcome Letter

Thank you for enrolling in the WSPP-WFF-1 Training Program. We are continuing to embrace positive changes in the Wildfire Structure Protection Programs, and we value your support through continued education, community, and provincial response. The fire seasons are becoming longer and more challenging each year with climate change, accompanied by the increase of constructed fuels in and around our forested lands. Adding structures and other improvements into the equation greatly increases the complexity. Over the last several decades an expansion of communities, homes and other improvements into wildland areas has created a significant challenge for the fire service agencies responsible for providing fire protection in those areas.

Contract companies, managers, team leaders and firefighters can prepare themselves for structure defense activities by developing a sound understanding of the wildland structure environment, fire behavior and forecasting, the Risk Management process, tactical terms and associated tactical actions. An understanding of all these components will allow firefighters to safely mitigate the fires impact upon the values they are charged with protecting.

To ensure fire departments and contract crews have a basic understanding of Structure Protection Strategies this training manual has been revised to accommodate the necessary basic training for crew members.

Wildland Urban Interface fires often overtax the local fire departments resulting in the activation of mutual aid and automatic aid agreements to augment jurisdictional resources. Nearly every WUI fire includes responses from a variety of wildland, municipal and volunteer fire agencies resulting in the need for clear text and common terminology among emergency responders. This program on Structure Protection Strategies in the Wildland Urban Environment is designed to provide common terminology and operating principles for province wide responders. It also includes guidelines and checklists to complement and enhance first responders differing levels of training and experience.

Respectfully,

Brian Hutchinson

Superintendent, Fire Services

Purpose

The purpose of this course is to provide a basic understanding of the Wildland and Wildland Urban Interface (WUI) fire incidents in which the structural fire company may be assigned. With the knowledge contained in this course, a structural fire fighter/officer will be able to operate within a structural fire company safely and effectively in a WUI Interface fire incident.

Objectives:

The objectives of this course are to deliver wildland firefighter training to members of BC fire departments that:

- exceeds the requirements for NFPA 1051 level 1 firefighter standard, BC Wildfire Service S100 and S-185, and WorksafeBC.
- meets the requirements for BC based structural fire departments to provide support to the BC Wildfire Service as requested.
- provides a basic training level that should be supplemented with additional hands-on training by your fire department.
- replaces the S-100 if you are working on behalf of a FD.
  - prepares structure fire department members to operate in their own jurisdiction as required

Background

To understand what your role is as a wildland firefighter, it is important to have a basic understanding of wildland fire.

What is a Wildland Fire?

A **wildland fire** is a fire involving vegetation. Wildland fire has been a natural process that has helped shape the diversity and health of our natural ecosystems since before humans were present on the land. Today, fire managers recognize two general types of wildland fire: prescribed fire and wildfire.

Prescribed fire is the knowledgeable application of fire to the landscape with the intent to meet desired outcomes; typically ecological, or hazard reduction (or both). The Indigenous People who cared for the land long before European settlement understood the importance of fire's role on the land and used **cultural burning** for many purposes.

Wildfire is an unplanned fire that occurs on the landscape and generally results in undesirable economic, social, or human health outcomes, but may have positive, or negative ecological outcomes.

A wildland fire may be a small grass fire burning in a vacant lot, a large fire burning in heavily timbered mountainous terrain that is several thousand hectares in size, or anything in between.

The intensity, rate of spread and direction that wildland fire burns is influenced by three factors: fuel, weather, and topography. The structural fire fighter needs to have a basic knowledge of how these factors influence the fire behavior and the application of the resulting strategies and tactics used by firefighters to safely respond to these incidents.

What is the Wildland Urban Interface (WUI)?

The Wildland Urban Interface (WUI) is any developed area where the conditions affecting the combustibility of natural and cultivated vegetation (wildland fuels) and structures and infrastructure (human built fuels) allow for the ignition and spread of fire through the combined fuels**.** Fires that start or spread into the WUI are highly complex to manage and require both wildland firefighters and structural firefighters to engage with strategies and tactics that are unique to this environment.

The WUI is further delineated into three distinct categories of development that the fire fighter may encounter:

Interface WUI is characterized by a development pattern where a defined line of a grouped development of structures and/ or infrastructure is directly adjacent to a large areas of wildland vegetation. In this development pattern, fire can spread from the wildland vegetation to structures that are immediately adjacent through exposure to the direct flames and heat of a wildfire, airborne embers, or structure to structure ignition (due to the close proximity of structures), while at the same time fire can spread to the structures further into the development through exposure to airborne embers and structure to structure ignition. However, the proximity of the structures also may provide opportunities for a lower ratio of suppression resources to structure numbers.

Intermix WUI is characterized by a development pattern of structures and/or infrastructure that is scattered throughout a wildland vegetation dominated landscape. In this development pattern, fire can spread from wildland vegetation to structures through direct flames and heat from wildfire, or airborne embers. Due to the typical spread-out nature of the structures, structure to structure ignition is less likely, but protecting the structures requires a higher ratio of suppression resources to structure numbers.

Occluded WUI is characterized by isolated areas of wildland vegetation (typically parks or green spaces) within and surrounded by a developed urban area. In this development pattern, fire can spread from the wildland vegetation to structures that are immediately adjacent through exposure to the direct flames and heat of a wildfire, airborne embers, or structure to structure ignition (due to the close proximity of structures), while at the same time fire can spread to the structures further into the development that surrounds the occluded WUI through exposure to airborne embers and structure to structure ignition. However, the proximity of the structures also may provide opportunities for less suppression resources to protect them.

The Home Ignition Zone (HIZ)

The Home Ignition Zone, or Structure Ignition Zone refers to the condition of the structure and the surrounding area out to 30 meters which determines each individual structure's vulnerability to wildfire impacts. Mitigation of a structure HIZ/SIZ is critical to the survivability of the structure and ideally is undertaken by the property owner will before a wildfire threatens the building. The mitigation of individual properties becomes even more critical to the survival of entire neighbourhoods in higher density interface WUI communities where the HIZ/SIZ of each structure overlaps with the neighboring HIZ/SIZ.

As part of structure protection and structure defense operations, firefighters will be involved in rapidly mitigating the HIZ/SIZ on properties that are threatened and protectable. These can either be defendable properties, or non-defendable properties.

IMPORTANT!

A crew briefing isn't a one-way process. After the briefing, ask questions on any points that weren't covered and make suggestions where needed.

- **If you aren't sure about a situation, SPEAK OUT.**
- **The most important consideration when attacking a wildland fire is a "safety first" attitude….. IF IN DOUBT – BACK OUT!**

Leaders Intent

Successful operations are built on the ability of leaders to define and communicate their intent so that it empowers their subordinates to exercise their initiative. Everyone, from a section chief down to every firefighter, must understand their responsibility under the Leader's Intent. The Leader's intent is a clear, concise statement that outlines what individuals must know to successfully achieve the mission's task, purpose, and expected results. On an incident the leader's intent is communicated through the Incident Action Plan (IAP). The intent communicates three essential pieces of information:

- Task: The objective or goal of the assignment
- Purpose: Why the assignment needs to be done
- End state: How the situation should look when the assignment is successfully completed.

The Leader's Intent enables subordinate leaders to adapt current incident plans to the site or situational specific unique conditions, and take **appropriate action** to accomplish the incident's objectives. This gives subordinate groups the freedom to adjust to ever-changing incident situations, within the parameters of the Leader's Intent. Within a given incident, there will be one leader's intent but there may be multiple subordinate leaders' intent statements that measure their actions against, and fall under the umbrella of, the overarching leader's intent.

Appropriate Action

On a rapidly developing incident, exercising appropriate action can make all the difference. Appropriate action is, action, necessary under the incident objectives when situations change or communication with command-and-control functions cannot be established. Appropriate action results from a firefighter's perception of leader's intent based on incident objectives, normal policies, procedures, or accepted safety practices. Being hesitant, risk averse, or indecisive can expose firefighters to greater long-term risks and waste time, opportunities, energy, and money. During an incident, one person may see something that must be done now, and take appropriate action to complete that task within the scope of leader's intent. Time may not permit obtaining permission, communicating the problem and mitigation options, or informing the chain of command of an action before the opportunity is lost.

In these time-critical situations, subordinate leaders must engage in appropriate action, that is, act within the leader's intent statement by:

- Utilizing acceptable and prudent suppression tactics

- Working in coordination with adjoining resources
- Developing and communicating an appropriate plan
- Informing the chain of command of the situation and mitigation actions as soon as possible
- Ensuring that their actions are within policy, procedure, and accepted safety norms

Unsafe Personal Conduct

Fire fighters must make an individual commitment to perform every task with safety as the foremost consideration.

Fire fighters must constantly guard against unsafe personal behaviour including:

- working while fatigued
- undertaking actions contrary to safe work practices
- rushing
- panicking
- not following the supervisors' directions.
- not understanding directions
- not communicating clearly

Personal Protective Equipment (PPE)

Firefighting in a WUI incident will involve both structure and wildland firefighters - each group has different personal protective equipment requirements.

Structure firefighters should not attempt wildland firefighting while wearing turnout gear. Structure coats, pants, helmets and boots are too heavy and expose firefighters to the risk of heat stress injury when worn on wildland fires. Structure boots do not provide good footing on slopes.

When structure firefighters (experiencing heat stress symptoms) shed coats to work in pants and t-shirts they are inadequately protected. Similarly, wildland personal protective equipment is completely inadequate for protection from structure firefighting hazards.

The use of structural firefighting equipment in wildland situations for a long duration of time may be detrimental to the user's health and safety because this equipment is not designed for prolonged use in such environments. The outfitting of structural firefighters with lightweight helmets, gloves, shrouds, lugged-sole work boots, Nomex™ shirts and pants, etc., should be a consideration for structural firefighters who frequently may be used in wildland firefighting operations. The National Fire Protection Association (NFPA) developed the NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting* (1993).

Clothing: Constructed of Fire Resistant (FR) rated material, coveralls or shirt/pant combinations must be long sleeved and loose fitting. Better protection is provided if cotton undergarments are worn. For maximum protection provide maximum coverage. No synthetic clothing should be worn while firefighting, even under FR clothing. Synthetics melt as opposed to char, increasing burn severity. It is dangerous to fight fire in synthetic clothing.

Footwear: Boots should be high-top — 20 - 22.5 cm (8 - 10 inches) — with a 'Vibram' or other non-skid sole. Medium to heavy wool socks should be worn (no nylon). Boots should be laced up all the way. Roots and duff can burn out underground creating pools of hot ashes that are hard to spot. Firefighters stepping into these pits can suffer serious burns or 'hot-foot injury' resulting from red-hot ashes pouring into a low-cut or unlaced boot top.

Helmets: Hard hats must be approved and equipped with a chin strap (to be worn when working around helicopters). Helmets are to be worn at all times. No items (e.g., pressure dressings) are to be attached to helmet shell and suspension. Structure firefighting helmets can be worn, but they are usually heavier and can be fatiguing if worn for prolonged periods of time.

Gloves: Constructed of leather, gloves must fit well and cover the wrists to the sleeve. Gloves protect the hands from slivers, blisters and burns and are only removed when firefighters are feeling for, or "cold trailing" hot spots while overhauling or mopping up.

Eye Protection: Protection of the eyes is very important. Goggles should fit well and easily accommodate eyeglasses, if necessary. Keep them clean and always have them with you. Eye protection must be worn whenever a firefighter is engaged in any work where there is a hazard of eye injury. This includes: working around helicopters, chainsaw operation, and working with high pressure fire hoses or Class A foam. No contact lenses shall be worn on the fireline.

Hearing protection: (muffs or earplugs) must be worn whenever a firefighter is working with high noise level firefighting equipment such as chainsaws, fire pumps or helicopters.

Hoods and Shrouds: Hoods and shrouds are constructed to keep the heat off your ears, neck and face. A hood is pulled over your face; a shroud is attached to your helmet. Hoods and shrouds can reduce your awareness of hazards such as falling trees or dangerous levels of heat.

Other Items: A sturdy belt should be worn by wildland firefighters. Belts are used to carry radios, canteens, hose washers, pressure dressings, and belt first-aid kits. Cotton neck bandanas are useful to screen the mouth and nose while working on dusty or ashy areas of the fire. Pack a large, nutritious lunch and carry as much drinking water as possible.

Firefighter Fitness

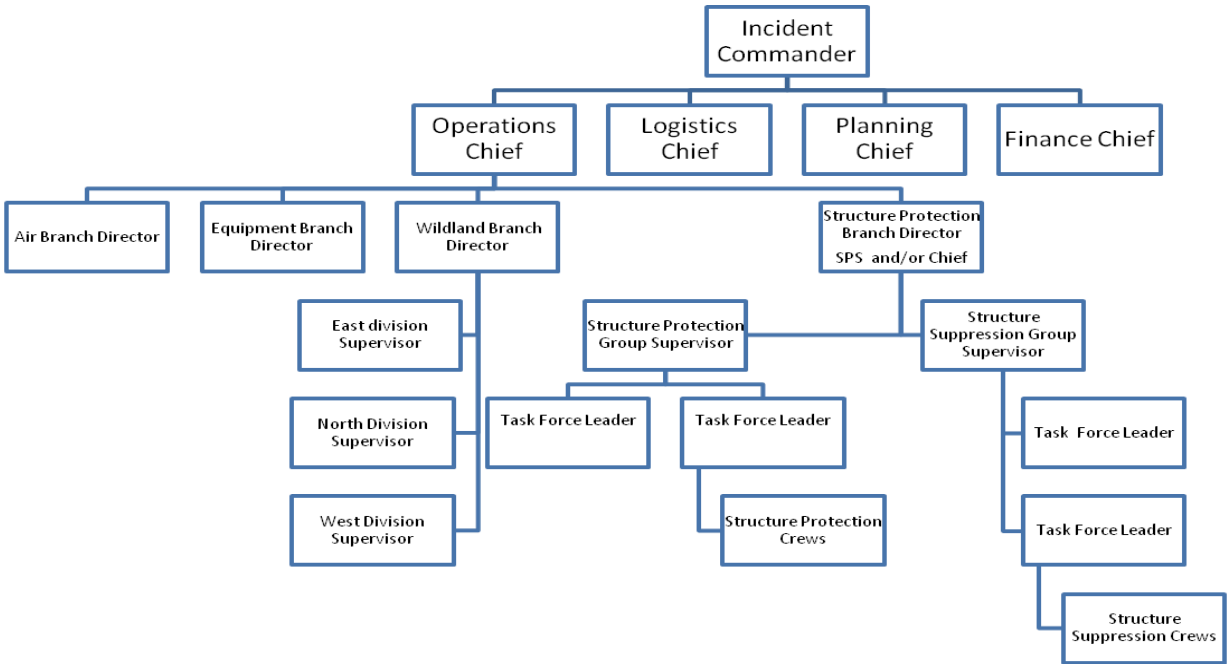
While donning PPE is an action that can be done at the time of the incident, maintaining basic firefighter fitness must be an ongoing process. Just as wildland terrain and basic extinguishment functions take their toll on firefighters wearing PPE, they also take their toll on firefighters' cardiovascular systems. There is no substitute for participation in a good physical fitness program by firefighters who might be called upon to function at such emergencies.

The Incident Command System (ICS)

Every fire in British Columbia, whether it is a small fire with only 2 firefighters and a crew leader, or a large fire with several hundred personnel, is organized using the principles of the **Incident Command System (ICS).**

ICS Organizational Activities

There are five major functions within the Incident Command System:



Sample Organization Chart

Detailing Structure Protection Branch in a large, expanded organization.

- Structure Protection Branch Director (Structure Protection Specialist and/or Local Fire Chief) could have 3 to 7 Structure Protection Group Supervisors/fire officers (senior, experienced Structure Protection Fire Officers) reporting to them.

- Structure Protection Group Supervisors could have 3 to 7 Task Force Leaders (Experienced Structure Protection Fire Officers) reporting to them.
- Each Task Force Leader could have 3 to 7 Structure Protection Crews reporting to them.
- On a smaller (or less complex) incident, the Task Force Leader(s)/fire officer or Crew Leader(s)/fire officer may report directly to the Structure Protection Branch Director.
- The Structure Suppression Group(s) would be included when operating in a Local Authority - Fire Protection Area, to respond to structure fires.

Crew Leader

The **Crew Leader** is considered a single resource leader in ICS and directs up to 7 fire fighters to perform certain tasks in a specific area of the fire. The crew leader typically reports to the Division Supervisor, or Operations Section Chief on larger fires. On smaller fires, the Crew Leader either takes charge as the Incident Commander, or reports directly to the Incident Commander.

Chain of Command

You will be assigned to a crew under a direct supervisor (typically a Crew Leader, or Engine Boss). You will take direction from your direct supervisor, and lonely your direct supervisor.

Common Denominators of Fire Behaviour on Tragedy Fires

There are five major common denominators of fire behaviour on fatal and near-fatal fires. Such fires often occur:

1. On relatively small fires or deceptively quiet areas of large fires.
2. In relatively light fuels, such as grass, herbs, and light brush.
3. When there is an unexpected shift in wind direction or in wind speed.
4. When fire responds to topographic conditions and runs uphill.
5. Critical burn period between 1400 and 1700.

Alignment of topography and wind during the critical burning period should be considered a trigger point to re-evaluate tactics. Blow-up to burn over conditions often occur in less than 60 minutes and can be as little as 5 minutes. A tactical pause may be prudent around 1400 (taking 10 at 2) for re-evaluating your situational awareness of topography, weather, and fuel.

Situational Awareness

Situational awareness is the ability to identify, process, and comprehend the critical elements of information about what is happening with regards to the mission, allowing organizations and

individuals to anticipate requirements and to react effectively and safely. More simply, it is recognizing and reacting to what is going on around you. On incidents, situational awareness involves knowing; objectives, communication paths, command structure, previous and current fire behaviour, weather, local factors, deployed and available resources, and evacuation needs. Situational awareness is a continuous cycle through four interrelated and overlapping processes:

- Observation: collecting data, Incident Action Plan (IAP)
- Orientation: analyzing and organizing data
- Decision: determining a course of action based on the data
- Action: the physical playing-out of decisions

Throughout this process, the situation may be changing. Sometimes leaders will need to cancel or change a planned action to meet tactical objectives or keep crews safe. The more quickly a leader can orient to an incident, the more successful future actions will be.

Fire Entrapment

Fire entrapment occurs when a fire suddenly changes its direction and rate of spread and prevents fire fighters from moving along escape routes to safety zones.

