SECTION 4 - MECHANICAL EQUIPMENT

Mechanical equipment can be very effective in fire suppression work and will normally replace the efforts of many people on the fireline. Cost benefits can be realized through the use of machines if good management practices are followed. To accomplish good management practices one must have a knowledge of mechanical equipment and devote enough time to the management of the equipment on the fire.

The three kinds of mechanical equipment covered in this section are dozers, tractor/plows, and engines.

Many of the fireline construction and safety principles covered in Section 1 also apply to the use of mechanical equipment.

DOZERS

Dozers are effective firefighting tools if they are used correctly. They are costly to operate and require good operators, good supervision, and adequate service and repair. However, in excessively rocky areas and in some dense timber stands, especially with many large trees, their progress will be drastically slowed. When they are needed to pioneer ahead of a tractor/plow or crew, they are indispensable. In this capacity they do the clearing work so that the plow or crew can build the line as they follow.

Dozers will come with various types of blades and control systems. There are two types of blade control systems used on dozers. These are cable and hydraulic. Almost all dozers produced during the past 30 years will have the hydraulic system. Cable systems were common before that period; however, there are still some of the older dozers with cable systems in use.

Cable controlled systems are best used in light fuels for light scarification of soil, for finishing fireline, and for road grading.

Hydraulic systems can exert pressure down as well as raise the blade, thus are best used for digging in hard ground, cutting through roots, cross ditching or water barring, digging sumps and pits, and downslope breaking action. The hydraulic control is also helpful if the dozer becomes high centered or stuck and the terrain needs to be built up under the tracks.

The three common types of blades and their best uses in fire suppression are:

1. The straight blade. It can usually be angled and push soil to either side of the dozer. This is not true with the other types. Thus, the best uses for straight blades are: Pioneering and finishing fireline, cross ditching, and road construction and maintenance.

2. The "U" blade. Best used for pioneering fireline, sump digging, and earth moving (as in road construction).

3. Brush blade. The best uses for brush blades are pioneering in brush, clearing and piling slash, mopup work, and certain rehabilitation work.

Table 1 discusses the types of dozers by size. It divides the various models into three size groups. Consider the age and condition of different dozers. For example, the newer Caterpillar D-5's can match the performance characteristics of the older D-6's, and so forth.

Table 1 – Comparisons of Dozers Used For Fireline Construction

Make	Size	Weight	Blade Width	Horse Power	Min. Ground Clearance
Large dozers (Type 1)					
Caterpillar	D-9H	95,000	16'	410	
Caterpillar	D-8K	69,000	15'6"	300	
Caterpillar	D-7G	52,000	15'7"	200	
International	TD-25L	69,780	13'2"	310	
Terex	82-30B	61,000	12'3"	260	18.25"
Terex	82-20B	42,000	11'5"	205	17"
Terex	82-30	54,000	12'3"	225	18.25"
Komatsu	D-155A-1	76,000	13'6"	320	20"
Komatsu	D85A-12	40,000	11'10"	180	16"
Medium dozers (Type 2)					
Case	1450	30,000	10'	130	15"
Case	1150B	25,000		125	15"
Caterpillar	D-6D	31 ,000	13'8"	140	
International	TD-30E	47,525	11'5"	157	19"
John Deere JD-750/6520		29,335	12'2"	110	14"
John Deere JD-750/6525		28,985	9'7"	110	14"
Komatsu	D65E-6	36,000	11'2"	155	16"
Komatsu	D53A-16	25,000	12'2"	110	13"
Light dozers (Type 3)					
Case	350	8,000	6'8"	39	11"
Caterpillar	D-3	14,000	7'11 "	62	
Caterpillar	D-4	20,000	8'-10'	75	
International	TD-8E	16,617	12'5"	56	14"
International	TD-7E	13,632	12'1"	48	12"
John Deere JD-350c/6300		10,300	7'6"	42	13"
John Deere JD-450c/6405		14,230	7'6"	65	14"
Komatsu	D45-A	18,000	10'4"	90	14"
Komatsu	D31P-16	15,000	8'2"	63	14"

Some conditions which limit dozer use are steep slopes, heavy fuels, rock outcroppings, bogs or swamps, and fragile soils. The use of dozers on side hills with soft fragile soils can be hazardous, and will increase erosion potential.

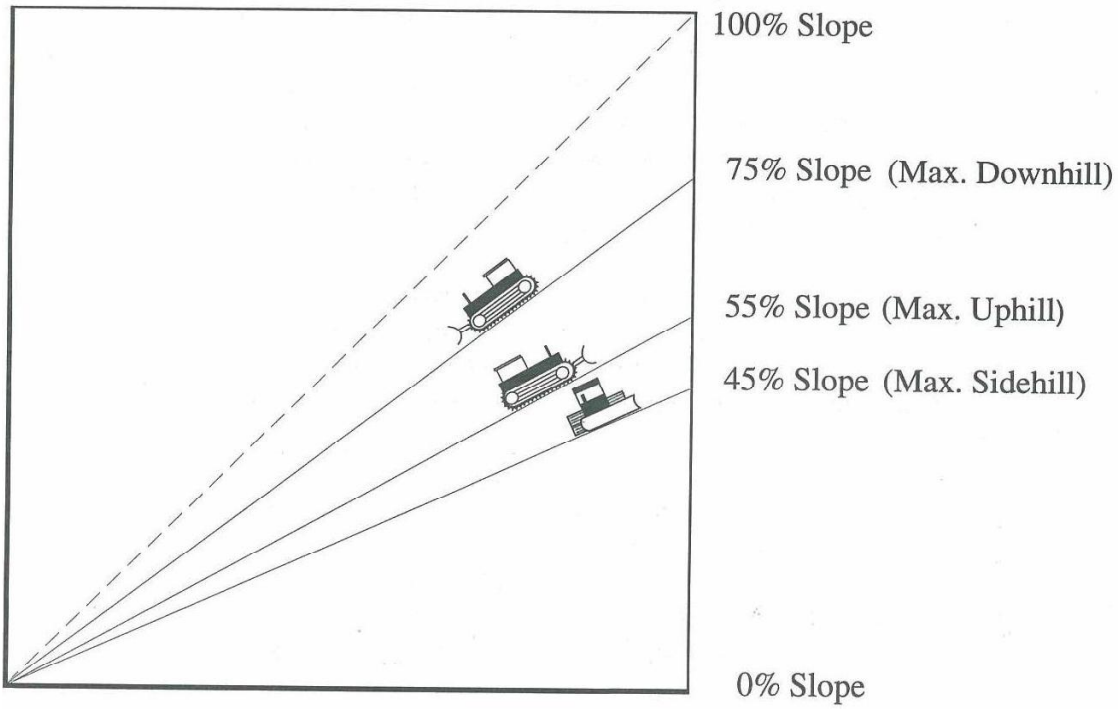
Light dozers (Type 3) are effective in building fireline in light fuels on level to moderate terrain. They perform best in soil with few rocks, and in wet soil conditions, especially when equipped with wide tracks. They're maneuverable in close quarters and generally do less damage to the environment. They also can be very useful in mopup operations.

Medium-sized dozers (Type 2) are generally the best all-around size for fireline construction as they are maneuverable and perform well on moderately steep slopes. They will handle the average fuel and terrain conditions in the mountainous areas and when fitted with wide tracks perform well in wet soil conditions.

Heavy dozers (Type 1) are generally too big for many fireline construction situations. They are hard to maneuver in close quarters, especially in steep terrain. They are best assigned as lead dozers to pioneer in heavy fuels on level to moderate terrain. Heavy dozers will have difficulty in wet ground unless fitted with extra wide tracks. On standard tracks their bulk weight more that offsets the hold up surface of the tracks, and once these large machines are stuck, it is a major job to free them.

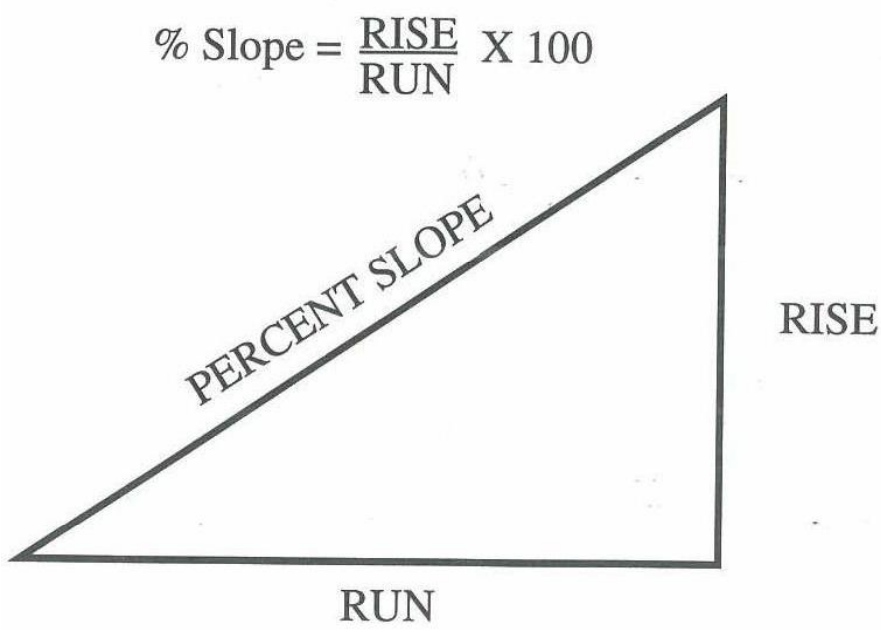
As a general guideline, dozers should not be operated across slopes (sidehill) greater than 45 percent, uphill on slopes greater than 55 percent, or downhill on slopes greater than 75 percent (see Figure 1).

