

**WILDFIRE CAUSE**

**DETERMINATION**

**HANDBOOK**

## CHECKLIST FOR WILDFIRE CAUSE DETERMINATION

1. Take essential investigation materials with you to fire.
2. Make factual notes of all your actions and findings, including;
  - A. Time fire was reported.
  - B. Name and identification of person reporting fire.
  - C. Observations en route to fire-people and vehicles.
  - D. Weather conditions-sunny, cloudy, etc.
  - E. Name and identification of persons or vehicles in vicinity of fire origin.
3. Locate and protect fire origin.
4. Search fire origin area for physical evidence of fire cause.
5. Protect evidence-but DO NOT REMOVE, unless necessary to prevent destruction.
6. Make sketches of origin area, using accurate measurements of relative locations of all evidence.
7. Take photographs from all angles and include long and medium-distance and closeup views of fire origin area and important evidence.
8. Turn over all notes, information, and physical evidence to the Police, or make your notes part of official fire record.

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## OBJECTIVE

This handbook is designed to assist personnel having wildfire protection responsibilities in taking appropriate early action to determine fire cause. It is written for the initial-attack firefighter who may have little experience in basic preliminary investigation work.

Accurate fire cause determination is a necessary first step in a successful fire investigation, and successful fire investigations are necessary in prevention of unwanted wildfires. Proper investigative procedures which occur with initial attack can more accurately pinpoint fire causes and can preserve valuable evidence that may lead to civil or criminal convictions.

By using this handbook as a training tool, reference, or checklist, a land manager can improve the accuracy and usefulness of fire cause information.

This guide is not intended to be a law enforcement handbook. It provides instructions only to serve for identifying and protecting potentially valuable evidence so that the cause of the wildfire can be determined.

## DEFINITIONS

1. Wildfire. Any unplanned fire burning timber, bush, grass, or cropland and requiring suppression actions.
2. Fire Origin. The point at which a wildfire starts.
3. Fire Ignition Source. The thing or object which actually ignites a wildfire.
4. Fire Cause. One of the nine general causes of wildfire listed by the Department of Conservation and Land Management (Oct 1985).



## CHAPTER 10 - PREPARATION

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#### 11 MATERIALS YOU WILL NEED TO TAKE TO THE FIRE

## CHAPTER 10 - PREPARATION

## 11 - MATERIALS YOU WILL NEED TO TAKE TO THE FIRE.

There are some basic and simple tools that you will need to assist you in your search for a fire cause. This list is by no means complete; however, to do an efficient job these should be considered as a minimum. Personnel responsible for responding to fire calls will find these items and this handbook helpful in determining fire cause.

1. Flagging. Plastic flagging will serve to mark clearly the area of wildfire origin, so it can be protected from disturbance. It will also help you divide the search area into segments for thorough search.
2. Straightedge. A straightedge will help you train your eye on small vision points while you are conducting your examination of the fire origin area. It will also serve as a background for photographs of evidence. It should be opaque for photographic reasons.
3. Camera. Although this item will not always be available, those crews or firefighters who have access to a camera and some photography skill should include it in their fire cause determination kit. It will help to confirm visually any evidence that is found in the fire origin area.
4. Writing Materials. A looseleaf notebook containing lined graph paper and pencils with erasers are necessary both for notetaking and for making sketches of the fire origin area.
5. Steel Tape. A steel tape measure will give you accurate distances for the location of evidence as related to permanent landmarks.
6. Compass. A compass should be used to orient your sketches to all four compass points.

## CHAPTER 20 - FIELD NOTES

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- 23 WHAT TO DO WITH YOUR COMPLETED NOTES

## CHAPTER 20 - FIELD NOTES

### 21 - PURPOSE.

Detailed notes taken at the scene will assist you in giving evidence if a case goes to court.

Your notes must be taken AT THE TIME the information of facts are FIRST brought to your attention.

### 22 - NOTETAKING.

To be useful your notes must be ;

1. READABLE. Notes must be readable not only by you, but also by anyone else who may need to read them. They must contain complete words to avoid misunderstanding. Do not use shorthand eg. HFROS etc.
2. BRIEF. Use short sentences or phrases, and avoid long, rambling sentences which could confuse a reader.
3. DESCRIPTIVE. Use words that actually describe what you see. For example, write "' Burned match'" rather than "'Burned object.'" Often, sketches will be valuable in supplementing your written description.
4. ACCURATE. Notes must be accurate as to times, dates, names, weather conditions, nicknames, addresses, scene description, and physical descriptions of vehicles and property, including serial numbers and licence plates. They must also have accurate map locations.
5. FACTUAL. You must keep your personal opinions or conclusions to yourself. DO NOT INCLUDE THEM IN YOUR NOTES.
6. COMPLETE. Your notes should answer the questions WHO, WHAT, WHEN, WHERE, WHY, and HOW.

### 23 - WHAT TO DO WITH YOUR COMPLETED NOTES.

You should turn your completed notes over to the Police or your fire officer for inclusion as part of the official fire record. NEVER THROW AWAY YOUR NOTES, UNLESS INSTRUCTED TO DO SO BY YOUR FIRE OFFICER.

FRIDAY 13/01/86

1648 HOURS

TALL HILL FIRE ON MOUNTAIN ROAD

CALLED BY D.M. WOOP WOOP TO ATTEND

FIRE

1650 LEFT WOOP WOOP D.H.Q.

1701 SAW RUSTY BLUE MINI SEDAN AT MOUNTAIN ROAD SW HIGHWAY  
JUNCTION, REG. NO. 6BD 797.  
2 PASSENGERS IN CAB, MALE PASSENGER WEARING YELLOW HARD  
HAT, WOMEN DRIVER.

1706 FOUND GATE INTO QUARANTINE AREA, 2KM UP MOUNTAIN ROAD  
FROM SW HIGHWAY, BROKEN. VEHICLE TRACKS ON ROAD - I  
DROVE AROUND THEM AND TOLD FOLLOWING GANG TO DO SAME.

TALL HILL FIRE

PAGE 2

1710 SMOKE BLOWING SW, WIND AT 15-18KM/HR, WEATHER CLEAR.

1731 PARKED MY VEHICLE OVER TYRE TRACKS. PUT YELLOW  
FLAGGING AROUND AREA 25M X 10M BESIDE ROAD. NO  
EVIDENCE IMMEDIATELY VISIBLE. FIRE ABOUT 2HA BURNING  
SW UP TALL HILL IN COASTAL HEATH.