Fire Entrapment Avoidance

Fire fighters must recognize the fuels, weather and topography that can cause hazardous fire behaviour and make use of lookouts, communications, escape routes and safety zones before fire entrapment occurs. Do not fight fire in a situation that compromises your safety. Stay alert and be aware of changing conditions.

Lookouts, Anchor Points, Communications, Escape Routes and Safety Zones (LACES)

LACES stands for:

- Lookouts
- Anchor Points
- Communications
- Escape Routes
- Safety Zone

LACES must be established and known to ALL firefighters BEFORE it is need on every incident.

Lookouts

- Experienced, competent, trusted
- Enough lookouts at good vantage points
- Knowledge of crew locations
- Knowledge of escape and safety locations
- Knowledge of trigger points
- Map, weather kit "if available", watch, IAP

Anchor Points

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

Communications

- Radio frequencies confirmed
- Backup procedures and check-in times established
- Provide updates on any situation change
- Sound alarm early, not late

On the fireline, Crew Leaders use two-way radios to communicate with the Incident Commander and other fireline resources. By law those who use radios should be trained and licensed as a **Restricted Radio Operator**. Under normal circumstances, firefighters working under the supervision of a Crew Leader will not use a radio, but they should know how to operate one in case of emergency.
Emergency Procedure- "Mayday"

The 'Mayday' distress transmission is only used in situations of grave danger (life threatening), such as serious injury, fire entrapment, aircraft accidents etc.

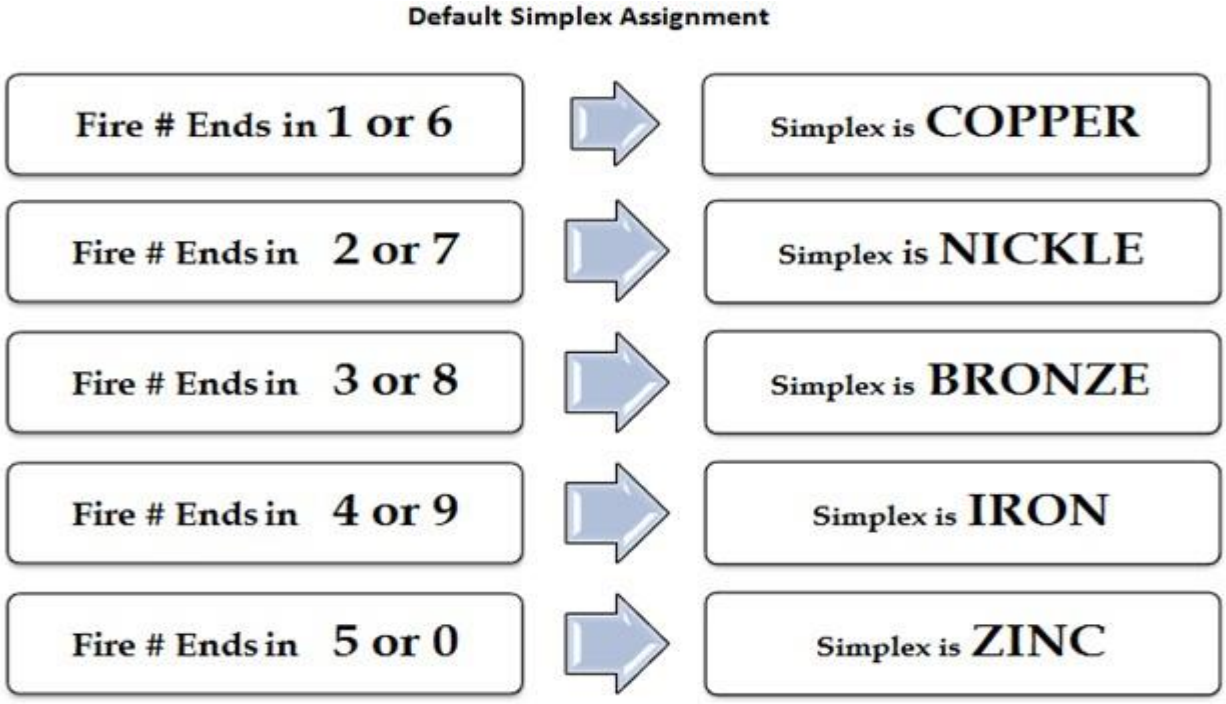
2. Make sure the radio is turned on.
3. Do not change the channel selector.
4. Call "MAYDAY, MAYDAY, MAYDAY," followed by "this is…." and identify your station or self, your location, and the nature of the emergency.

    - All stations hearing your call will monitor all transmissions on that channel and one station (usually the one nearest or most able to assist) will respond and make arrangements to assist.

    - If you do not get any response after several attempts, set channel selector to CH1/F1 and repeat steps 1 – 3. Changing locations (move upslope or into a clearing) may help.

- If you still do not get any response, listen to the other channels, find one with some activity and repeat steps 1 – 3.

Default Simplex Assignments:



Emergency Signals

An emergency signal of **constant horn blasts** allows an officer to signal a crew to immediately return to their vehicle in case of an emergency or withdrawal from the fire ground. At the engine company or fire crew level, supervisors should discuss the emergency signal, focus training on the signaling procedure, and practice it regularly.

Escape Route

- More than one escape route
- Avoid steep uphill escape routes
- Scouted for loose soils, rocks, vegetation

- Timed considering slowest person, fatigue, and temperature factors
- Marked for day or night
- Evaluate escape time vs. rate of spread
- Vehicles parked for escape

An escape route is an identified route used to withdraw from a tactical work area to a predetermined safety zone. When identifying escape routes, consider the distance between the tactical work area and the safety zone and the amount of time it will take to travel between the two. The escape route must be tested and timed. Base withdrawal times on the slowest travel rate of any individual resource, fatigue, visibility (smoke), traffic, and any other mitigating factors.

Travel time should always account for the expected rate of fire spread. Firefighters must be able to reach the safety zone well in advance of the fire.

Ideally, firefighters should identify more than one escape route in the event that one becomes compromised. As resources move within their tactical work area, escape routes and TRA's must be reevaluated and re-established as needed.

Travel on Foot:

The escape route should be clear of obstructions that could hinder a safe and hasty withdrawal. Scout potential routes for loose soil, rocks, and heavy vegetation. Avoid steep uphill escape routes. Escape routes on foot could include driveways, roads, sidewalks, or walking paths. Escape routes might also follow the fire line, a dozer line, or a hose lay path. If no clear route exists, firefighters will need to cut a path through vegetated areas along the most direct route to the safety zone. The escape routes must be clearly marked for daytime, low visibility (smoke) and nighttime use. They must also be tested and time by all resources

When withdrawing along escape routes by foot, ensure that travel time and distance to the safety zone are realistic based on terrain, fire behaviour, environmental factors, and personnel capabilities.

Travel by Vehicle:

During a WU Incident, firefighters often travel escape routes by vehicle. Always Park vehicles faced toward the escape route; leave the engine running with the headlights on. Do not park vehicles or plan escape routes under areas with power lines. When multiple engines are working in the same tactical area, a Task Force/Strike Team Leader or Division or Group Supervisor needs to preplan emergency egress to coordinate all resources prior to withdrawal. Emergency egress should be well-timed and orderly to avoid congestion and accidents. Travel and time and distance should be based on road conditions, the number of vehicles using the same escape route, the slowest vehicles and the potential for congestion or accidents along the route.

Safety Zones

- Survivable without a fire shelter
- Back into clean burn
- Natural features (rock areas, water, meadows)
- Constructed sites (clear-cuts, roads, helispots)
- Scouted for size and hazards
- Upslope? Downwind? Heavy Fuels? Each means more heat impact meaning larger safety zone. Time available to use escape routes will decrease and safety zone size will increase (possibly by more than double) as wind exceeds 10 kph and/or slope exceeds 20%!

Safety Zones must be large enough to provide a separation distance between firefighters and the flames of a MINIMUM of four times the maximum continuous flame height on all sides of the safety zone where fuel exists.

In the WUI, adequate safety zones to accommodate both personnel and equipment can be difficult to find in the WUI. However, large open areas such as parking lots, athletic fields, and parks may be suitable for safety zones. Additional space may be required if other resources are utilizing the same safety zone, in addition consider increasing size if located on a slope. If a safety zone that allows structure defense resources to access it during fire impingement cannot be established, the area of operation must be considered **non-defendable**, and the appropriate tactics implemented.

Additional space may be required if other resources are utilizing the same safety zone, in addition consider increasing size if located on a slope.

Escape time and safety zone size requirements will change as fire behaviour changes. If the fire has the ability to burn completely around the safety zone, this distance must be maintained on all sides of the safety zone, meaning the diameter should be twice the value indicated above. Convective heat from wind or topographic influences will increase this distance requirement. Firefighters should remember that safety zones should be large enough to accommodate fire apparatus in addition to all personnel.

Temporary Refuge Areas

Temporary Refuge Areas (TRA's) should be identified by firefighters operating on fire apparatus, ahead of time for emergency use in the event that an escape route to a safety zone becomes compromised. The TRA should be used only until it is safe to move to the safety zone or safely return to work. A TRA is not a replacement for an identified safety zone; it is merely a temporary, short-term emergency solution that firefighters is use ONLY if the escape route to a safety zone is compromised.

Potential WUI TRAs include:

- Large turnouts, cul-de-sacs or parking lots
- On-site greenbelts, meadows, pastures, large lawns
- Lee side of structures
- Inside apparatus
- Inside structures

Dangerous Trees

A Dangerous Tree is any tree that is hazardous to people or facilities because of:

- location or lean,
- physical damage,
- overhead hazards,
- deterioration of limbs, stem or root system,
- a combination of the above.

The Dangerous Tree definition has replaced the snag definition, ***a standing dead or dying tree over three meters in height***, in all Work Safe BC Regulations which state; Areas being worked in by crews, but continually be revaluated and monitored for Danger trees.

'If work in a forestry operation will expose a worker to a dangerous tree, the tree must be removed.'

INTERFACE FIRELINE HAZARDS

Interface fire operations are conducted in a high-risk environment subject to the dangers of fire entrapment, overhead and slope hazards, vehicle and aircraft accidents and medical emergencies. Interface fire responses add hazards such as fires involving vehicles, power lines, pressurized gas containers and other hazardous materials to the list. Vehicle accidents enroute to the fire and medical emergencies involving responders are additional hazards that interface firefighters must be alert for.

General Fireline Safety

Wildland and Interface fire suppression is a hazardous occupation. Most injuries and fatalities on the fireline are the result of firefighters not following safe work guidelines. When injuries occur, a crew's efforts are diverted away from the fire which may escape and threaten other firefighters.

The first responsibility of all firefighters is to prevent injury to themselves and others.

Firefighters must approach every fireline situation with a 'safety first' attitude and remember that no fire suppression tasks are considered sufficiently urgent to justify any risk-taking or shortcuts with safe work guidelines.

Heavy Equipment

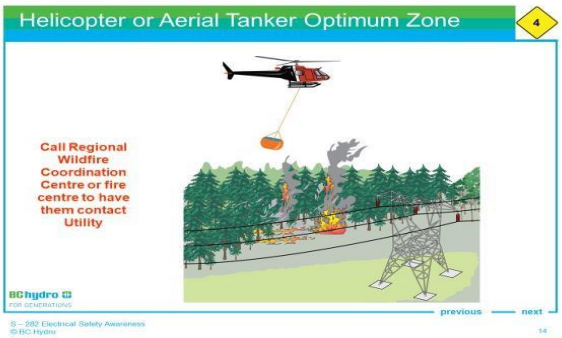
- Trees pushed by heavy equip. can fall suddenly – leaving brushed trees & "widow makers"
- Debris can roll or slide downhill
- Stems lying on the ground that are run over by heavy equipment can pivot suddenly
- Unattended or out of control equipment can roll or slide downhill

Any tree pushed over by heavy equipment may have sideways pressure on it, and must not be considered safe, even when flat on the ground.

Power Line Safety

If there is a downed conductor on the vehicle, stay in vehicle until the power company arrives. If the vehicle is on fire or fire is near, jump clear, keep feet together and don't hang on.

- Smoke, water, and retardant are all good conductors and can cause power line-toground arc.
- Do not operate heavy equipment under power lines
- Do not use right-of-way's as a jump or cargo drop spot
- Do not drive with long antennas under power lines
- Do not fuel vehicles under power lines
- Do not stand near power lines during retardant drops
- Do not park under power lines
- Do not apply straight stream to power lines
- Maintain a 12m distance from transmission lines
- Spot fires or low ground fires can be fought with hose lines if heavy smoke or flame is not within 30m of the power lines
- If safe, extinguish wood poles burning at the base to prevent downed wire hazards later



WUI Hazards

On a WUI incident, firefighters may encounter:

- Panicked, angry, or trapped civilians
- Civilians who refuse to evacuate structures
- Civilians creating additional hazards on roadways during an evacuation
- Animal evacuations requiring additional vehicles
- Poor ingress/egress or road grades and surfaces not designed for large fire equipment
- Hazardous materials
- Downed power lines, fuel storage tanks, propane tanks, explosives, and other hazards
- Structures as part of the fuel load, (constructed fuels)
- Little or no defensible space around structures
- Inadequate water supply
- Increased smoke exposure (poor visibility, carbon monoxide effects, breathing difficulties)
- Extreme fire behaviour
- Concurrent structure defense and perimeter control operations
- Conflicting orders, or instructions from individuals not in the incident chain of command
- Limited options for shelter in place, escape routes, and safety zones.
- Increased political pressure and media interest

Wildland Fire Behaviour

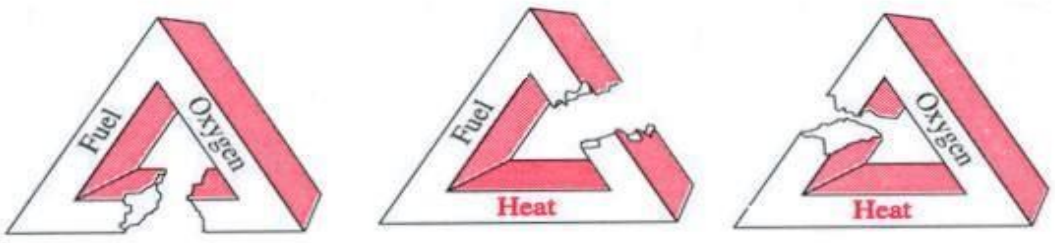
Fuel + Oxygen + Heat

In order to control and successfully fight forest fires we must first understand what makes fire spread. **Three elements:** *fuel*, *oxygen* and *heat* must be present to start and maintain a fire.

In a forest fire:

- Forests provide the fuel;
- oxygen is in the air and;
- heat results either naturally (lightning strike) or is introduced by people.

These three elements (fuel, oxygen, heat) are related to a triangle with each side representing one element. If any one of these elements is altered, the fire will behave differently; if one side of a triangle is removed, the fire extinguishes.



The Heat Transfer Process

The process by which heat travels from one body or object to another is known as heat transfer. There are three processes.

Radiation: Transfer of heat through the air from warm surfaces to cooler surroundings (the heat you feel when you are sitting next to a campfire)

Convection: Transfer of heat by the movement of a hot air mass; usually upwards (burning objects below heat objects above)

Conduction: Transfer of heat through solid matter (objects touching each other) There are three key factors that influence fire behaviour. They are:

KEY FACTORS		
1. Fuel	**2. Weather**	**3. Topography**
Moisture	Wind	Slope
Size	Precipitation	Aspect
Spacing (continuity)	Relative Humidity	Terrain
Fuel Loading	Temperature	Elevation

Factors That Affect Fire Behaviour

Fuel

Fuel factors that affect the start and spread of wildland fires include

- fuel moisture;
- size and shape;
- fuel loading;
- horizontal continuity; and
- vertical arrangement.

Fuel Types

A simple definition of fuel in the wildland environment is any combustible material. Wildland fuels can be defined further as live or dead plant material. The wildland firefighting community has categorized fuels into the various types described below. You will note that each fuel is very simply categorized by the primary fuel that carries the fire. Types of fuels vary in nature from one area of the country to another and even within the same area. There are four major fuel types.

1. **Grass**: found in most areas, but more dominant as a fuel in dry desert like range areas where other types of fuel are less prevalent. It can become prevalent in the years after a fire in formerly timbered areas.
2. **Shrub (brush)**: found throughout most of B.C., cedar, juniper, pine, tall grass, spruce, broom, are some examples.
3. **Timber litter**: This type of fuel is most dominant in mountainous topography.
4. **Logging slash**: Found throughout B.C., this is the debris left after logging, pruning, thinning, or shrub-cutting operations. It may include logs, chunks, bark, branches, stumps, and broken understory trees or shrubs.

Fuel Characteristics

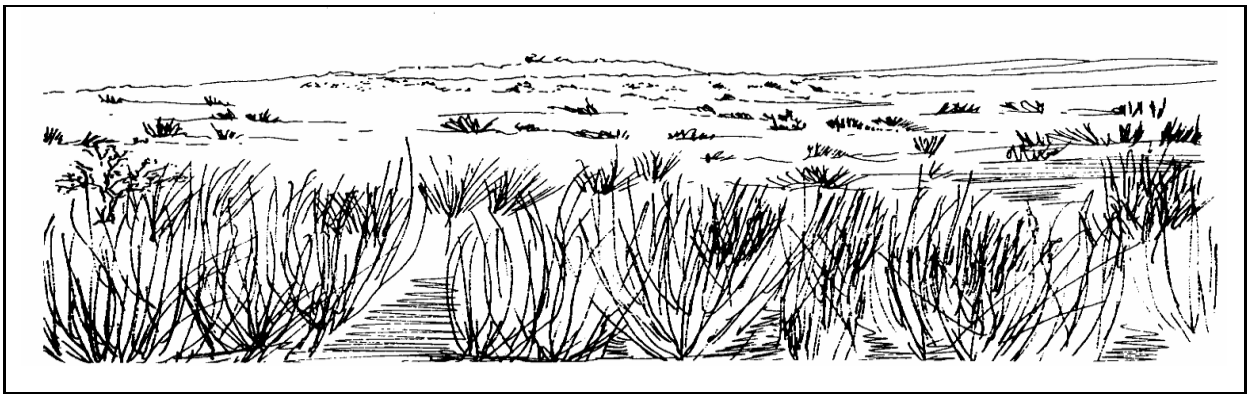
Fuel Moisture

Fuel moisture is the amount of water (moisture) in a fuel. This measurement is expressed as a percentage. The higher the percentage, the greater the content of moisture within the fuel. How well a fuel will ignite, and burn is dependent, to a large extent, on its moisture content. Dry fuels will ignite and burn much more easily than the same fuels when they are wet (contain a high moisture content). As fuel's moisture content increases, the amount of heat required to ignite and burn that fuel also increases. Remember that light fuels take on and lose moisture faster than heavier fuels.

