Wildland Fire Investigation, FI–210
Origin and Cause Determination

UNIT 0
INTRODUCTION/ORIENTATION

0-1 Welcome

Welcome. This is your pre-course work for Wildland Fire Investigation FI-210, Origin and Cause Determination.

A competent fire investigator must have skills and knowledge from two diverse backgrounds: fire behavior and law enforcement. Few students start this course with a full understanding of both. Therefore, this pre-work is intended to fill in those gaps whether you are a firefighter or law-enforcement officer.

Even if you believe you are already familiar with the subject matter, it will be worth your time to work through each of the units, if only to refresh your knowledge.

0-2 Using This Course

Finding your way around the course software is simple. The NEXT button takes you to the next page, and the BACK button will take you back one page. If you miss something or want to start a specific page over again, just click RESTART and the media information for that page will begin again. Clicking on the MENU button will bring up a list of all the units in this course. Double click on any one of them to go to that unit. Click on the GLOSSARY button to bring up a page of standard terms used in the course and their definitions. You might want to print this page out for future reference. The EXIT button will shut down the course.

How to use this course:

- NEXT goes forward one page
- BACK goes back one page
- RESTART restarts the current page
- MENU displays all of the units in this course
- Double-click on any unit to go to that unit
- GLOSSARY displays terms used in this course
- EXIT ends the program

0-3 Course Objectives

Once you have completed this self-study course you will be able to understand the three sides of the fire triangle, identify the environmental factors of wildland fire behavior that affect the start and spread of fire, and recognize situations that indicate problem or extreme fire behavior.

Objectives:

- Understand the three sides of the fire triangle
- Identify environmental factors affecting the start and spread of fire
- Recognize situations that point to problem or extreme fire behavior

UNIT 1
FIRE BEHAVIOR REVIEW

1-1 Unit Objectives

The first unit will look at fire-behavior factors affecting the start and spread of wildland fire. It is presented in a format originally intended for firefighters, but it is equally important for fire investigators.

This information is vital for a complete understanding of fire-ignition sources and the interpretation of burn patterns. Even though you may already have a suppression background, we encourage you to review it carefully.

To begin, study each of the nine objectives listed on the screen carefully. Feel free to go back and review at any time. At the end of this unit you must successfully complete a short examination.

Objectives:

1. Describe the fire triangle
2. Identify three methods of heat transfer
3. List the three principal environmental elements affecting wildland fire behavior
4. List three factors of fuel that affect the start and spread of wildland fire
5. List three factors of weather that affect fuel moisture
6. Describe how wind affects wildland fire spread
7. Describe how slope affects wildland fire spread
8. List four factors of topography that affect wildland fire behavior
9. Describe the dangerous conditions that can develop in a box canyon and steep narrow canyons

1-2 Fire Behavior Factors

Each year upwards of 60,000 wildland fire ignitions occur throughout the United States. Each one of them must be handled in accordance with identified resource-management objectives. Selecting the proper management option requires a thorough knowledge of fire behavior.

Any ignition has the potential to grow into a major fire that could have dramatic effects on resource values, the appearance of the landscape, and public opinion. All it takes to unleash this powerful force of change is something as simple as a carelessly thrown match, an unattended campfire, or a thunderstorm.

Unnoticed, even the smallest blaze can soon become a rapidly growing wildland fire that requires extensive management. But many of these ignitions don't become big fires because firefighters like you intervene and stop them; firefighters who know how a fire behaves. In order to manage fire, you must learn its characteristics, and the factors that influence fire spread. The more you know about wildland fire behavior the more likely you are to choose the correct strategy to provide for safety and meet resource-management objectives as you work to put the fire out.

1-3 Factors of Fuel - Ignition

Any fire begins with ignition, and a match is the most common ignition device. Friction creates sufficient heat to ignite the phosphorus, combustion occurs, and the match flames.

1-4 Factors of Fuel - Elements

In order for combustion to occur, three elements must be combined. There must be fuel to burn, air to supply oxygen, and heat to ignite the fuel which emits gasses in the form of flame. These three elements make up what we call the fire triangle. If any one of them is missing, there can be no fire.

1-5 Factors of Fuel - Demonstration

All the necessary ingredients for combustion are present in this demonstration – heat from the match, oxygen from the air, and fuel in the candle. But remove any one of these ingredients, in this case oxygen, and the fire goes out. The same principle is used in controlling wildland fires. We remove heat, we remove oxygen, or we remove fuel, and the fire goes out.

Ingredients for combustion:

- Heat
- Oxygen
- Fuel

1-6 Factors of Fuel – Heat Transfer

In order for a fire to continue burning, heat must be transferred from one piece of fuel to another. There are three ways this can happen – conduction, convection and radiation.

Heat transfers in three ways:

- Conduction
- Convection
- Radiation

1-7 Factors of Fuel – Conduction, Convection and Radiation

Conduction is the transfer of heat within the material itself. Think of a spoon being heated in a hot drink. Most metals are good conductors; wood, on the other hand, is a poor conductor and transmits heat slowly. Conduction is the least important factor in the spread of wildland fires.

Convection is the transfer of heat by the flow of liquids or gases which, when heated by the fire, expand and rise. In wildland fires you see them as smoke. If this heated mixture of air, particles, and gases is confined to a column, the convection current can become strong enough to reach 20,000 feet or higher and loft burning embers beyond the fire front. If wind pushes the convection column over unburned fuel, these hot gases can dry and ignite other fuels.

Radiant heat is what you feel from the sun on a warm day, or when you stand close to a campfire. In wildland fires radiation will dry fuel ahead of the fire and increase its ability to ignite.

1-8 Fire Behavior Factors

How fire behaves is governed by the amount and types of fuel available, as well as the weather and the topography. Careful observation of these three critical environmental elements allows us to accurately predict wildland fire behavior.

Fire behavior is governed by:

- Fuel
- Weather
- Topography

1-9 Fire Behavior Factors – Fuel Types

Fuel can be defined as any combustible material. Most wildland fires are fueled by plant material, both living and dead, which is grouped into these four major types based on the primary fuel that carries the fire. It's important to note that live fuels have different effects on fire than dead fuels. Fuel types vary from one part of the country to another, and often even within the same area. You will need to become familiar with all the fuel types in any area where you are working with fire.

Fuel types:

- Grass: Found almost everywhere; dominant fuel in desert and range
- Shrub: Found almost everywhere
- Timber litter: Dominant in mountains, especially in the Northwest
- Logging slash: Debris left after logging, pruning, thinning, or shrub-cutting

1-10 Fire Behavior Factors – Moisture Content

How easily a fuel will ignite and how fast it will burn depends, to a large extent, on its moisture content. The higher the moisture content of the fuel, the more heat needed to ignite and burn it. When fuels are moist, combustion is slow because more heat is required to evaporate the

moisture. As the fuel becomes drier, more heat is available to heat the fuel itself. Dry fuels will ignite and burn quickly. Because of their different sizes and characteristics, different fuels in the same area will have different moisture levels. In this demonstration, the fuel in the upper chamber has a moisture content of 7%, while the fuel in the lower chamber has a moisture content of 25%. All other conditions are equal.

1-11 Fire Behavior Factors – Fuel Types

Size and shape of fuel also contributes to fire spread. Light, fine fuel is surrounded by plenty of oxygen, so it can be quickly heated to ignition. Fire in light fuel spreads rapidly, but burns out quickly. Heavy fuel, on the other hand, dries and warms slowly, and the interior becomes exposed to oxygen only after the outside surface has burned off.

Light vs. heavy fuels:

- Light fuel: Ignites, spreads, and burns out quickly
- Heavy fuel: Dries and warms slowly; the interior is exposed to oxygen only after the exterior has burned away

1-12 Fire Behavior Factors – Horizontal Fuel Arrangement

The quantity of fuels available for combustion in an area is referred to as fuel loading. Ordinarily, the greater the fuel loading, the more intense the fire will be, and the greater the heat output. However, in addition to considering the moisture content, you should also look at the way the fuel load is arranged. It may be light fuel or heavy fuel, spread uniformly over the ground, or in a patchy formation.

Horizontal continuity: One of the two ways in which fuel is distributed over a given area. It can be broken down as follows:

- Uniform fuels: Fuels distributed continuously over the given area, providing an unbroken path for a fire
- Patchy fuels: Fuels distributed unevenly, or fuel areas divided by breaks or barriers

1-13 Fire Behavior Factors – Vertical Fuel Arrangement

Vertical fuel arrangement is just as important as its arrangement over the ground. Ground fire consumes the organic and combustible materials beneath the surface, such as peat and duff. Surface fire burns surface litter, debris, grass, small shrubs, and other vegetation. Crown fire burns through the tops of trees or tall shrubs, and while it often advances with surface fire, a crown fire can also move in a completely different direction on its own.

Vertical fuel arrangement is the second way in which fuel is distributed. There are three categories:

- Aerial fuels: All materials in the upper forest canopy
- Surface fuels: Materials lying on or immediately above the ground
- Ground fuels: Materials beneath the surface

1-14 Fire Behavior Factors – Weather

Weather is one of the more complex factors affecting wildland fire because it is constantly changing and difficult to predict. The temperature of the air, ground, and fuel all influence the way fire behaves. Higher ground and fuel temperatures make it easier for the fuel to ignite and burn. There may be as much as 50º difference in temperature between fuels in the sun and those in the shade.

1-15 Fire Behavior Factors – Wind

One of the most important and least predictable influences on wildland fire behavior is wind. Wind increases the amount of oxygen available, making the fire burn faster. Wind drives fire into new fuel, encouraging combustion and the spread of fire in one direction, but it can also cause rapid changes in the fire's direction. Wind carries sparks and firebrands ahead of the main fire, starting spot fires. Wind directly affects fuel moisture by increasing evaporation from damp spaces, carrying away moist air and replacing it with drier air.

1-16 Fire Behavior Factors – Relative Humidity

Relative humidity is another weather factor that directly affects wildland fire behavior. Dry air, or low humidity, takes moisture out of fuel. When the relative humidity is high, fuel absorbs moisture from the air. Remember, the size of the fuel also influences how quickly it takes on or gives off moisture. A light fuel such as pine needles responds dramatically to changes in humidity. As fuel size increases the change in fuel moisture happens more slowly. All these weather factors can change rapidly, on their own or in combination, and always affect fire behavior.

1-17 Fire Behavior Factors – Topography

The lay of the land, otherwise known as topography, is the most constant of the three environmental elements affecting wildland fire, making its influences much easier to predict than those of fuel or weather.