1941 FOUND FOOTPRINT INSIDE FLAGGED AREA. 2.1M FROM DITCH  
AND 3.6M FROM STEEL SURVEY MARKER. (NOTED ON SKETCH).

JOE BLOKE

13/1/86

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##### 32.3 Search for and Protect Evidence

##### 32.4 Identify Witnesses and Other Persons at the Fire

## CHAPTER 30 - ACTIONS ON THE WAY TO THE FIRE

## 31 - ON THE WAY TO THE FIRE.

Your determination of fire cause must begin before any suppression action. YOU MUST START YOUR FIELD NOTES AT THE TIME YOU RECEIVE YOUR DESPATCH ORDERS. Your notes from the time the despatch is received until you arrive at the fire should include the following;

1. Identification of Yourself. Put name, unit and title on you notes.
2. Time and Date. Record the time and date you receive the despatch.
3. Person Reporting Fire. Record the complete identification of the person reporting the fire. This person may be the only witness the Police will be able to interview. Be sure to get his or her address and telephone number if possible.
4. People and/or Vehicles. Record complete descriptions, locations, and time of any people or vehicles observed coming from the direction of the fire.
5. Gates and/or Tracks. Record any gates that are broken or open or locked. If on gravel roads or tracks, watch carefully for vehicle tracks or footprints. Drive or walk in such a manner as to avoid disturbing the tracks. Notify the fire-fighters following you of their presence and the need for protection.
6. Smoke Column. While on the way, watch for the smoke column, and from its appearance, make an estimate of wind direction and approximate speed, and estimate the size of the fire. Record the time of your estimate in your notebook.
7. Missing Items. Things that are missing may be as important as things you see. Note these also.
8. Weather Items. Record weather condition, temperature, type of clouds, rain, etc.

## 32 - ARRIVAL AT THE FIRE

When you get to the fire, your responsibility is to prevent further spread of the fire. At about the same time, you should be able to do the following. MAKE NOTES OF YOUR ACTIONS.

32.1 - Estimate Fire Size. Estimate the size of the fire. Record your estimate and the time of your estimate. Write down size, direction of spread, rate of spread, type of fuel, slope, wind direction and speed, and other weather conditions.

32.2 - Locate and Protect General Origin Area of Fire. Since 90 percent of all wildfires are contained at less than 2ha, you will probably be able to locate the fire's general area of origin as soon as you arrive. If this is possible, immediately use the flagging you brought with you to mark this area. You should then evaluate the fire's size and other factors mentioned in the previous paragraph.

If possible, post a guard at the general origin and keep suppression efforts in this area to a minimum. Vehicles, fire ploughs, and walking firefighters should be routed around this area. Ensure that firefighters or observers do not put materials such as cigarette butts into this flagged area.

If the fire is so large that the origin area is not easy to find, rope off or restrict access to large area which you think probably contains the fire's immediate origin point. At this time, it is most important to protect the entire area from further disturbances.

Chapter 40 of this handbook contains detailed instructions which will help you narrow down this larger area into an actual origin point.

32.3 - Search for and Protect Evidence. After protecting the origin area, look around you for such things as persons, vehicles, tracks, ignition devices, discarded Polaroid backing, paper bags, beer cans, or any objects or impressions which may have even the slightest possible value as clues DO NOT DISTURB THESE OBJECTS. Use your flagging to mark anything you find. Tracks on roads can be protected by parking a vehicle over them. Footprints or tracks on roads can be protected by routing traffic to one side of the road. If there is no way to avoid disturbing what might be valuable evidence, handle it as carefully as possible, and put it in a safe place.

#### 32.4 - Identify Witnesses and Other Persons at the Fire.

1. Witnessess. Interviewing witnesses at the scene is a very important part of a fire investigation. You can help by recording the following information in your field notes:

1. Names and descriptions of persons at the scene.
2. Make, license number, and description of vehicles at the scene.
3. Notes of any remarks made by persons at the scene that are in any way related to the fire.

2. Other Persons. Persons at the scene when you arrive or who come during the progress of a fire will often give written statements voluntarily but would be reluctant to do so at a later date. You should not hesitate to capitalize on this situation. This should not be confused with interviewing a witness, as you are merely asking these persons to record any observations or other knowledge they are willing to give in their own handwriting. The following guidelines can be used when obtaining voluntary statements:



1. Have the person write the facts in detail.
2. If possible, provide the person with some degree of privacy, so this can be accomplished uninterrupted.
3. Have the person number, date, and sign each page.

Whether this statement is ever introduced in a court of law is not as important as your having an immediate and accurate record of all his stated observations and knowledge.

Do not share your opinions or what you have seen at the fire or information about the person or thing that may have started it to anyone other than the Police or the fire boss who has responsibility for suppression of the fire. REMEMBER, YOUR JOB IS TO GATHER INFORMATION, NOT GIVE IT.

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## CHAPTER 40 - DETERMINATION OF FIRE ORIGIN

## 41 - DETERMINING FIRE ORIGIN

If your fire was discovered early, you may have the general origin area already accurately flagged. It may be anywhere from a few square meters to a hectare or two in size. This early discovery and flagging will give you a headstart in your fire cause determination. But if the fire, for any reason was already large when your initial attack crew arrived, you may have several hectares in which you will have to determine an exact point of origin.

Even with large areas, there is a scientific way of identifying the exact spot in which the fire started. A thorough knowledge of fire behaviour is a necessity in determining a point of origin. Fires start small. They smoulder, creep, run, crown and spot. Their behaviour is controlled by weather, fuels, and topography. As a fire moves over an area, it will leave distinct char patterns that will indicate the direction the fire was going. The various char patterns, when taken together, will lead you to the point of origin. The char pattern in one location is not enough. You should select many points, determine the direction the fire was going at each of them, and then backtrack until all the tracks come together to the spot where the fire started.

By using the principles of fire spread and the indicators of fire direction contained in this chapter, you can narrow several hectares down to an exact point of origin. Only after determining that point can your search continue for clues to what started the fire.

## 42 - PRINCIPALS OF FIRE SPREAD

Fire always burns outward from its origin and, if all conditions are equal, it will burn in a circle or an oval pattern. Also near the area of origin, the fire usually is small and slow burning and leaves more unburned material on the ground.

As the fire reaches a certain size it will not stay at even or equal intensities. Due to the factors of wind speed, slope changes, amount of fuel, and barriers, the fire will slow down or speed up and burn with more or less intensity. These changes are usually visible on the ground and will help you to the fire's origin.

42.1 - Wind. Wind probably has the greatest effect of all the elements on fire spread and intensity. Fire moving with the wind burns faster than a fire backing into the wind. You will be able to observe the difference in the char patterns and the amount of fuel consumed. After the fire reaches a certain size,

it will begin to create its own wind and burn even faster than before. Fires will normally spot in the direction the wind is blowing. If a new fire is reported in the opposite direction, check it out.