Size and Shape

The physical characteristics of fuel. Basically, fuels can be divided into two categories on the basis of their size and shape.

1. Light fuels such as shrubs, grasses, leaves, and pine needles (any fuel having a diameter of one-half inch or less) burn rapidly and are quickly ignited, as they are surrounded by plenty of oxygen. Fires in light fuels spread rapidly but burn out quickly, are easily extinguished, and fuel moisture changes more rapidly than in heavier fuels.



Light Fuels

2. Heavy fuels such as limbs, logs, and tree trunks (any fuel one-half inch or larger in diameter) warm more slowly than light fuels, and the interiors are exposed to oxygen only after the outer portion is burned.

Heavy Fuels

Fuel Loading

Fuel loading refers to the weight or mass of fuels in a given area, usually measured in tons per hectare. Fuel loads may vary across the landscape. Higher density fuel loads will burn at higher intensities if fuel moisture conditions make all the fuel available for combustion.

Weather

Wind

Wind is the single most important weather factor affecting fire behaviour and influences fire behaviour by:

- Increasing or decreasing fuel moisture
- Bending the flames ahead, heating, drying and igniting new fuels
- Carrying sparks and embers into new fuel sources (spotting)
- Feeding more oxygen to a fire
- Driving the direction of a fire

Precipitation

Precipitation influences fire behaviour by affecting fuel moisture. The effect of precipitation on fuel moisture is mostly dependant on fuel size:

- Less precipitation is required to raise the fuel moisture content in fine fuels than in heavy fuels
- Fine fuels will dry out faster than heavy fuels

- Precipitation may not wet ground fuels if they are located under a dense canopy
- Duration of precipitation, not quantity, is the most important factor determining the effect of precipitation on fuel moisture.

Relative Humidity

Relative Humidity influences fire behaviour by affecting fuel moisture.

Relative Humidity is the percentage of water vapour present in the air. When the air is dry (low Relative Humidity), fuels are likely to dry out; when the air is damp (high Relative Humidity), fuels are likely to absorb moisture (fuel moisture increases). Typically, the relative humidity will increase overnight and decrease during the day.

Temperature

Temperature fluctuations affect relative humidity, thereby affecting fuel moisture content. To a lesser degree, temperatures also influence the amount of preheating required to bring fuel to it's ignition temperature.

The Crossover Concept

Refers to rising temperature (in °C) and falling RH reaching the point where they are equal (highlighted boxes in the table). Interpretations suggest the potential for extreme fire behavior.

		Relative Humidity, in %																			
Temp (°C)	Temp (F)	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5
0	32	0	0	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6
2	36	0	0	1	1	1	2	2	2	3	3	4	4	4	5	5	5	6	6	6	7
4	39	0	0	1	1	2	2	2	3	3	4	4	4	5	5	6	6	7	7	7	8
5	41	0	0	1	1	2	2	3	3	3	4	4	5	5	6	6	7	7	7	8	8
6	43	0	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	7	8	8	9
7	45	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10
8	46	0	1	1	2	2	3	3	4	4	5	5	6	6	7	8	8	9	9	10	10
9	48	0	1	1	2	2	3	3	4	5	5	6	6	7	7	8	9	9	10	10	11
10	50	0	1	1	2	2	3	4	4	5	6	6	7	7	8	9	9	10	10	11	12
11	52	0	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	10	11	12	12
12	54	0	1	1	2	3	4	4	5	6	6	7	8	8	9	10	11	11	12	13	13
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15	59	0	1	2	3	3	4	5	6	7	8	9	9	10	11	12	13	14	14	15	16
16	61	0	1	2	3	4	5	5	6	7	8	9	10	11	12	13	14	15	15	16	17
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19	66	0	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	18	19	20	21
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23	73	0	1	3	4	6	7	8	10	11	13	14	15	17	18	20	21	22	24	25	27
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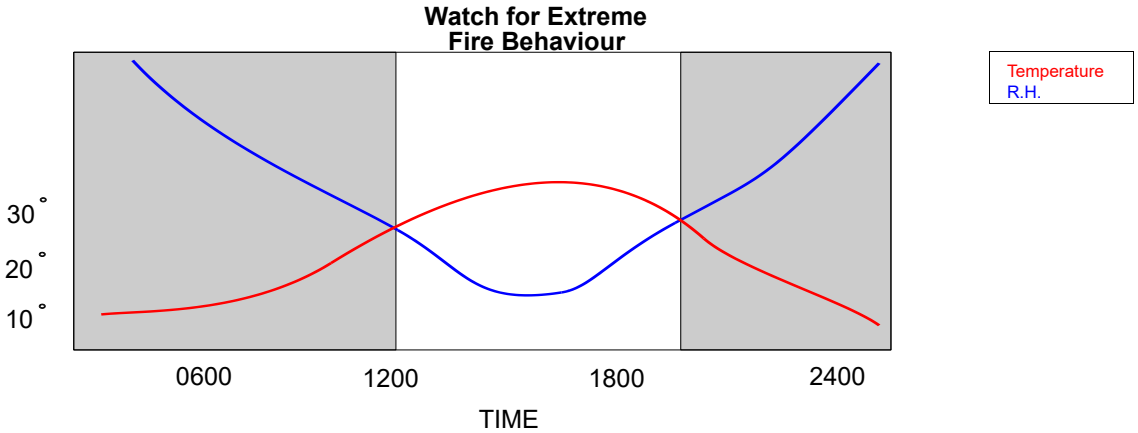
33	91	0	3	5	8	10	13	15	18	20	23	25	28	30	33	35	38	40	43	45	48
34	93	0	3	5	8	11	13	16	19	21	24	27	29	32	35	37	40	43	45	48	51
35	95	0	3	6	8	11	14	17	20	22	25	28	31	34	37	39	42	45	48	51	53
36	97	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	50	53	56
37	99	0	3	6	9	13	16	19	22	25	28	31	35	38	41	44	47	50	53	56	60
38	100	0	3	7	10	13	17	20	23	26	30	33	36	40	43	46	50	53	56	60	63
39	102	0	3	7	10	14	17	21	24	28	31	35	38	42	45	49	52	56	59	63	66
40	104	0	4	7	11	15	18	22	26	29	33	37	41	44	48	52	55	59	63	66	70

The Black Cross

Watch for Extreme Fire Weather

Cross over conditions are where the Relative Humidity percentage number drops below temperature. If this occurs on the fireline, this is a useful rule of thumb to potentially expect extreme fire behaviour – precautions must be taken accordingly.



Topography

There are three topographical factors that influence fire behaviour:

- Slope
- Aspect
- Terrain

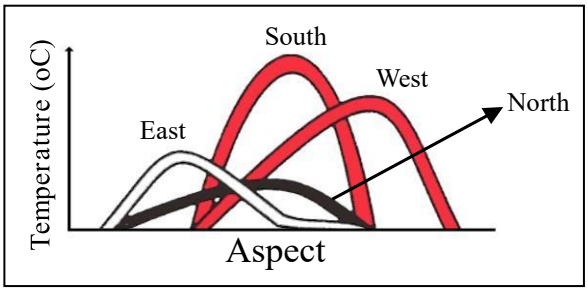
Slope

Slope is the single most important topographical factor affecting fire behaviour.
Slope affects fire behaviour in the following ways:

- Flames are closer to fuels on the uphill side, heating and igniting these new fuels
- Convective heat (rising heat) from the fire travels up the slope, heating and drying new fuels
- The convective air may carry firebrands, which can ignite spot fires above the main fire
- Burning embers and large burning material may roll downhill igniting new, unburned materials below the fire
- Firefighting efforts are hampered and slowed on slopes
- Cooling at night and weather changes can cause winds to blow down slope.

Aspect

Aspect refers to the direction the slope faces. For example, a southwest aspect is a slope that faces southwest.



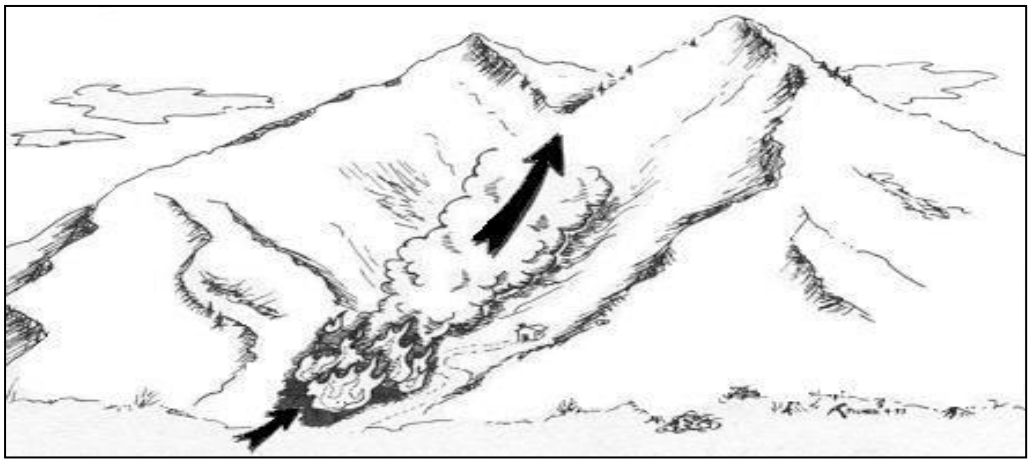
South Aspect **North Aspect**

Terrain

Terrain is the variation in land features, which primarily affects fire behaviour by altering wind direction and speed at a local level. It is useful to think of the wind patterns over terrain as water flowing in a river. Terrain affects wind patterns in the following ways:

- Turbulence or “eddies” can be generated on the leeward side when wind blows across ridges.

- Terrain restrictions, such as narrow portions of valleys, or knolls, can increase wind speed as the wind passes through, or around these restrictions.
- Steep-sided gullies or canyons running uphill can create a “chimney effect” dramatically increasing uphill spread rates and intensity. In many cases these terrain features will also have heavy fuel loadings, increasing fire behaviour.



Fire Type and Intensity

Understanding how fuel, weather, and topography affect fire leads us into what types of fires we will actually be dealing with. Fires are put into three categories:

1. **Subsurface**
2. **Surface**
3. **Crown**

Subsurface (Ground) Fires

Subsurface or ground fires burn on or beneath the forest floor. Fuels consist of duff (topsoil, partially decayed leaves, tree needles) and decayed woody material at a depth that may vary from 8 - 10 cm (3-4") in dry areas, to 1 m (3') in wet areas. Because ground fuels are compact, have limited oxygen supply and are protected from wind, a persistent slow burning fire is produced. As a result, fire suppression can be very difficult.

Surface Fires

Surface fires burn on and above the forest floor (excluding crowns of trees). Fuels include ground debris, vegetation, windfalls, brush, slash, young trees and lower branches of standing timber. Forest growth up to 7.5 m (25') may be affected. The spread rate of fires depends on fuel type, density, continuity and size, plus slope of the terrain and weather.

Crown (Aerial) Fires

Crown Fires burn in the upper foliage of standing timber in conjunction with surface fires. Surface fires may intermittently burn into the crown as a result of intense heat from accumulated surface fuels. In this case the main surface fire occasionally runs into the tops of trees, burning isolated patches and then dropping to the surface again.

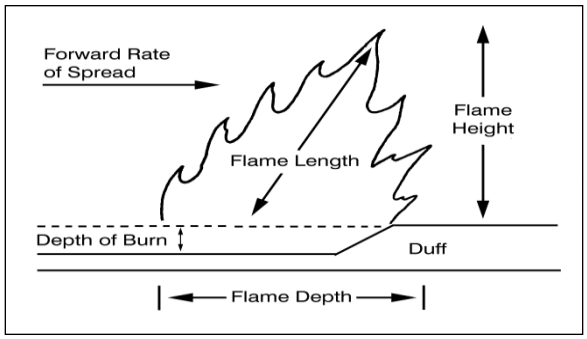
This **"candling"** effect occurs where the canopy is not continuous and where the boles (trunks) of trees are covered with dead limbs, mosses or lichens providing a ladder effect from the surface area to the crown. Candling can also occur in isolation and affect only one tree.

When the canopy is continuous and the conditions are right then a **running crown fire** may develop. This is the type of fire which will grow exponentially and any suppression tactics will offer little resistance.

Flames

Flames are the visible by-product of combustion and are described in the following manner:

Flame Depth: The width of the zone within which continuous flaming occurs behind the edge of the fire front.
Flame Height: The average maximum vertical extension of flames at the fire front.
Flame Length: This is the distance between the flame height tip and the midpoint of the flame depth at the ground surface.



Why is knowing the flame length important? Flame length is an observed indicator of fire intensity. The longer the flame length, the greater the fire intensity.

Fire Behaviour Terms to Describe Fire Spread

Smoldering: A fire burning without flame and with limited to no spread.

Creeping: A fire spreading slowly over the ground and generally with a low flame.

Running: A fire spreading rapidly and with a well-defined head (advancing flame front).

Candling: A single tree or a small clump of trees is said to "torch" when its foliage ignites and flares up. This is usually from the bottom to the top.

Fire Intensity Ranking System

It is important to understand the Fire Intensity Ranking System which enables fire fighters to communicate a summarized assessment of fire behaviour. Numbers from 1 (low) to 6 (extreme) are based on the FWI values.

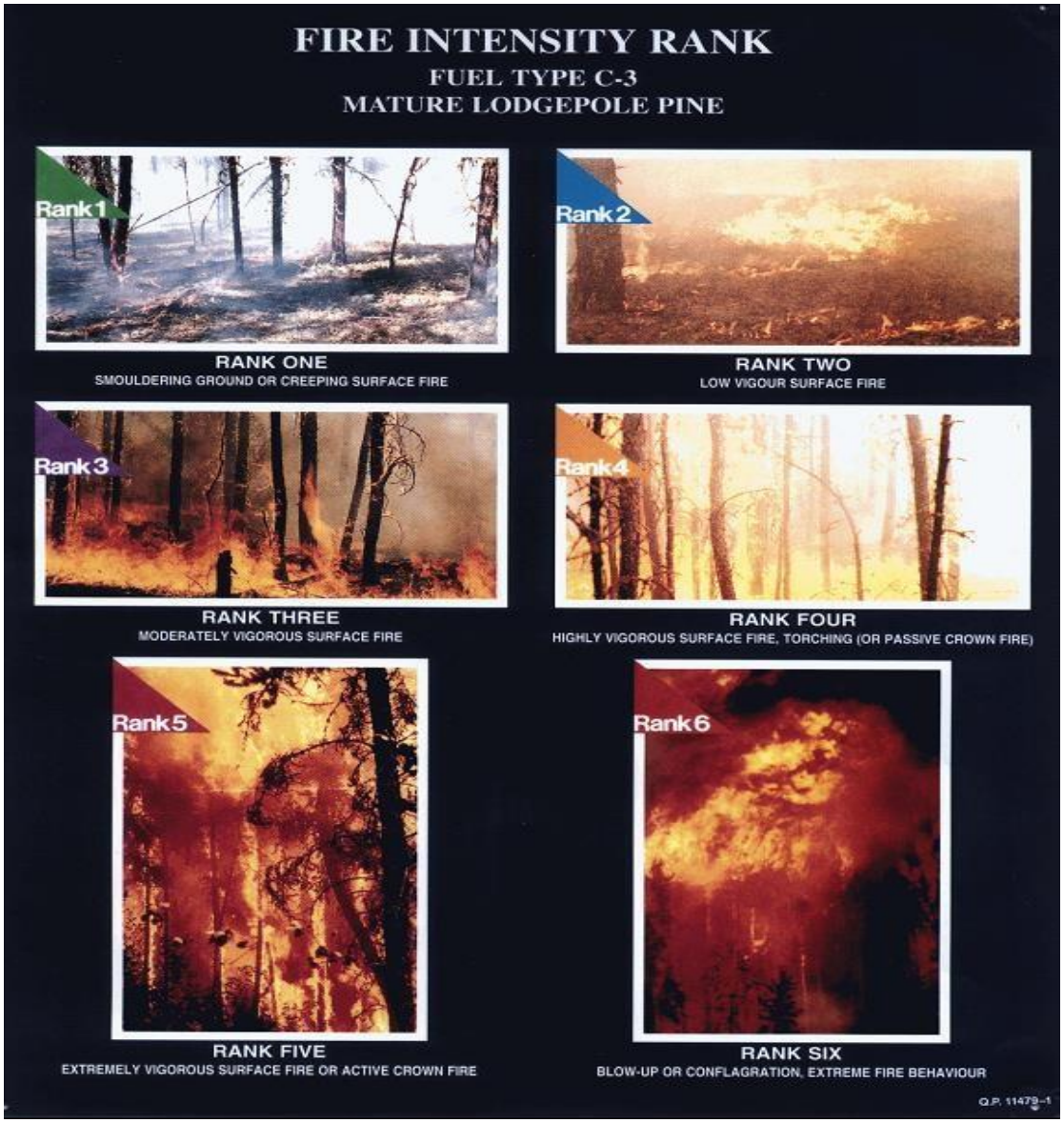
Rank 1

- No open flame, white smoke, smouldering ground fire **Rank 2**
- Visible open flame, surface fire only
- Unorganized flame front, little or no spread **Rank 3**
- Organized surface flame front
- Moderate rate of spread
- Vigorous surface fire **Rank 4**
- Organized surface flame front, disorganized crown involvement
- Moderate to fast rate of spread on the ground
- Short range spotting
- Grey to black smoke **Rank 5**
- Organized crown fire front
- Moderate to long range spotting

- Independent spot fire growth
- Copper to black smoke

Rank 6

- Organized crown fire front
- Moderate to long range spotting
- Independent spot fire growth
- Presence of fire balls and fire whirls



Additional Fire Behaviour Definitions

Candling - A single tree or a small clump of trees is said to candle when its foliage ignites and flares up, usually from bottom to top.

Spotting - A fire producing firebrands carried by the surface wind, a fire whirl and/or convection column that fall beyond the main fire perimeter and result in spot fires

Parts of the fire

It is very important that you are able to describe the anatomy of a wildfire. You will need this to describe your position on the fire or the position of an observation you are making from afar. The following anatomical descriptors are important to remember and understand:

The structural fire fighter needs to be aware of the terms used to describe the parts of a wildland fire. These include

Head- The head or the front of the fire is the portion of the fire that has the greatest rate of spread. The head is the direction in which the fire is growing. The head is usually on the downwind or upslope part of the fire.

