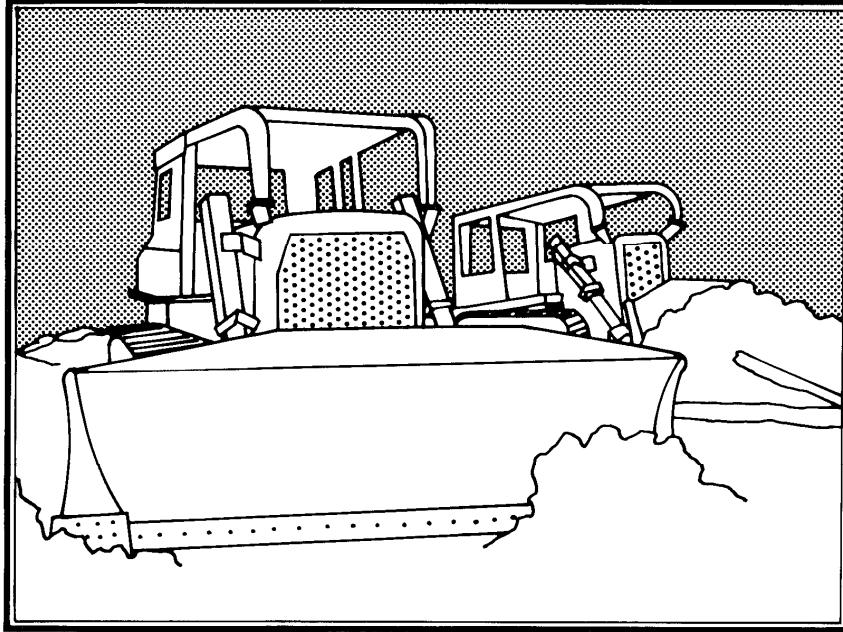


S-213 (B.C.)



USE OF BULLDOZERS

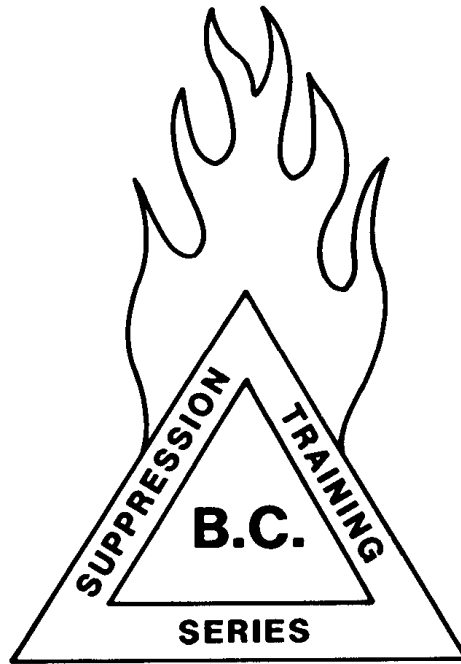
STUDENT WORKBOOK



Province of British Columbia Ministry of Forests







FIRE SUPPRESSION TRAINING

S-213

USE OF BULLDOZERS

STUDENT WORKBOOK



SELECTION OF TRACTORS FOR FIRE SUPPRESSION

The introduction to fire suppression of the crawler-type tractor, or "bulldozer", during the 1940's was a major breakthrough in more effective fire control. It permitted faster and superior fireline construction, using machines rather than manpower and hand tools.

Each year throughout B.C., the Ministry of Forests hires large numbers of operators with their bulldozers of all makes and sizes for use in firefighting.

Protection personnel need not be Bulldozer Operators or Mechanics, but you will be required to:

- speak knowledgeably to Bulldozer Operators;
- inspect and select equipment during pre-organization;
- select the most suitable machine for the job to be done;
- direct and coordinate the use of bulldozers on fires;
- ensure their safe and cost-effective operation on fires.

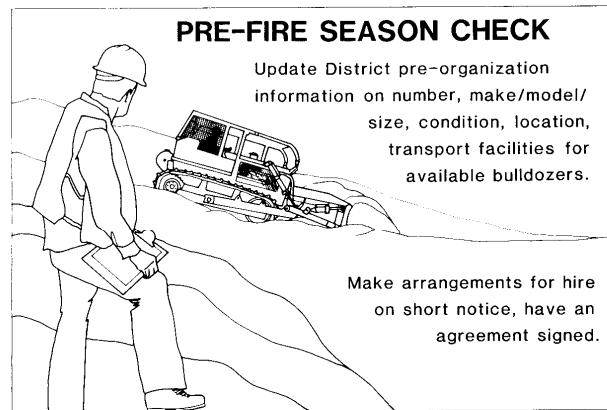
METHODS OF EVALUATING MACHINES

The condition of a bulldozer should be the deciding factor in hiring and matching the machine to the job.