42.2 - Slope. Slope is the next greatest factor in the rate of firespread. Fire will burn faster uphill than downhill because of the preheating of the uphill fuels. A fire backing downhill will move slower.

42.3 - Fuels. Fuels are also an important clue. Fire will burn faster and more completely when fuels are dry. High humidity, or moisture-filled, fuels will burn more slowly and are likely to leave more unburned material.

42.4 - Barriers. Barriers, such as a log or a rock can cause a fire to slow down or even go out. Almost any barrier will at least lessen the intensity of the fire as it passes. Barriers often cause wind eddies which can change the fire's direction at least for short distances. Don't confuse the effect of a barrier's temporary change of a fire's direction with the actual direction the fire came from.

#### 43 - INDICATORS OF FIRE DIRECTION

43.1 - Indicators. Most of the following indicators will be apparent on both large and small fuels:

1. Grass Stem Indicators. As fire approaches a grass stem, it heats and begins to char one side first. This side is reduced in size and weakened. The effect is about the same as a scarf on a tree. Eventually, the grass stem will fall toward the weakened side. As a fire moves into a stand of vegetation the fallen stems will point in the direction the fire came from. However, as with all indicators, you must get the proper direction from several different sources, because such things as wind or time could affect the direction in which the stems fall. (fig 1.).



Figure 1

2. Protected-Fuel Indicators. A slowly burning fire with low heat will burn only that side of the vegetation toward the approaching fire. Often fuels that are protected will not show any signs of being burned (fig 2). Because of this, a larger area that burned slowly will look lighter due to ash and more complete combustion when looking away from the point of origin and darker when looking toward the origin.

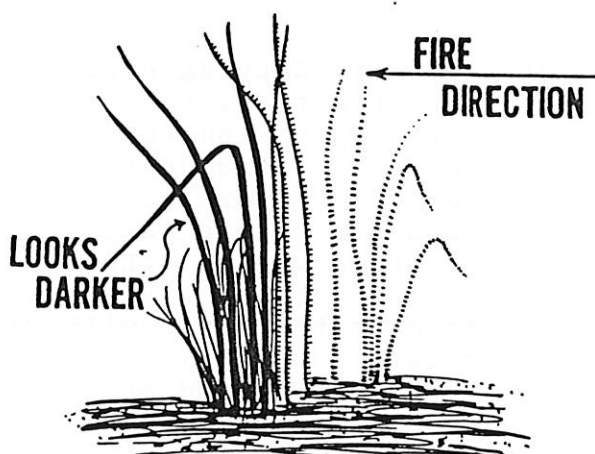


Figure 2

That part of a leaf or limb will show more complete combustion on the side from which a fire approached. This edge will show more burn stains, white ash, and charring, while the other side will be protected and show less signs of burning.

Any item lying on the fuel and protecting it from the fire leaves a definite burn pattern that will indicate in which direction the fire burned. Besides the charring, white ash, and burn stains on the limb shown in figure 3, the protected area is very distinct. There will be a clean burn line on the front side indicated by point "A" and a ragged burn line, indicated by point "B" on the other side. This shows that the fire moved from point "A" to point "B".

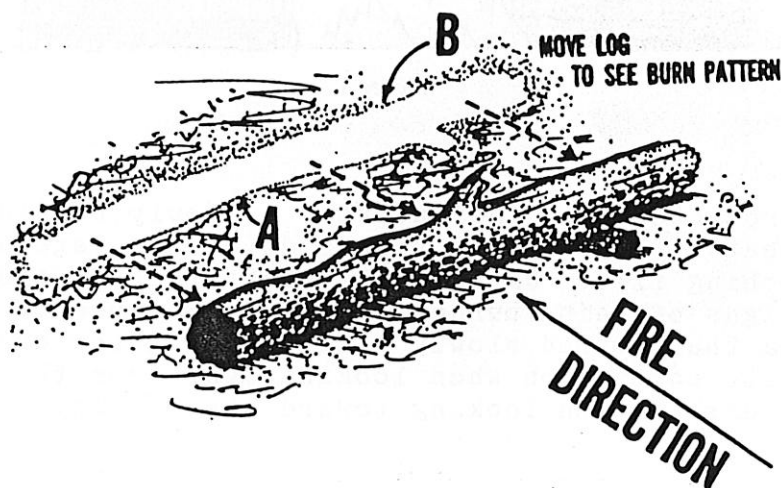


Figure 3

3. Cupping Indicators. Cupping normally occurs on the windward side of a stump or a tree, bush or grass (fig 4). This is the side exposed to the most wind and should be expected to burn the deepest, while the other side remains cooler and protected by the remains of the burning side. This effect takes place even in grass which can be examined closely by rubbing the back of the wrist over burned grass. When rubbing in the direction the fire burned, there will be a velvety feeling but while rubbing in the opposite direction, you will feel some suction and prickling on the wrist. You should move your hand in all directions until the most velvety and most resistant directions are found.

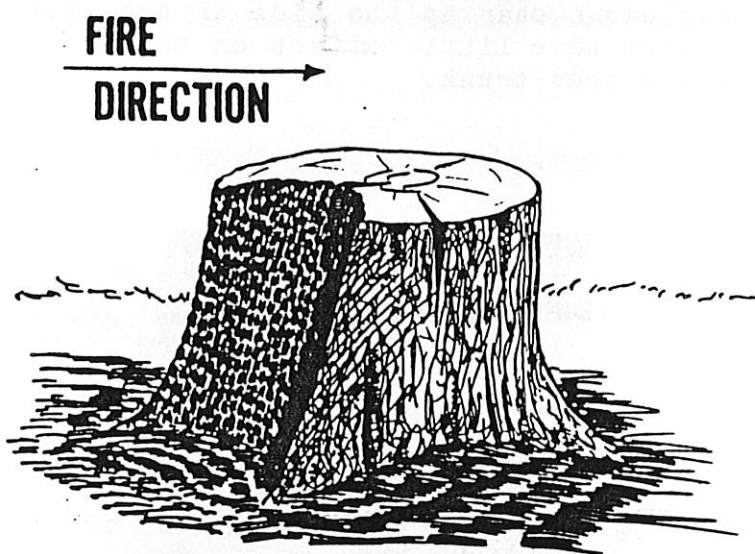


Figure 4

4. Char Pattern Indicators. A fire burning uphill or with the wind creates the type of char pattern shown in figure 5. The char pattern will slope at a greater angle than the ground slope. This is a normal pattern on trees and will remain for many years after the fire. It is caused by a vacuum on the back side of the tree which draws the flames into an eddy on that side. The flames are then drawn up the tree by heat movement, accumulation of fuel on the uphill or windward side will have little effect on the char pattern.