Figure 1 – Guideline For Maximum Percent Slope Dozer Operation



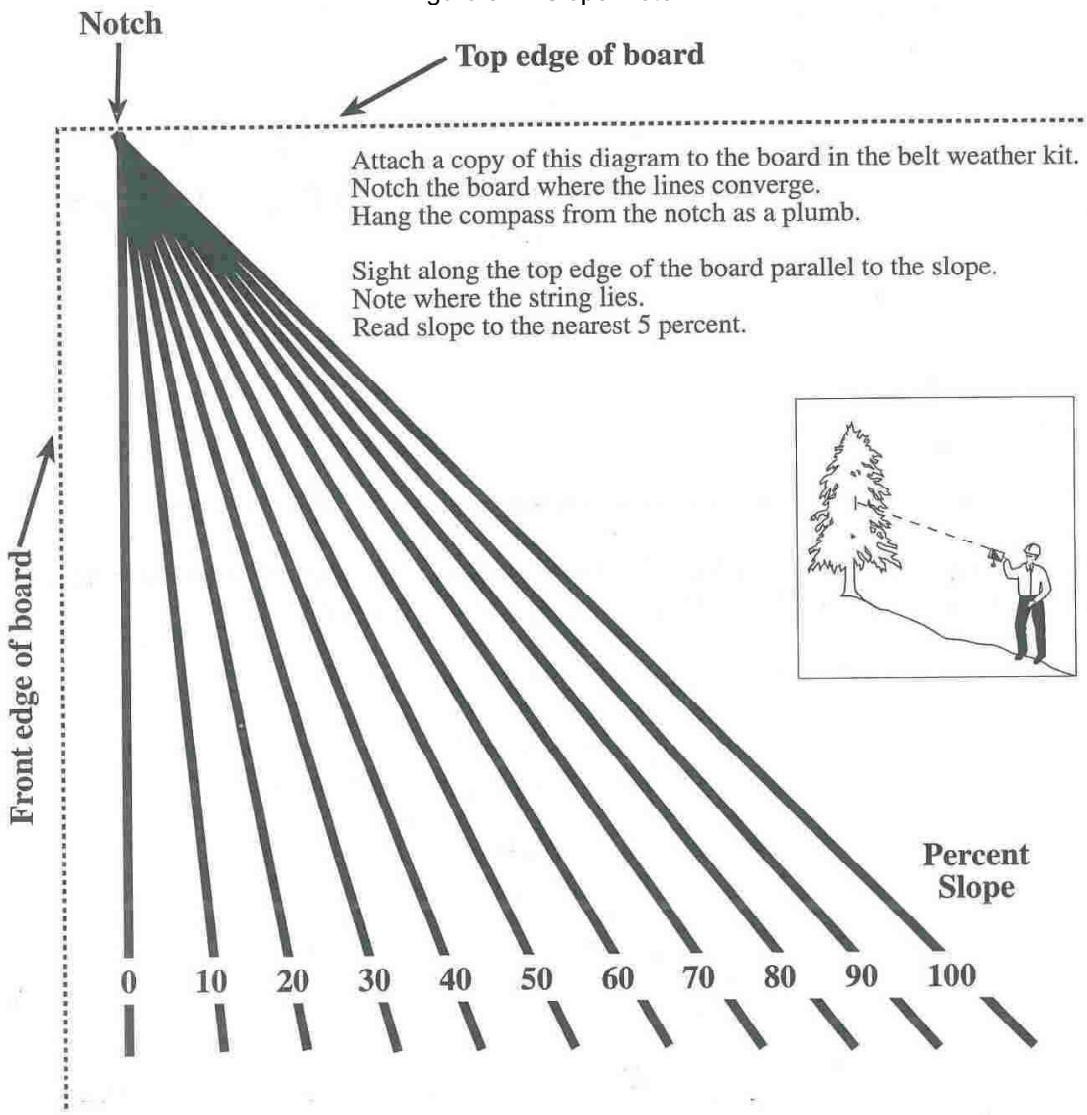
Percent slope is determined by the vertical distance (rise) divided by horizontal distance (run) multiplied by 100 (see Figure 2).

Figure 2 – Calculation of Percent (%) Slope



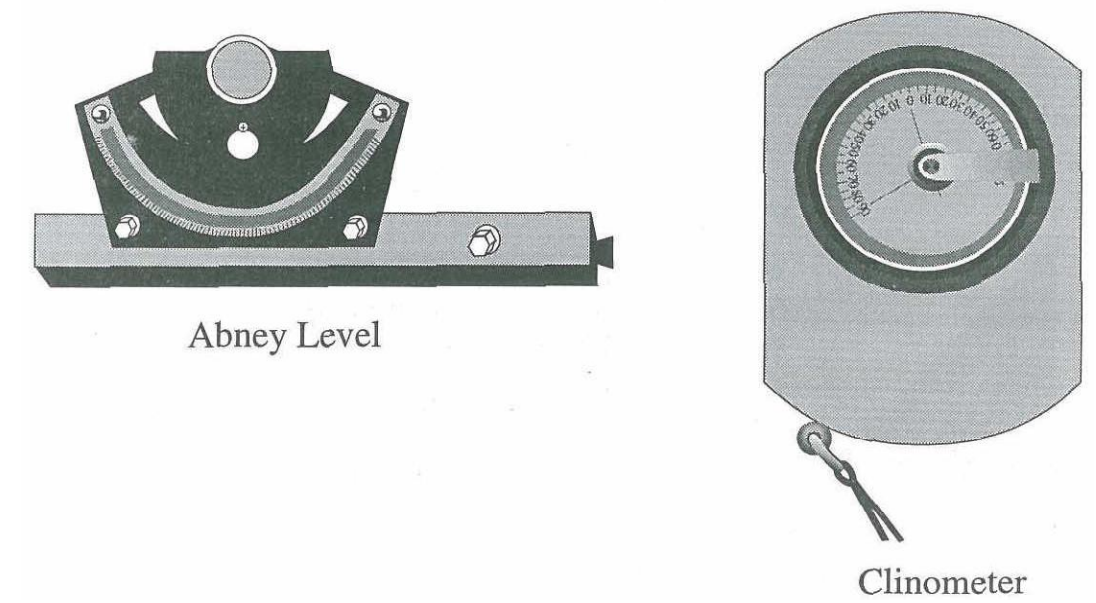
An easy method to determine percent slope is with the use of a slope meter (see Figure 3).

Figure 3 – Slope Meter



Clinometers or abney levels are instruments that can be used to measure percent slope (see Figure 4).

Figure 4 – Instruments to Measure Percent Slope



To use the clinometer hold it to your eye and with both eyes open, look simultaneously through the lens and alongside the housing. A horizontal sighting line will appear. Raise or lower the clinometer (by tilting your head) to place the sighting line at the top or bottom of the object. Read the percent slope number closest to the sighting line.

Operate the abney level similarly to the clinometer, but rotate the outside scale forward or backward to align the bubble inside the instrument rather than tilting your head. Read the number from the outside percent slope scale.

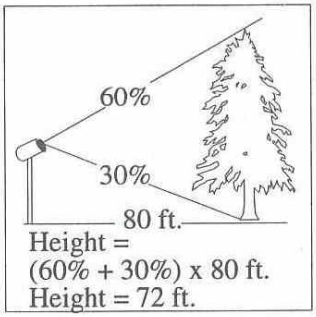
Clinometers and Topographic Abney Levels can be used to measure slope, height of objects, and vertical angles (see Figure 5).

Figure 5 – Measurements With Clinometer or Abney Level

Measurements

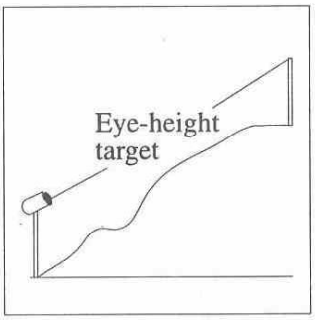
Height

For height measurement, choose a scale and a convenient baseline distance. Standing at the baseline distance, sight the tip of the object and read the scale; sight the bottom of the object and read the scale. Add the two scale readings together and multiply this total reading by the baseline distance. This is the object's height.



Slope

Sight upslope or downslope on the object at eye level. Read directly from the percent or degree scale.



Vertical Angles

Sight upslope or downslope on the object at eye level. Read directly from the degree scale.

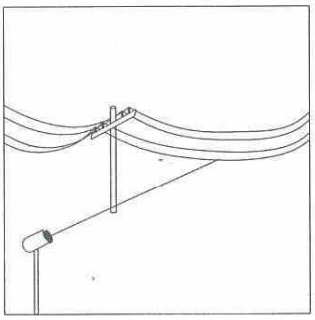


Table 2 provides single pass line construction rates in chains per hour for several variables. The table was developed from a series of field tests.

Some generalities that can be concluded from Table 2 are: 1) production rates drop as the fuel loadings increase and 2) slope has an effect on production rates, particularly traveling upgrade, and some dozer sizes are better suited for select jobs than others.

Table 2 – FIRELINE PRODUCTION RATES (SINGLE PASS) FOR DOZERS MANUFACTURED SINCE 1975

Fire behavior fuel model	Slope class 1 (0%-25%)		Slope class 2 (26%-40%)		Slope class 3 (41%-55%)	
	Up	Down	Up	Down	Up	Down
	Chains per Hour					
Small dozers (Type 3)						
1, 2, 3	63	88	36	88	14	16
4	22	29	12	30	3	22
5	63	88	36	88	14	61
6	39	59	22	62	8	42
7	39	52	22	56	8	35
8	63	88	36	88	14	16
9, 11 , 12	22	30	12	30	3	11
Medium dozers (Type 2)						
1, 2, 3	88	118	58	112	35	73
4	32	47	18	53	5	31
5	88	118	58	112	35	73
6	51	75	26	78	9	48
7	51	75	27	78	9	48
8	88	118	58	112	35	73
9, 11, 12	32	47	18	53	5	31
10, 13	17	23	10	25	3	11
Large dozers (Type 1)						
1, 2 3	91	124	62	118	35	83
4	43	60	27	62	12	40
5	91	124	62	118	35	83
6, 7	63	91	41	90	22	57
8	91	124	62	118	35	83
9, 11, 12	43	60	27	62	12	40
10, 13	27	38	15	34	4	16

Line location is as important for dozers as for handtools, and the same principles of width, depth, and location apply. Locate the line in accordance with the fire control strategy, vegetation, and terrain. The line should be located well ahead of the dozers but not so far that the line location would need to be changed by the time the dozers get there. The locator should check periodically with the spotter or operator of the lead dozer or with the dozer boss to advise them of what is ahead.