Back- The back or rear of the fire is opposite the head and usually has the slowest rate of spread. It is also known as the heel or base.

Flank- The flanks are any areas between the head and the back. The flanks are often referred to in relation to a geographic feature such as the 'North Flank".

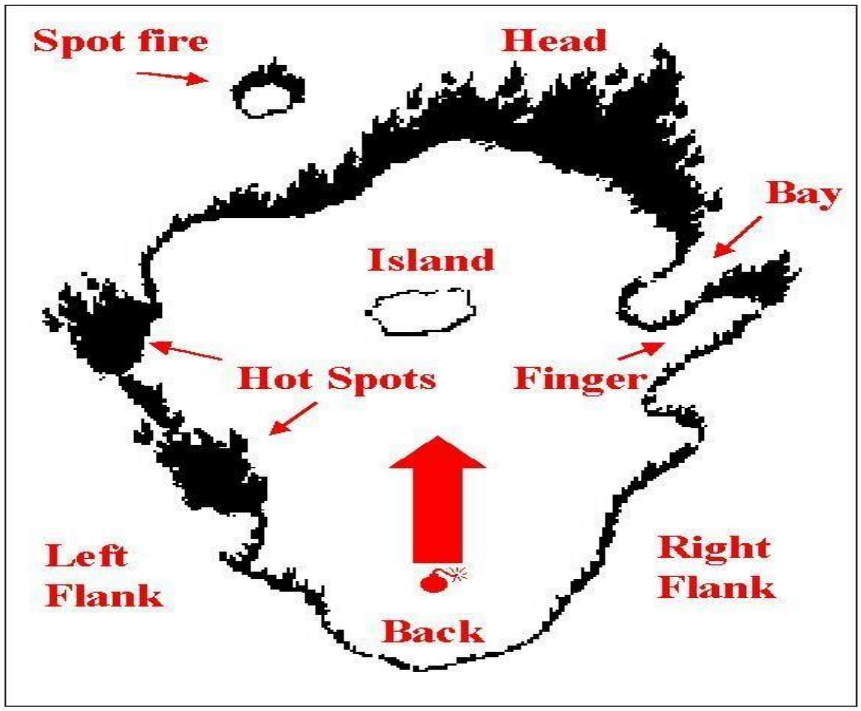
Finger- A finger is an elongated burn area projecting from the main body of the fire. Fingers often occur on wind driven fires.

Bay- A bay is a marked indentation in the fire perimeter. A bay is usually located between to fingers.

Island- An island is an area of unburned fuel located within the fire perimeter.

Spot Fire- Spot or jump fire is a fire ignited by firebrands outside the main perimeter of the fire. Spots can occur very close to the fireline or under windy conditions a great distance from the fireline.

Hot Spot- A hot spot is any part of the fire that is particularly active.


Spot fire
Head
Bay
Island
Hot Spots
Finger
Left
Flank
Right
Flank
Back

Crowning: An ascending fire that spreads into the crowns of many free and from crown to crown.

Spotting: Firebrands carried by the wind, a fire whirl and/or convection from a column that fall beyond the main fire perimeter and result in spot fires.

Heat Stress

Hot weather and hot fires can quickly add up to heat stress and develop into more serious conditions like syncope (fainting), cramps, heat exhaustion or potentially deadly heat stroke. Firefighters are at particular risk because of their heavy personal protective equipment (PPE), strenuous work and exhaustion.

- Train firefighters on recognizing and preventing heat stress
- Use relief fighters, assign extra personnel and provide rest periods

- Monitor firefighters for signs of heat stress and fatigue **Individual firefighters can:**
- Take more breaks in extreme heat and humidity, and take them in the shade or a cooler area.
- Drink water frequently (about 1 cup every 15-20 minutes), and avoid alcohol and highcaffeine/high-sugar beverages.
- Understand that PPE may increase the risk of heat stress, and stay aware.
- Monitor individual physical condition and that of your fellow firefighters.
- Notify emergency personnel if heat stress symptoms occur, stop working, move to a cooler area, and begin cooling activities to reduce the body's temperature (spraying, sponging, or showering with water, and by fanning the body).

Fire Suppression Strategies

We have determined the factors which influence fire behavior and the types of fire as well as fire intensity we might witness in the field. Your role is obviously to help suppress these fire safely and efficiently.

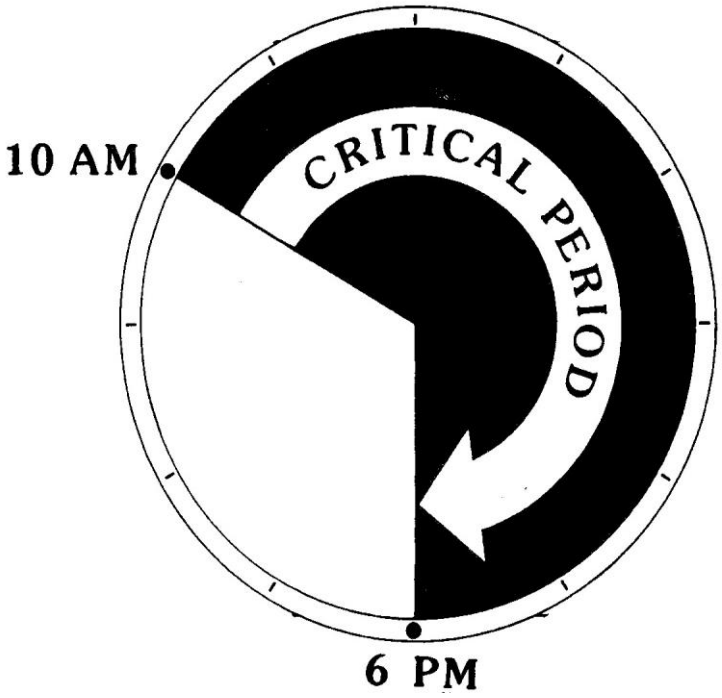
Increasing effective use of both wildland and structural resources to support communities engaged in a WUI fire incidents requires wildland and structure firefighters to increase cooperation and change perspectives, through cross training and the adoption of new strategies, tactics and equipment.

It is also important that WUI fire incidents be managed using the Incident Command System (ICS) and common terminology.

As a structural fire fighter providing fire protection in the wildland and WUI incidents, it is important that you understand basic wildland fire behaviour to help you understand the wildfire suppression concepts, tactics that you are engaging in, and above all, to stay safe.

THE 10:00 A.M. CONCEPT

The BC Wildfire Service's philosophy on fire suppression: every effort shall be made to **control wildfires by 10:00 a.m.** of the morning following discovery. Early detection is therefore imperative. This is called "the 10:00 a.m. concept."



The 10:00 a.m. concept recognizes that after 10:00 a.m. the Temperature increases and Relative Humidity (RH) decreases.

As the factors influencing fire behavior increase so does fire intensity and potential fire size; making suppression a more involved and time-consuming process.

Therefore, the goal of the Wildfire Service is to control fires before this heating and drying period occurs.

This minimum expectation is a **Success Rate of 92 % of** holding fires under **4 hectares** in areas of unwanted fire.

In order to achieve these successes, the Wildfire Service bases its fire suppression strategy on these three rules:

1. **Fast Initial Attack** - Be organized, move crew to the fire as quickly as possible and stop the fire from spreading.

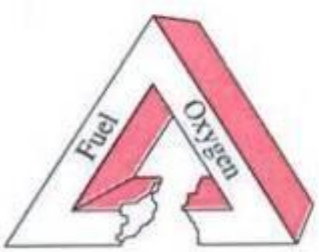
2. **Aggressive Action** - Deploy adequate resources, work hard and work quickly to bring the fire under control.

3. **Prompt and Complete Mop-up** - If the fire is contained, a thorough mop-up must commence immediately.

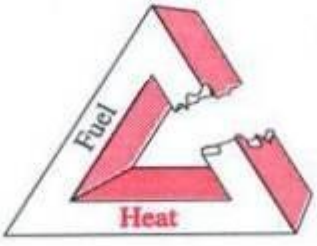
Three Ways to Attack A Fire

The basic approach to successful fire suppression is to attack where the fire is most likely to escape by simply removing one side of the fire triangle.

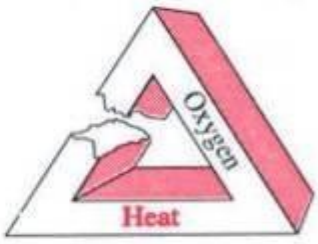
Remove heat by



Remove oxygen by covering burning



Remove fuel by creating a fuel-free control line



Pre-Incident Planning

Pre-incident planning helps all Wildland Interface responders make prompt, critical decisions about a WUI incident. A pre-incident plan (pre-plan) created prior to need and validated through realistic training exercises is the foundation for a safe, organized incident response. A pre-plan prepares suppression resources at all levels to respond to an incident within the planning area.

Developing Pre-Plan Maps

The comprehensive planning area map covers a wide range of features impacted by or utilized during a WUI incident, including:

- Structure locations
- Access routes and road systems
- Evacuation routes
- Special needs/concern areas
- Infrastructure
- Incident-specific information
- High hazard areas

Pre-Arrival

Anyone responding to an incident should begin to gather information about available resources and fire behaviour en route to the incident. Resource considerations:

- Where is the fire burning and are pre-plans available for the particular area?

- What resources are available in the initial protection area mutual or automatic aid?
- What resources will likely arrive at the incident first, day time mid week vs weekend?
- Are other incidents influencing resource availability, other fires in the area?
- Are specific resources at critical draw down levels?
- Will reflex time be an adverse factor affecting initial attack success, when will help show up?
- Will the topography require specialized resources, air attack?
- Have air resources arrived on scene before ground resources, communicate with Wildfire?
- Have IA crews started, confirm on route.

Arrival on Scene

The initial Officer or FF plays a pivotal role in establishing the Incident Action Plan and organizational structure. The Officers (IC) plan should include objectives, strategy and tactics that may remain in place throughout the duration of the incident. The organizational structure established by the initial IC sets the stage for expanding the incident organization if the incident escalates.

Size Up

Completing an accurate size up is critical for initial structure protection success. Size up includes evaluating fire behaviour and identifying evacuation needs, area closures, ground and air hazards, and values at risk including residential structures, out buildings, commercial buildings, historical sites, threatened and endangered habitat, and other exposures. When structures are threatened, the initial IC must decide if the threat demands immediate intervention or if a structure defense strategy should be utilized to stop the fire spread eliminating the threat to structures. The IC must take decisive action in either situation. It is unsafe and unacceptable to take a stand at a structure, or group of structures, and let the fire front advance to that position when there is ample time to initiate perimeter control action.

Initial Fire Report

For the size-up of wildfire reporting, the BCWS uses the **Initial Fire Report (IFR)** to maximize efficiency and accuracy of wildfire reporting. While sizing up a wildland fire, the IC completes the IFR form; when communicating the size-up to the appropriate BCWS Fire Centre, the IC follows the progression of the IFR. The BCWS dispatcher will be recording the received information in the same IFR progression and format.

Information Gathering

The Fire Behaviour Analyst (FBAN on a large fire) will be able to provide information on Fire Behaviour and Fire Spread Rates to help determine which areas will be at risk and when.
The FBAN will also be able to help determine trigger points to identify when it is appropriate to commence structure protection on different areas. If an FBAN is not on site, the BCWS I/C or

Ops will be able to get a Fire Behaviour Forecast from the Fire Centre. If available request and review the Incident Action Plan, this will assist you in determining critical incident information.

Incident Briefings

An incident briefing is the best way to ensure that all structure protection resources understand the incident objectives, strategies, and tactics. The briefing is especially important when new resources arrive at the incident and when resources move from one area of the incident to another. Use the Incident Response Pocket Guide (IRPG) briefing checklist to ensure the briefing is as complete as possible.

Structure protection crew leaders must learn how to prepare and deliver a crew briefing. Understanding and being able to develop an incident action plan (IAP) is the first step in requiring the critical information needed to deliver a briefing. A different safety message should be discussed prior to crew(s) being deployed each day. Safety messages can be found in an IAP, if no IAP has been developed, the team leader needs to make sure he or she writes an informal incident action plan. Use the above checklist as a guide, add other information in as required.

Briefing Checklist

Situation

□ Fire name, location, map orientation, other incidents in area
□ Terrain influences
□ Fuel type and conditions
□ Fire weather (previous, current, and expected) □
Winds, RH, temperature, etc.
□ Fire behaviour (previous, current, and expected) Time of day, alignment of slope and wind, etc.

Mission/Execution

□ Command Incident Commander/immediate supervisor
□ Leader's intent Overall objectives/strategy
□ Specific tactical assignments
□ Contingency plans
□ Medevac plan: Personnel, equipment, transport options, contingency plans.

Communications

□ Communication plan Tactical, command, air-to-ground frequencies Cell phone numbers

Service/Support

□ Other resources working adjacent and those available to order aviation operations □ Logistics, Transportation Supplies and equipment

Risk Management

□ Identify known hazards and risks

□ Identify control measures to mitigate hazards/reduce risk, Include LACES

□ Identify trigger points for re-evaluating operations

Hazards

On a WUI incident, firefighters may encounter:

- Panicked, angry, or trapped civilians
- Civilians who refuse to evacuate structures
- Civilians creating additional hazards on roadways during an evacuation
- Animal evacuations requiring additional vehicles
- Poor ingress/egress or road grades and surfaces not designed for large fire equipment
- Hazardous materials
- Downed power lines, fuel storage tanks, propane tanks, explosives, and other hazards
- Structures as part of the fuel load, (constructed fuels)
- Little or no defensible space around structures
- Inadequate water supply
- Increased smoke exposure (poor visibility, carbon monoxide effects, breathing difficulties)
- Extreme fire behaviour
- Concurrent structure defense and perimeter control operations
- Conflicting orders, or instructions from individuals not in the incident chain of command
- Limited options for shelter in place, escape routes, and safety zones.
- Increased political pressure and media interest

Risk Management Process:

Step 1 Situation Awareness:

- Gather Information
- Objective(s)
- Previous Fire Behaviour
- Communication
- Weather Forecast
- Who's in Charge?

- Local Factors
- Scout the Fire

Step 2 Hazard Assessment:

- Estimate Potential Fire Behaviour Hazards
- Look Up/Down/Around Indicators
- Identify Tactical Hazards
- Watch Outs
- What other safety hazards exist?
- Consider severity vs. probability.

Step 3 Hazard Control:

- 18 Watchout Situations
- 10 Standard Firefighting Orders
- LACES Checklist – MANDATORY
- Anchor Point
- Downhill Checklist (if applicable) What other controls are necessary?

Step 4 Decision Point:

- Are controls in place for identified hazards?
  NO – Reassess situation YES – Next question
- Are selected tactics based on expected fire behaviour?
  NO – Reassess situation YES – Next question
- Have instructions been given and understood?
  NO – Reassess situation YES – Initiate action

Step 5 Evaluate:

- Personnel: Low experience level with local factors?
- Distracted from primary tasks?
- Fatigue or stress reaction?
- Hazardous attitude?
- The Situation: What is changing?
- Are strategy and tactics working?

Accountability

Supervisors at every level need to know the location and assignment of all resources under their supervision. Maintaining this type of personnel, resource, and functional accountability on a WUI incident can present a challenge for fire line supervisors. Accountability systems vary and there is no universal standard within the fire service. Each firefighting resource (SPU, SPC, Engines, Dozers, Aircraft, Crews, etc.) must maintain an accountability system, commensurate with its departmental policy. Supervisors need to maintain accurate personnel rosters and document resource assignments and status on the Tactical Worksheet. Use an accountability system to track personnel and resources such as T-cards, a name tag system, or roll call. Everyone should provide information updates on their location and status at regular intervals.

Personnel Accountability Report

A PAR is a report verifying the status of personnel assigned to the incident. After a PAR is requested, all resources must report directly to their supervisor

Wildland Firefighting Strategies and Tactics

Many structural fire departments are becoming increasingly involved in the suppression of Wildland and Wildland/Urban fires. It is important to understand the tactics in which you will be directed to undertake. For maximum effectiveness, flexibility and safety, appropriate planning of tactics will be developed using the acronym P.A.C.E.

OFFENSIVE TACTICS- firefighter safety and structure defense

- **Primary** Tactic- undertaken to meet the objective
- **Alternate** Tactics- alternate tactic that can be undertaken if a trigger point is reached, but it is still safe to pursue the primary objective

DEFENSIVE TACTICS- firefighter safety and fire front following

- **Contingency** Tactics- Firefighter safety withdrawal and re-evaluation of current tactics
- **Emergency** Tactics- Firefighter safety is the only concern- withdraw and re-plan

Direct attack

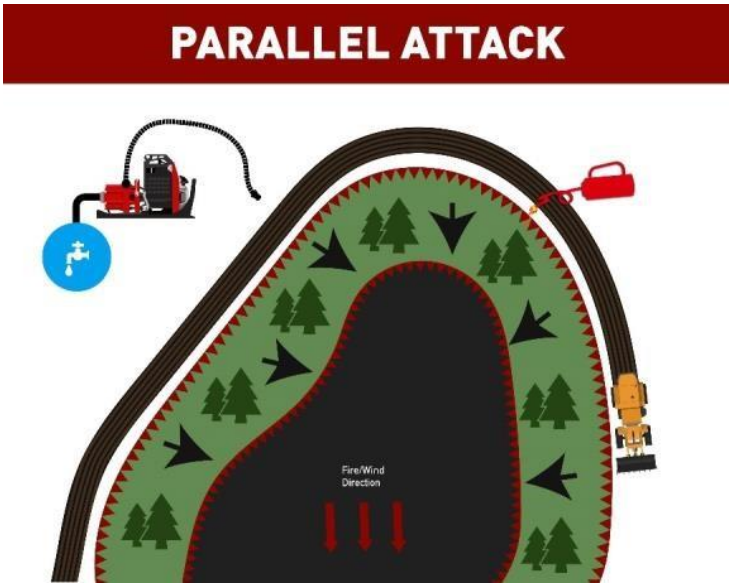
The direct attack method generally works best on fires burning in light fuels, or on low-intensity fires accessible to firefighters, enabling them to work close to the fire's edge or perimeter.