Topography, or the lay of the land, can be divided into these elements:

- Aspect
- Slope
- Position of fire
- Shape of country

1-18 Fire Behavior Factors – Aspect

Aspect, or the direction in which a slope faces, determines how much heating the fuels get from the sun. Different aspects receive sunlight at different times of day, which means fuel temperature on a given aspect will change throughout the day. South- and southwest-facing slopes are normally more directly exposed to sunlight and generally have lighter, more sparsely arranged fuels. Higher average temperatures mean lower relative humidity and, therefore, lower

fuel moisture. More shaded north aspects, on the other hand, receive less sunlight and therefore have more vegetation – heavier fuels. Lower average temperatures result in higher relative humidity and higher fuel moisture.

Aspect: The direction in which a slope faces, determining how much heating the fuels get from the sun.

1-19 Fire Behavior Factors – Slope

Slope: The degree of inclination of a hillside.

The shape of the country can also influence the direction of fire spread, rate of spread, and the intensity of wildland fires. A fire on level ground is primarily influenced by fuels and the wind. On a slope, fuel uphill from the fire is pre-heated by radiation and convection and ignites easily, spreading the fire more rapidly. The steeper the slope, the faster the fire burns. You should also be alert to the possibility that burning material can roll downhill and ignite fuels below the main fire.

1-20 Fire Behavior Factors – Canyons

Fires starting near the base of steep, narrow canyons, especially box canyons, may react like a fire in a fireplace. Convection draws air up from the bottom of the canyon creating a chimney effect that results in very strong upslope drafts. This extreme fire behavior can cause very rapid fire spreading up the canyon that is highly dangerous to firefighters. Narrow canyons also trap much of the radiant heat from a fire, which can dry adjacent fuel on the opposite slope and allow fire to cross the canyon.

In wide canyons, the prevailing wind direction can be altered by the topography – the direction of the canyon. Cross-canyon spot fires are not as common, except in high winds, but strong differences in general fire conditions often occur between north and south aspects.

1-21 Fire Behavior Factors – Wind Behavior

Wind normally follows the direction of a canyon and you can expect eddies at sharp bends. When fires burning along lateral ridges reach a canyon edge the flow of air can sometimes draw the fire down into the canyon. In some cases a strong flow of air around the point of a ridge will cause the fire to behave in a whirling, eddying motion.

When wind blows through a saddle or pass in a mountain range, wind speed can increase as it passes through the constricted area, creating eddy action as it spreads out on the lee, or downwind, side.

1-22 Fire Behavior Factors – Elevation

Elevation influences the amount and condition of fuels in a given area. Higher temperatures at lower elevations dry fuels out earlier in the year than those at higher elevations.

On extremely high mountain peaks and ridges fuels are sometimes completely absent. The amount of precipitation received, exposure to winds, and the amount of fuels on the surrounding terrain are other factors affecting fire behavior.

1-23 Fire Behavior Factors – Barriers

There are many barriers, both man-made and natural, which will slow or stop the spread of fire. Rivers, lakes, rock slides, and sparse or moist fuels are some of Mother Nature's roadblocks, while roads, highways and reservoirs are some of the human impediments, as is the fire line you build.

UNIT 2
WEATHER & FIRE

2-1 Unit Objectives

Study each of these objectives carefully. Feel free to go back and review at any time. At the end of this unit you must successfully complete a short examination.

Objectives:

1. List the indicators of an approaching cold front and describe what wind changes to expect.
2. List three common Foehn wind conditions and the areas in which they occur.
3. Identify a thunderstorm and describe how and when it is dangerous.
4. Describe the daily cycle of slope and valley winds.
5. Describe the effect relative humidity has on wildland fire behavior.
6. Identify the wildland fire environment indicators that can produce problem and extreme fire behavior.

2-2 Fire Behavior - Introduction

Sometimes Mother Nature can cause some very sudden changes in the direction and intensity of a fire. In a very short time a fairly calm situation can turn into a life-threatening ordeal. Someday you as a firefighter might find yourself retreating from an oncoming wall of flame. As your knowledge of fire and fire behavior increases, fire will become less and less a wild and mysterious force, and more a calculated and predictable occurrence. Likewise, understanding fire weather can make you aware of warning signs that might alert you to possible trouble, and could save your life.

All of the factors and variables that come together to produce weather can sometimes seem very complicated. But if you break weather down into its basic parts, you'll find it's built on very simple concepts – winds, moisture and atmospheric stability.

The Rodeo-Chediski Fire:	465 homes lost
The Butte Fire:	72 fire shelters deployed

The 30 Mile Fire:	4 fatalities
The Paint Fire:	551 homes destroyed
The South Canyon Fire:	14 firefighters killed

2-3 Fire Behavior – Winds

Winds have the most obvious affect on how a fire will behave. In this course you'll be learning about three different types of wind – winds that blow on a large scale across the continent, winds that are generated by the buildup of thunderstorms, and winds that are produced on a very small, localized scale. But first, let's lay some groundwork.

2-4 Fire Behavior – Atmosphere

The very thin, blue layer of gases surrounding the earth is called our atmosphere. It's divided into layers that are characterized by differences in temperature. The layer closest to the earth, called the troposphere, is where all of the constantly changing weather that affects us every day takes place.

2-5 Fire Behavior – Circulation 1

Most of our weather is based on a very simple principle – hot air rises, and cold air sinks. This is the principle of convection that you learned about earlier, making the smoke from a fire move upward. As this hot air rises, it cools and sinks back down where it is pulled in to replace the rising, heated air. This cycle is called a circulation cell. Because the sun heats the equator more than the poles, the earth produces a similar circulation pattern. As warm air rises from the equator, a void or low-pressure area is created. Cooler air from the poles is pulled in to fill that void, forming a completed circulation cell.

2-6 Fire Behavior – Circulation 2

Sometimes a hot-air mass moving up from the equator collides with a cold-air mass moving down from the poles. If conditions are right, eddies can form. These circulation systems rotate counter-clockwise, drawing air from the ground up through the system and forcing it out the top, producing a low-pressure system at ground level. The air that is forced out settles back down in an adjacent area, creating or adding to a high-pressure system. Because the high-pressure system has more mass and weight, the low-pressure system pulls air from it to fill the void created by its rising air, completing the cycle of air movement between the two systems.

2-7 Fire Behavior – Pressure Systems

On a weather map, lines connect all the locations with the same high and low pressure readings, creating a picture of the pressure systems in a given area. There is a constant movement of air between these highs and lows as they try to equal out their pressure. This movement of air is wind. The greater the difference, or gradient, between high- and low-pressure systems, the stronger the wind.

2-8 Fire Behavior – Fronts

Any time you have hot and cold trying to occupy the same space, expect some unrest. When air masses of different temperatures and moisture content collide, the boundary between them is called a front. A cold front is a cold-air mass moving in to replace a warm-air mass. A warm front is just the opposite. In the northern hemisphere, fronts generally move from the west or northwest to the south or southeast. In a fire burning under a warm-air mass, winds will generally be out of the southwest. When a cold front moves over the fire, winds become gusty and their direction can change up to 180º. You should pay particular attention to a fire-weather forecast when a front passage is predicted.

2-9 Fire Behavior – General Winds

Winds blow at all levels in the atmosphere. At the higher levels, winds like the jet stream drive weather systems across the country. Winds produced within a few thousand feet of the earth's surface are called general, or free-air, winds if they are undisturbed by the earth's topography. However, when a general wind hits a mountain range, an oscillating wave pattern can develop on the lee side of the range. These standing waves, or mountain waves, can cause extreme fire behavior if they reach the ground.

This lens-shaped cloud, called an alto-cumulus standing lenticular cloud, is one indicator that strong winds from a mountain wave are blowing above. You will need to adjust your fire strategy in case these winds move to the ground and over your fire.

2-10 Fire Behavior – Foehn Winds

When a strong high-pressure system builds on one side of the mountains, and a low-pressure system is present on the other, the strong gradient or pressure differential between the two systems will cause the wind to blow over the mountains from the high-pressure system to the low-pressure system. These are called Foehn or gravity winds, and as they move down slope toward the low-pressure area they become compressed, warming and drying the fuels. By the time they get to the bottom of the mountain range, their temperature can be as much as 20º warmer than on the other side. They can be extremely dry and blow as hard as 30-50mph. Mix a fire with these winds and you have a major problem.

In Southern California these are the famous Santa Ana winds. They're called mono or north winds in central or Northern California and east winds in the Pacific Northwest. On the east side of the Rockies they're known as Chinook winds. Warmer, compressed gravity winds also form off the Appalachians.

2A-1 Fire Behavior – Thunderstorms

In the summer of 1990 the Dude Fire in the Tonto National Forest was hit by high winds from a thunderstorm that developed over the fire. In combination with other factors, it caused extreme fire behavior that overran a number of firefighters, six of whom lost their lives.

Whenever you see a thunderstorm in the vicinity of a fire you need to take special notice, and understand that strong winds are possible, which can affect you and your safety.

2A-2 Fire Behavior – Thunderstorm Conditions

Thunderstorms need three conditions in order to develop: moisture, unstable air, and a triggering device that produces upward movement of that air. This could be a frontal passage, intense heat from below such as the sun heating the ground on a hot day, or air being forced up the side of a mountain.

Thunderstorm conditions:

- Moisture
- Unstable air
- Triggering device producing upward air movement

2A-3 Fire Behavior – Thunderstorm Stages

A thunderstorm's life cycle has three stages. In the first one, called towering cumulus, fluffy, cumulus clouds start building vertically when one of the triggering devices you just learned initiates air movement within the cell, creating updrafts. As the moisture in this rising air changes to liquid a tremendous amount of heat energy is released, which feeds the upward motion in the cell until it eventually becomes taller than it is broad. On the ground, you might feel a slight surface wind shift toward the towering cumulus as the air is pulled up into the cell.

In the second or mature stage, the upper part of the cloud takes on a fuzzy appearance and a classic, anvil-shaped top. The updrafts can no longer support all the raindrops and ice particles. As they start to fall, they drag air with them, starting downdrafts in one part of the cell while updrafts continue in another. The appearance of virga, precipitation that evaporates before reaching the ground, is a visual indicator that the downdrafts have begun. These downward winds can reach speeds of 60mph as they race out the bottom of the cell. The strongest gusts will be at the front edge of the storm, which can be identified by the anvil top. Lightning will also be at its peak during this stage.

In the third or dissipating stage, the updrafts end. With no more upward movement to feed the cell, the downdrafts quickly stop as well. Wind, temperature, and air pressure all return to the levels that occurred before the storm.

2A-4 Fire Behavior – Alto Cumulus Castelladas

If you see this cloud formation in the early morning, it's a signal that moist, unstable conditions are present and thunderstorms are possible in the afternoon. The turret or battlement formations, like you might see on a castle, give these clouds the name alto cumulus castelladas.