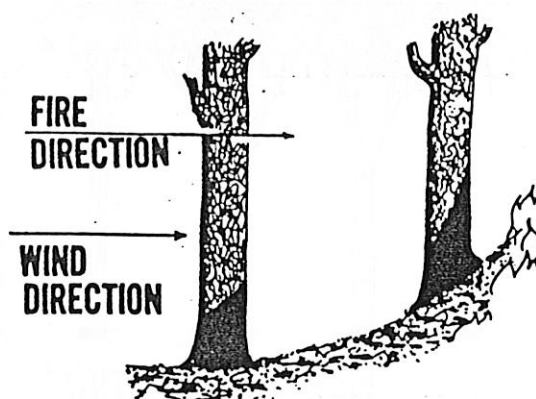


Figure 5

On the other hand, a fire backing downslope or against the wind will create the type of char pattern shown in figure 6. This pattern will be even or parallel to ground slope. Accumulation of debris may cause char up the side of the tree above its location, but it will have little effect on the char pattern around the rest of the tree trunk.

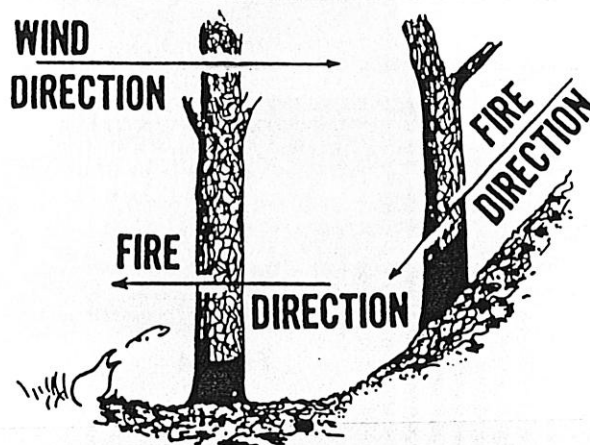


Figure 6

Figure 7 shows a burn pattern created by the way a fire moves through trees and scrub. The less wind, the more vertical the burn pattern will become. While in high winds, this pattern may be almost parallel to the ground.

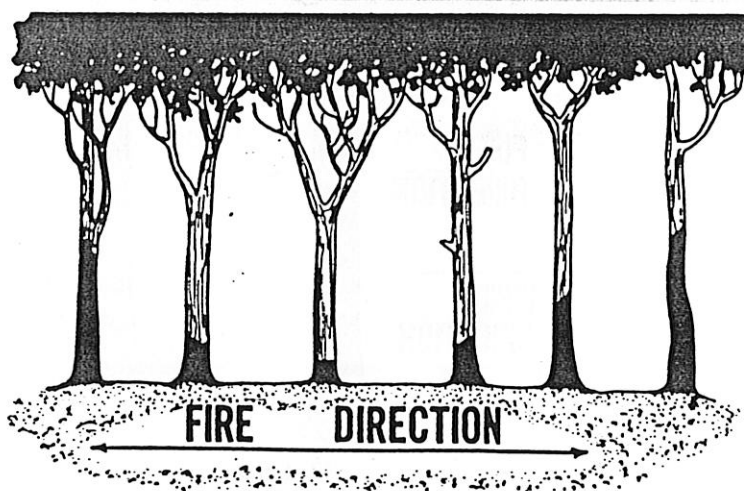


Figure 7



Figure 8 shows the typical effect on the crowns of trees or scrub as a fire starts at point "A" and moves out, slowly building up heat and speed. At the point of origin, the fire is still relatively cool as surface fuels are burned, but the tree's crown is more or less intact. Farther from the point of origin, the fire has become hotter, and more crown is burned. All of the crowns may be burned as the fire intensifies.

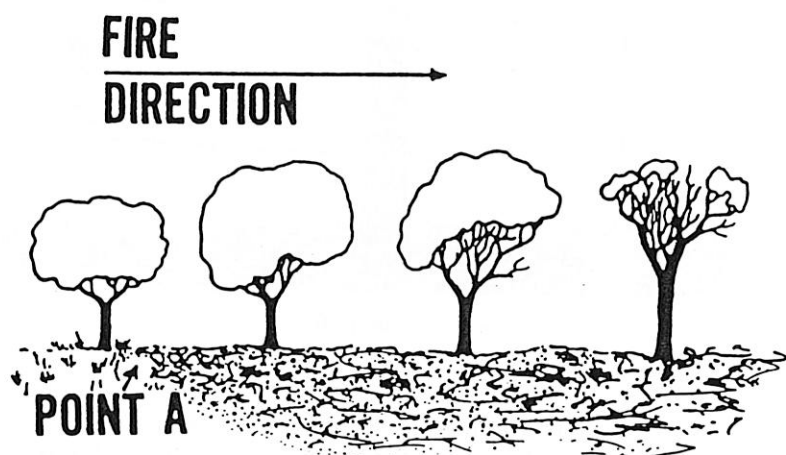


Figure 8

5. Alligatoring. Alligatoring is a form of charring and is normally found on such things as fenceposts, boards, structures, signposts, etc. It can be either large or small and either shiny or dull black. Large, shiny scales mean it was burned by a hot, fast fire while small, dull scales mean the fire was slow and not so hot. The depth of the char is a good indicator of the fire's direction of travel. Figure 9 shows that the char on the fencepost is deeper on the side indicated by the arrow. This means that the fire moved from left to right.

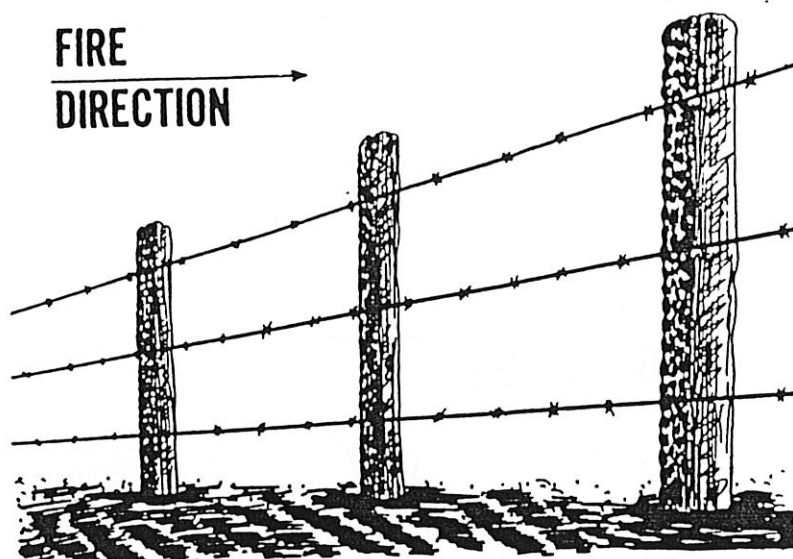


Figure 9

6. "Freezing" of Branches. When leaves and small stems are heated they tend to become soft and easily blown by the prevailing wind or drafts created by the fire. They often remain pointed in the same direction as they cool after the fire passes. Figure 10 illustrates how the smaller branches may look as if they were frozen in the direction the fire went. Again, it is necessary to check several indicators to be absolutely sure of the fire's direction.