Locations where dozers cannot work effectively should be avoided and completed with handtools. These locations would include areas of large rocks, rock outcrops, excessively steep terrain, or other limitations to the use of dozers. Trench undercut lines, and treat all hazards in the same manner as hand line construction and mopup.

The principles of direct, parallel, and indirect attack also apply to dozer line construction (see pages 16-17); and, as a general rule, all dozed material should be cast outside the line and scattered. In a very few instances the dozer might be used on very small fires to push the burning edge into the fire area all the way around the perimeter. This is not a highly recommended practice.

Dozers are extremely effective tools for building firelines, particularly in heavy fuels and brush. They must be followed with handtools to finish the line, to burn out where necessary, to hold the fire within the line, and to combat slopovers and spot fires.

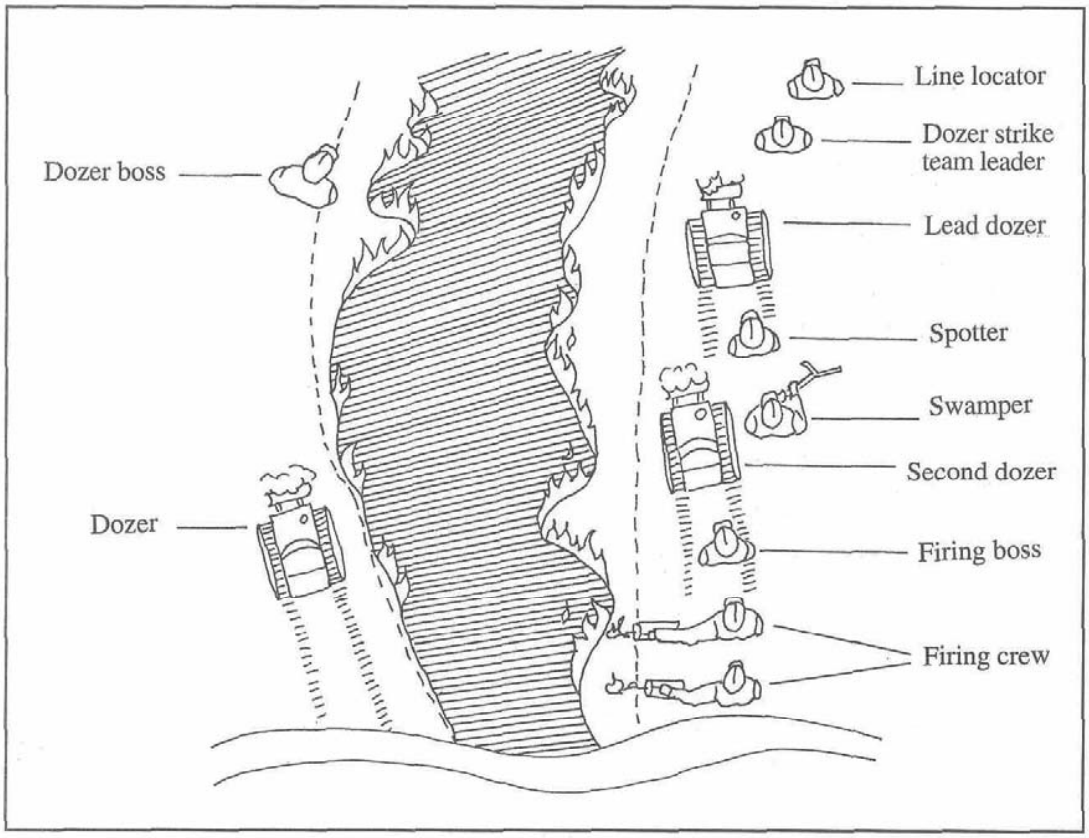
Once the fireline is built, it is necessary to begin the mopup from the fire edge toward the center of the fire, and this operation requires handtools. Often, engines or hose lines can be used to assist with holding action and mopup. Much will depend on the kind and volume of fuels. Dozers can be used to a limited extent on mopup operations.

Often it is practical and desirable to build the dozer line where it will serve as an access road for engines and the movement of crews. Grade along the line then becomes important so that four wheel drive vehicles can travel. This use is very valuable but should not dictate the location of the fireline. The location for fire control purposes must take precedence.

It may be necessary for dozers to clear out safety areas. These should be built well in advance of probable need.

Dozer organizations will vary with the size of the fire, the kind and amount of fuels, the topography, the practice in that locality, and the personnel available. On a large fire with several dozers a dozer boss or dozer strike team leader will normally supervise dozer operations (see Figure 6).

Figure 6 – Dozer Organization On A Large Fire



In heavy going a spotter, swamper, line locator, and hand crew may be assigned to assist with dozer line construction. Because of the danger from rolling rocks and/or debris, no personnel should work directly below a dozer.

At least one person should be assigned to each dozer as a swamper. The contractor will normally provide a swamper for contract dozers. The swamper is to:

- Handle the winch line and choker, help change blade positions, assist with the maintenance, and otherwise assist the operator of the dozer.

- Communicate by hand signals with the dozer operator.

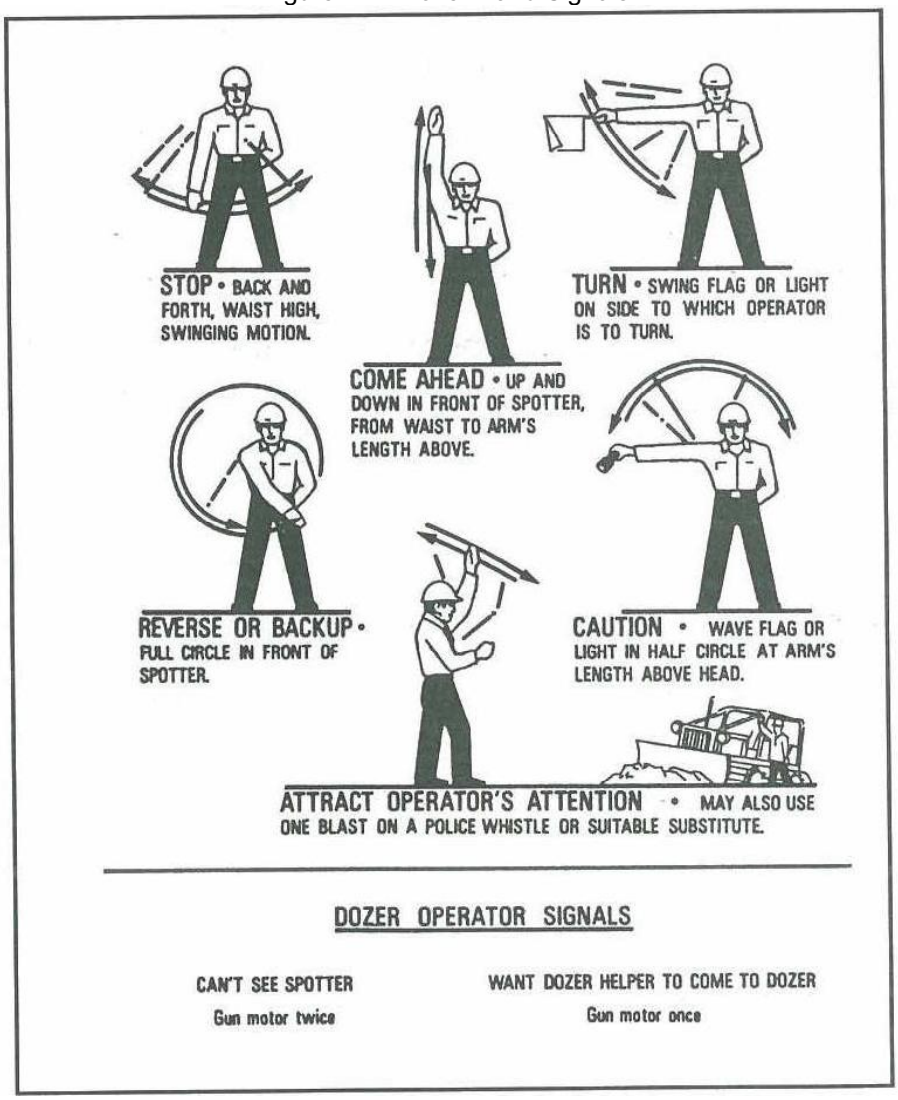
- Cut away projecting branches and sticks that may jam the machine and cause damage or endanger the operator, to remove rocks and debris from the machine on signal from the operator, and to cut with an ax or chain saw where necessary to move logs and tangled windfalls.

- Work as a spotter if one is not assigned or as a contact between the operator and the spotter.

- Act as an alternate operator.

Since mechanical equipment is generally noisy and it's difficult for operators to hear other personnel in the area, a simple but effective communications system can be accomplished through the use of hand signals and other signals (see Figure 7).

Figure 7 – Dozer Hand Signals



By gunning the dozer motor twice, the operator can signal that he cannot see the spotter, and by gunning the motor once, he can signal that he wants the helper to come to the dozer.

The following are good dozer line construction principles:

1. Utilize anchor points and LCES (lookouts, communications, escape routes, and safey zones.)

2. All unburned fuels should be cast away from the fireline and scattered to the extent possible.

3. Where both soil and debris must unavoidably be pushed to the inside, spread and scatter this material well back into the burn. In fuel types with down timber it may be best to use power saws ahead of the lead dozer to "buck" the material.