As you can see, thunderstorms can be very dangerous for firefighters, and there are usually many cells in a given area at the same time, in different stages of development. When you're in the field, always watch oncoming storms and try to anticipate where downdrafts will

occur so you can be ready to move to a safe position in relation to your fire. For a quick review, make sure you study all the text on this page before moving on.

2A-5 Fire Behavior – Local Winds

Local winds can develop off the ocean or off large lakes. Because the sun's radiation is absorbed more deeply in water than it is on land, water tends to change temperature much more slowly than land. So when the sun comes up in the morning the land heats faster than the water, causing air over the land to rise, creating an area of low pressure. Following the cycle you've already learned, it cools as it rises and falls back over the water, adding to a high-pressure system. Air from the high-pressure system feeds the void left by the rising warm air, creating a shore or sea breeze flowing on shore. At night, because the water temperature stays about the same while the land temperature falls below it, the process is reversed, causing a land breeze to blow in the opposite direction.

Be aware of the effect these winds will have on your fire. Along the South Carolina coast, for example, the sea breeze often creates fronts that produce a very marked wind shift, causing thunderstorms to develop.

2A-6 Fire Behavior – Aspect Winds

Another type of localized wind is generated by pressure differences that occur when one slope of a mountain is warmer than another. As you learned earlier, aspect is the direction a slope is facing. As the sun rises on this mountain range the east aspects are warmed first, creating upslope winds. Later in the day, the south and west aspects also warm, and because they receive more sun, these aspects usually have stronger upslope winds. The replacement air for these rising winds comes from the lower valleys, so in addition to upslope winds a cycle of up valley winds is created as well.

As the sun moves on, leaving each aspect in shade, the winds gradually reverse and move down slope, combining to form down valley winds at night. Since south and west aspects are the last to receive direct sun, they're the last to cool and their down slope winds start later. On any aspect, a nighttime down slope wind is rarely as strong as a daytime upslope wind.

The key to local winds is to realize that they can develop in any geographical region. Any time two surfaces have a difference in temperature, for whatever reason, winds will be produced, and they will affect the direction and intensity of your fire, assuming they're not overpowered by a stronger weather system moving through the area. Always check with a fire weather meteorologist and learn wind and weather patterns that are unique to your fire area.

2B-1 Fire Behavior – Moisture

Moisture, in the air and in fuels, has a pronounced effect on how your fire will burn. The primary thing to remember is that warm air can hold more water vapor than cold air. With enough moisture air can reach saturation, and when it does we get precipitation in the form of rain, snow, fog or dew.

2B-2 Fire Behavior – Relative Humidity Demonstration

Let's say this small sponge represents the amount of moisture air can hold at 35º. The large sponge represents the amount of moisture this same air can hold at 80º. If we pour the amount of water that would saturate the small sponge, the 35º air, into the large sponge, the 80º air, it's only one-fifth saturated.

Relative humidity, or RH, is the amount of water in the air divided by the amount of moisture the air could hold at saturation. So if the sponge represents the air, we have one-fifth saturation, or 20% relative humidity.

As the air cools through the night and into the early morning RH goes up. The moisture in the air stays the same, but the amount of moisture the air can hold at saturation gets less, so fires will have difficulty burning and could possibly go out in fine fuels.

When the sun comes up, the temperature gets warmer and warmer, and the amount of water the air can hold at saturation gets more and more. So the relative humidity could go from a morning high of 100%, saturated air with fog or dew, all the way to, say 20% relative humidity at the hottest part of the afternoon. Just remember, as temperatures go up, RH goes down, which means the air gets drier and fires get more active.

2B-3 Fire Behavior – Moisture Content

The moisture content of fuels affects fire behavior in the same way as the relative humidity of the air. With low RH and low fuel moistures fires can burn very aggressively and be difficult to control, especially with the addition of wind. When RH is high and fuels are wet, fires are difficult to ignite and burn very poorly, if at all.

The normal, daily fluctuation in relative humidity can dramatically effect the moisture content of small diameter fuels like conifer needles or small twigs. As they air warms and RH goes down, these small fuels dry out quickly.

The amount of fuel moisture in large diameter fuels, such as logs, depends on how long moisture stays in contact with them. If ¼ inch of rain drops in 10 minutes, large fuel will absorb very little of the moisture, and will probably dry out in a relatively short period of time. If that same ¼ inch of rain falls over a period of 10 hours, the log will absorb a lot more of the moisture and will take a lot longer to dry out.

2C-1 Fire Behavior – Atmospheric Stability 1

The stability of the atmosphere around a fire, in other words the resistance of the air to vertical movement, has a strong effect on how that fire will behave.

Visual indicators of stable air:

- Clouds in layers

- Stratus-type clouds
- Smoke column drifts apart after limited rise
- Poor visibility due to smoke or haze
- Fog layers
- Steady winds

Visual indicators of unstable air:

- Clouds grow vertically and smoke rises to great heights
- Cumulus-type clouds
- Gusty winds
- Good visibility
- Dust devils and firewhirls

2C-2 Fire Behavior – Atmospheric Stability 2

If surface winds are light or if you notice smoke or haze hanging near the ground, you're probably looking at stable conditions. Stratus clouds like these, showing no evidence of vertical building, are another indication of a stable atmosphere.

Unstable days are characterized by gusty winds, hot days and cumulus-type clouds. Any upward movement of air is enhanced. For example, if a stable layer near the surface is heated to a high enough temperature, either from the sun or a wildfire, it can break through the stable layer and a free moving vertical column can develop.

2C-3 Fire Behavior – Fire Whirls

A dust devil or whirlwind is one of the best indicators of an unstable atmosphere. Because of the accelerated movement of the air, fires can generate their own fire whirls. These extremely strong updrafts pick up loose, burning material and carry it out away from the main body of the fire where it can start new spot fires.

2C-4 Fire Behavior – High Pressure Systems

High pressure systems are like domes of stable air that are covered by a blanket. The sun heating the ground might cause some air to rise, but unless the heating is fairly strong the air won't break through that blanket.

In the summer large high pressure systems over the western U.S., produce clear skies and warm temperatures, setting up a phenomenon called "subsidence." As this warm, dry air starts to settle, or subside below the mountain peaks, it's compressed, much like in the Santa Ana's we talked about earlier. If your fire is burning above the level of this subsiding air, you can expect its behavior to be active.

On the east coast, subsidence often develops in advance of tropical storms. This satellite image of hurricane Diana shows a band of warm, dry air on the outside of its rotation. Humidity in this area dropped below 25% and greatly increased fire activity.

2C-5 Fire Behavior – Inversions

Another product of a stable atmosphere is a night inversion, where a layer of cold air is capped by a layer of warm air.

2C-6 Fire Behavior – Thermal Belt

By measuring the temperature at different levels up the slope, we find that it increases to a certain point and then decreases again as we keep moving up. This heated area is called the thermal belt, and it contains the warmest and driest air on the nighttime slope. These conditions can cause a fire in this area to burn with just as much intensity at night as it did during the day.

By the same token, a fire burning under the inversion layer will slow down considerably during the night because of cooler temperatures and rising humidity. Remember, at night down slope winds are settling dense, cool air into the valley floors. But think about what's happening to the smoke. Warm air and smoke rise, but only until they reach a point where the temperature is the same as theirs, then they level out and spread horizontally, trapped under the inversion layer. Visibility may be reduced and your health, along with that of your fellow firefighters may be affected.

When the sun warms the air again in the morning, once it reaches the temperature of the warmer air above the inversion will break. This causes the warmer and drier air in the thermal belt to mix very rapidly into the air below, and fire activity can accelerate extremely fast as this takes place.

2C-7 Fire Behavior – Safety

As you can see, weather plays a very significant role in wildfire behavior. In order for you to do your job safely, you must understand how wind, moisture and atmospheric stability, acting individually or together, can affect the fire. Your fire-weather forecast will give you an idea of what to expect on any given day, but always remember that unexpected changes can and will occur and you must be prepared to take action to provide for your safety as well as the safety of those around you.

2D-1 Fire Behavior – Indicators of Problem and Extreme Fire Behavior

Any wildfire is a problem that needs to be dealt with as quickly as possible, but different types of fire behavior require different strategies. You'll need to know how to differentiate between problem fire behavior and extreme fire behavior. Extreme fire behavior is characterized by a rapid rate of spread, intense burning, spot fires and crowning.

Problem fire behavior is fire activity that presents potential hazards to fireline personnel if the tactics being used are not adjusted. The prediction or anticipation of fire behavior is the key to good safety and tactical decisions.

Extreme fire behavior is the highest level of problem fire behavior and it can be described with four specific elements:

- Rapid rate of spread
- Intense burning
- Spotting
- Crowning

2D-2 Fire Behavior – General Indicators

Continuously monitoring specific indicators related to fuels, topography, weather, and fire behavior will help you anticipate fire behavior and determine the best strategy for handling the fire.

Anticipate fire behavior by monitoring these indicators:

- Fuels
- Topography
- Weather
- Fire behavior

2D-3 Fire Behavior – Fuel Indicators

Fuel indicators:

- Unusually dry fuels
- Large, continuous amount of light fuels (shrubs, grass, needles, moss, etc.)
- Fuels exposed to direct sunlight
- Fuels dried by prolonged drought
- Ladder fuels that will allow a surface fire to move into the crowns of brush or trees
- Crown foliage dried by surface fire over a large area
- Concentration of snags

Key fuel indicators include unusually dry fuels – check air temperature and humidity levels throughout the day. A large amount of light fuels such as shrubs, grass, needles and moss spread continuously throughout the fire area could cause rapid fire spread. Watch for fuels that are exposed to a lot of direct sunlight, or that have been dried out by prolonged drought. Ladder fuels can allow a surface fire to move into the crowns of tall shrubs or trees. A surface fire that covers a large area can dry out crown foliage. Any concentration of snags or other dead fuels represents a potential hot spot for a quick increase in fire intensity.

2D-4 Fire Behavior – Topography Indicators

During the day, when winds are moving up slope, radiant heat will dry fuels ahead of the fire, causing it to move faster. Remember, the steeper the slope the faster the fire burns. Saddles, chutes and box canyons are all potential wind tunnels and provide ideal conditions for convection to occur, better known as the chimney effect. In narrow canyons, fire can easily spread to the opposite side by radiation and by wind carrying burning fuels which start spot fires.