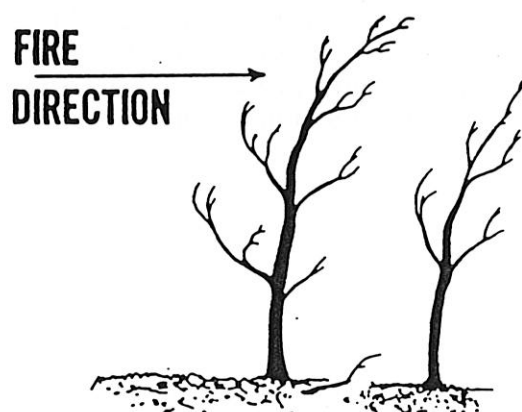


Figure 10

7. Staining. Rocks and other nonburnable objects that are exposed to the fire will be stained by vaporized fuels and minute particles carried by fire. The stain is shown as the shaded area in figure 11 and indicates that the fire moved from left to right. Objects which will show stains include beer cans, pieces of scrap metal, dirt clods, and unburned vegetation.

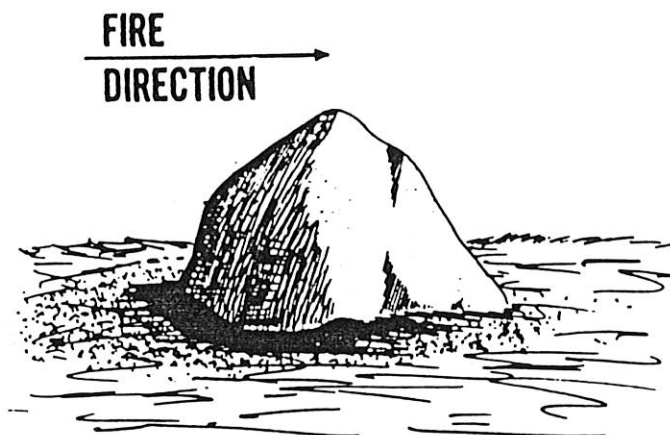


Figure 11

8. Soot. Soot will be deposited on the side of fences toward the origin of the fire and can be noticed by rubbing your hand along the wire (fig 12). On larger objects, soot deposits can also be noticed by rubbing your hand across the surface. However, in many cases there will be more positive indicators, such as protected fuel or staining. When checking a wire fence for soot, check the lower wires as they will show more evidence of soot than the higher wires.

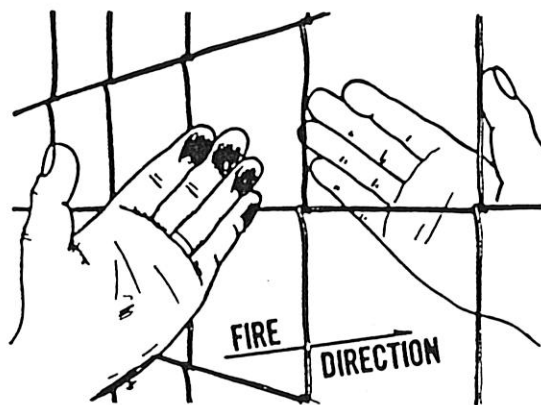


Figure 12

43.2 - Guidelines. You should follow these simple guidelines when using indicators to locate the origin of the fire.

1. The size of the indicator becomes smaller as you approach the point of origin.

2. Always follow the majority of the indicators when determining which way the fire spread.

## CHAPTER 50 - DETERMINATION OF FIRE CAUSE

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- 52 ELIMINATION OF CAUSES
- 53 METHODS OF SEARCH
- 54 FIRE IGNITION SOURCE INDICATORS

## CHAPTER 50 - DETERMINATION OF FIRE CAUSE

Once you have worked through the fire direction indicators to the point of fire origin, the cause of ignition may be apparent. If the fire was accidental, the ignition source may still be there, but, if the fire was intentional or incendiary, the ignition source may have been removed or destroyed by the fire. In any case, you must search the fire origin area for an ignition source which will identify the fire cause. If one is not found, you should continue the search until you are convinced that the ignition source has been destroyed or removed.

### 51 - FIRE CAUSE CATEGORIES

The end result of your fire cause determination will be your placing of the fire cause in one of the nine categories.

1. Deliberately and illegally lit.  
Specify (A) Suspected (B) Known.
2. Escapes from C.A.L.M. prescribed burns.
3. Escapes from other burning off. Specify by whom, e.g. farmers, shire, government services etc.
4. Accidental by timber industry, e.g. tractors, chainsaws, sawmill waste. Specify.
5. Accidental by other industrial causes, e.g. mining, S.E.C., Westrail, apiarists, etc. Specify.
6. Accidental by recreational land users, e.g. marroners, trail bikes, picnickers. Specify.
7. Lightning.
8. Unknown.
9. Causes not listed in 1. to 8. Specify.

### 52 - ELIMINATION OF CAUSES

As mentioned earlier, once you get to the fire origin area, the fire cause may be apparent. Even if the ignition source is not readily apparent, you may be able to eliminate what did NOT cause the fire. For instance, if you had no lightning, then you can eliminate lightning as a cause. By the same token, if there

are no railway lines within several kilometers, you can eliminate railroad operations as a cause; and, if the fire is in the middle of an inaccessible wilderness area, you may be able to eliminate equipment use.

This elimination will help you concentrate on what is possible while you search for the fire ignition source using the indicators listed in section 54.