Direct attack usually begins by selecting an anchor point and advancing a 1-1/2-inch hoseline or handline directly around the fire's edge or perimeter. Flames may be knocked down by throwing dirt or by applying water to create a fire line. The fire line is constructed by scraping vegetation down to the mineral soil. There are two common direct-attack methods used to accomplish this tactic:

- Begin at a secure anchor point, usually at the rear of the fire, and proceed around the flanks toward the head.
- Advance hoselines from the rear up through the blackened area that already has burned over light fuels, splitting the head and working the flanks back to the rear. **This tactic works well on light fuels burning with low intensity. This tactic should not be used on medium or heavy fuels, or on residual burning and intensely burning fires.**

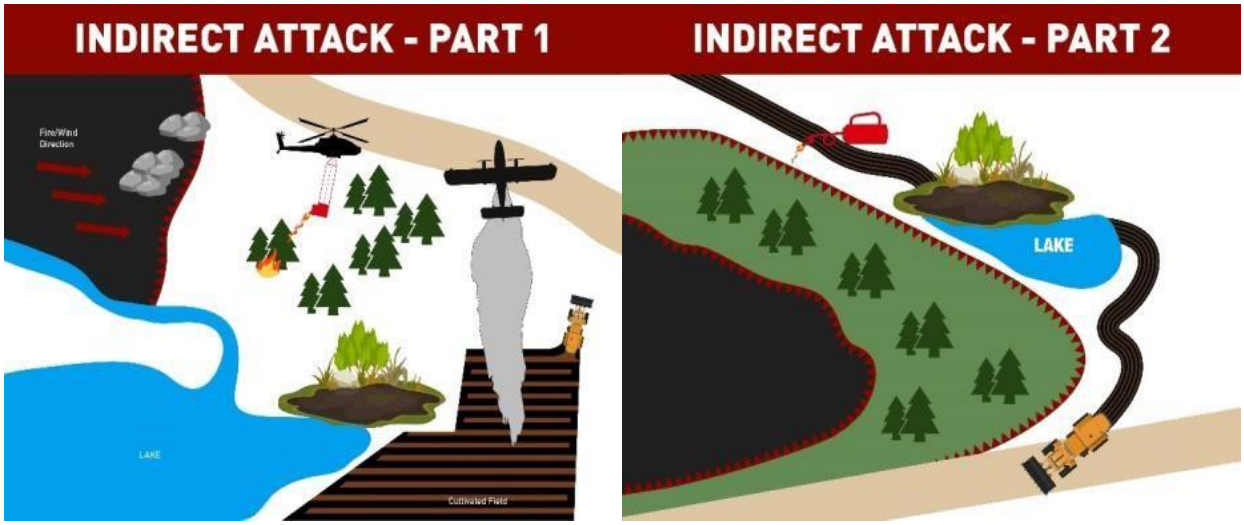
Parallel Attack

This method is applied in situations where a fire is spreading fairly rapidly. The fireline is constructed as close to the fire as heat, flames and smoke permit. This technique helps to control the fire rather than immediately stopping it (Direct Method). This may be done by crews or heavy machinery. The placement of the fireline must take into account all fire behavior factors to keep the fire within its intended boundary. If the fireline is constructed at a distance from the fires edge (leaving a strip of unburned fuel) **Prescribed Fire** can be an effective technique to reinforce your control line.



Indirect Attack

A method of suppression where the control line is located a considerable distance away from the fire's active edge. Generally used on fires burning in heavier fuels, high-intensity fires, or when fires are inaccessible and too hot, making it potentially unsafe to allow operations on the fire's edge or perimeter. Indirect attack is accomplished by building a fire line some distance away from the fire's edge or perimeter and removing the fuel between the fire line and the fire edge (frequently with Prescribed fire). Indirect attack takes advantage of natural or manmade barriers and allows the selection of final perimeter control. An engine company may be called upon to support this effort with hose lays to reinforce the fire line, fire line construction, or to patrol activities such as spot fires or hot spots along the fire perimeter.



Structure Defense Tactics

Structure defense is wildland firefighting and involves the use of WUI adapted wildland firefighting tactics. It also may include exterior activities to prepare the area for structure defense such as removal of wildland fuels around structures and using water enhancers and/or foam on surrounding vegetation and on the structures, themselves. Structural firefighting occurs when structure defense has failed, and the structure becomes involved in fire. The best form of structure defense is to suppress the wildland fire prior to structure ignition. Every effort should be taken to save property as long as these efforts **DO NOT** result in an undue safety risk for firefighters and the public we serve. Firefighters are taught that when engaged in indirect attack and there is unburned fuel between the firefighter and the fire, escape routes and safety zones must be established. The definition of a safety zone is a preplanned area of sufficient size

and location which is expected to protect personnel and equipment from the fire without using a fire shelter. The size of the safety zone is determined by the observed maximum flame height.

Resources

In many instances there are not enough firefighting resources to defend all structures immediately threatened. Save the structures that are most easily defended first before committing effort into those that will need further preparation to defend.

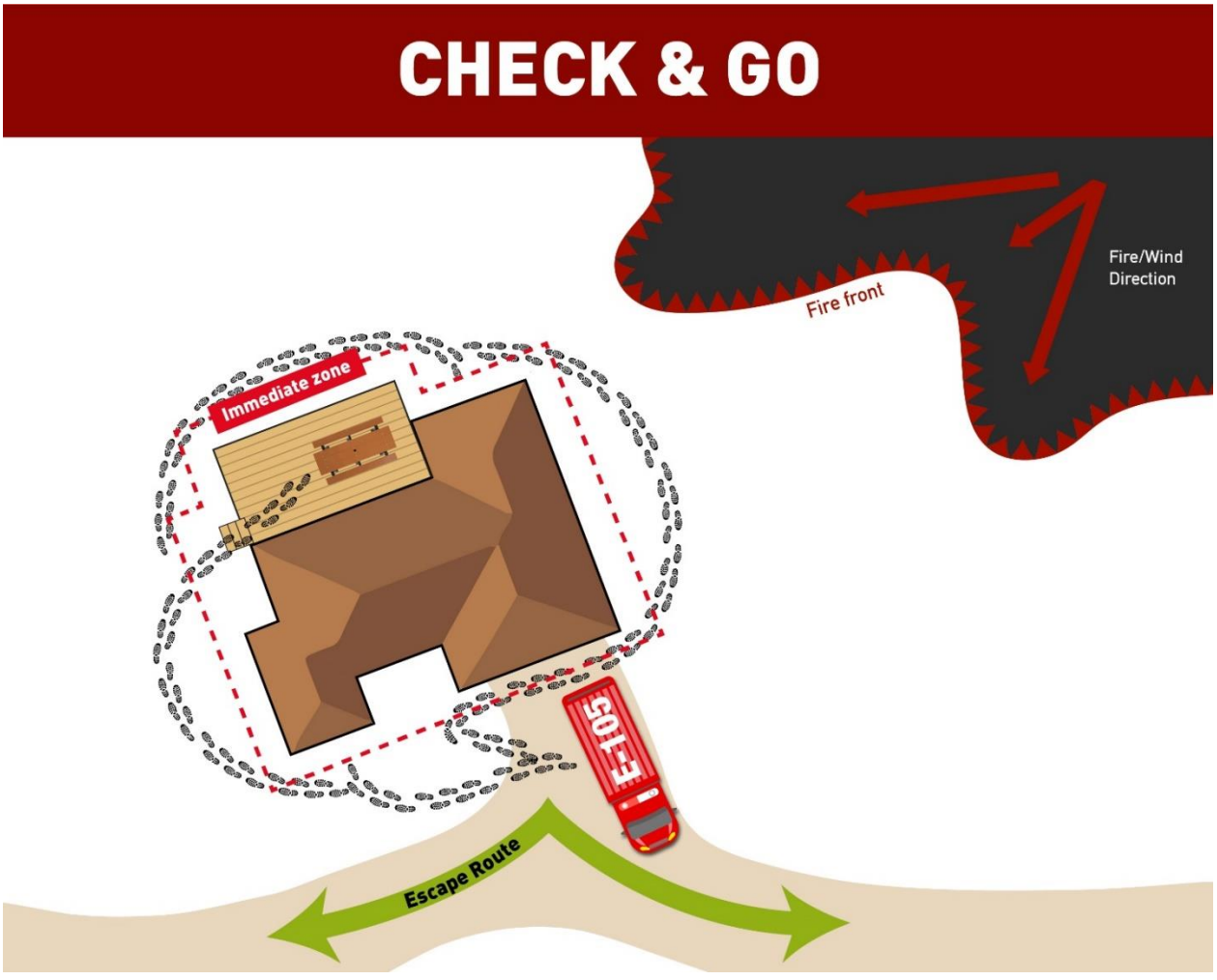
Non-Defendable Tactics

Non-Defendable Tactics are used when fire suppression resources DO NOT have safe access to Safety Zones during fire impingement operations.

Check and Go

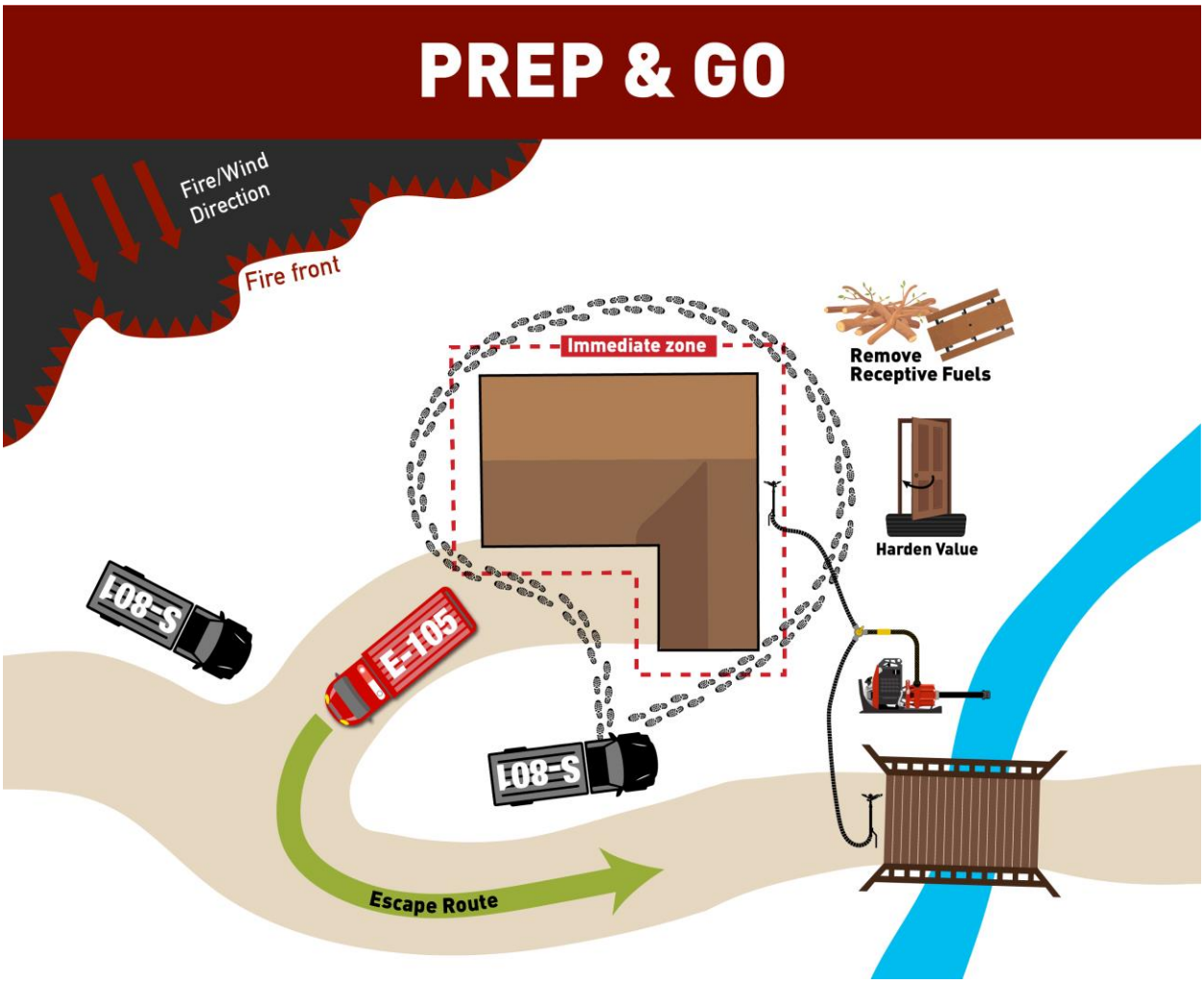
Check and Go is a rapid evaluation to check a structure for occupants who may require removal or rescue. In some instances, it may be necessary for firefighters to assist with evacuations prior to leaving. This tactic is appropriate when fire spread, intensity, lack of time, or inadequate defensible space prohibits resources from taking action to defend the structure.

- No Safety Zone/TRA is present, with possible extreme fire behavior, compressed time constraints and/or inadequate defendable space
- Engine positioned pointed in direction of travel to safety; be cautious committing to long driveways
- A rapid evaluation to check for occupants and evaluate for possible follow up action
- LEAVE NOW
- Close doors and windows as you check the building, consider removal of combustibles



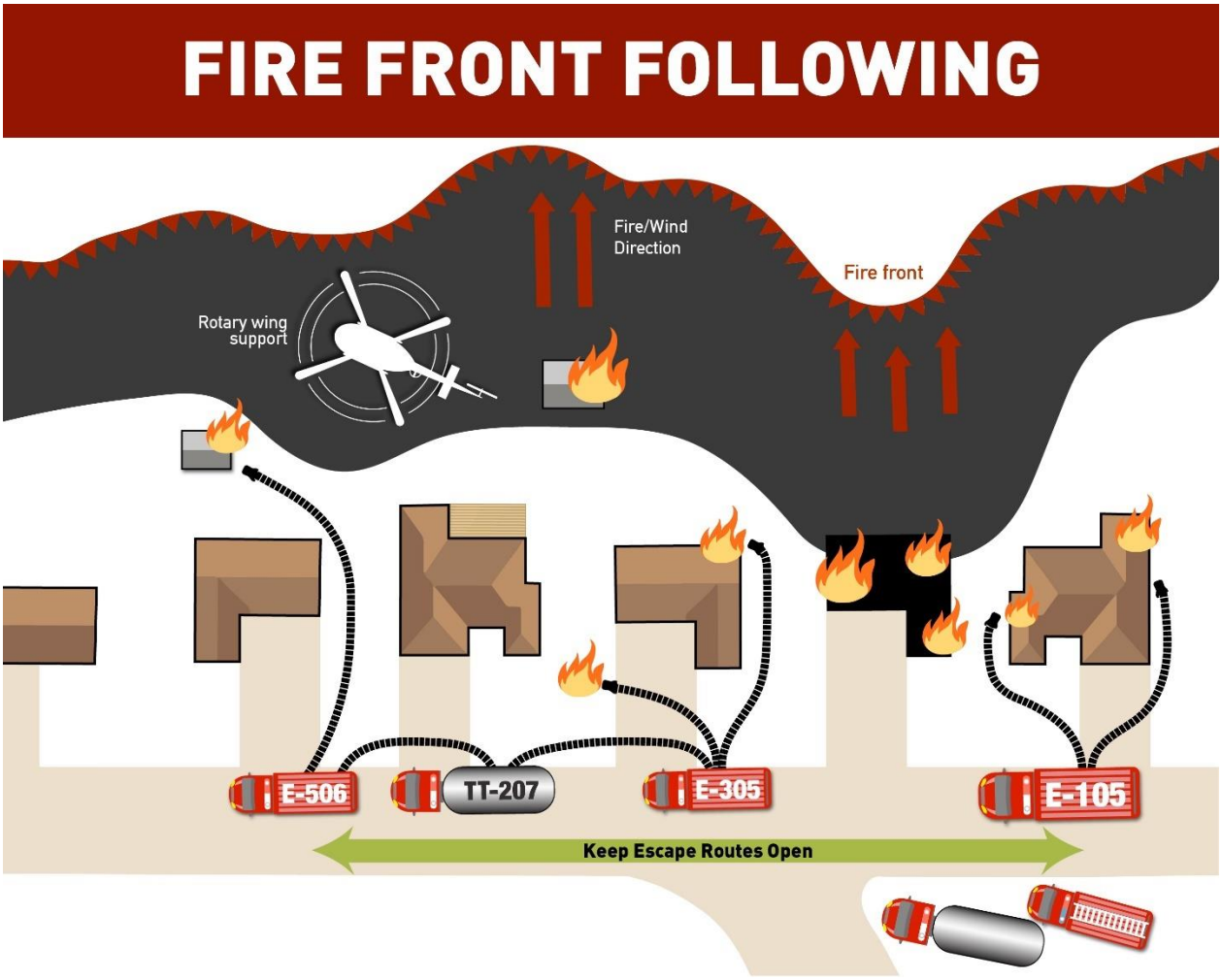
Prep and Go

- No Safety Zone/TRA is present and/or potential fire activity is too dangerous to remain
- Engine positioned pointed in direction of travel to safety; be cautious committing to long driveways
- Structure Preparation can be safely completed prior to fire front impact
    - Close Windows, Seal Vents, Remove Fuel, Mitigate Risks in Immediate zone, Deploy Sprinkler Protection Resources
- LEAVE before escape routes are compromised



Fire Front Following

- Used once fire front has passed
- Move into the area and action structures that are minimally involved in fire or immediately threatened by fire
- Maintain close communication with other engines to maintain situational awareness and identify targets
- When possible, conduct primary searches for victims and render aid to survivors