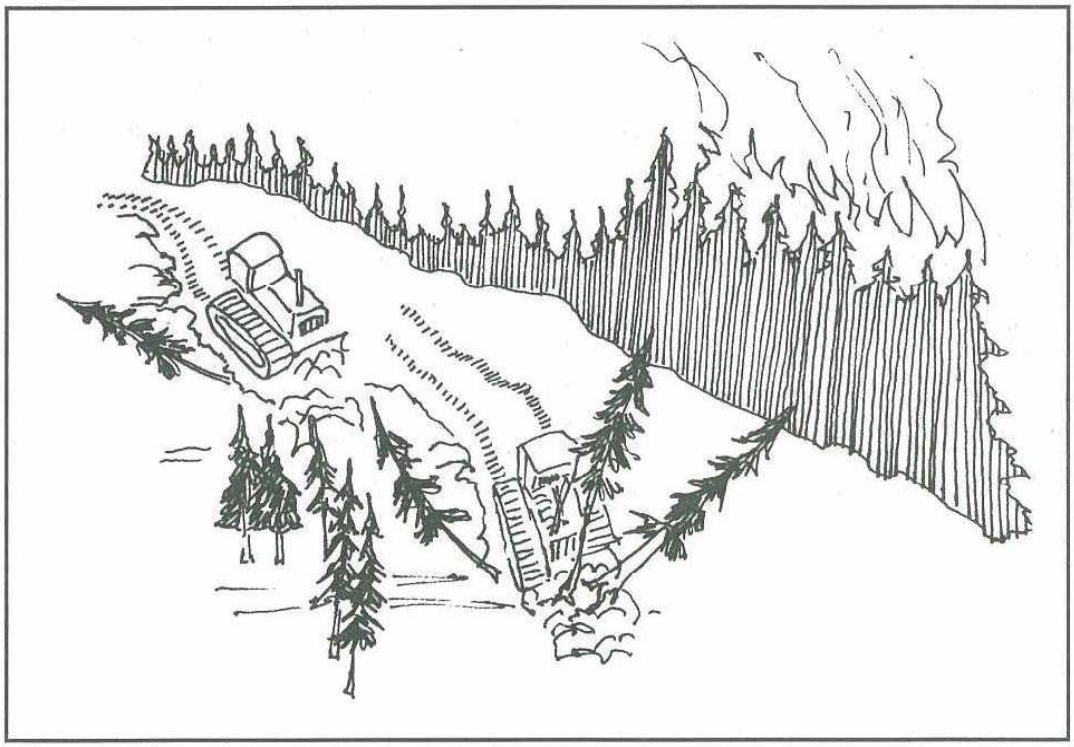
4. Chain saw crews should be closely supervised, kept well ahead of the dozer, and avoid doing work the dozer can do. Saw crews are not needed if the lead dozer is large enough to do the job or if it can do the job without creating excessively large piles of debris.

5. Snags can be quickly felled by dozers. Where snag felling is hazardous to dozers, the job should be done by felling crews. Local practices will vary for different sections of the country.

6. Consult with the operator (both operator competence and dozer capability) before assigning dozer work in steep terrain and contouring sideslopes.

7. Generally, two dozers should work together in pairs or tandem when constructing fireline. They can reinforce each other and assist each other if one dozer needs help. The largest machine or the one in the best condition should serve as the lead dozer. Neither machine should be operated below the other on slopes or too close together because of the danger of rolling and falling material. If a narrow fireline is needed the lead dozer pioneers the line by doing the rough clearing job and the second dozer cleans up the line. If a wider fireline is needed both dozers may be doing a substantial amount of clearing. However, the second dozer still cleans up the line.

Figure 8 – Tandem Dozers Constructing a Wide Fireline



8. The line may be wider in some sections than in others depending on the job it is intended to do. There must be a reason for extra width of line. It may be because the brush is tall and thick, because the canopy needs to be opened up, or to keep the crew from being scorched during burnout.

   The line should be wide enough to hold the fire; *usually 1-1/2 times the height of the fuel in brush and not less than one-half the height of the fuel in timber.*

   It is often impractical to make it wide enough to withstand a run of the fire. Enough area must be burned out from the line toward the fire to contain it and any spotting.

9. Use a cleanup crew behind the dozer to speed up the line construction and to make it secure. The job of the cleanup crew is to prepare the line for burnout by reducing the kind and amount of fuel along the edge of the line so that the chances of radiated heat and mass transport across the line will be reduced. The job is accomplished by:

- Felling snags on both sides of the line.

- Felling leaners.

- Breaking up, tearing apart, flattening, and dispersing accumulations of fuel close to the line.

- Lopping and scattering tops and branches and cleaning up the lower stems of standing trees by cutting off limbs, moss, and vines.

- Making sure the line is continuous and free of surface fuels.

Normally, three to six people are needed in a clean up crew plus a squad boss. They may be part of the burnout crew if the cleanup job is light.

The main point here is that hand tools are needed to follow the dozers in any type of fuel to make sure the line is ready to bum out and hold. The cleanup crew must stay away from the immediate area around the dozers, since they are constantly backing and maneuvering.

10. The burnout crew may be part of a combination crew that does both cleanup and burnout. On larger fires it will be separate and supervised by a squad boss or a crew boss according to its size.

    If burning out follows the dozers, it should not follow so close that the firing will handicap the dozer's operation or jeopardize the line construction and cleanup.

11. Proper supervision must be provided for hired equipment. Proper organization and supervision are the keys to successful operation of equipment.

12. Provision must be made for servicing equipment as soon as the equipment moves onto the fire. These are expensive machines, and they cannot be operated long without servicing.

13. Dozers and tractor/plows must be properly equipped:

- They should have canopies of sufficient strength to withstand rolling over and to protect operators from falling material.
- The dozers should be armored underneath.
- They should have functioning lights, both front and rear when it is dark.
- They should have seat belts.
- They should have a fire extinguisher and shovel.
- They should have a properly functioning spark arrestor.
- Operators must be supplied with required personal protective equipment, including fire shelters. It may be necessary to instruct the operator on the proper use of the fire shelter.

TRACTOR/PLOW

Plows are pulled by 4-wheel drive vehicles and by dozers. For the purpose of this document, a plow pulled by a dozer will be called a tractor/plow or a tractor/plow unit. There are a number of different kinds and sizes, but the ones used with tractors are in the majority and generally are the most satisfactory. In the southern pine flat woods, plows outnumber engines because they are so effective. The medium units are the most numerous. These are pulled by the TD-9, HD-6, and D-4 size class dozers. Light units include TD-6 and D-2 size class dozers. Heavy units include TD-14 and D-6 size class dozers.

Plows are a principal wildland fire tool in the flat woods and coastal plains of the South, Southeast, and Florida. They are generally used in the Midwest and the Lake States and the Northeast. They are in limited use in the Southwest. The fireline plow is best used in fuel types that can be traversed without too much interference from standing timber, where the topography is more or less level to rolling, and where the soils are generally sandy or friable with a minimum of rock. Rocky soils are a deterrent to plows. As the slope increases, the efficiency of the plow decreases.

Since the plow is pulled by a dozer, the fuel type must allow access to that size dozer. Otherwise, the plow unit must be preceded by a dozer and/or a saw crew. Tractor/plow units can usually walk down trees up to five inches in diameter if they are not too closely spaced.

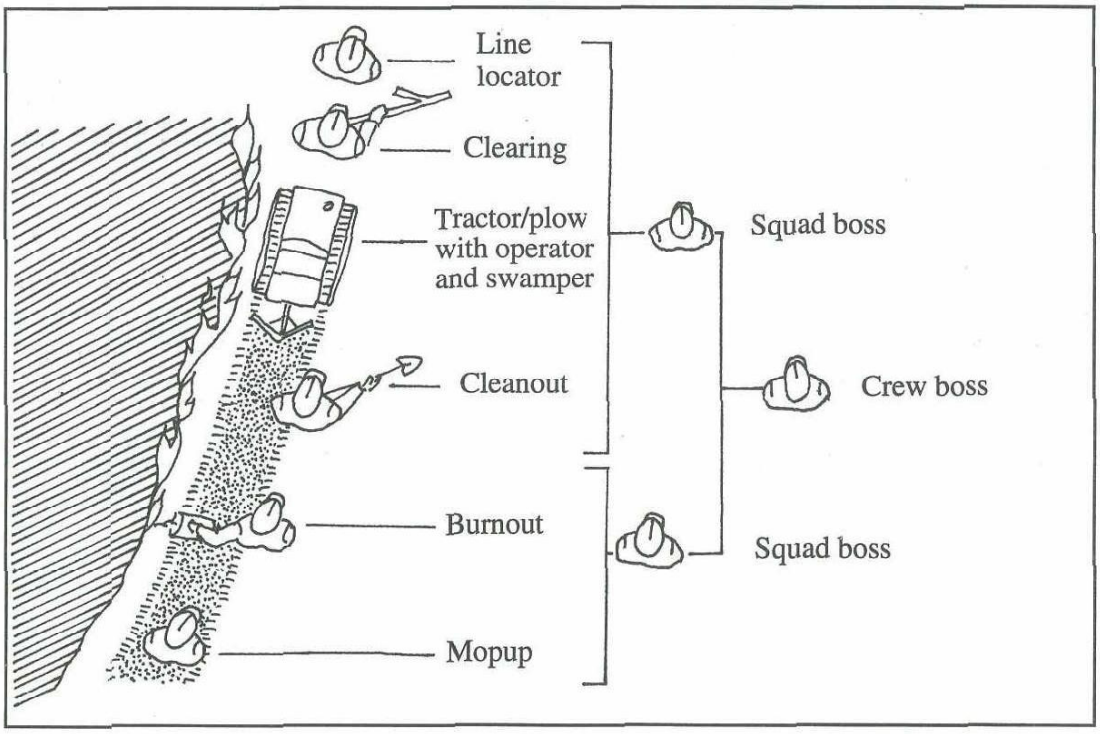
In suitable fuels and soils, most tractor/plows are able to construct line at a maximum of three mph (240 chains/hr). The speed will vary considerably below the three mph on account of soils, stumps, boggy sections, trees, and other obstructions.