Topography indicators:

- Steep slopes that allow fire to spread faster upslope
- Chutes, saddles, and box canyons the provide the right conditions for "chimney effect"
- Narrow canyons that increase the possibility of fire spreading by spotting across drainages

2D-5 Fire Behavior – Weather Indicators

The stronger the wind, the more oxygen the fire receives and the more intense it will burn. Pay particular attention to weather fronts moving through the area, they can bring about sudden changes in wind direction or velocity that can change the direction your fire is burning. Thunderstorms in particular can create dangerous downdrafts in the vicinity of a fire. Any time you see high clouds moving fast it's an indication that unusual surface winds could be on the way. An unexpected calm may indicate that the winds are about to shift. Unusually high early morning temperatures are a good indicator of high fire activity that day. Whirlwinds, or dust devils, are a sign of unstable air. You must know all the variables that can affect your fire when these conditions occur.

Weather indicators:

- Strong wind
- Sudden changes in direction and/or velocity of wind when weather fronts move through the area
- High clouds moving fast; may indicate unusual surface winds to follow
- Unexpected calm; may indicate winds will shift
- Thunder-storms above or close to a fire usually lead to dangerous downdraft winds
- Unusually high temperatures early in the morning
- Dust devils and whirlwinds
- Bent smoke column

UNIT 3
METRIC SYSTEM

3-1 Metric Equivalents

Since 1992, Public Law 100-418 has required all federal agencies to use the metric system of measurement in procurements, grants and other business related activities. Study and learn this information.

Linear Measure	**Liquid Measure**
1 centimeter = 10 millimeters = .39 inch	1 centiliter = 10 milliliters = .34 fl. ounce
1 decimeter = 10 centimeters = 3.94 inches	1 deciliter 10 centiliters = 3.38 fl. ounces
1 meter = 10 decimeters = 39.37 inches	1 liter = 10 deciliters = 33.82 fl. ounces
1 decameter = 10 meters = 32.8 feet	1 deciliter = 10 liters = 2.64 gallons

1 hectometer = 10 decameters = 328.08 feet	1 hectoliter = 10 deciliters = 26.42 gallons
1 kilometer = 10 hectometers = 3,280.8 feet	1 kiloliter = 10 hectoliters = 264.18 gallons

Weights	**Square Measure**
1 centigram = 10 milligrams = .15 grain	1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
Decigram = 10 centigrams = 1.54 grains	1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 gram = 10 decigrams = .035 ounce	1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 decagram = 10 grams = .35 ounce	1 sq. decameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 hectogram = 10 decagrams = 3.52 ounces	1 sq. hectometer (hectare) = 100 sq. decameters = 2.47 acres
1 kilogram = 10 hectograms = 2.2 pounds	1 sq. kilometer = 100 sq. hectometers = .386 sq. mile
1 guintal = 100 kilograms = 220.46 pounds	
1 metric ton = 10 guintals = 1.1 short tons	

Cubic Measure
1 cu. centimeter = 1000 cu. millimeters = .06 cu. inches
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

3-2 Metric Conversion Factors

You'll need to know this metric conversion information as well. Keep for future reference.

TO CHANGE	TO	MULTIPLY BY	TO CHANGE	TO	MULTIPLY BY
inches	centimeters	2.54	centimeters	inches	.394
feet	meters	.305	meters	feet	3.280
yards	meters	.914	meters	yards	1.094
miles	kilometers	1.609	kilometers	miles	.621
square inches	sq. centimeters	6.451	sq. centimeters	square inches	.155
square feet	square meters	.093	square meters	square feet	10.764
square yards	square meters	.836	square meters	square yards	1.196
square miles	sq. kilometers	2.590	sq. kilometers	square miles	.386
acres	sq. hectometers	.405	sq. hectometers	acres	2.471
cubic feet	cubic meters	.028	cubic meters	cubic feet	35.315

cubic yards	cubic meters	.765	cubic meters	cubic yards	1.308
fluid ounces	milliliters	29,573.0	milliliters	fluid ounces	.034
pints	liters	.473	liters	pints	.211
quarts	liters	.946	liters	quarts	1.057
gallons	liters	3.7851	liters	gallons	.264
ounces	grams	28.349	grams	ounces	.03
pounds	kilograms	.454	kilograms	pounds	2.205
Short tons	Metric tons	.907	metric tons	short tons	1.102
pound-feet	Newton-meters	1.365			
pound-inches	Newton-meters	.11375			
ounce-inches	Newton meters	.394			

Temperature (Exact)

°F (Fahrenheit) = (°C x 9/5) + 32
°C (Celsius) = 5/9 x (°F-32)

UNIT 4
FIRE INVESTIGATION

4-1 Fire Investigation – Definition

Investigation: "To observe or study by close examination using systematic inquiry." (Webster's New Collegiate, 1981)

4-2 Fire Investigation – Purpose

Every investigation requires collecting evidence, but the integrity of that information is equally important. Any information you acquire must meet strict legal requirements. That means the information you collect, and the way in which you collect it must conform to rules of evidence that will withstand the adversarial challenges of administrative, civil and criminal proceedings.

Formal guidelines are laid out in NFPA 921, Guide for Fire and Explosion Investigation, along with a detailed description of how scientific methodology can be applied to fire investigations.

Purpose of an investigation:

- To locate, document, and preserve all relevant evidence that shows what and who caused the fire, and
- To do so in such a manner that public agencies and the courts can make sound decisions based on the results of the investigation

4-3 Fire Investigation – Causes

In simple terms, fire investigation is the discovery of the circumstances, conditions and sequence of events that caused the fire.

Applying the scientific method merely goes into a little more detail. There has been a fire, and you, the investigator, must determine the cause. You study burn patterns, assess any physical evidence you find at the scene, and analyze all the fire behavior data collected from firefighter reports. Once you have studied all the facts, formulate a working hypothesis as to how the fire started. Begin with the simplest, most logical explanation, then test your hypothesis with scientific data to see if it's sound and explains all the facts in evidence. If it does, this becomes your final hypothesis and you can complete your report. If not, you must go back and re-analyze the data until you find the correct cause.

- A fire investigation is the discovery of the circumstances, conditions, and sequence of events that bring together fuel and an ignition source to cause a fire.

4-4 Fire Investigation – Right to Privacy

Attorney Melvin Belli once said, "If your investigator is good enough, almost any attorney will do." As a fire investigator you are the one responsible for determining the cause of the fire, and in the event of any legal challenges you may be called upon to defend your determination in court. So while you are applying scientific methodology to determine the cause, you must also be sure that, where applicable, you follow all NFPA legal guidelines and ensure that all your actions are based on a sound Constitutional foundation.

"The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated..."

Fourth Amendment, US Constitution

4-5 Fire Investigation – Reasonable Expectation

When you conduct a fire origin and cause investigation you are searching for evidence, but before you can seize anything relevant you must consider the legal question of whether the search was reasonable, and whether the subject of the search has a reasonable expectation of privacy under the 4th Amendment. The answer to this question lies in where you are searching and exactly what you plan to seize.

It's up to the courts to define what is reasonable, and that definition may change over time as new rulings are made. If the court rules that any evidence was seized in violation of current standards, it will be excluded from those proceedings, which means that particular evidence cannot be used in civil or criminal court proceedings.

If the court rules certain evidence is excluded, that evidence cannot be used in civil or criminal court.

Application of the Fourth Amendment:

- Does the subject have a reasonable expectation of privacy?
- Is the search reasonable?

What is "reasonable"?

- What is "reasonable" is defined by the courts in their rulings.
- These rulings are called "case law."

Exclusionary Rule

- "Excluded" means that that evidence cannot be used in civil or criminal court

Mapp v. Ohio, 1961

4-6 Fire Investigation – Seizure of Evidence

Any time you decide to seize evidence you must ask yourself two questions. First, can the individual possessing the evidence be expected to exercise his right of privacy? In other words, has he done anything which demonstrates that expectation, such as closing a door, locking a gate, putting up fences, or posting No Trespassing signs? And second, is the expectation of privacy one which society is prepared to grant as reasonable?

Reasonable expectation of privacy

- Does the individual actually expect privacy? If so,
- Is the expectation of privacy one which society is prepared to grant as reasonable?

Katz v. US, 1967

- Locked gates and "No Trespassing" signs on an "open field" do not prevent entry by police.

(Open Fields)
Oliver v. US

- Observation of marijuana from the air, even when surrounded by a high fence, is admissible.

(Plain View)
CA v. Ciraolo

- Evidence discarded by the subject is subject to examination by police

(Abandonment)
CA v. Greenwood, 1988

4-7 Fire Investigation – Public Property

Generally, evidence found at wildland fire scenes on federal, state, or local government lands can be seized without a warrant.

Certain situations, however, may require you to obtain a search warrant. Any time you're in doubt, consult your agency or cooperating law-enforcement officials.

Fire origins on public property

Situations that may not require a warrant:

- Evidence is in open fields
- Evidence is in plain view
- Evidence has been abandoned

Situations that may require a search warrant:

- Evidence is in a tent or structure, even if the tent or structure is illegally present
- Evidence is in a vehicle or a locked container
- Evidence has not been abandoned

4-8 Fire Investigation – Private Property

There are four types of search authorization for private property. The first is to obtain search warrant. Second, you may conduct a search with the consent of the property owner with certain provisions. The third option is an Administrative Warrant, and finally, there are specific conditions that allow you to search the fire scene without a warrant.

Fire origins on private property

There are four types of search authorization:

- Search without a search warrant
- Consent of the property owner
- Search with an administrative warrant
- Search with a search warrant

4-9 Fire Investigation – Search Warrants

"Probable Cause" is a legal concept that describes a degree of certainty.

Probable cause:

- Probable cause is said to exist if something is more probable than not
- In other words, 51% vs. 49% probability that something is true
- Probable cause determination is a judgment made by a judge or the "reasonable and prudent" officer

In order for a search warrant to be issued there must be a reason why it's necessary – in other words, probable cause. Is the likelihood that you will find the evidence you are searching

for more probable than not, or is there a better than 50% probability that the evidence will support your hypothesis. This determination can only be made by a judge.

Administrative warrant:

- Issued after "reasonable" time has passed
- Requirements:
  - a fire occurred
  - undetermined origin and cause
  - need to return to the scene to determine origin and cause
- Issued by magistrate or judge
- No requirement for probable cause

Michigan v. Clifford, 1984

"… no warrants shall issue, but upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the person or things to be seized."

Fourth Amendment, US Constitution

4-10 Fire Investigation – Witness Interviews

Interviewing witnesses is an essential part of any wildland fire investigation. Information obtained in those interviews is often crucial in determining the cause of the fire and may need to be presented in court. The 5th Amendment of the Constitution gives all U.S. citizens the right not to incriminate themselves. However, issues of self-incrimination do not apply to witnesses, only to persons suspected of committing a criminal violation. In your role as a Type III Investigator, the majority of the persons you question will be witnesses.