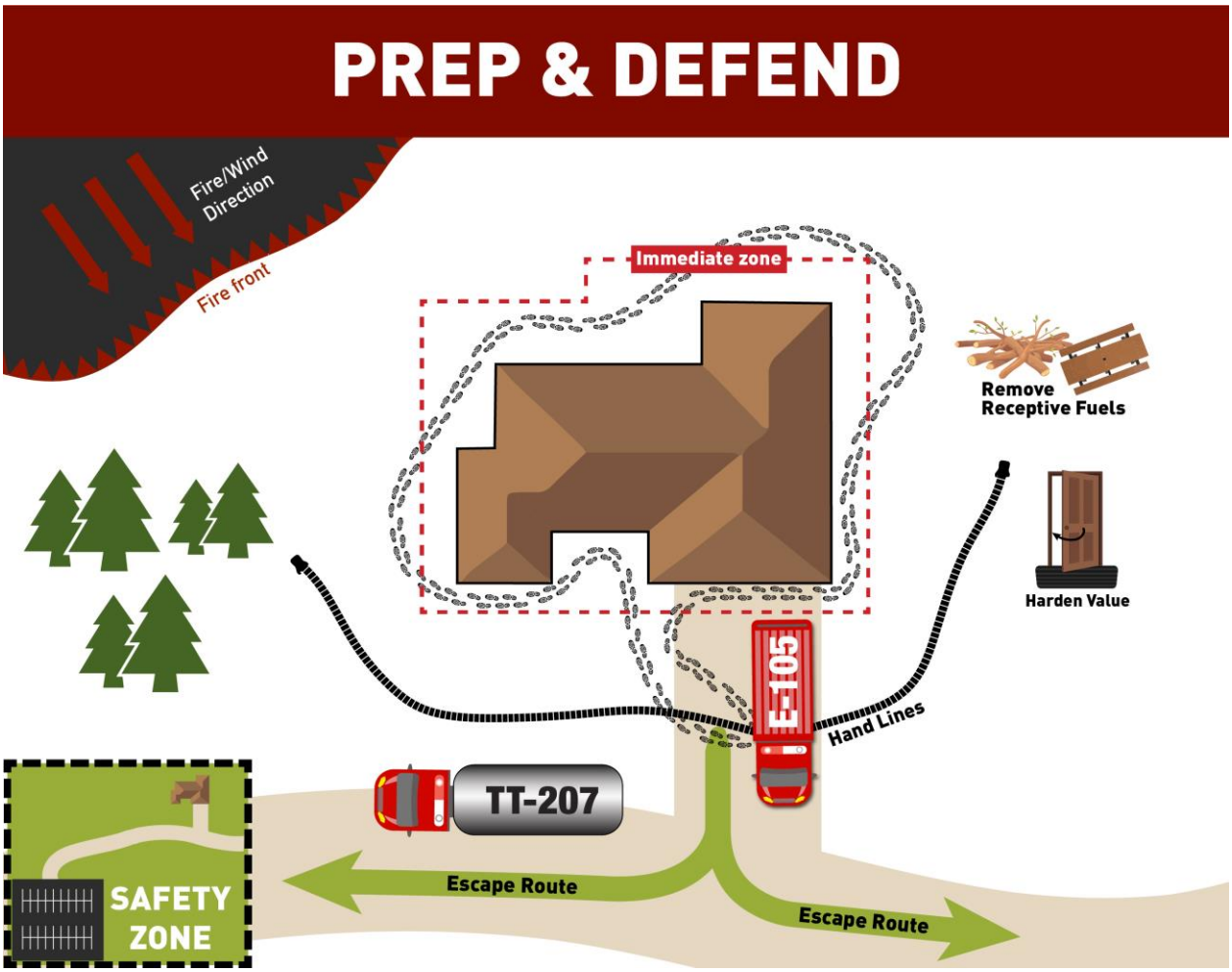
Defendable Tactics

Defendable Tactics require that fire suppression resources have safe access to Safety Zones during fire impingement operations.

Prep and Defend

Based on defense preparation priorities, deploy resources based on the probable fire impact area and where they will provide the most benefit. Structures requiring extensive preparation should receive more attention than standalone structures.

- Safety Zone is nearby AND a TRA is present
- There is enough time to prepare the structure for defence before the fire front arrives
- In high density areas, one engine may be able to defend 2-3 structures, depending on fire behaviour
- Situational awareness and escape routes must be maintained



Bump and Run

"Bump and Run" is a tactic where resources typically move ahead of the fire front in the spotting zone to extinguish spot fires and hot spots, and to defend as many structures as possible. Bump and run may be effective in the early stages of an incident when the resource commitment is light and structure defense is the priority.

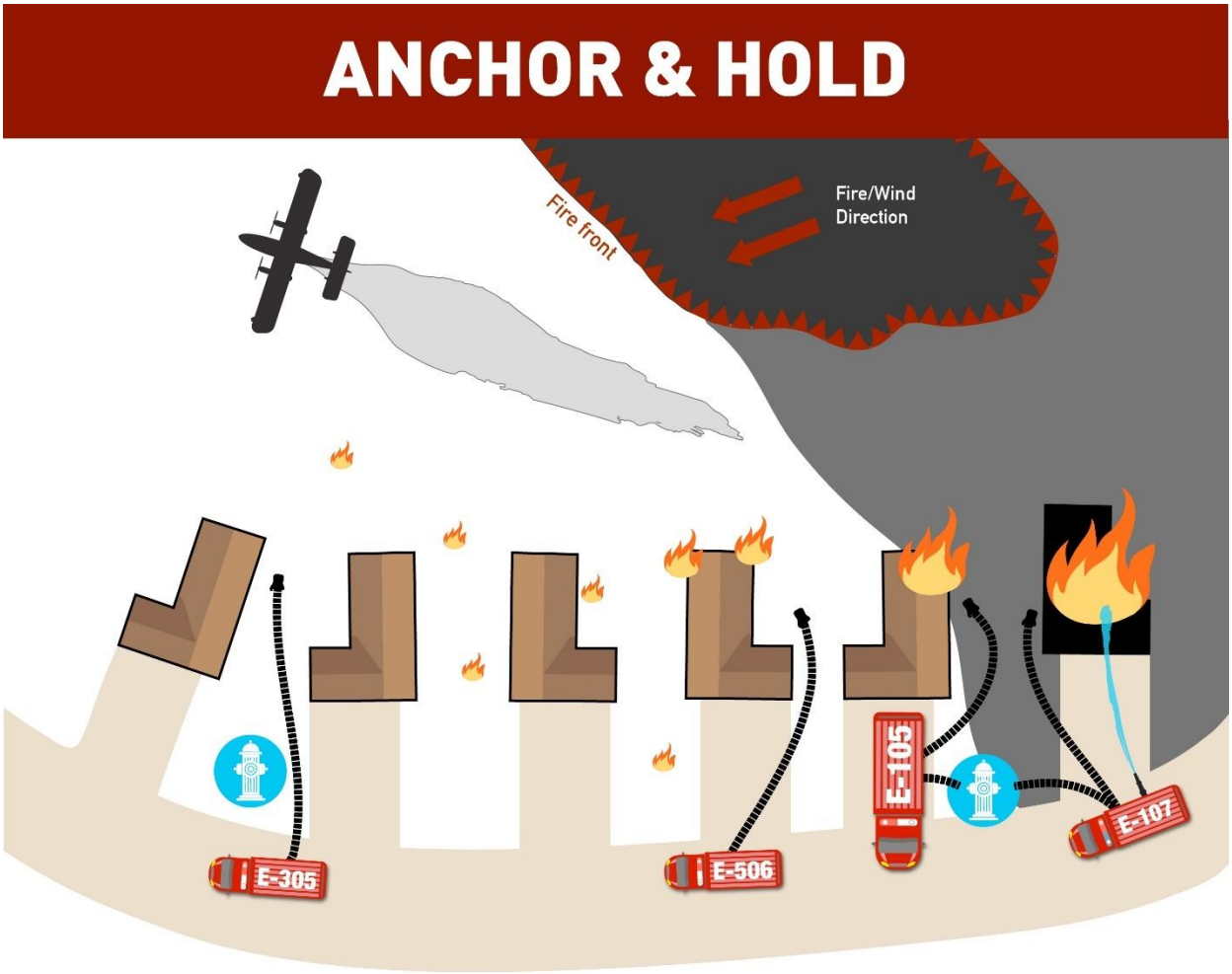
- Highly mobile tactic used in the spotting zone to control spot fires before they ignite structures
- Characterized by "leap-frogging" from target to target
- Maintain close communication with other engines to maintain situational awareness and identify targets
- Escape routes, safety zones and TRAs must be constantly re-established

Anchor and Hold

When the “Anchor and Hold” tactic is used, resources utilize control lines and large water streams in conjunction with fixed water supplies to control fire spread. The goal is to extinguish structure fires, protect exposures, and reduce ember production.

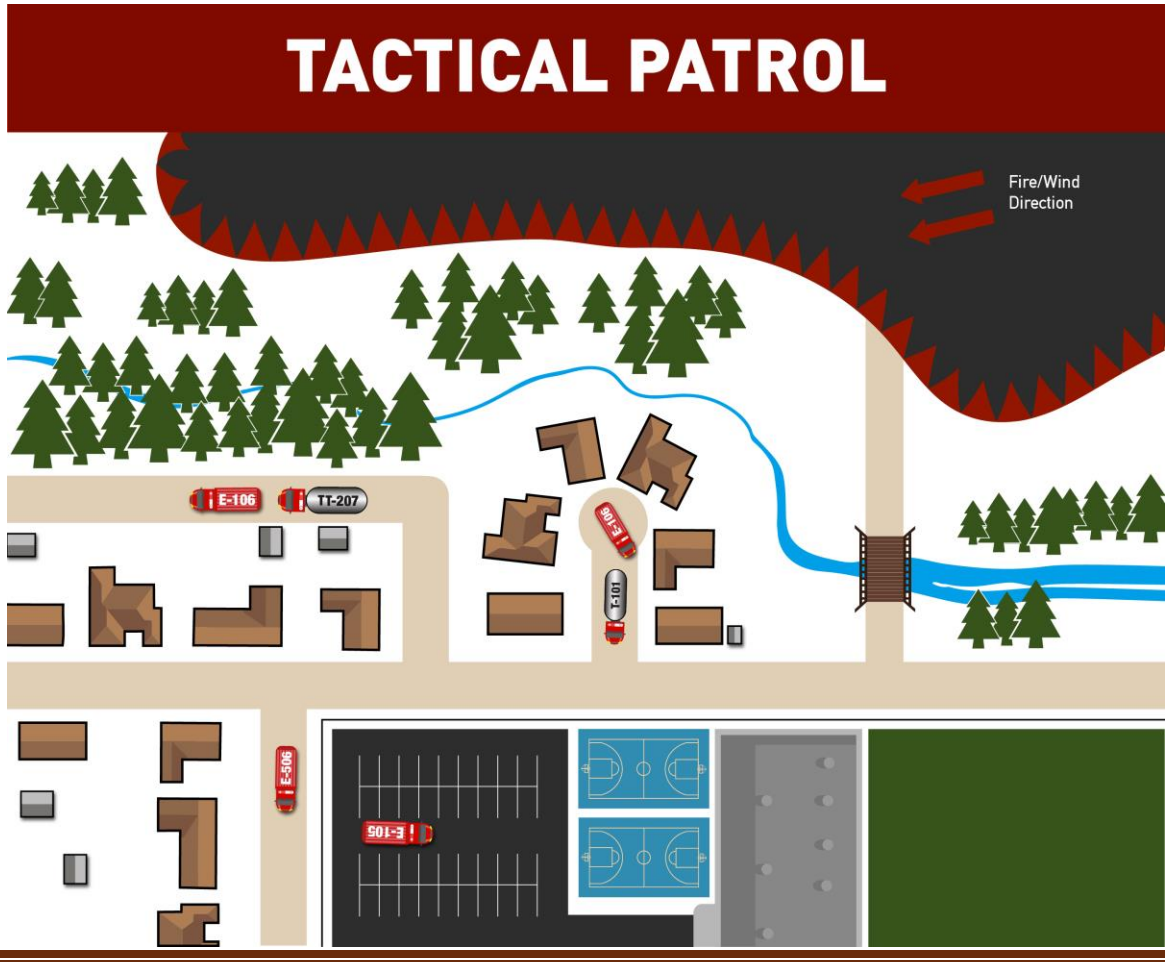
Anchor and hold can be called taking a stand to stop the fire's progression.

- Used to “make a stand” to hold the forward spread of the fire and/or prevent structure-to-structure ignition via radiant heat, ember ignition, or direct flame impingement
- Primarily Types 1 and 2 Engines, using deck guns and/or large diameter handlines, tied into hydrants or directly supported by assigned Tenders
- Full structural PPE may be required
- Must be used in conjunction with Tactical Patrol; crews must be ready to “cut and run” immediately, if fire behavior changes, or escape routes/TRAs are compromised



Tactical Patrol Can be either Defendable or Non-Defendable Tactic

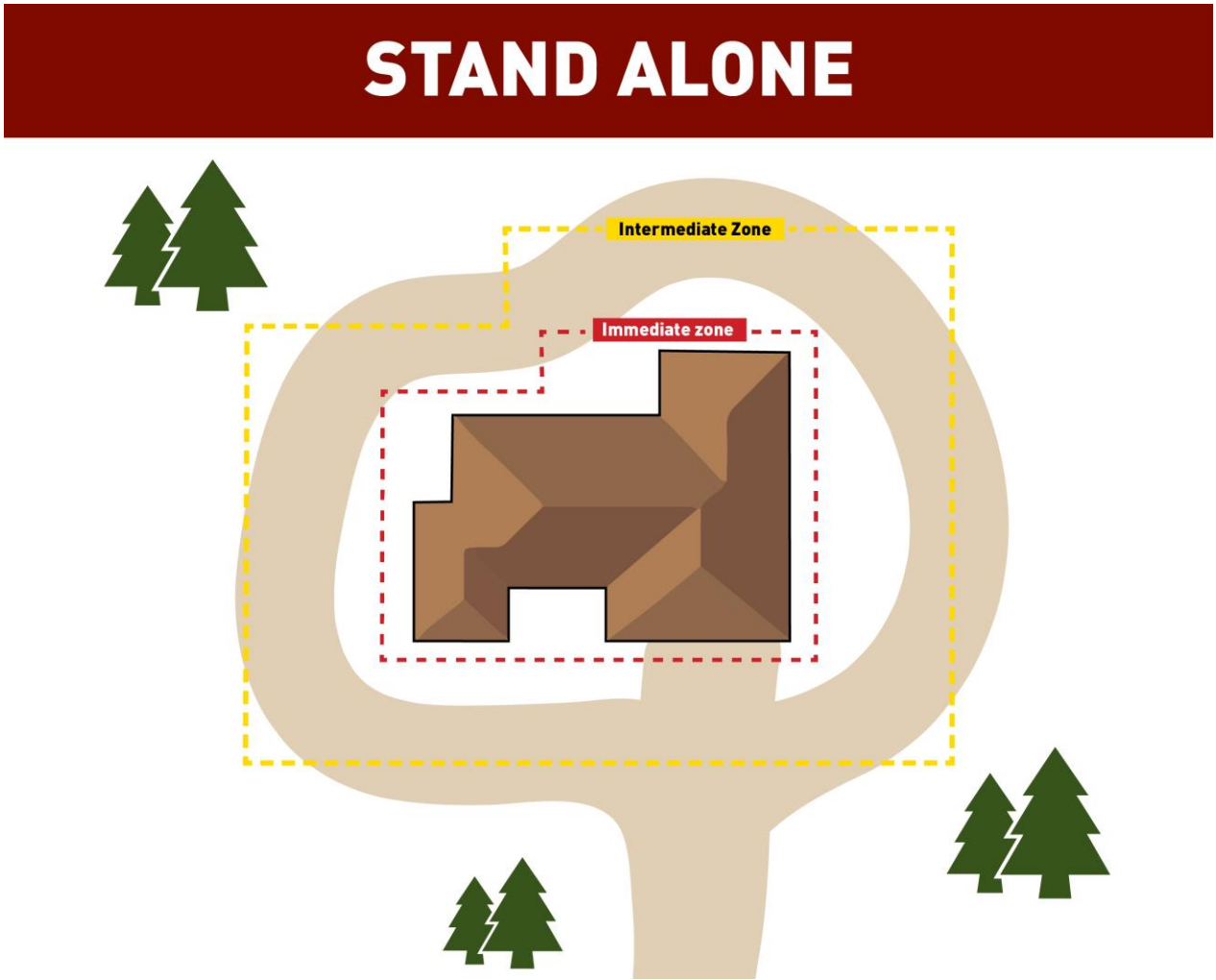
- Often overlooked
- An aggressive search and neutralize tactic
- Engines assigned specific areas to conduct saturation patrols and extinguish hot spots, spot fires or creeping fires around structures
- Also used to maintain escape routes and situational awareness for units engaged in Anchor and Hold operations
- Quick fire suppression to “Save what you can, and lose what you must”.
- Tactical patrol is reconnaissance performed in a non threatened area.
- Tactic: patrolling for area orientation, proactively triaging critical infrastructure and ember cast. LACES and trigger points must be identified to determine if the area is defendable or non defendable if it were to become threatened



Standalone

Standalone properties are those that have very few (if any) wildfire mitigation deficits within the Structure Ignition Zone, and very few tactical challenges with no tactical barriers. Firefighters may not need to be directly assigned to protect or defend the structure as it is not likely to ignite during fire impingement, however patrol and fire front following will likely be needed to defend the structures.

- Condition and Nature of the value (construction type) is resistant and not in proximity to projected fire spread, impingement and ember transplant.
- Ensure Fire Smart principles are being practiced and mitigate any immediate concerns (Door Mats- Open windows-Firewood- removing fuel trail that connects to structure, open gates of wooden fences.)
- Tactical Patrol is adequate to maintain situational awareness on any risks to this value



Structure Defense Guidelines

Personal Protective Equipment (PPE):

- Structure defense tactics can be undertaken utilizing standard wildland PPE.
- If the structure becomes involved in fire, and a decision is made to extinguish the fire, utilize the appropriate Structure Fire PPE including SCBA's as required.
- DO NOT enter a structure to extinguish a fire inside the structure unless you are trained to Interior or Full Operational, equipped and authorized, Work Safe 2 in 2 out applies.
- DO NOT base your decision to remain at a structure and/or the safety of your personnel on the use of SCBA's.

Apparatus Placement:

- Identify Escape Routes, Safety Zones and make them known to all personnel, STAY MOBILE and wear all your PPE.
- Back equipment in for a quick escape.
- Park in a cleared area (watch for overhead hazards).
- Protect your equipment (park behind the structure, placing the structure between equipment and fire front; be aware of spot fires occurring behind you).
- Watch for hazards (drop-offs, pot holes, above-ground fuel storage, chemicals, septic tanks, garbage pits, storm or root cellars, vehicle pits).
- Keep egress routes clear, especially if smoke conditions are an added hazard.
- Have an engine/personnel defense line charged and readily available.
- Avoid long hose lays.
- Try to keep sight contact with all personnel.
- Keep SPU's hooked up and facing outwards towards escape route, for easy egress if required.
- SPC trucks must be positioned for ease of access and egress options.