Line construction and line location principles are the same for plows as for any other method. The depth of plowing should be as shallow as possible and yet should obtain a clean line down to mineral soil. The shallow line is equally as effective as the deeper one as long as it is clean and continuous. The shallow line puts less drag on the tractor so that plowing is faster, the line is less restrictive to wheel traffic, and less erosion is caused on slopes. The depth should be adjusted while the plow is in motion and should be frequently checked if it is hydraulically operated. Since burning out is the usual practice in line construction, the plowed line should be as straight as possible. The line should be adjusted as necessary to keep stumps, snags, fuel accumulations, and other hazards outside the line.

The principles of operating a single tractor/plow are much the same as operating with teams of two or more tractor/plows. However, two tractor/plows are the optimum number per team.

Most of the time, a tractor/plow crew consists of two people, one operating and the other swamping or firing. A holding crew of one or more people may be required to clean up, hold the line, and chase spot fires, depending on the fuel type and conditions (see Figure 9). If an engine is available, these jobs are accomplished by the engine crew.

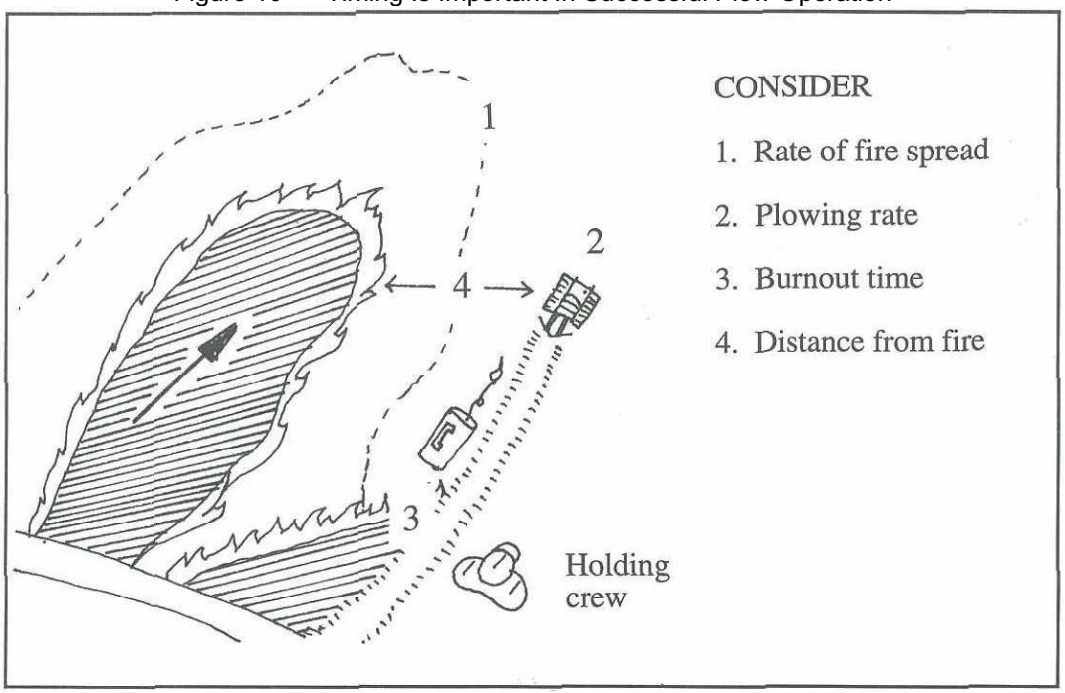
Figure 9 - Tractor/plow Crew Organization.



Timing is important in successful plow operation (see Figure 10). Timing must be adjusted to:

1. Rate of fire spread
2. Plowing rate
3. Burnout time and extent of burnout
4. Distance from the fire to:
   - heavy or lighter fuels
   - plantations, buildings, etc.
   - natural barriers, swamps, ect.

Figure 10 – Timing Is Important In Successful Plow Operation



In brush and scrub timber or light fuels and where stumps are readily visible, it is best to plow as close to the fire as possible and as fast as possible. In heavier fuels the best tactic is to give the fire some room and to burn out from the line.

There is a general guideline in Florida: "If it's worth plowing, it's worth burning out."

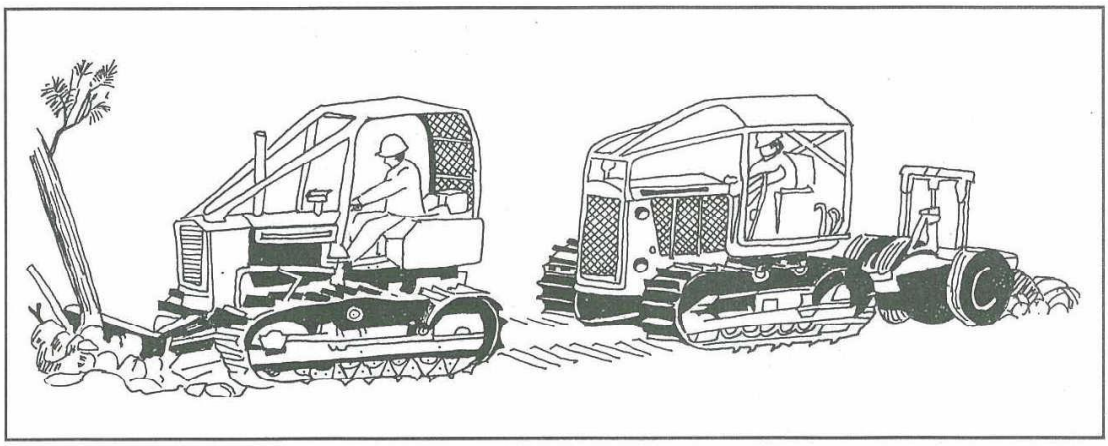
Normally, each tractor/plow should take a different portion of the line. This is particularly true if enough engines and/or personnel are available to follow up each tractor/plow.

On more difficult fires, the best results are usually obtained by working plow units in teams, particularly if it is difficult to construct and hold the line.

Two parallel plowed lines are made to obtain the width needed for holding. The rolled-out turf of each line should just touch the brim of the adjacent line. The outside plow follows a short distance behind the inside plow.

In difficult line construction, the units are operated in tandem (see Figure 11). The first unit (usually a dozer without plow) takes out obstructions such as big brush and snags and as much surface as time will allow. The second unit makes a clean line. They must work as a team, adjusting the work load between them.

Figure 11 – In Tandem Operations, The First Unit (Dozer) Clears The Line, And The Second Unit Plows The Line.



In trees and heavy brush, the heaviest dozer takes the lead to walk down obstructions or push them to the outside. Material that has no fire in it is always pushed to the outside. If the difficulty is frequent bogging, the favorite method is to send the smaller dozer in the lead to "feel out" the line. It is much easier for the heavier unit to pull the smaller one out of a bog than vice versa. Both should strive to stay in sight of each other so that they can immediately give aid to each other.

If using dozers and plows as described above, only a dozer would be placed in the lead. There are some situations when a dozer is needed, because a tractor/plow alone cannot do the job.

Safety is a very big concern in any fire job and certainly in mechanical equipment operations. Here are some safety practices that you should remember.

1. Keep crews a safe distance from working mechanical equipment.
2. Never work immediately downslope from mechanical equipment.
3. Never mount or dismount while mechanical equipment is moving.
4. Don't allow riders on mechanical equipment.
5. Attract the operator's attention before approaching mechanical equipment.
6. Do not allow anyone to rest or sleep near heavy equipment.
7. Drop dozer blades to the ground when equipment is idling or stopped.
8. Use hand signals between operator and crew.
9. Limit an operator's tour of duty to 12 hours per day.
10. Ensure that personal safety gear is provided and used.
11. Instruct the operator on the proper use of a fire shelter if necessary.
12. The dozer operator has the final authority on whether the assigned dozer work can be completed.
13. The dozer boss should inform the appropriate supervisor upon entering and leaving the assigned work area.

ENGINES

Engines can be very effective for control of wildland fire. Their uses include:

- Direct, parallel, and indirect attack.
- Patrolling fireline.
- Hot spotting to aid in direct attack.
- Supplying water and additives through hose lays.
- Supplying water for backpack pumps or other units.
- Mopup operations.
- Ground application of fire retardants.
- Protection of structures and improvements threatened by wildfire.

Like any firefighting unit on the line, firefighters and equipment must be properly managed to safely and effectively accomplish the suppression job. Situations where engines probably should not be used include:

- Fuels are too heavy to permit travel along the fireline.
- Poor access to and from the fireline.
- Terrain is too rugged for vehicle travel.
- If access is poor and terrain is restrictive consider stationary pumping operation.
- Water supply is too far from the fire for effective operations.
- Support units for engines are not available.
- Attempting to control the fronts of fast spreading fires.

It is important that good management and safety practices for engines be followed. Some of these are listed below.

1. Obey all traffic regulations en route to fires. More serious engine accidents probably occur on the way to the fire than on the fireline itself.

2. Mark vehicles parked on improved roads with flags, flares, and so forth. Also, normal traffic should be regulated on these roads.

3. Require that engine crews include a driver, hose puller, and nozzle operator. These are minimum required positions for many agencies.

4. Use trained and experienced people on engines, particularly during the control phase of fire suppression activities. There might be opportunities for training others later.