Two considerations must always be taken into account when you are questioning a witness or a potential suspect. First, does the person being interviewed believe the questioner is a government official? In other words, have you clearly identified yourself as a fireman, fire investigator, ranger, or whatever the case may be? Second, does the person being questioned believe that they are free to leave, that is, not being held in custody or against their will? Ultimately this issue may rest with that person's perception of the situation. Even if they are not actually being detained by law-enforcement officials, they may perceive that they are in custody simply because they are in a police dominated environment, such as a police station.

Self-incrimination for wildland fire investigations:

- An essential part of any origin-cause investigation is interviewing witnesses
- Information gained from those witnesses may be useful

4-11 Fire Investigation – Popular Misconceptions 1

Self-incrimination is a tricky issue, and one you need to understand fully if you are to become an effective fire investigator. Here are just a few popular misconceptions about the issue.

Is the individual questioned in custody?

- Does the person being questioned believe that he/she is free to leave?
- Is there a "police" dominated environment? (e.g. at a police station)
- Ultimately, the issue of custody may rest with the perception of the person being questioned

Belief: A subject must always be advised of his/her rights before any questions can be asked.
Truth: If the subject is not in custody, you may ask questions, and even if the answers are incriminating they will still be admissible in court.

Beckwith v. US (1976)

Belief: If a subject has become the focus of the investigation, he/she must be advised of his/her rights before any questions can be asked.
Truth: The subjective views of the officer do not trigger the requirements of Miranda.

Stansbury v. California (1994)

4-12 Fire Investigation – Popular Misconceptions 2

This course will not attempt to teach you the complexities of the various justice systems and jurisdictions found across the country. However, it is critical for fire investigators to know where and how their reports will be used. Any time the Agency enters one of these proceedings, it is attempting to recover money spent on fire suppression and pay for the rehabilitation of resources and government property damaged by the fire.

Adversarial forums:

- Agency Administrative Proceedings
- Civil Court
- Criminal Court

Do you know where your report is going to be used when you arrive at the fire? (Hint: No, you don't!)

4-13 Fire Investigation – Jurisdiction

All Agency Administrative Proceedings are governed by the administrative rules applicable to the agency in that particular jurisdiction. Any evidence or information gathered by reasonable or prudent officials conducting a fire investigation is generally accepted, and decisions are rendered by an agency official or an administrative law judge.

- You must investigate every fire as if it were going to result in a criminal prosecution
- If you investigage and document to the highest standards, then you will always have sufficient documentation for administrative and civil proceedings

4-14 Fire Investigation – Civil vs. Criminal Courts

Civil courts deal with wrongs or injuries which are not a crime. Evidence codes and rules of procedure are set down in state or federal law. Based on the preponderance of evidence standard a judge or jury decides to what extent the accused party will be held responsible.

Criminal courts punish those who have committed an act which the legislature has defined as a crime. Strict rules of evidence and criminal procedures are contained in state and federal law, and outcomes are based on a standard of "proof beyond a reasonable doubt." A judge or jury decides the guilt or innocence of the accused.

Civil Court vs. Criminal Court:

- Civil Court
  - Defendant is subject to monetary damages, but no imprisonment is possible.
  - Burden of Proof is "Preponderance of the Evidence" (51% vs. 49%)
- Criminal Court
  - Defendant can be imprisoned and/or fined
  - Burden of Proof is "Beyond a Reasonable Doubt" (99% vs. 1%)

4-15 Fire Investigation – Evidence

From a legal standpoint, evidence is anything used to prove or disprove an alleged fact. The evidence itself is not proof it is used to establish facts, so proof is the result of evidence. In order for your evidence to be admitted into the court record it must be relevant, authenticated and properly identified.

Evidence

Admissibility – Can your evidence be introduced in court?

- Relevance: To be admissible, the evidence must have a demonstrable connection to the facts of the case.
- Authentication: To be admissible, it must be shown that the evidence is the same evidence that was collected at the fire scene.
- Identification: To be admissible, it must be shown that the evidence has not been tampered with, altered, or contaminated since it was collected at the fire scene.

4-16 Fire Investigation – Chain of Custody

Evidence usually passes through many hands on its way to a courtroom. The written record that contains the name of every person, date and time a piece of evidence is handled or changes possession is known as the Chain of Custody. Making sure this record accurate will help prevent allegations of evidence tampering or spoliation. In addition, each piece of evidence must be properly and thoroughly identified. This is usually done by attaching an authentication tag that contains as much information as possible about that evidence.

Evidence

Chain of Custody:

- Chain of Custody describes the written record containing the name of every person who handles evidence and the dates and times it's handled or changes possession
- Proper documentation of the chain of custody will help prevent allegations of evidence tampering, alteration, or spoliation.
- Proper documentation of the chain of custody will help an investigator accurately identify and authenticate a piece of evidence.

Identification:

- Attach a completed evidence tag, which contains, at a minimum:
    - Item description
    - Item number
    - Case number
    - Date and time recovered
    - Location recovered
    - Name of the recovering officer
    - Signature of the recovering officer

4-17 Fire Investigation – Expert Witness

In most fire cases investigators will be called to testify about their findings. Unless the person testifying is qualified as an "expert" their opinion is not admissible, only their factual observations. Recent Supreme Court decisions have made it more difficult for "technical experts" like fire investigators to qualify as expert witnesses.

What is an expert witness?

- Anyone with special knowledge or experience with respect to the issue in question may qualify as an expert
- An expert may qualify based on his/her training and experience
- The trial-court judge determines if an individual is qualified after the opposing attorneys in the case have questioned the witness about his/her qualifications

Who qualifies as an expert witness?

- The trial judge will use the rules of evidence regarding expert witness testimony, and
- recent Supreme Court decisions about how those rules are applied, such as:
    - *Daubert v. Merrel Dow Pharmaceuticals* (1993)
    - *Kumho Tire Co v. Carmichael* (1999)

4A-1 Fire Investigation – Federal Statutes

As a fire investigator you must be familiar with specific elements of the federal statutes dealing with arson and wildfire and be able to identify agency fire regulations.

- Statutes
- Regulations

- Recovery of costs

4A-2 Fire Investigation – 18 U.S. Code 81

United States Code 81, Title 18 outlines four elements of concern for wildland firefighters: jurisdiction, intent, the act itself, and the materials protected under the law.

Elements of federal criminal statutes dealing with fire

18 U.S. Code 81

- Jurisdiction: Special maritime and territorial
- Intent: Willfully and maliciously
- Act: Sets fire to or burns (includes attempts)
- Material protected: Buildings, structures, vessels, machinery, building materials or supplies, etc.

4A-3 Fire Investigation – 18 U.S. Code 1855

U.S. Code 1855 deals with timber set afire. Familiarize yourself thoroughly with the details of each element, but in a nutshell, willfully setting a fire that destroys timber or other materials on any land under the jurisdictions listed is punishable by a fine of up to $250,000 and up to five years in prison.

18 United States Code 1855 - Timber Set Afire

- Jurisdiction: Public domain, lands owned or leased by or under the partial, concurrent, or exclusive jurisdiction of the US, or under contract or condemnation, or Indian country
- Intent: Willfully and without authority
- Act: Sets on fire
- Material protected: Timber, underbrush, grass, or other material on specified lands
- Penalty: $250,000/5 years

4A-4 Fire Investigation – 18 U.S. Code 1856

Leaving a fire unattended and un-extinguished, even with no intention of committing harm, is a Class B misdemeanor under U.S. Code 1856. If that fire destroys protected materials on lands under the jurisdictions listed here, responsible parties can face fines of up to $5,000 and up to six months in jail. If someone dies as a result of the fire, the fine can be as high as $250,000. More information on this can be found in U. S. Code 3571.

- Jurisdiction: Lands owned, controlled, or leased by, or under the partial, concurrent, or exclusive jurisdiction of the US, or under contract or condemnation, or Indian country
- Intent: No specific intent; general intent law (bad purpose or state of mind)
- Material protected: Forest, timber, or other inflammable material
- Penalty: $500 to $5,000/6 months Class B misdemeanor; up to $5,000 fine; if fire causes a death or deaths, up to $250,000

4A-5 Fire Investigation – USFS 36 CFR 261.5

U.S. Forest Service 36 CFR 261 contains specific Codes of Federal Regulations, or CFRs, dealing with fire-related violations of the law. For example, issuing citations.

There are remedies for recovering costs of fire suppression, resource damage, and loss of other property that apply to criminal as well as civil actions. You must follow these procedures as you prepare your report on the total costs of suppression and damages so that the prosecutor can be as effective as possible in attempting to recover these costs.

Code of federal regulations:

- Violation notices (citation) may be issued under these regulations (USFS 36 CFR 261.5)

Criminal remedies:

- Criminal prosecution (beyond-a-reasonable-doubt standard)
- Restitution may be ordered upon conviction
- Provide prosecutor with total costs, i.e., damages and suppression costs

Civil remedies:

- Burden of proof ("Preponderance of evidence")
- The responsible party may be sued in federal court
- May be prosecuted criminally and sued in civil court for same act to recover suppression costs, losses, and damages

4A-6 Fire Investigation – Federal Caims Standards

Remember, the information you compile in your investigation will be under intense scrutiny by everyone from administrative personnel to judges, prosecutors and defense attorneys. Become familiar with federal claims standards such as demand letters – formally asking for payment of damages, and compromise of claims, which describes the authority to negotiate a compromise in damage payments, so you can present a convincing case for recovery of costs.

In addition to federal laws and regulations, you must also be thoroughly familiar with any applicable state and local laws governing both criminal and civil actions. So as you can see, your responsibilities as a fire investigator extend far beyond the fire itself.

- Demand letters
- Compromise of claims
  - Costs exceeding $100,000; authority to negotiate a compromise is with DOJ
  - Costs less than $100,000 may be resolved by agency (consult your agency's policy)

Responsibilities of investigator:

- Considerations when weighing alternatives:
  - Criminal prosecution – no need for demand letter since prosecution is pending.
  - Keep self-incrimination issues in mind

4B-1 Law Enforcement Safety – Introduction

Knowing the laws and regulations governing wildland fires is vital to conducting a thorough investigation, but you must also be able to determine whether the fire was started for criminal reasons, and if so, why.

4B-2 Law Enforcement Safety – Crime Scene

The first rule of fire investigation is to assume that any fire scene may be a crime scene. Taking this attitude as you begin your investigation will automatically heighten your regard for personal safety and will help in the recovery of evidence for either criminal or civil cases.