### 53 - METHOD OF SEARCH

There will be as many ways to go about searching the fire origin area as there are ways to divide the area into segments. The whole area can be searched at once if it is small enough; however, it is best to divide it into various segments and compartments as shown in figure 13

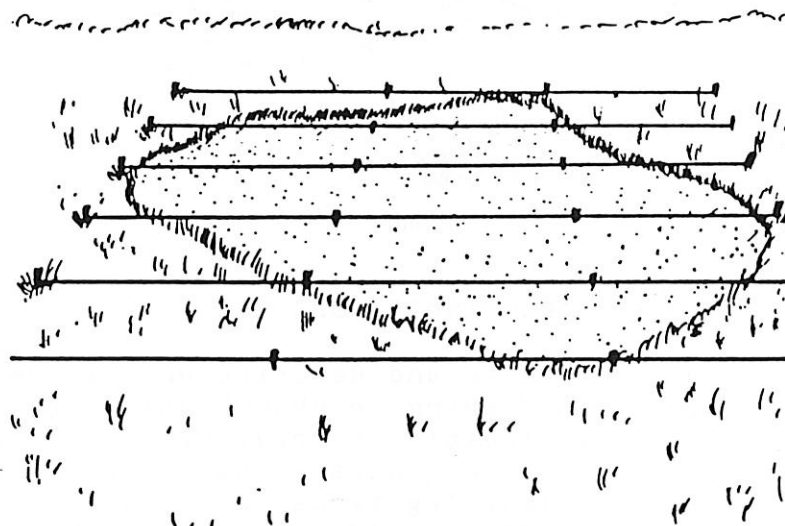


Figure 13

Note that the person making the search has divided the area into long narrow compartments. Each segment can be thoroughly searched without disturbing any of that area within it during the search. Remember, there is often no second chance. Therefore, it is advisable to search each area two or three times and, if possible, have a second person search the segment at least once before moving on.

In searching each segment of the fire origin, you should concentrate on the smallest possible portion of the area at one time. This can be done by moving your point of vision along a straight-edge placed across the narrow part of each segment (fig 14) and moving it only slightly after each scan. Be sure to cover the entire fire origin area in this manner.

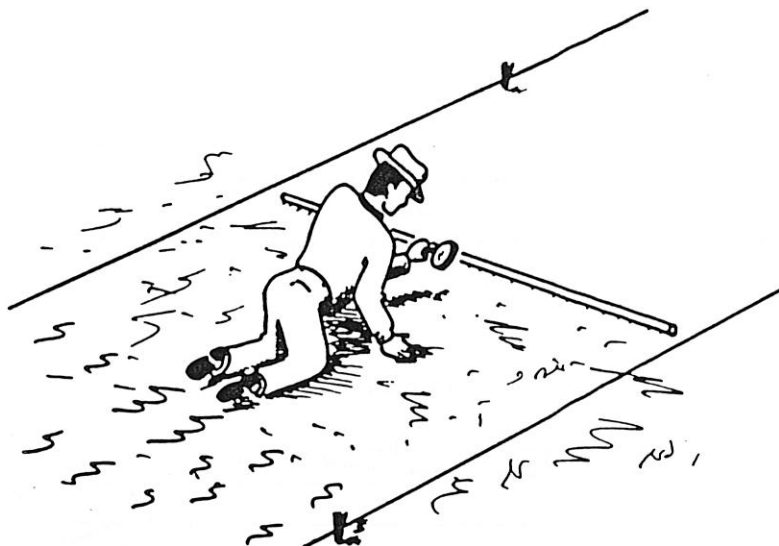


Figure 14

#### 54 - FIRE IGNITION SOURCE INDICATORS

This section contains lists and descriptions of indicators which will identify the actual thing or object which ignited the fire. Once you determine the ignition source, you can classify fire cause according to the nine general causes listed in section 51.

1. **Lightning.** Lightning fires are usually easy to determine because of the physical evidence of a strike in the area of origin. This may include strike marks on trees, poles, etc.; splinters from logs, trees, and roots; and disturbed earth. Another indicator is the knowledge that the fire origin area was in the path of a recent electrical storm. Remoteness and improbability of human activity may also be indicators.



2. **Incendiary Devices.** Incendiary fires normally involve the use of incendiary devices which include matches, cigarettes, candles, rope, wire, tape, or rubber bands and which may appear in many forms and combinations.

A cigarette, in combination with matches, is often used as an incendiary device. When a cigarette is found at the point of origin, look for the remnants of tape, string or rubber bands used to attach a match. These together would indicate an incendiary rather than a smoking fire. When a cigarette lighter is used, it will usually be replaced in the user's pocket, so no evidence will remain. This lack of evidence is also an indicator. When matches are used, one or more may be found at the point of origin. On the other hand, the person starting the fire may have discarded the match in another location after temporarily retaining it.

When no device is found, the investigator can locate the ignition point and determine the height above ground level where the device was applied. Stubble height and an area of more complete combustion will indicate the point of application.

3. **Human-Caused Fires Where Probable Ignition Sources Are Obvious.** Listed below are sources of ignition which could probably be readily apparent:

- a. Burning Buildings.
- b. Burning Dumps.
- c. Burning Vehicles.
- d. Camp and/or Cooking Fires.
- e. Crashed aircraft.
- f. Debris Burning.
- g. Land Management Practice.
  - (1) Paddock Burning.
  - (2) Land Clearing.
  - (3) Prescribed Burning.
  - (4) Roadside burning.
- h. Signal Fires (lost person)
- i. Smoking out bees or game.

4. **Human-Caused Fires Where Probable Ignition Sources Are Not Obvious.** Following is a list of ignition sources which may not be readily apparent:

a. **Blasting.** This blasting is associated with construction, ground clearing, road building, or stump removal where explosives are used. There is usually an associated human activity and extensive evidence of blasting on the ground. The ignition can take place well after the explosion from kindled material which was blown out of the immediate area.

b. Equipment Use.

(1) Brakeshoes. Fragments, such as broken pieces or flakes from metal brakeshoes, may cause fire and are usually associated with railroad operations. This is normally a problem where trains go downhill or brake when approaching curves, a switching yard, a siding, a small community, or a junction. Usually the metal fragments will be large enough to see with the naked eye and may roll downhill on a fill or trestle but will seldom go any distance up a bank.

(2) Breakdowns. Mechanical failure or breakdown can result in broken pieces of heated metal scattering in a fanlike pattern. On a sealed roadway, the tip of the fan, or point of impact, may be marked by a chipped or gouged spot. The distribution of metal fragments will indicate the direction of vehicle travel and approximate rate of speed. Brake failure occurs most often during prolonged downhill travel. Clutch slippage and fragmentation occurs during uphill climbs.

(3) Cutting, Welding and Grinding. Welding and cutting operations and to a lesser extent, grinding and smoothing wheels are ignition sources. When hot particles land on dry, punky wood or compacted fine litter, a smoldering fire is a common result. Wind and preheating by the sun will increase the possibility of ignition from these sources.

Hot metal fragments from welding, cinders removed while cleaning a weld, molten welding rods and discarded rod ends, or waste from cutting operations may ignite ground fuels when conditions are right.

Sparks from grinding wheels are a less serious problem due to the short life of these small particles. An occasional larger fragment of metal discharged by the grinder retains a high temperature longer and may become a fire source.

(4) Exhaust. Exhaust or carbon particles blown from an exhaust system must be large enough to keep the heat necessary to ignite the fuels. Large low-compression engines in trucks, locomotives, or tractors are more likely to discharge large carbon particles than smaller high-compression automobile engines.