5. Work the flanks rather than making a frontal assault. This is a common sense practice for any fireline unit.

6. Never block a road. Allow room for traffic to pass.

7. Keep engines headed in the right direction. Back in for quick egress if necessary. This is particularly important where turning around could be difficult.

8. Keep engines on the opposite side of roads from the oncoming fire. If an engine is stalled or abandoned, it will have a better chance of surviving a flaming front.

9. Plan an ample water supply for engines. It might require some road work to make a water source more accessible, or a water tender might be needed to transport water over long distances.

10. Coordinate units so all do not run out of water at the same time. A rotation system should be set up to handle emergency needs for water.

11. Provide adequate supervision and communications for engines. This is another common sense item that applies to all firefighting units.

12. Use buildings or natural barriers for protection.

13. Do not park at the top of draws, chimneys, saddles or natural funnels.

14. Try to work engines together.

15. Watch for hazardous materials stored in houses and garages, such as gasoline and pesticides.

16. Look for fire hydrants that have "disappeared" into overgrown brush.

17. Check reliability of hydrants.

18. Be cautious around propane tanks adjacent to structures.

19. Be extremely cautious around utilities (power lines, underground gas lines, septic tanks, cisterns). Care must be taken when operating heavy equipment and engines around structures due to the presence of these. Septic tanks and cisterns may collapse under the weight of machinery.

Methods of Attack

There are three methods of attack used on wildland fires; 1) direct, 2) parallel, and 3) indirect. They are covered in Section 1 - Fire Suppression Principles, pages 16 and 17.

Engines are invaluable when used for direct attack, especially in light fuels such as grass. The engine provides the firefighter with the mobility and flexibility in fire suppression by providing water, retardant or foam where needed on the fire.

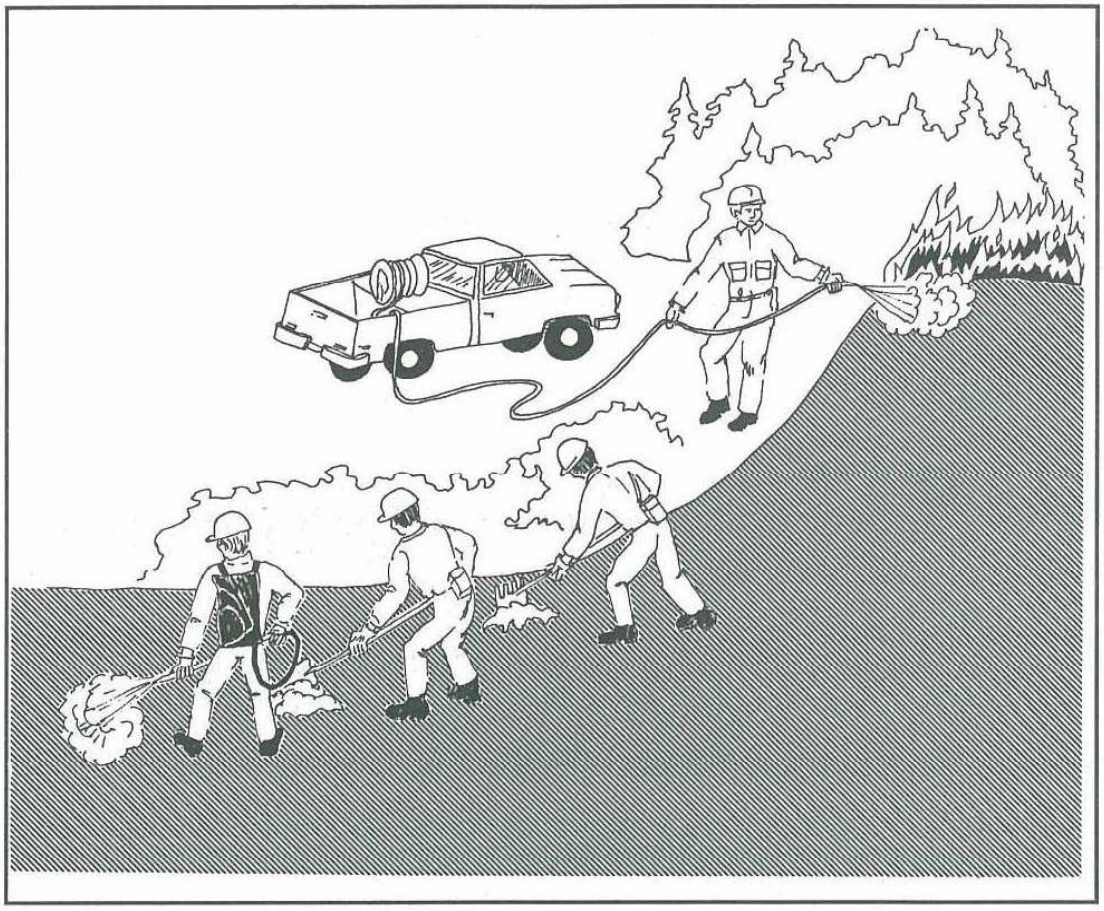
When using engines in direct attack consider the terrain, point of attack, escape routes, fuel types, fire intensity, rate of spread, and the capabilities of the crews and equipment.

There are several tactical uses of engines in direct attack. They are mobile, tandem, pincer, envelopment, inside-out, and stationary.

Mobile Attack

When terrain and conditions allow, the mobile attack is the fastest and most effective method (see Figure 12). The engine is driven along the fire's edge while a nozzle operator applies water parallel to the fire and at the base of the flame. The nozzle operator should be in full view of the driver at all times. Follow-up action will be taken with hose, hand tools, or both.

Figure 12 – Mobile Attack



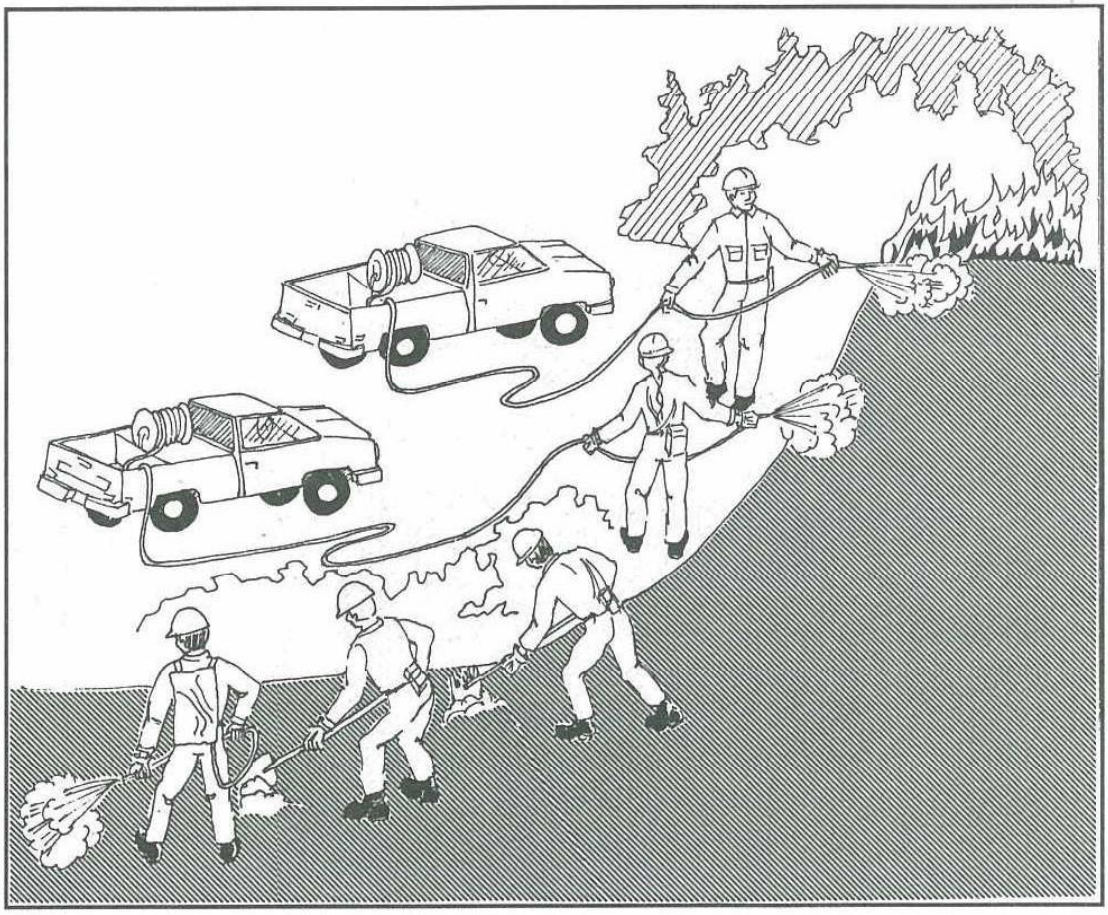
The mobile attack requires an engine with the ability to make a running attack (pump and roll). Generally, all wheel drive engines with a short wheel base are better suited for off road travel.

In heavier fuels or on a hotter burning fire, two nozzle operators can be used with a mobile attack. The first nozzle operator knocks down the hot spots and the second nozzle operator totally extinguishes the fire.

Tandem Tactic

Two engines can be used in tandem with a mobile attack (see Figure 13). Again the first engine hits the hot spots and the second engine follows up totally extinguishing the fire. Two engines working together make a safer operation because one can help the other if it gets stuck, broken down, etc.