Assume that any fire may be a crime scene:

- Treat all incidents with the same precautions
- Personal safety is paramount
- Aids in evidence recovery for either criminal or civil case

4B-3 Law Enforcement Safety – Criminal Intent

Assume the fire was started with criminal intent until another cause is proven. With that in mind, try to determine whether it was started through negligence, possibly as a result of violent acts, or intentionally, either to conceal culpability for violent acts or to conceal another crime.

Crime/fire relationship:

- Negligence or intent
- Concealment by violent act(s)
- Intent to conceal other crime(s)

4B-4 Law Enforcement Safety – Hidden Agendas

It could be the unintended result of another crime, or a terrorist act, set intentionally to destroy infrastructure or concentrate emergency personnel away from an intended target. Or it could be a setup to draw emergency personnel to the scene in order to commit acts of violence against them.

Crime/fire incident relationship:

- Unintended result/other crime
  - Drug lab
  - Homicide
  - Auto theft
- Concentrates responders
- Primary target elsewhere
- Second set – endangering suppression efforts
- Setup to draw emergency services personnel in to scene

- Sniper
- Bomber
- Delay fuse
- Remote trigger
- Multiple sets
- Terrorist

4B-5 Law Enforcement Safety – Observation

Fire-scene investigators, whether they're law-enforcement officers or not, should begin by conducting an overall assessment of the scene as soon as they arrive. Carefully observe any people at the scene, including law enforcement and emergency services personnel as well as bystanders. Take detailed notes on them and on any unusual items or settings found at or near the scene. This information will be very useful both in the ongoing investigation and as evidence in any court proceedings, so make sure you keep your records in a clear and easily understandable form. They could be used to develop a witness list, or a suspect list later on. Be aware of any other ongoing emergencies in the area and look for possible related circumstances. Your observations are also essential for the safety of responding emergency personnel.

Investigators fire scene size-up:

- Conduct an overall assessment of the scene on arrival
- Observe and record people:
  - Emergency personnel
  - Bystanders
- Observe and record the surroundings
  - Unusual items
  - Unusual settings
- Useful for later use as evidence
- Essential personal safety
- Be aware of ongoing emergencies in the region or area
- May develop witness list
- May develop suspect list

4B-6 Law Enforcement Safety – Equipment

Law-enforcement officers responding to fires are frequently performing a number of different functions. It is essential that they carry the proper equipment to deal with any change in threat conditions and to combat potential criminal activities. Because it is a fire scene, they should also be wearing the proper personal protective equipment.

Personal Protective Equipment (PPE):

- Fire investigation is often collateral duty
- Law enforcement and Fire PPE are essential

Threat conditions change rapidly:

- Wear and maintain control of law-enforcement equipment

  - Firearm
  - Intermediate weapon
  - Handcuffs
  - Ballistic vest on the person in ready mode
  - Credentials/badge
- Wearing of Fire PPE is also critical
  - Nomex
  - Boots
  - Hardhat
  - Gloves
  - Fire Shelter

4B-7 Law Enforcement Safety – Communications

Maintaining clear and concise communications throughout the investigation is vital, whether you're working at the fire scene, or in another area altogether.

Communications safety

Maintain communication:
- When working independently on investigation
- Away from main suppression efforts
- Away from backup
- Away from fire incident altogether

4B-8 Law Enforcement Safety – Hazards

Every fire presents its own kind of hazards, and law-enforcement officers need to be aware of ongoing suppression efforts as well as any potential dangers during the course of their investigation such as downed power lines, traffic, hazardous materials, or human threats. Be aware that encounters with witnesses or potential suspects may become hostile, and look for intentional bystanders, or people listening to conversations. Note the use of language as well as non-verbal clues such as body language.

Above all, ensure your "legal survival" by making sure you know your scope of authority in the investigation, and by understanding and complying with the policies of any collaborating agencies.

Threat environment awareness:
- Be aware of ongoing suppression activities/hazards
- Be aware of hazards created by the fire
- Be aware of threats caused by humans
- Contacts with witnesses/suspects may be or may become hostile encounters

- Threat analysis
  - Use of language

- Non-verbal clues (body language)
- Intentional witnesses

Legal survival:

- Ensure your scope of authority to conduct investigation
- Understand your authority to enter upon lands (public/private)
- Understand your local authority to secure scenes
- Understand and comply with applicable agency policies

UNIT 5
FIRST RESPONDER RESPONSIBILITIES

5-1 First Responder -- Introduction

The next phase of this course will provide you with a basic understanding of what can cause a wildfire and the proper procedures to follow as a first responder.

5-2 First Responder – Unit Objectives

The information will focus on three primary objectives, all of which you must understand thoroughly and be able to put to use in the field.

Course objectives:

- Causes of wildfires and their indicators
- Basic procedures and techniques to provide witness/observer information to fire investigators
- Recognize and protect wildfire origin areas

5-3 First Responder – Responder Objectives

Each year federal agencies respond to an average of 67,000 wildfires that burn some 2.7 million acres on federal, state and private lands throughout the U.S. 95% of these fires are suppressed during the initial attack, but the 5% that escape that first phase result in millions of dollars in suppression costs and damage to natural resources. Your role as a first responder is outlined in the eight objectives listed here. Understanding that role is crucial to your effectiveness as a fire investigator.

Student performance objectives:

1. Identify why accurate fire cause determination is important
2. Assemble the items needed in a wildfire origin protection kit
3. Describe the major cause categories of wildland fires and their indicators
4. Understand the basic principles of fire behavior and describe their influence on wildfire burn patterns and indicators
5. Identify the principles of fire detection and describe the fundamentals of fire reporting and dispatch
6. Make observations that may be encountered en route to and upon arrival at a wildfire

7. Perform the proper steps to be taken upon arrival as a first responder to a wildfire
8. Perform the proper steps to be taken while in a wildfire area during demobilization and post fire

5-4 First Responder – Origin and Cause

Fighting a fire efficiently and successfully begins with an accurate determination of its origin and cause. It's the responsibility of all personnel to ensure that every fire is properly investigated so that civil or criminal responsibility can be established, successful fire prevention programs developed, and strategic plans for future fires can be prepared.

Roles and responsibilities

Agencies are mandated to investigate fires to determine the origin and cause. Reasons for fire-cause determination include:

- Preparation of an effective fire prevention program based on accurate fire-cause statistics.
- Pursuit of criminal and/or civil prosecution of violators.
- Collection and recovery of damages and fire-suppression costs.

5-5 First Responder – Professional Standards

Recent court decisions have encouraged the establishment of professional standards that have significantly increased the requirements for conducting a fire investigation. Only highly trained and qualified personnel can ensure that an investigation conforms to legally and scientifically sound methodologies. The observations and actions of the first responder are critical to the success or failure of any investigation.

Professional investigation standards:

- Record observations enroute to and upon your arrival at the fire scene
- Identify potential witnesses
- Record weather data upon arrival
- Identify and protect the general origin area
- Protect any physical evidence at or near the scene
- Photograph the fire scene

5-6 First Responder – Basic Equipment

To accomplish your responsibilities some basic equipment is necessary, and should always be readily available in your vehicle. These items will help you collect vital preliminary information and evidence for the investigator.

First responder's kit:

- Flagging
- GPS unit or compass
- Camera (one-time use cameras are acceptable)
- Note taking materials

- Belt weather kit or digital weather instrument
- Flashlight
- Steel tape measure
- Pocketknife
- Binoculars

5-7 First Responder – Thunderstorms

Agencies classify fire causes into several categories for reporting and statistical purposes.

Thunderstorms often produce lightning strikes close to the ground. They can reach temperatures of 54,000º Fahrenheit and usually leave obvious physical evidence at the origin area.

Fire Cause Categories

Lightning:
- Electrical discharge associated with thunderstorms
- Often strikes trees, snags, power poles and other items and ignites fires
- Extremely high temperature
- Often leaves obvious physical evidence at the origin area
    - Strike marks on trees and other vegetation and objects
    - Splintered wood fragments
    - Needle shower

5-8 First Responder -- Campfires

Unattended or improperly extinguished campfires can escape control through spotting or creeping into nearby fuels. Look for signs of recent camping activity and a fire ring at or near the general origin area. Make sure you secure and protect the area, and identify any potential witnesses.

Fire Cause Categories

Campfires:
- Unattended, improperly extinguished or abandoned
- May escape control into adjacent vegetation
- Look for signs of camping activity and a fire ring in the general origin area
- Secure the area and protect it
- Identify any persons in the area

5-9 First Responder – Cigarettes

Contrary to popular belief, conditions necessary for a cigarette to cause a fire are very limited, but it can occur. Roadside fires started from cigarette butts will often have an origin

within a few feet of the road edge. This type of evidence is very fragile and you must be careful to keep hose streams and other suppression activity well away from the origin area.

Fire Cause Categories

Smoking:

- A carelessly discarded cigarette is often erroneously blamed for wildland fires
- Conditions necessary for a cigarette to cause a fire are very limited
- Roadside fires started from cigarettes often have an origin within a few feet of the road
- Cigarette-related evidence is very fragile
- Keep hose streams and other suppression activity well away from the origin area

5-10 First Responder – Debris

Windblown embers from burning debris can easily fall into uncleared vegetation. If you find a burn barrel or a debris pile at or near the origin do not enter the area, just secure and protect it, then take notes on the evidence and photograph the area if possible.

Fire Cause Categories

Debris burning:

- Fires escape by windblown embers or by creeping into uncleared vegetation
- A debris pile or burn barrel will be present near or at the origin area
- Secure the origin area
- Without entering the origin area, note and document hot piles or barrels

5-11 First Responder – Arson

Multiple fires set over a period of days or weeks often indicate arson. Origins are usually near roads or trails. Protect but do not disturb any footprints or ignition sources you find.

Fire Cause Categories

Incendiary:

- Arson
- May involve a “hot set” or a time-delayed device
- Often multiple fires set over a period of days or weeks
- Origins near roadsides or trails
- Protect the origin, tire impressions, footwear impressions, and any other evidence of the cause
- If the ignition source is observed, do not touch it, but do protect it from suppression activity

5-12 First Responder – Equipment Operation

PP Slides 34-42

Fires can be started in a number of ways by virtually anything powered by an internal-combustion engine. You'll usually find evidence of operation, and often the equipment itself, near the origin. Make sure you look for and protect any signs of equipment use in the area.