Any engine may emit hot particles. A badly tuned engine, when operated for short periods, will build up carbon deposits in the cylinders and exhaust system. When this engine is operated for a longer time, higher temperatures cause the accumulation of carbon to soften and loosen. These exhaust particles may then be thrown out. Exhaust gas flow can expel more carbon particles when an engine is being shifted. When this happens in highway or railway cuttings, grass-covered slopes provide ideal fuel beds close to exhaust pipe.

(5) Friction. Friction between wire rope cables and logs, trees or stumps is a possible ignition source in cable logging operations. When this type of ignition is suspected, a careful examination of these obstructions in the cable path may reveal a groove and other signs of abrasions. Defective sheaves or pulley wheels in the rigging of a cable system may bind on the cable and overheat, dropping hot metal or burning wood into accumulated litter below the point of attachment. Friction between two metal surfaces or between metal surfaces and rock may create sparks that ignite fuels. Indicators are abrasion at the point of contact and/or metal particles in the origin area. Here a magnet can detect small particles.

(6) Manifolds and Mufflers. During vehicle operation, temperatures within an internal combustion engine may be as high as 2200°C. After a period of operation the entire exhaust system becomes hot. Tall fuels, such as grass or scrub may come in contact with a hot exhaust pipe or muffler. Pieces of light vegetation can be caught by the exhaust system. As the vehicle proceeds, burning materials may drop and ignite surface fuels. This ignition source might be identified by determining what time a vehicle parked in or passed through the area. Vehicle tracks straddling burned off grass stems indicate a parked vehicle. Multiple starts or small pieces of charred grass along the travel route indicate a moving vehicle.

(7) Tyres and Lubricating Oil. A vehicle dropping burning material, oil, molten rubber, or grease will leave a readily visible trail. Congealed drops of unburned fuel may be found outside the fire area along the vehicle's travel route. Ignition may occur either at or above ground level, depending on fuel height and density.

c. Electric Fences. Fires can occur from electric fences. Fire may occur anywhere along the fence where it comes in contact with vegetation. An indicator is burned-off stubble of the same height as the fence.

d. Fireworks. So-called "safe" fireworks present relatively little hazard to the user, but still pose a high fire-starting potential. For instance, sparklers will readily ignite dry fuels if discarded while burning. The wire may also be an ignition source if it is dropped while still hot and glowing.

Residues from explosive devices or firecrackers are more difficult to detect. Burned and unburned bits of shredded paper may be scattered some distance from the explosion location. The ground directly beneath the explosion point will be slightly compressed or cupped out. Careful examination at this precise point may reveal fragments of paper that were mixed with the soil at the time of detonation.

e. Flares. These chemical igniting devices have a metal or paper binding that acts as a handle or support. Unless thrown away by the user, this portion of the device will remain after the flare is consumed. A characteristic grey powder residue is left in locations where chemical igniters are used.

f. Glass lenses and Reflective Metal. The chance of ignition from these sources is remote. Elements of sunny weather conditions, dry fuels, and orientation of the glass or metal to the sun must all be present for a fire to start. Clear glass jugs or jars filled with clear liquid may concentrate the sun's rays like hand-held magnifying glass. The reflective concave bottom of an aerosol spray container can act the same way. Magnifying mirrors will also concentrate the sun's rays and can raise fuel temperatures to ignition point in a short time.

g. Electrical Powerlines. Power transmission and distribution lines can start fires when the lines themselves or the accompanying hardware fails.

When grounded objects fall or are blown into a single wire, ignition can result. Fire may start on the pole when an insulator is broken, a line is overloaded, or routine maintenance is neglected. Wires may swing together or sag into adjacent or understory vegetation resulting in a violent flashover or short.

Surface fires can be started by fallen or broken wires. Foreign objects, such as electrocuted animals or birds and trees or limbs may be ignited prior to falling. Other possibilities include burning crossarms, tops of poles, transformer parts and blown fuses. Fires may result if a down wire is reenergized during line testing.

h. Smoking, Cigarettes and Matches. Fuel conditions must be critically dry before a discarded cigarette will ignite a fire.

Relative humidity generally must not exceed 25 percent and at least 30 percent of the smouldering cigarette must be in contact with extremely fine fuel. The bottom part of a cigarette which is in direct contact with the ground is not completely consumed as the butt progressively burns. This unburned cigarette paper and the presence of nicotine stains indicate a discarded cigarette.

Older, previously discarded cigarettes are readily identified by obvious weathering and the absence of progressive burning.

i. Spontaneous Combustion. Spontaneous combustion involves the ignition of something with no external heat source. In the case of compounds, such as oil, grease, or paint, the process is triggered by chemical action. Bacterial action starts the process when vegetative substances, such as decomposing hay, grain, or sawdust are involved. It is caused by heat generated in a confined space without adequate oxygen for complete oxidation. Considerable time may go by before the chemical or bacterial process develops enough heat for ignition. The elements of moisture, heat, and no air are critical in this combustion process. Wet hay or damp sawdust piles are the most frequent source of spontaneous combustion in wildfire situations. Black carbonized material looking like charcoal is produced and is helpful in identification of the ignition source.

## CHAPTER 60 - MAKING VISUAL RECORDS

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#### 61 PHOTOGRAPHIC FIRE SCENE

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## CHAPTER 60-MAKING VISUAL RECORDS

### 61 - PHOTOGRAPHING FIRE SCENE

61.1 - Purpose. Photography is a valuable tool in any investigation, because photographs are the best method of reproducing any scene and can record facts more accurately than word descriptions. Photography can provide the following advantages:

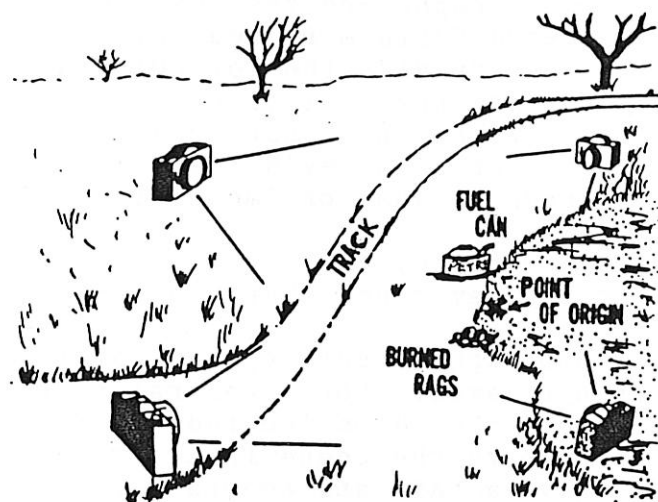
1. Present facts and physical circumstances visually.
2. Pictorially preserve perishable evidence.
3. Permit consideration of evidence which cannot be transported into a courtroom because of immobility, size, weight, etc.
4. Verify your testimony.
5. Reveal facts or evidence that you may have overlooked.