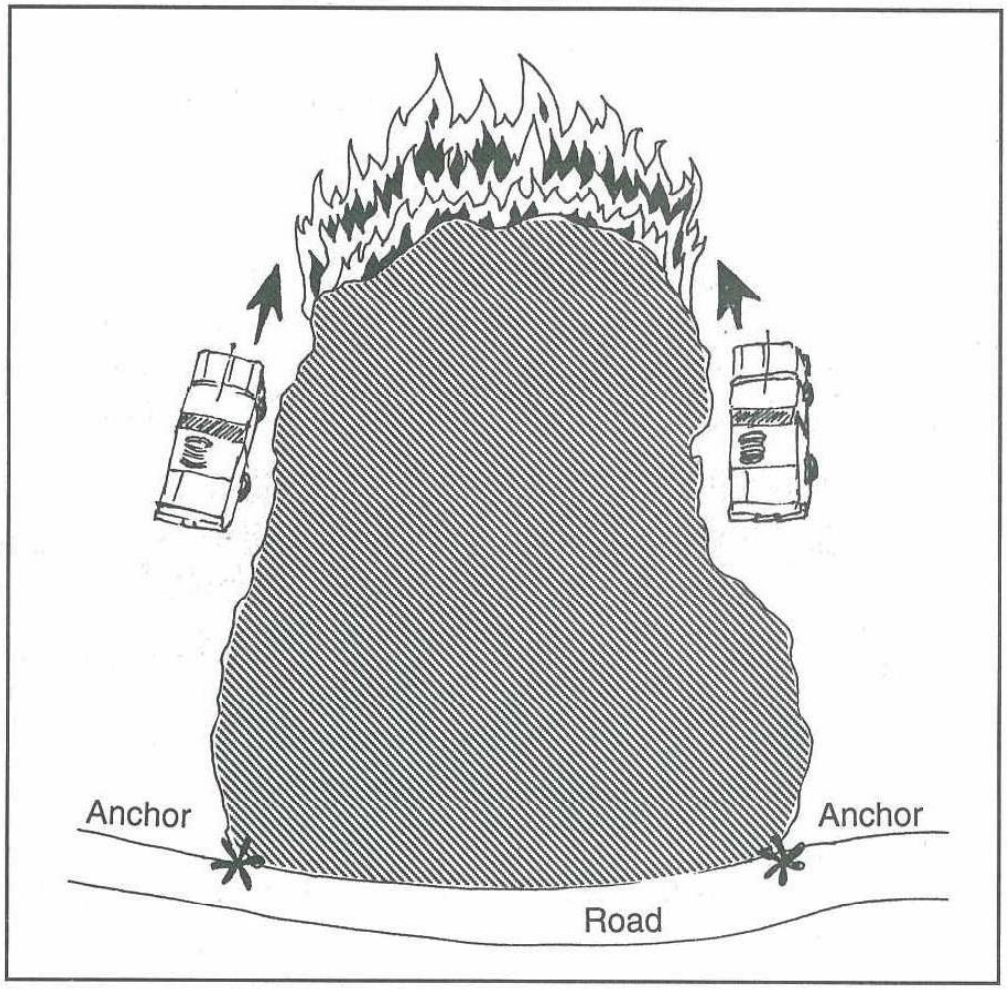
Figure 13Tandem Engines



Pincer Tactic

The pincer tactic is direct attack around a fire in opposite directions by two or more engines (see Figure 14). The rear, flanks, or head of the fire can be attacked, but it is safer to anchor at the rear of the fire, flank the fire, and cut off the head.

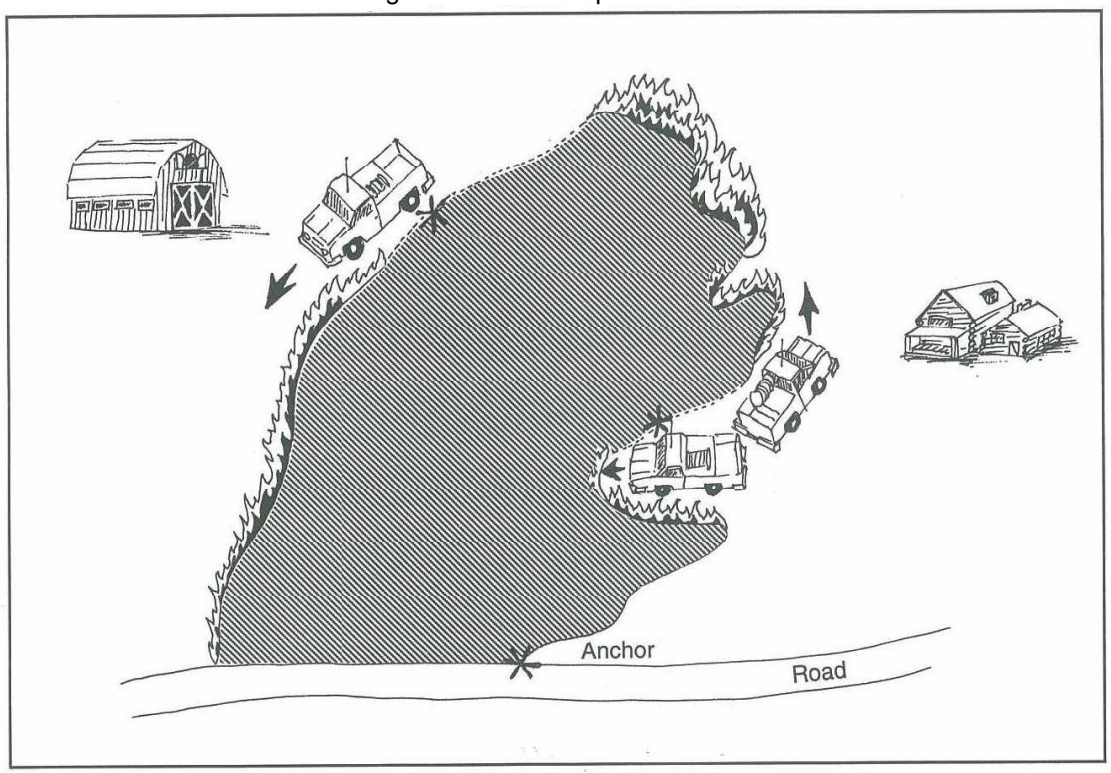
Figure 14 – Pincer Tactic



Envelopment Tactic

The envelopment tactic involves striking key or critical segments or structures around the fire area at approximately the same time. Establishing anchor points for the different points of attack is required to keep from being outflanked or overrun by the fire. Critical areas are attacked first using the hotspotting technique. The engine moves towards another engine, tying lines together. If the envelopment tactic is used, the attack must be well coordinated.

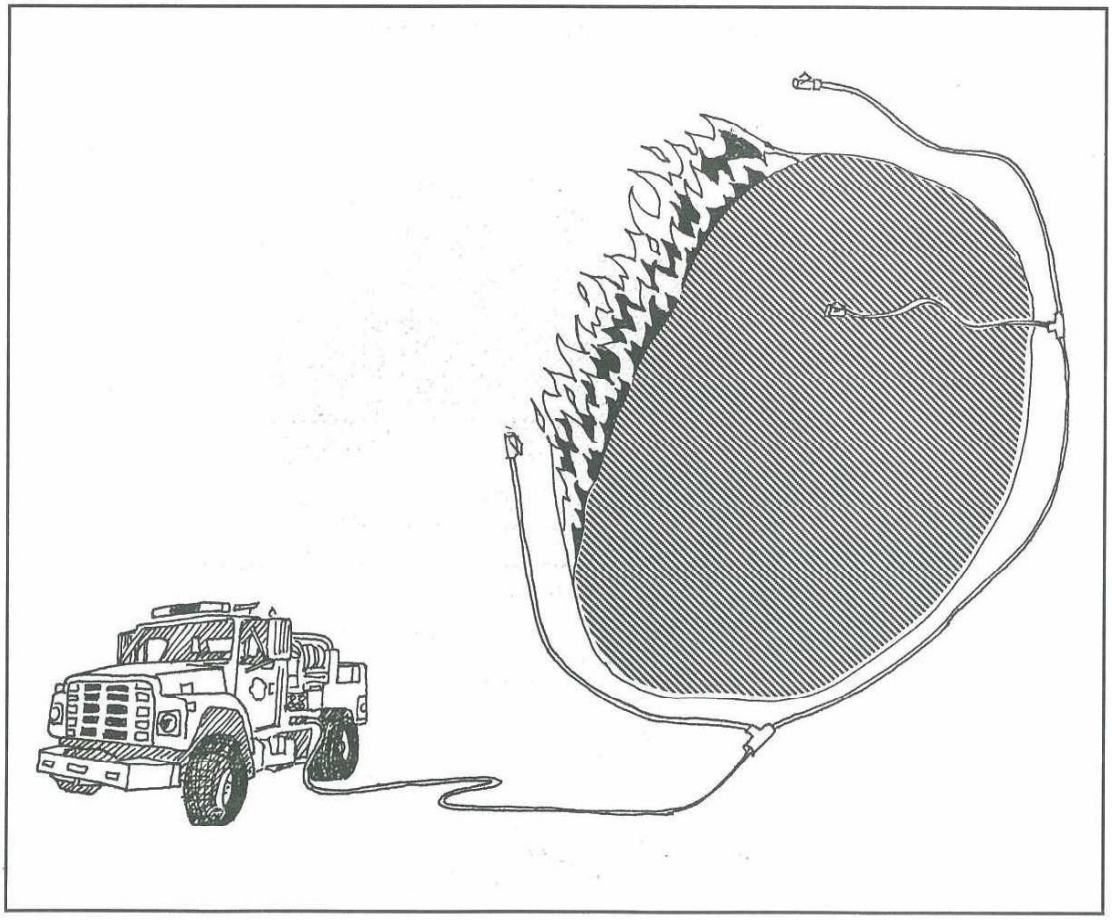
Figure 15 – Envelopment Tactic



Stationary Attack

A stationary attack is the use of a simple or progressive hose lay from a parked engine (see Figure 16). Simple and progressive hose lays are covered in Section 2 - Use of Water and Additives, pages *75* to 77. A stationary attack is used primarily for inaccessible areas for engines, but where a quick hose lay will reach the fire.