Fire Cause Categories

Equipment use:

- Fires started from any mechanized equipment except railroad equipment
- A variety of ignition sources include exhaust particles, friction, fuel or fluid leaks or spills, malfunction or direct heat transfer
- Equipment can range from bulldozers and road graders to passenger cars, motorcycles, chainsaws, pumps and generators
- Look for and protect evidence
  - Tire or track impressions
  - Chainsaw or other portable equipment use
  - Blade scrape or gouge marks
  - Blade strike marks
  - Equipment itself

5-13 First Responder – Railroads

Railroad operations can start fires in a variety of ways. The origin will almost always be on or very near the track right-of-way. However exhaust carbon can also ignite fuels some distance away, so it's important to protect a general origin area that extends from the tracks to at least 75 or 100 feet out. If train brakes or exhaust systems fail, multiple fires, and therefore multiple origins, can occur. It is very important to stop the train that is suspected of starting the fire in order to collect evidence and prevent additional fires.

Fire Cause Categories

Railroads:

- Ignition sources
  - Exhaust carbon, brake failure, other mechanical malfunctions, track maintenance, flares, warming fires, debris burning
- Origin is on or near track right-of-way
- Exhaust carbon may cause origins at much greater distances
- Protection and recovery of any physical evidence is critical
- Protecting a general origin that starts on the tracks and extends to at least 75 or 100 feet
- When brakes or exhaust systems fail, multiple fires and/or origins may result
  - Identify and stop the suspected train
  - Preserve evidence

5-14 First Responder – Children

Children experimenting with fire often cause uncontrolled wildfires. Because many of them occur in residential areas they're usually detected and suppressed quickly, and the origin areas are not adequately protected. However, these fires usually exhibit several obvious indicators, and it's important to secure any origin evidence you find. Most fires of this type the result of natural curiosity, but some motives are more pathological. That's why it's also important to identify any children leaving or at the scene of the fire, so the responsible parties can be referred to juvenile authorities for counseling.

Fire Cause Categories

Children:

- Children experimenting with fire sometimes leads to uncontrolled wildland fire
- Many of these fires occur in residential areas where they are quickly suppressed and origin areas are not adequately protected
- Fires started by children often exhibit obvious indicators
  - They occur in places frequented by children
  - The children may try to suppress the fire themselves
  - Burned toys, cardboard boxes, fireworks and/or multiple matches may be present at or near the origin
- Identify or be able to describe children leaving or at the scene
- Protect the origin area and any physical evidence near the origin
- Children's motives are usually normal curiosity but can also result from more pathological reasons
- It is important to identify the responsible child and have them referred to juvenile authorities for counseling

5-15 First Responder – Miscellaneous

Several other ignition sources are classified as miscellaneous.

Fire Cause Categories

Miscellaneous:

- Fires from ignition sources not in any other category are classified as Miscellaneous
- Ignition sources such as:
  - Powerlines
  - Fireworks
  - Cutting and welding
  - Firearms and ammunition
  - Spontaneous heating
  - Electric fences
  - Blasting

5-16 First Responder – Powerlines

Powerline fires usually originate close to lines or poles and present a variety of evidence. You may not be able to prevent utility company employees from making necessary emergency repairs, but you can legally prevent them from taking evidence from the scene. Photograph the conductors and any other evidence you find before the repair crews arrive, and remember to use extreme caution, especially if a conductor is on the ground.

Fire Cause Categories

Powerlines:

- Origin close to lines or poles
- Evidence at the origin may include charred limbs, dead birds or squirrels, downed conductors, fuses, insulators, or other hardware lying on the ground.
- Utility employees may make emergency repairs but you can legally prevent them from taking evidence.
- Secure and protect the origin area and any physical evidence
- Photograph the conductors and any other relevant evidence prior to the utility company repair crews if possible
- Use extreme caution around and under conductors

5-17 First Responder – Fireworks

Fireworks start many wildland fires every year, usually around holidays or other celebrations. Protect and preserve any evidence you find in and around the origin area.

Fire Cause Categories

Fireworks:

- Start many wildland fires annually around holidays or other celebrations
- Evidence observable near the origin includes spent fireworks, wrapping paper, packages, chemical residue

5-18 First Responder – Cutting, Welding, and Grinding

Welding, grinding, and other activities that cause sparks or produce hot metal fragments can easily start fires. Look for cart wheel marks as well as any fragment evidence.

Fire Cause Categories
Cutting, welding, and grinding:

- Sparks or hot metal fragments during welding operations
- Evidence may include welding debris, cart wheel marks and the material that was being cut or welded

5-19 First Responder – Firearms

Firearm fires are an infrequent occurrence, but bullet strikes from steel-core ammunition or tracer and incendiary rounds can ignite dry fuels. There is usually evidence of firearm use near

the origin.

Fire Cause Categories

Firearms and ammunition:

- An infrequent occurrence
- Bullet strikes from steel core ammunition, tracer and incendiary rounds are common ignition sources
- Evidence near the origin could include empty shell casings, target materials, bullet holes or strike marks, empty shell boxes

5-20 First Responder – Spontaneous Heating

Most fires started from spontaneous heating originate from inside chip or green slash piles. Look for evidence of the pile at the origin and protect the area from suppression efforts.

Fire Cause Categories

Spontaneous heating:

- Most originate from inside chip or green slash piles
- Evidence of the pile will be at the origin
- Do not suppress the origin area

5-21 First Responder – Electric Fences

Electric fences occasionally start wildfires. Protect the origin, usually along the fence line, and do not let the owner attempt to make repairs.

Fire Cause Categories

Electric fences:

- Origin will be along the fence line
- Protect the origin and the fence line itself
- Do not let the owner make repairs

5-22 First Responder – Origin Identification

The most important tool you have in identifying the origin area of a wildfire is understanding fire behavior. What you learned earlier in this program becomes very important in accomplishing one of your primary responsibilities as a first responder – locating and securing the origin area.

Fire behavior:

- Accurately identifying and protecting the general origin area of a wildland fire is one of your primary responsibilities
- Wind and slope affect the the preliminary spread and shape of the fire

5-23 First Responder – Rate of Spread

Once a fire starts it will burn outward in a circular fashion until wind and slope begin to define its general shape, also known as its personality. As you learned earlier, the rate of spread is also influenced by fuel size and continuity, and the amount of moisture it contains.

Fire Behavior

Topography:
- Slope
- Aspect
- Shape of land

Fuels:
- Size
- Moisture
- Continuity

5-24 First Responder – Areas of Spread

These effects will cause the fire to form three distinct areas of spread. The advancing area, or head, moves the fastest and burns with greater intensity, creating more noticeable damage. The backing area, the heel, spreads more slowly, with less intensity and less damage, while the flanks, or lateral areas usually exhibit behavior characteristics that fall somewhere in between. Within these three areas are several transition zones.

Fire Behavior

- Head – Advancing area:
  - Greater intensity
  - Faster spread
  - More damage

- Heel – Backing area:
  - Less intensity
  - Slower spread
  - Less damage

- Flanks – Two areas of lateral spread

- Transition zones – Between distinct areas of fire spread

5-25 First Responder – Origin Area

The precise location where the ignition source comes into contact with the fuels is called the point of origin. The area immediately around this point, where the fire spreads evenly before wind and slope have an effect, is called the specific origin area. It's usually less than 5 feet square.

Once the fire develops a direction of travel, the area burned is referred to as the general origin area. It can range from 10 feet square to half an acre depending on fuels and fire behavior conditions. In other words, it may occur within the first few inches of the fire's progression, or it may take up to half an acre or more to develop. Remember, it's always better to secure too large an area than too small.

Fire Behavior

Point of origin:

- Precise location of ignition source
- Keep people and suppression action away

Specific origin area:

- Immediately around the point of origin
- Usually less than 5x5 feet

General origin area:

- Area burned once the fire develops a direction of travel from wind or slope influence
- First responders secure and protect
- Range from 10x10 feet to over ½ acre
- When determining an area to protect, it is better to secure too large an area rather than too small an area

5-26 First Responder – Slope

You know fire burns upslope faster than downslope. As it moves uphill it will generally burn outward in a V- or U-shaped pattern. The origin will normally be at the bottom of the V or U.

Fire Behavior

Slope and wind are the two major factors that govern fire spread:

- Wildfire burns upslope more readily than downslope
- Fire burns outwards as it moves uphill in a V- or U-shaped pattern
- The origin will normally be in the bottom of the V or U

5-27 First Responder – Wind

You also know that fire usually moves in the direction the wind is blowing. So the origin area will normally be upwind from the head of the fire. In the early stages of the fire, wind can also influence the shape of the origin area. Under moderate to strong winds the origin will be

closer to the heel, but in light or no-wind conditions it will be nearer the center of the burned area.

Fire behavior – wind:

- Fire normally advances with the wind
- The origin area will be upwind from the advancing area
- Moderate to strong wind – origin closer to the heel
- Light or no wind – origin closer to the center of the burned area

5-28 First Responder – Transition Zones

Transition zones can also help you identify the general origin area. Once the fire begins to advance under the influence of slope or wind it burns with more intensity. There are a number of large, "macro-scale" indicators that will help you locate the general origin area and possibly the actual point of origin. Once you've learned these you should be able to answer the following four questions.

Fire Behavior

Identifying transition zones:

- Changes in fire intensity
- Point of slope or wind influence
- Macro-scale indicators

Fire direction indicators:

- Angle of char in tree and brush crowns is steeper than the slope
- Deeper charring on the sides of objects facing the approaching fire.
- "Foliage-freezing" consistent with wind direction
- Grass stems completely consumed in advancing areas; unburned and toppled to the ground in backing areas with heads pointing toward the origin

5-29 First Responder – Question 1

(Refer to CD.) The angle of char on this tree crown is steeper than the slope. Therefore, we know that this is an area of advancing fire.

On which side of this picture would the origin area be?

5-30 First Responder – Question 2

(Refer to CD.) These downed logs show more damage on one side than the other.

On which side of this picture would the origin most likely be?

5-31 First Responder – Question 3

(Refer to CD.) This foliage crown is “frozen” in the direction the wind was blowing when the fire passed it.

On which side of this picture would the origin most likely be?

5-32 First Responder – Question 4

(Refer to CD.) This is most likely an area of backing fire spread. Advancing fire spread areas would have an absence of grass stems. In which direction would the origin most likely be?

5-33 First Responder – Basic Information

Fires are reported in many different ways. If you are the one who takes the call be sure to get some basic information about the caller in addition to the location of the fire.

As a first responder you’ll want to record specific facts about the fire that will be important to firefighters responding and to investigators trying to determine the cause and effects.

Responding to the Fire

Discovery and reporting:

- Telephone
- Radio
- Lookout towers
- Aircraft
- Passersby

When you take the report make sure to get the basic information:

- Name
- Phone number
- Address
- Location of fire
- How the fire started

Other important information to record:

- The time the fire was reported
- How it was reported and who reported it
- Location of the fire
- Weather conditions
- Access
- Jurisdiction
- Other units responding

5-34 First Responder – Smoke Column

En route to the fire pay attention to the smoke column and relay the information to dispatch or take notes for later reference.