Structure Triage

Structure triage is the process of inspecting and classifying structures according to their likelihood of being **protectable**, or **not protectable** based on fire behaviour, location, construction materials, proximity of adjacent fuels, resources and timelines. The decision to engage in structure protection should always be based on a determination that the structure is in fact protectable and that any risks to firefighters can be safely mitigated. Therefore, structure triage decisions must be based on current and forecasted fire

behaviour. Any change in fire behaviour can quickly change the protectability status of a structure.

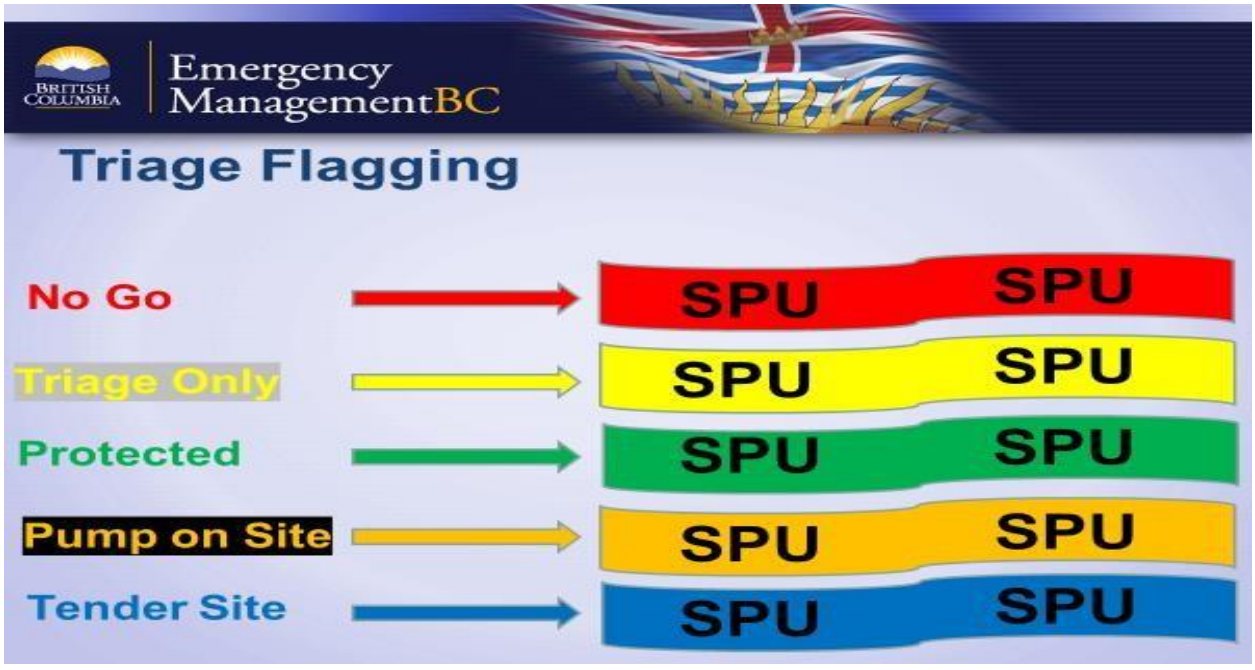
When deciding to protect a structure, firefighters must continually assess the fire environment as well as the physical features of the structure and its surroundings and make a reasonable forecast of what will happen when the fire impacts the location. Accurate fire behaviour forecasting is essential to effective structure triage and conducting safe structure defense operations. Firefighters have been injured and killed during structure ~~protection~~ defense operations when fire behaviour was underestimated.

Structure Triage App

A pre- designed app using Survey 123 is used by structure protection crews to assess and document structure vulnerabilities and equipment used. This can also be use in the preplanning stages of an incident.

BCWS Structure Triage Flagging

The following flagging colours will be displayed on each property as structures are triaged, protected and demobilized. Note that the RED flagging indicates a no go due either because the structure is not protectable or is unsafe for firefighters. DO NOT ENTER red flagged properties.



Structure Protection Tactics

Depending on time constraints, and firefighter safety, firefighters will engage in Structure Protection Tactics during the pre-impingement phase.

Rapid mitigation measures

- Remove small combustibles immediately next to the structure (Immediate Zone).
- Close windows and doors, including garage (leave unlocked).
- Clean area around fuel tank
  - Apply Class A foam if approved to do so by IC.
- Mark entrance to indicate a staffed location if it is not obvious.
- Charge hose lines.
- Long hose lays are not recommended.
- Keep 100 gallons of water in reserve.
- Identify a backup water source.
- Identify powerlines for aerial resources.
- Never rely on water for firefighter safety.
- If time permits, return to the structure and remove combustibles from the Intermediate Zone around each structure.

Patrol following the fire front

- Many structures do not burn until after the fire front has passed.
- Be aware of the structural collapse zone when structures are exposed to fire.
- Move to closest safety zone and let fire front go through.
- Return as soon as conditions allow safe access to structures.
- Secondary ignition is usually due to residual spot fires or creeping ground fire, as well as fire ember accumulation .
- Take suppression actions within your capability.
- Call for assistance if needed.

Mop Up & Patrol

Whether you are fighting a structure fire or a wildland event, you still will be required to mop up the incident. After the primary fire lines are constructed, many things need to be done to make the fire line safe and to extinguish the fire. The objective of mop-up is to extinguish all fire embers or sparks to prevent them from crossing the fire line.

Mop-up begins with the construction of the fire line. Ordinarily, mop-up is composed of two actions: putting the fire out and removing the fuel so that it cannot burn.

Structural fire apparatus may be assigned to patrol areas around the structure. The structural fire fighter and his/her crew should continually monitor fire behaviour.

General Guidance of Firefighter Work Practices

The Use of Gel Products

BCWS structure protection crews will not be using gel.
The use of gel by other agencies is subject to the approval of the local jurisdiction.

Chainsaw use

Other than certified fallers, only trained personnel may use chainsaws for bucking or falling trees under 15 cm. (6 inches) in diameter. Anything over 15 cm. (6inches) you must be a certified faller.

Conducting Firing Operations

Structure protection crews are not authorized to conduct burn outs. Inside an FPA – is at the discretion of the Local Authority. BCWS crews would normally conduct any burning out outside of an FPA.

Ladders

Ladders are used to access areas like gable ends of roofs to hang sprinklers or clean out eaves troughing. Structure Protection and Defense personnel do not go onto roofs. Ladders use must follow training and Department Operational Guidelines.

Structure entry

BCWS structure protection and structure defense crews will not enter structures unless directly approved to do so by SPS or IC. They will not enter a locked structure, 2 personnel must enter the structure together and only in relation to exposure mitigation, for example closing windows on a 2nd story that is inaccessible by ladder.

You must be knowledgeable of your own agency's procedures, and those of the agency you are working for.

Water Supply

Water delivery systems for supplying water for sprinkler operations may be simple or complex, involve the use of a single pump, multiple pumps or a gravity system that may require no pump

at all. Structure protection crews must assess each situation and develop an action plan to deliver water to support sprinkler operations in the most efficient and effective manner possible

Establishing a Pump Site

Establishing a safe pump site is important, because firefighters spend considerable time at the pump site.. This may mean taking the time to extend the hose lay along the edge of the water source to a safer pump site. Other pump site hazards include high concentrations of carbon monoxide at poorly ventilated pump sites and pump site fires started in dry fuels by the pump exhaust.

Effective Pump Site

Ideally, select level, solid ground, close to and preferably at the same level as the water source. This will allow the pump to be set up quickly and minimizes suction lift requirements. While you should never accept a pump site that compromises safety, you often have to adapt to establish an effective pump site. For instance, it is common to have to build a platform of logs for the pump to sit on in boggy ground.

Managing the Pump Site

A well-managed will be orderly and clean. The following are considerations:

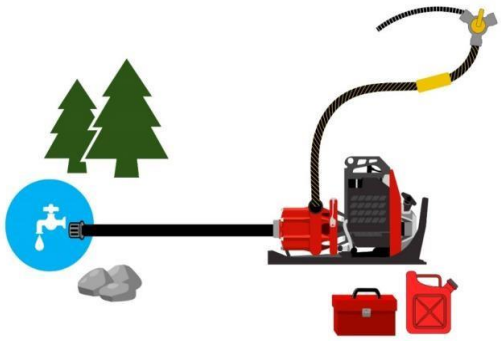
- pump is secure, supported off soft or wet ground-staked or roped as required
- fuel cans-secure, in a berm with sufficient quantities of fuel
- fuel cans are located on opposite side of pump exhaust • bleed off line is well away from pump, located in the elbow between the intake and discharge
- tool box secure and complete, no tools lying on ground
- foam is being used in accordance with established safety and environmental procedures
- consider theft adjacent to roadways

Pumps and Pumping

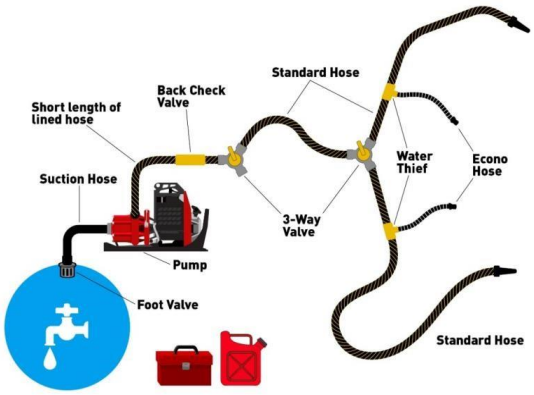
Single Pump System: Standard Hose Lay

- Is the most commonly used water system.
- Employs a single pump.
- Will support a dead end or looped supply line.
- Utilized for close in pumping.
- Utilized for long hose lays with minimal elevation.

SINGLE PUMP



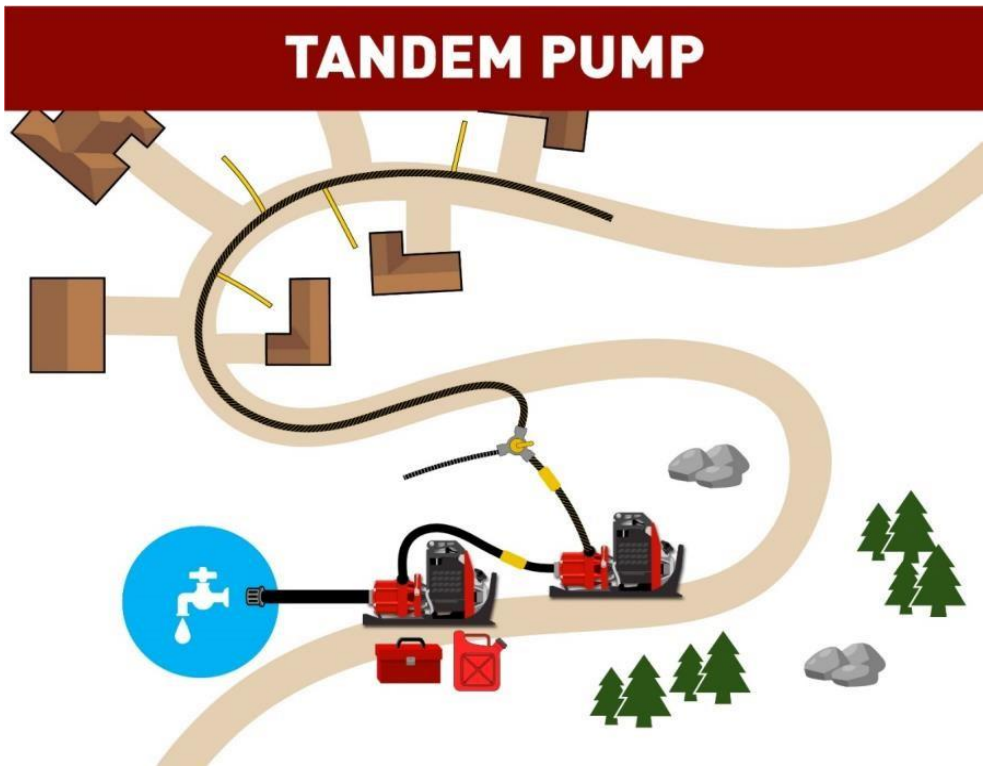
STANDARD HOSE LAY

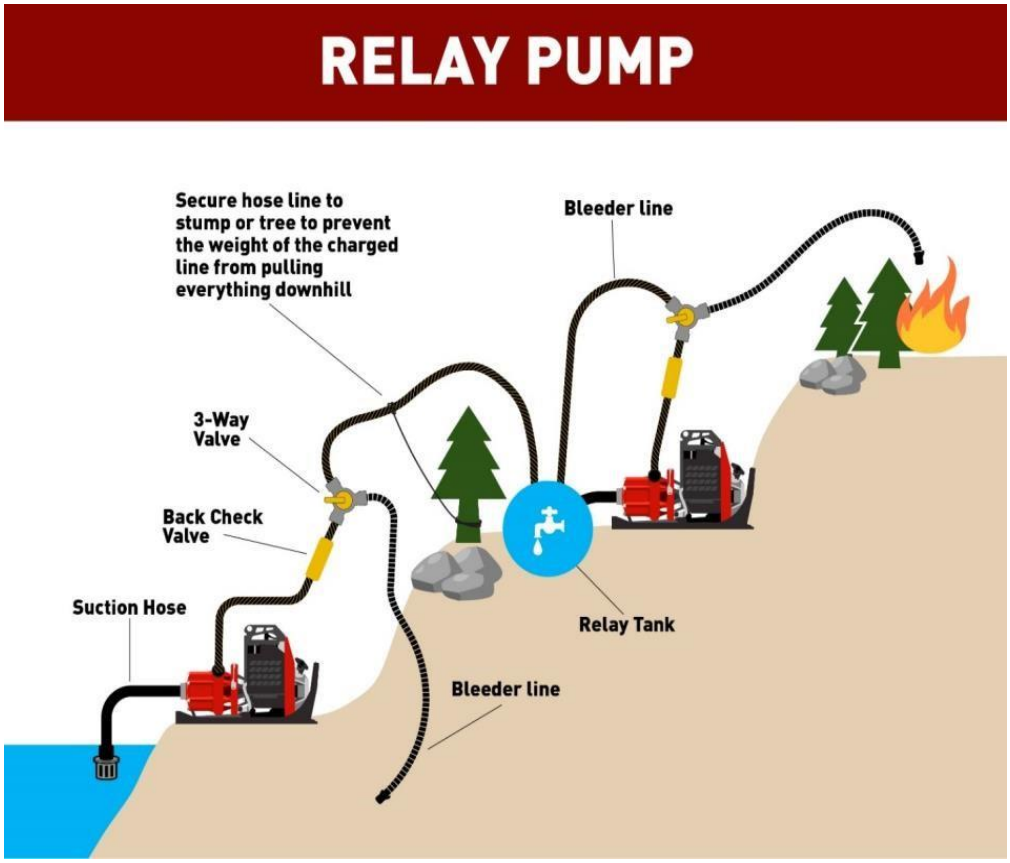


Multiple Pump Systems

Tandem Pump System

- Is not that common in structure protection.
- Employs multiple pumps (one behind the other).
- Used when a single pump is no longer able to maintain the required water pressure to support effective sprinkler operations.
- Utilized to overcome the effects of elevation gain or friction loss due to the length of the hose lay.



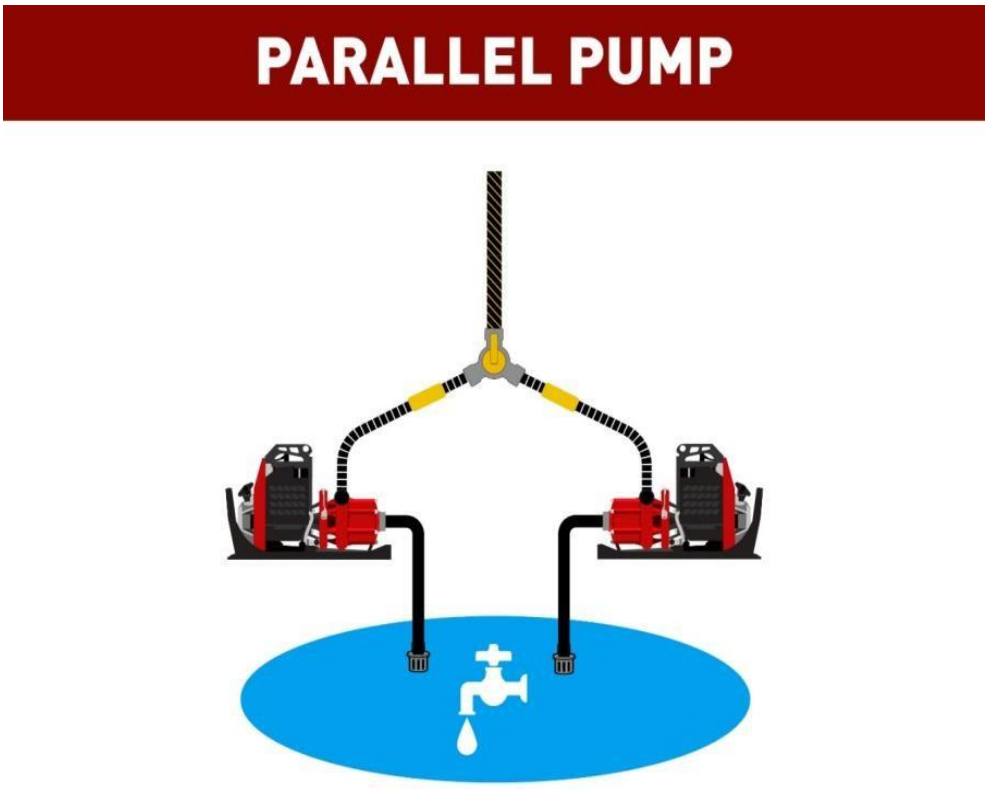


Relay Pump System

- Is not that common in structure protection.
- Employs multiple pumps.
- Incorporates a portable tank into the water delivery line (relay tank)
- Relay tank is placed between two pumps and serves as a reservoir in the relay of water from one pump to the other.
- Used when a single pump is no longer able to maintain the required water pressure to support effective sprinkler operations.
- Utilized to overcome the effects of elevation gain or friction loss due to the length of the hose lay.
- Eliminates water pressure strains on the hose that may be generated in a tandem pump system.