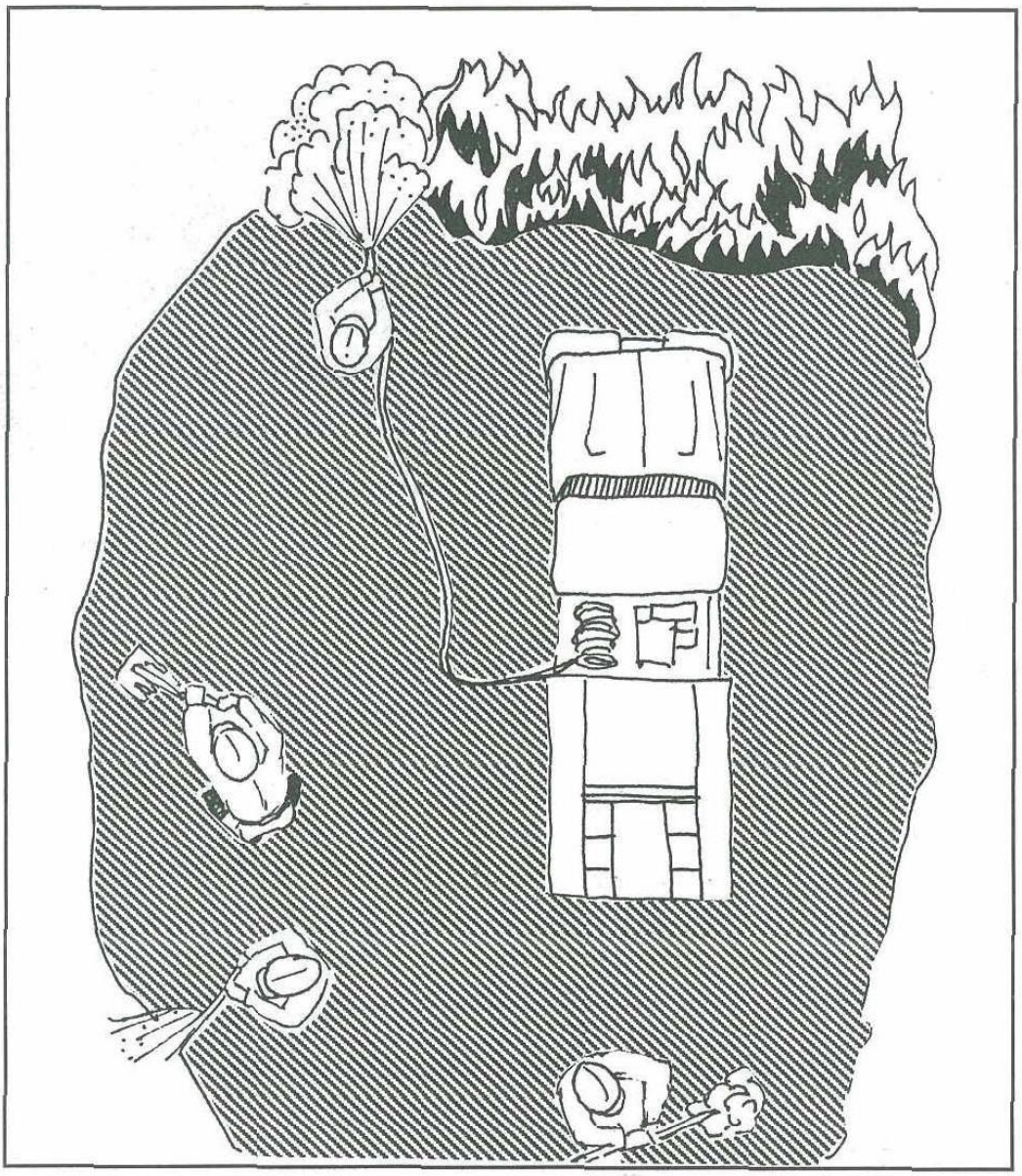
Figure 16 – Stationary Attack



Inside-out Tactic

The inside-out tactic is a direct attack on the head or flanks of a fire from within the fire perimeter (see Figure 17). The engine can either be mobile or stationary, but should not stand in any hot materials. If the engine is stationary, wet down the area under the engine. Watch for hot rocks and fuel beds. Always have a charged line on the engine that can be used to protect the engine. In light fuel the inside-out tactic can be a safe way to attack the head of a fire because the engine and crew are already in the burned area where fuels have been consumed. An engine can use one or two nozzle operators or engines can work in tandem.

Figure 17 – Inside-Out Attack

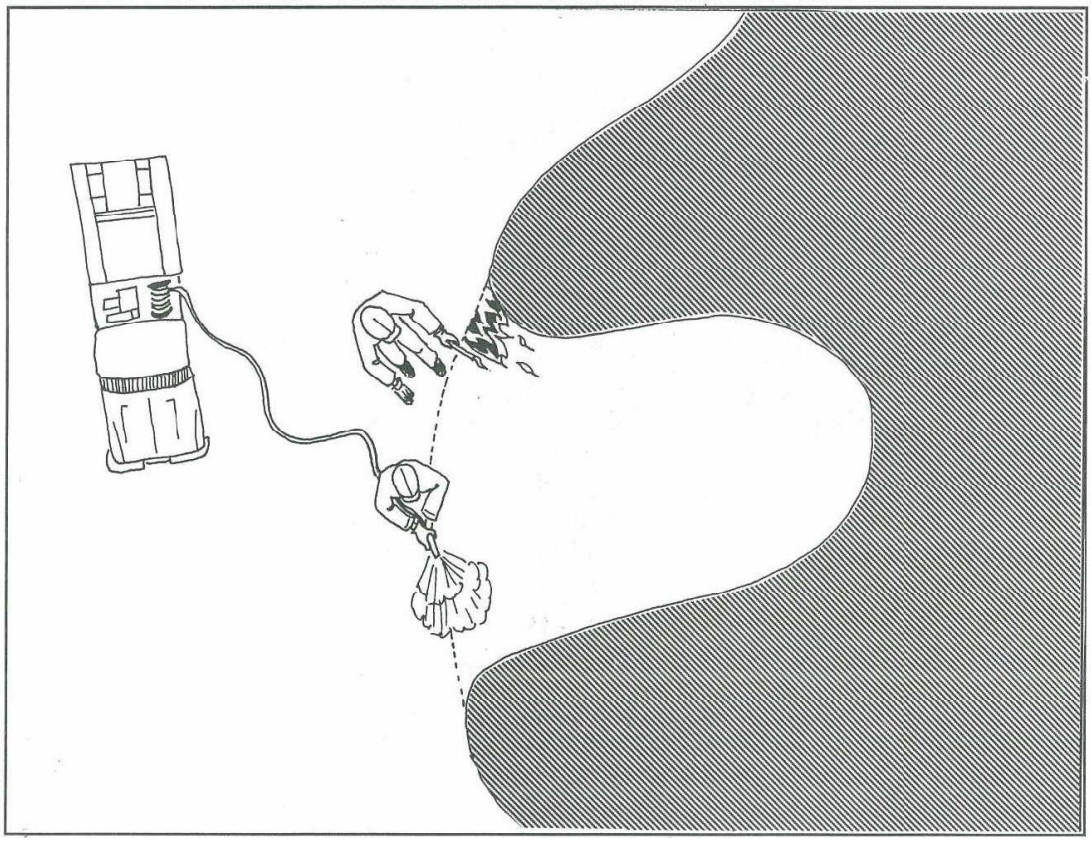


Engines can be used to make a parallel attack on fires burning in light fuel by laying down a wetline and burning out (see Figure 18). The wetline can be made from retardant, foam, or plain water.

The nozzle person uses a spray or fog nozzle to make the wetline as heavy and wide as needed to stop the fire under the current burning conditions. The wetline can be narrower if it is immediately burned out rather than allowing the fire to burn up to the wetline. Wetlines made from water must immediately be burned out.

It is always safer to anchor the wetline and flank the fire rather than attack the head of the fire.

Figure 18 – Parallel Attack With Wetline and Burn Out



This method works well with engines in tandem. The first engine lays the wetline and burns out while the second engine reinforces the wetline and extinguishes any slopovers.

With indirect attack, engines can be used to reinforce an existing barrier such as a road or they can be used to support a dozer line or backfiring operation.

Two additional tactics that should be mentioned that could be classified as either direct or indirect attack are exposure protection and deluge.

Exposure protection is keeping the fire from high hazard fuels, high value property and equipment, and public danger areas. Water, foam, or retardant is used to cool or treat fuels or property ahead of, or adjacent to, the fire when fire fighting resources are inadequate to stop the fire spread.

Deluge is flooding or applying water in large volume to an area to completely extinguish a fire such as a fire in sawdust piles, log decks, or peat bogs. An adequate water supply is a prerequisite for using this method.

Table 4 is an overall average engine production rate for initial attack.

Table 4 – Engine Production, Initial Attack

Fire behavior fuel model		Conditions used in	Rates in chains per crew-hour Number of persons in crew				
			1	2	3	4	5+
1	Short grass	Grass	6	12	24	35	40
	Tundra		2	8	15	24	30
2	Open timber/ grass understory	All	3	7	15	21	25
3	Tall grass	All	2	5	10	14	16
4	Chaparral	Chaparral	2	3	8	15	20
	High pocosin						
5	Brush (2 feet)	All	3	6	12	16	20
6	Dormant brush/ hardwood slash	Black spruce	3	6	10	16	20
		All others	3	6	12	16	20
7	Southern rough	All	2	5	12	16	20
8	Closed timber litter	Conifers	3	8	15	20	24
	Hardwoods		10	30	40	50	60
9	Hardwood litter	Conifers	3	7	12	18	22
	Hardwoods		8	25	40	50	60
10	Timber (litter and understory)	All	3	6	12	16	20
11	Light logging slash	All	3	8	12	16	20
12	Medium logging slash	All	3	5	10	16	20
13	Heavy logging slash	All	2	4	8	15	20