61.2 - Method. Photographs should appear natural to the eye by taking them at eye level. For a general view of the whole scene, the camera lens should be located and directed just as an eye witness would observe the scene from a standing point. The photograph should give a fair and accurate representation of the scene or the subject matter. This is important if the photographs are later used in court proceedings.

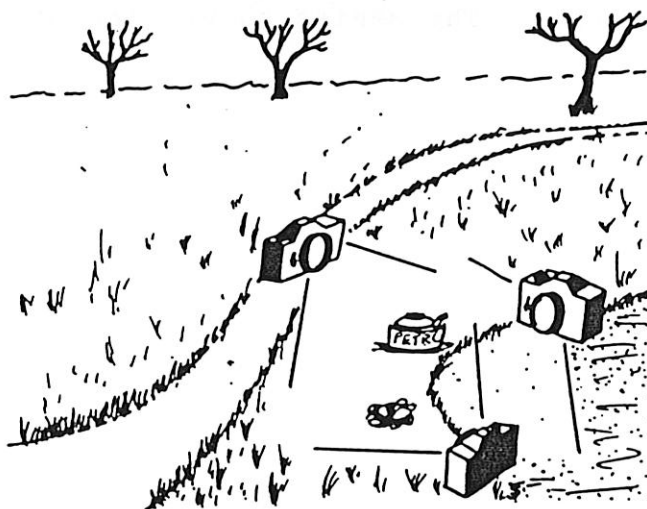
You may want to use your flagging to mark important evidence in your photographs or to give an idea of relative size. But, here again, some courts will object to unnatural objects appearing in a photograph, so you should take photographs both with and without flagging or markers.

61.3 - Range. Carefully examine the fire origin area in order to record a maximum of useful information in a series of pictures that will enable the viewer to understand where and how the fire was started. The series should include the following.

1. Overall Scene. First take pictures of the overall scene in a variety of positions which show all applicable material in its relative position.

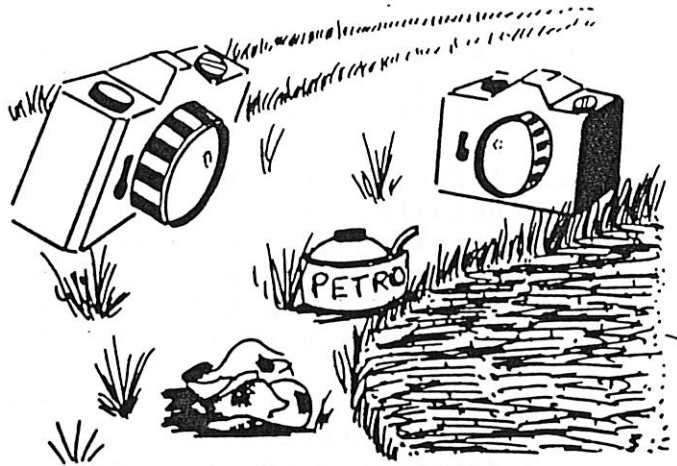


2. Medium-Distance Shots. Medium-Distance shots should be taken that show important areas in greater detail than the full-scene shots. Each area of importance should be photographed so it can be easily located in the full-scene pictures.





3. Closeup Shots. All important items should be photographed as closely as possible to give the greatest possible detail.



61.4 - Records. You must keep careful records of each photograph you take, identifying the subject, time, date, location, and weather, as well as the direction of the shot, type of camera and lens, type of film and exposure and the photographer's name. If you are using a Polaroid-type or instant picture, be doubly careful by placing all of this information on the back of each picture.

## 62 - SKETCHING FIRE SCENE

62.1 - Purpose. A clear sketch of the fire scene will serve to outline facts and circumstances. An objective sketch of the fire scene must be made before anything can be altered or destroyed. Sketching will not replace photography nor can photography replace sketching. A photograph will frequently appear crowded with irrelevant material whereas your sketch will only contain important items and details.

62.2 - When to Sketch. A sketch of a fire scene should be utilized whenever you have identified a fire to be human-caused with possible civil or criminal liability.

62.3 - How to Sketch. A sketch must be complete and simple showing only important details. It should be oriented by showing all four compass points on the sketch. Items included should be accurately measured in their relationship to fixed landmarks and so indicated on the sketch. Camera positions, if any were used, should be indicated on the sketch.

Remember to use accurate measurements as references on your sketch. If you do not have a steel measuring tape with you during your fire cause determination, then measure distances in paces. Be sure to note on your sketch that your measurements are in paces. Do NOT try to convert paces to meters. Avoid mistakes in measuring and recording by double checking all your measurements before you leave the fire scene. See exhibit 1 for an example of a fire scene sketch.

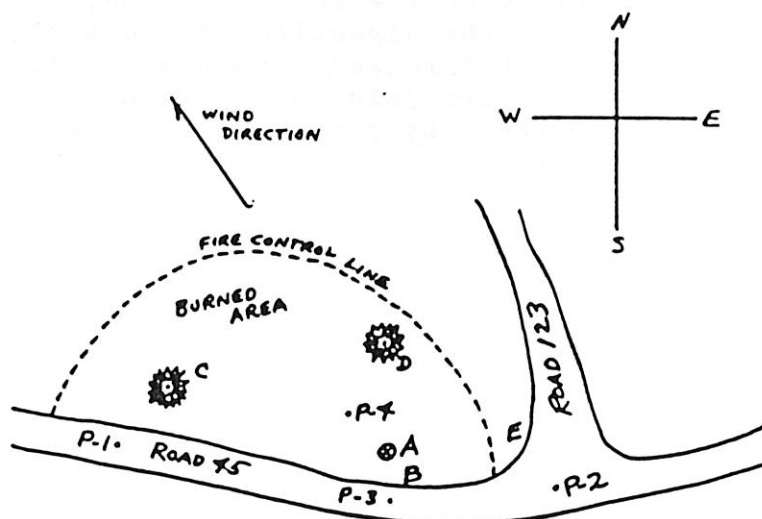


EXHIBIT 1

CHAPTER 70 - AFTER YOU DETERMINE THE FIRE CAUSE

Contents

71 INSTRUCTIONS

## CHAPTER 70-AFTER YOU DETERMINE THE FIRE CAUSE

### 71 - INSTRUCTIONS

After going through all the steps in chapter 50, you should have identified your fire cause. If you have found the fire to be human-caused with some indication civil or criminal liability, you should now follow the instructions of your District Manager.