Responding to the Fire

Smoke column:

- Size
- Direction of drift
- Color
- Volume
- Changes in any of the above

5-35 First Responder – Vehicles

Also make note of any vehicles leaving the scene. A pocket tape recorder is handy for this, along with a reference sheet listing the kinds of information that will be helpful.

The same goes for any people you see leaving or at the scene. Again, use a reference sheet if you need one to make sure you get all the description details you can.

Responding to the Fire

Vehicle identification information:

- Make
- Model
- Year
- Color
- License plate
- Number of occupants
- Cargo on board
- Damage to the vehicle
- Unusual or obvious accessories
- Direction and speed of travel

Subject description information – fixed traits:

- Sex
- Race
- Height
- Hair color
- Weight

Subject description information – unfixed traits:

- Clothing
- Facial hair
- Glasses
- Scars/tattoos
- Eye color

5-36 First Responder – Evidence

Don't forget to check out conditions at the scene carefully and make note of any potential evidence of the fire's cause

Responding to the Fire

Other observations:
- Condition of gates, (open, closed, locked)
- Tire or footwear impressions on roads/trails
- Any items that appear out of place and might be potential evidence

5-37 First Responder – Protect Origin Area

Once you arrive at the scene take steps immediately to protect the general origin area and any physical evidence you find. Do not allow any suppression activity to disturb the origin area.

Arrival at the Scene

First priority – Identify and secure the general origin area:
- Use flagging or rope
- Post guards as necessary
- Keep suppression activity away
- Keep all unauthorized persons out

5-38 First Responder – Identify Witnesses

Your next priority is to identify any witnesses in the area. Write down their personal and vehicle information, and, if possible, have them wait for the investigator who will conduct a more thorough interview. Write down the license number and description of any vehicles that drive by the scene more than once, and take extra note of people who seem unusually interested in the fire, or who try to assist with suppression or the investigation.

Arrival at the Scene

Next priority – Identify witnesses:
- Have them wait for the investigator if possible
- Obtain identification information
  - Name
  - Address

- Phone number
- Vehicle license number and description

5-39 First Responder – Record Data

Weather may be a critical factor in corroborating cause determination, so make sure to properly record as much data as you can.

Do not touch any evidence unless it's absolutely necessary to keep it from being destroyed. If you have to move something, try and get a photograph of its original position first. Finally, make notes on fire behavior at the time of your arrival and photograph the scene thoroughly.

Arrival At the Scene

- Weather readings:
  - Take readings in an area consistent with origin conditions
  - Use a belt weather kit or digital weather instrument
  - Record data for investigators

- Physical evidence:
  - Tire impressions
  - Footwear impressions
  - Beverage containers
  - Any obvious cause of ignition
  - Do not pick up or touch unless absolutely necessary to prevent destruction

- General fire behavior conditions:
  - Wind direction
  - Wind Speed
  - Flame height and length
  - Overall fire intensity
  - Direction of spread
  - Suppression tactics

- Photograph the fire scene if possible
- Identify vehicles that drive by origin area more than once
- Record descriptions of persons unusually interested in the fire or that try to assist with suppression or investigation

5-40 First Responder – Remain Available

Continue to keep the origin and any relevant evidence protected until the investigator arrives, and be ready to make personnel available to guard the area. Turn over your notes and any tapes or photographs, and make yourself available for additional interviews that might be needed later on.

Afterwards, keep your ears open for any rumors or facts about the cause of the fire and report them to the investigators. Make sure they gets any additional information they request, and do not discuss the investigation or any information related to it with anyone, especially the media or the general public.

Post-Response Phase

- Once you have accomplished your primary duties as a first responder, your responsibility does not normally end
  - Continue to keep the origin and any relevant evidence secured until the investigator arrives
  - Make personnel available to guard the origin if the investigator requests them
  - Once the investigator arrives, pass all your information on
  - Turn over any notes and film to the investigator
  - Be available for additional interviews if requested
- Remain vigilant for any rumors or facts regarding the cause of the fire and report them to the investigator
- Ensure that investigators receive any additional information that they request from you, including fire reports, dispatch logs, etc.
- Do not discuss the investigation or any information related to the investigation with others, especially the public and the media, without prior approval from the investigator and public information officer

5-41 First Responder – Situations

You should now be able to identify the general origin and evidence protection areas in these four fire situations.

5-42 First Responder – Exercises

Before you move on to the next unit, take a few minutes to complete these eight exercises. The information was all presented in this first responder section. If you can't remember everything, go back and study it again. It will be important in upcoming sections.

Review exercises:

- Describe why adequate fire cause determination is essential.
- List the items needed in a wildfire origin protection kit.
- Identify the major fire ignition/cause categories and their indicators.
- Describe the basic principles of fire behavior and their influence on wildfire burn patterns and indicators.
- Identify the principles of fire detection and describe the fundamentals of fire reporting and dispatch.
- List observations that may be encountered en route to and upon arrival at a wildfire.
- Describe the proper steps to be taken upon arrival as a First Responder to a wildfire

- Identify the proper steps to be taken while in a wildfire area, during the post response phase.

UNIT 6
INCIDENT COMMAND SYSTEM

6-1 ICS – Chain of Command

A chain of command helps any organization operate smoothly efficiently. The same is true when an incident such as a wildland fire occurs. That's when the Incident Command System (ICS) comes into play.

6-2 ICS – Unit Objectives

This review will give you a working knowledge of ICS organization, terminology and common responsibilities.

6-3 ICS – Introduction

The Incident Command System is used to manage both emergency and non-emergency events, large or small, human-caused or natural phenomena, that require action by emergency service personnel to prevent or minimize loss of life or damage to property and natural resources.

Examples include fire (both structural and wildfire), hazardous material situations, search and rescue, oil spills, forest pest eradication, planned events such as parades or political rallies, just to name a few.

6-4 ICS – Incidents

The vast number of incidents that occur every day across the country, from major wildland fires that can last for months, to a city shop fire that's over in a few hours, require many different agencies to work together in a smooth, coordinated effort under the same management system. ICS is very flexible. It can grow or shrink to meet the needs of a specific event, making it extremely cost efficient.

6-5 ICS – Activities

ICS is organized around five major activities – Command, Operations, Planning, Logistics, and Finance/Administration. Let's take a closer look at each one of these.

6-6 ICS – Command

Command is headed by an Incident Commander who may have one or more deputies, either from the same agency or from other agencies or jurisdictions. They have overall responsibility and will set objectives and priorities for managing the incident.

Directly under the IC and any deputies is the Command Staff, who may also have assistants.

Each of the other Chiefs of Staff may also have deputies, each of whom must be fully qualified.

6-7 ICS – Operations

Operations develops tactical objectives, organization and directs all resources to carry out the operation. There is only one Operations Chief although additional levels of supervision may be necessary.

Divisions may be added to divide an incident into geographic areas for better management.

At the same level, Groups are often established to describe functional areas of operation. They can work wherever they're needed and report, along with Divisions, to the Operations Section Chief or the Branch Director.

In very large or complex operations where multiple agencies or jurisdictions are involved, Branches are created to help control the functional span of the incident. Each Branch has a Director, and may also have a deputy. Air operations, for example, are usually established as a separate branch to support both tactical and logistical operations.

Staging areas are established whenever it is necessary to temporarily locate resources awaiting assignment. The Staging Area Manager is responsible, under the control of the Operations Section Chief.

6-8 ICS – Planning

The Planning Section develops the action plan to accomplish the management of the incident. They collect and evaluate information as the incident unfolds and document the status of all resources involved. They are also responsible for developing a demobilization plan

6-9 ICS – Logistics

Logistics provides the resources and all other services needed to support the incident operation, including personnel, facilities, equipment and supplies. Because of their broad scope, Logistics may have one or more Branches in addition to the 6 basic functions established within the section.

6-10 ICS – Finance/Adminstration

A Finance/Administration Section is set up for any incident that requires on-site financial management. Depending on the size of the operation, four additional units may be established as necessary.

6-11 ICS – Communications

In order to keep communications clear and precise during an incident, a terminology has been developed to identify the various positions. On small incidents these major activities may all be managed by one person, the Incident Commander. The larger the event the more expanded the ICS becomes to meet the needs of the operation.

Primary Position	Title	Support Position
Incident Commander	Incident Commander	Deputy
Command Staff	Officer	Assistant
Section	Chief	Deputy
Branch	Director	Deputy
Division/Group	Supervisor	N/A
Strike Team/Task Force	Leader	N/A
Unit	Leader	Manager
Single Resource	Use Unit Designation	N/A

6-12 ICS – History

ICS has been used nationally on wildfires since the early 1980s. It was used on the *Exxon Valdez* oil spill in 1989, on hurricanes Hugo in 1990 and Andrew in 1992, and to manage the World Cup soccer matches at Giants Stadium in New Jersey in 1994.

6-13 ICS – Incident Action Plan

In order to provide all supervisory personnel with a common direction for action, every incident has an IAP, an Incident Action Plan, either oral or written. IAPs are based on operational periods, which can vary in length from 1 to 24 hours. On large incidents they're usually divided into two 12-hour shifts.

6-14 ICS – Basic Responsibilities

You need to be aware of several basic responsibilities any time you report to an incident. Familiarize yourself with all check-in locations for the operation.

Once you arrive, get a briefing from your immediate supervisor, then organize and brief any subordinates assigned to you. And don't forget to brief your relief at the end of your shift.

Always communicate clearly, whether you're talking to someone in person or over the radio. Get in the habit of using ICS terminology so everyone understands your message the first time. And remember to bring along any specialized equipment or supplies required for your job.

When the incident is over, demobilize according to plan. Complete any required forms and reports and give them to your supervisor on time.

6-15 ICS – Additional resources

As you become more involved with emergency services you may want to learn more about the Incident Command System. ICS curriculum is divided into six subject areas that cover everything from Beginning ICS to Multi-Agency Coordination to ICS for Executives. Ask your supervisor or training group how to get more information.

UNIT 7
FIRE INVESTIGATION KIT

7-1 Fire Investigation Kit

Finally, study the contents of the investigation kit carefully and familiarize yourself with the basic equipment for a wildland fire investigation kit. As you study them, make a list of other items that investigators may want to acquire or have access to.

UNIT 8

8-1 Conclusion

Congratulations! This completes your pre-course work for Wildland Fire Investigation and Safety Review, Origin and Cause Determination, FI-210. Good luck as you move on to your next phase of training.