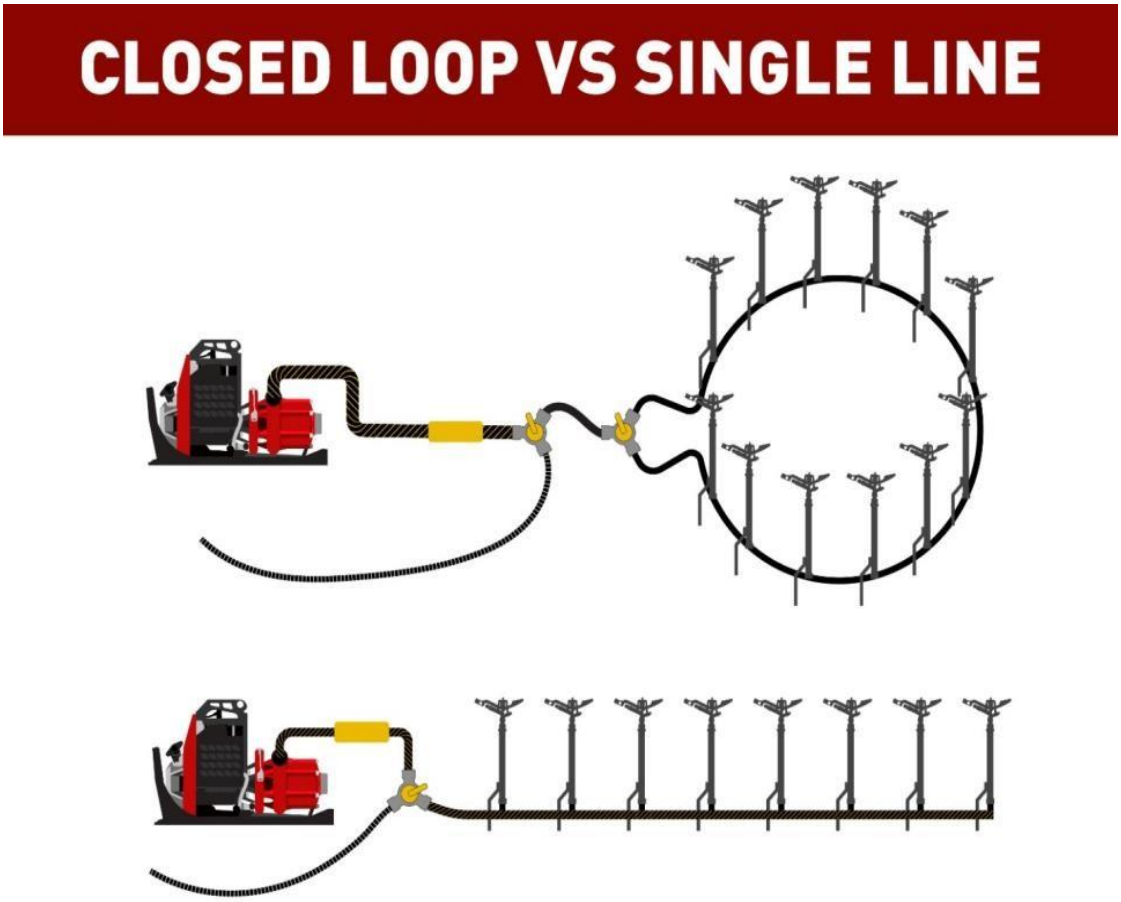
Parallel Pump System:

- A common pumping system when increased water volumes are required.
- Employs multiple pumps.
- Pumps are placed beside each other.
- The discharge water volume from each pump is channeled into a larger diameter hose line for distribution.
- Utilized when the water volume from a single pump is not adequate to support sprinkler operations and eliminates multiple supply lines from the pump site to the sprinkler site.



Closed loop hose lay

- Maintains constant pressure to all sprinklers
-20% increase in sprinklers supported



Documentation

- Complete documentation of structure protection operations is essential.
- Ensure structure triage form with site map is completed – note all equipment left on site as it's possible that other crews will demobilize.

Wildland Fire Management Guiding Principles

1. The first priority for all-risk decisions is human survival, both firefighters and the public.
2. Incident containment strategies specifically address and integrate protection of defendable improved property and wildland values.
3. Direct protection of improved property is undertaken when it is safe to do so, where there is sufficient time and appropriate resources available, and when the action directly contributes to achieving the overall incident objectives.
4. The firefighter's decision to accept direction to engage in structure defense actions is based on the determination that the property is defendable (safety zones) and the risk to firefighters can be safely mitigated under the current or potential fire conditions.
5. A decision to delay or withdraw from structure defense operations is the appropriate course of action when made in consideration of firefighter safety, current or potential fire behaviour, or lack of defensibility of the structure or groups of structures.
6. Firefighters at all levels are responsible for making risk decisions appropriate to their individual knowledge, experience, training, and situational awareness.
7. Every firefighter is responsible for awareness of the factors that affect their judgment and the decision-making process, including: a realistic perception of their own knowledge, skills, and abilities, the presence of life threat or structures, fire behaviour, availability of resources, social/political pressures, mission focus, and personal distractions such as home, work, health, and fatigue.
8. An individual's ability to assimilate all available factors affecting situational awareness is limited in a dynamic wildland and urban interface environment. Every firefighter is responsible to understand and recognize these limitations, and to decide, and act in preparation for the "worst case."
9. It is the responsibility of every firefighter to participate in the flow of information with supervisors, subordinates and peers. Clear and concise communication is essential to overcome limitations in situational awareness.

Ministry of Forests, Lands and Natural Resource Operations

INITIAL FIRE REPORT

INCIDENT NUMBER

REPORTED BY	DATE YY MM DD	TIME
GEOGRAPHIC LOCATION		
CO-ORDINATES LAT LONG	ELEVATION M/ft	

ALPHA – SIZE

- ☐ 1. Single Tree
- ☐ 2. Spot_____mX_____m
- ☐ 3. 0.1 - 0.2
- ☐ 4. 0.3 - 0.5
- ☐ 5. 0.6 - 1.0
- ☐ 6. 1.1 - 2.0
- ☐ 7. 2.1 - 4.0
- ☐ 8. 4.1 - 8.0
- ☐ 9. Other_____ha

BRAVO – FIRE RANK

- ☐ 1. Rank 1, Smoldering Ground Fire
- ☐ 2. Rank 2, Open Flame, No Spread
- ☐ 3. Rank 3, Vigorous Surface Fire, Moderate Spread, May See Candling
- ☐ 4. Rank 4, Moderate to Fast Spread Short Aerial Bursts, Spotting
- ☐ 5. Rank 5, Continuous Crown Fire, Spotting, dist. _____m
- ☐ 6. Rank 6, Continuous Crown, Blow-up

CHARLIE – FUELS

- ☐ 1.Grass
- ☐ 2. Brush
- ☐ 3. Deciduous
- ☐ 4. Slash
- ☐ 5. Reproduction
- ☐ 6. Open Timber
- ☐ 7. Heavy Timber
- ☐ 8. Other _____
- ☐ 9. FBP Type_____

DELTA – VALUES AT RISK (Immediately Threatened)

- ☐ 1. Life/Property _____
- ☐ 2. Timber (Forest)Resources (Includes Reproduction) _____
- ☐ 3. Other Special Values (Watersheds, Parks) _____
- ☐ 4. Distance _____ m. N S E W of the fire

ECHO – WIND

- ☐ 1. Calm
- ☐ 2. Speed _____ kph
- ☐ 3. Direction N S E W

FOXTROT – ADJACENT FUELS

- ☐ 1. Grass
- ☐ 2. Brush
- ☐ 3. Deciduous
- ☐ 4. Slash
- ☐ 5. Reproduction
- ☐ 6. Open Timber
- ☐ 7. Heavy Timber
- ☐ 8. Other _____
- ☐ 9. FBP Type _____

GOLF – SLOPE

- ☐ 1. Flat/Rolling
- ☐ 2. Moderate < 30%
- ☐ 3. Steep >30% < 60%
- ☐ 4. Extreme >60%

HOTEL – ASPECT

- ☐ 1. North
- ☐ 2. South
- ☐ 3. East
- ☐ 4. West

INDIA – SLOPE POSITION

- ☐ 1. Bottom
- ☐ 2. Lower Third
- ☐ 3. Middle Third
- ☐ 4. Upper Third
- ☐ 5. Top

JULIET – ACCESS

- ☐ 1. Road _____ m
- ☐ 2. Helispot _____m
- ☐ 3. Hover Exit _____m
- ☐ 4. Other _____m
- ☐ 5. N S E W of the fire

KILO – AVAILABLE WATER

- ☐ 1. None
- ☐ 2. Adjacent
- ☐ 3. _____ m. N S E W of the fire

LIMA – PAPER TRAILED

☐ 1. Yes ☐ 2. No

MIKE – PHOTOS

☐ 1. Yes ☐ 2. No

NOVEMBER – SUSPECTED FIRE CAUSE

☐ 1. Human ☐ 2. Lighting

ACTION TAKEN/RECOMMENDED

PROBABILITY OF SUCCESS: LOW_____ MED _____ HIGH _____

RECEIVED BY: **ESTIMATED COST OF CONTROL: $**

FS 260 HPR 2012/04

BC Fire Weather Codes:

FFMC - Fine Fuel Moisture Code

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

DMC - Duff Moisture Code

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

DC - Drought Code

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, and amount of smouldering in deep duff layers and large logs.

ISI - Initial Spread Index

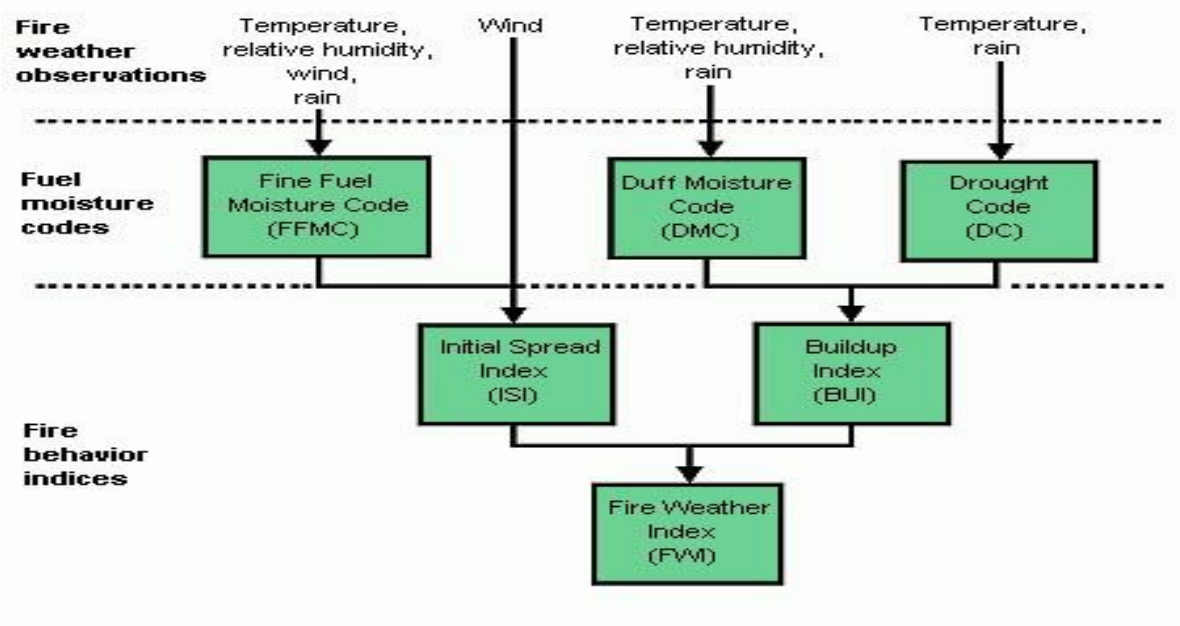
A numerical rating of the expected rate of fire spread. It combines the effects of wind and FFMC on rate of spread without the influence of variable quantities of fuel.

BUI - Build Up Index

A numerical rating of the total amount of fuel available for combustion that combines DMC and DC.

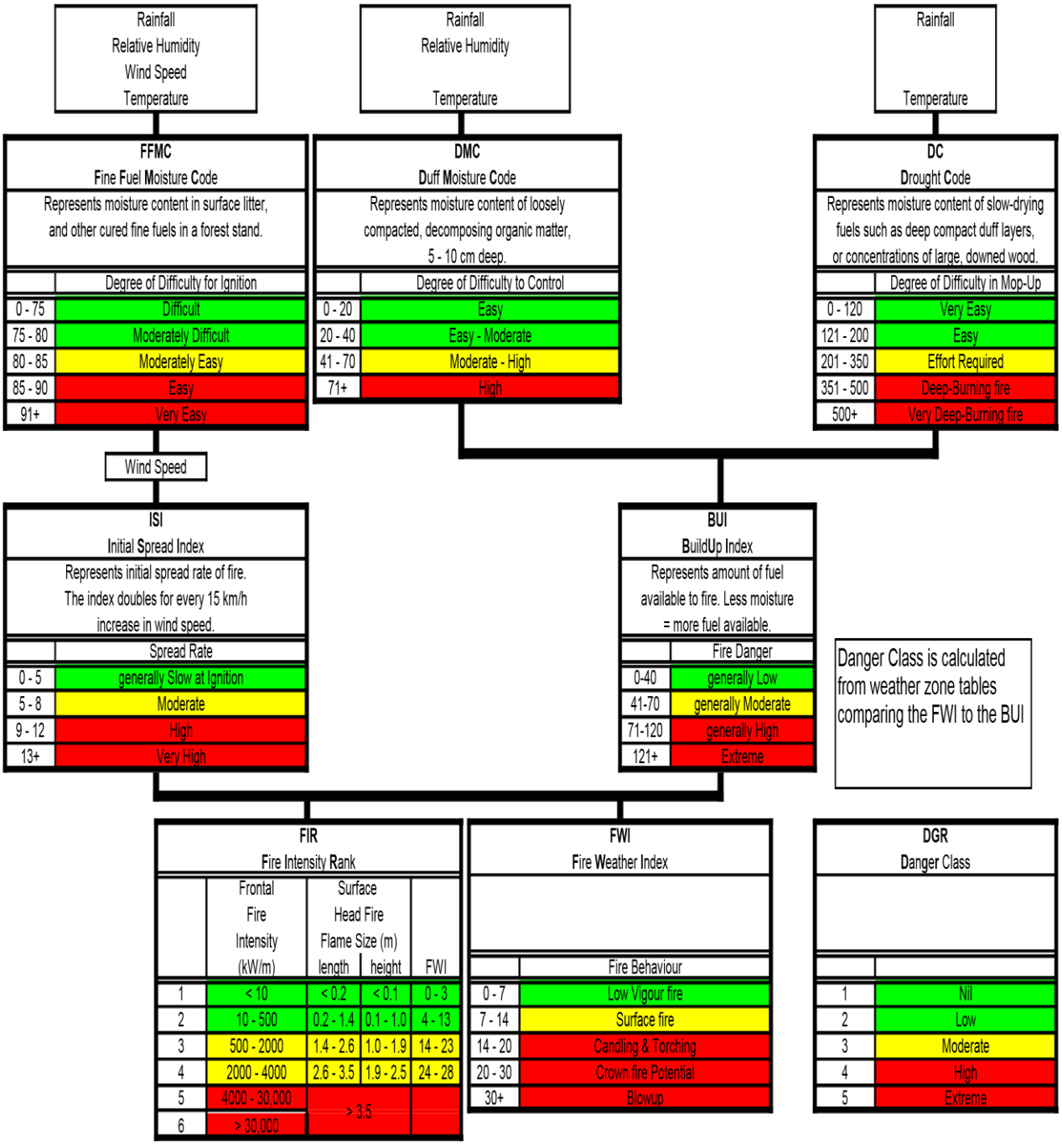
FWI - Fire Weather Index

A numerical rating of fire intensity that combines ISI and BUI. It is suitable as a general index of fire danger throughout forested and rural areas.



FIRE-WEATHER INDICES FIELD-GUIDE

1300 Daylight: **TEMP** Celsius/tenths temperature **RH** % Relative Humidity **WD** 8 points Wind Direction FROM **WS** km/h Wind Speed 0=calm **PREC** mm/tenths 24-hour Precipitation


Rainfall
Relative Humidity
Wind Speed
Temperature
Rainfall
Relative Humidity
Temperature
Rainfall
Temperature
FFMC
Fine Fuel Moisture Code
Represents moisture content in surface litter, and other cured fine fuels in a forest stand.
Degree of Difficulty for Ignition
0 - 75 Difficult
75 - 80 Moderately Difficult
80 - 85 Moderately Easy
85 - 90 Easy
91+ Very Easy
DMC
Duff Moisture Code
Represents moisture content of loosely compacted, decomposing organic matter, 5 - 10 cm deep.
Degree of Difficulty to Control
0 - 20 Easy
20 - 40 Easy - Moderate
41 - 70 Moderate - High
71+ High
DC
Drought Code
Represents moisture content of slow-drying fuels such as deep compact duff layers, or concentrations of large, downed wood.
Degree of Difficulty in Mop-Up
0 - 120 Very Easy
121 - 200 Easy
201 - 350 Effort Required
351 - 500 Deep-Burning fire
500+ Very Deep-Burning fire
Wind Speed
ISI
Initial Spread Index
Represents initial spread rate of fire. The index doubles for every 15 km/h increase in wind speed.
Spread Rate
0 - 5 generally Slow at Ignition
5 - 8 Moderate
9 - 12 High
13+ Very High
BUI
BuildUp Index
Represents amount of fuel available to fire. Less moisture = more fuel available.
Fire Danger
0-40 generally Low
41-70 generally Moderate
71-120 generally High
121+ Extreme
Danger Class is calculated from weather zone tables comparing the FWI to the BUI
FIR
Fire Intensity Rank
Frontal Fire Intensity (kW/m)
Surface Head Fire Flame Size (m) length
Surface Head Fire Flame Size (m) height
FWI
1 < 10 < 0.2 < 0.1 0 - 3
2 10 - 500 0.2 - 1.4 0.1 - 1.0 4 - 13
3 500 - 2000 1.4 - 2.6 1.0 - 1.9 14 - 23
4 2000 - 4000 2.6 - 3.5 1.9 - 2.5 24 - 28
5 4000 - 30,000
6 > 30,000
> 3.5
FWI
Fire Weather Index
Fire Behaviour
0 - 7 Low Vigour fire
7 - 14 Surface fire
14 - 20 Candling & Torching
20 - 30 Crown fire Potential
30+ Blowup
DGR
Danger Class
1 Nil
2 Low
3 Moderate
4 High
5 Extreme

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