When seeking machines, rely on personal knowledge and observation of tractors owned and operated in the local area. Extensive checks on the condition of the bulldozers at the time of hiring should not be required when dealing with companies and equipment owners with reputations for having good, well-maintained machines and skilled operators.

PRE-FIRE SEASON CHECK

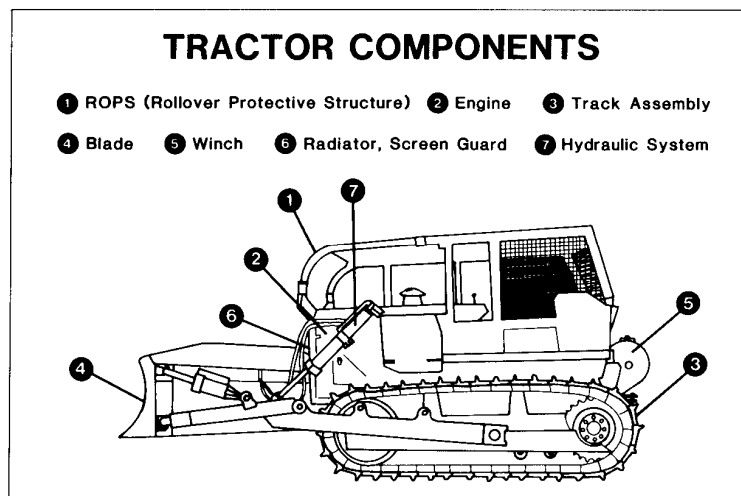
Annual pre-fire season checks are made with logging companies and equipment owners to update the District pre-organization plan information on the number, make, size, condition, location and transportation facilities of all tractors suitable for firefighting. Arrangements for hiring equipment and operators on short notice for firefighting is discussed with the owners, and a hire agreement signed.



INSPECTION AT TIME OF HIRE

Inspection at the time of hire should be carried out by a Protection Officer or, if available, a Mechanical Superintendent to determine the condition and suitability of the tractor for firefighting.

To understand the operation of tractors, and to evaluate their condition, you should know the main components of the machine and some common inspection practices.



1. ROPS (rollover protective structure)
2. Engine
3. Track Assembly
4. Blade
5. Winch



6. Radiator
7. Screen Guard
8. Hydraulic System

1. ROPS (rollover protective structure)

Under our Workers Compensation Board Regulations every tractor used in the woods must have ROPS

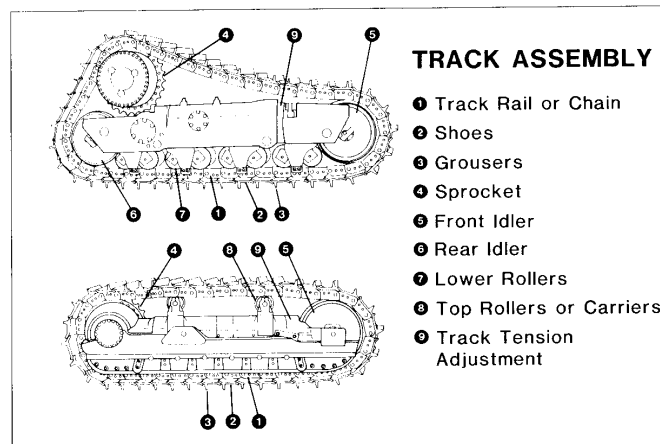
2. ENGINE

The engine may be checked by having the operator start it up and by listening to it run.

3. TRACK ASSEMBLY

The track assembly takes the brunt of the wear. Most of the [parts of the track assembly are readily visible and, along with the blade, are the most reliable indicators of the tractor's condition.

The parts of the track assembly that should be checked are



a) TRACK RAIL OR CHAIN

The track rail or chain consists of steel links held together by bushings and pins to form a continuous chain. Wear takes place and can be seen on the face of the rail where it contacts the rollers, and in the pins and bushings.

It may be difficult to determine the exact amount of wear on the face of the rails without the use of special gauges, but a visual check should suffice if substantial thickness of metal remains without cracks or distortion.

b) TRACK TENSION

Loose or sloppy track results in thrown track or jumping off its rollers when the machine is working on steep ground or hill-sides. Proper tension for normal operation is:

- 3/4" to 1" sag measured between idlers on machines with two top idlers;
- 1-14" to 1-1/2" sag between top and front idlers when there is only one top idler.

The method of checking track tension is to place a straight board across the top of the grousers and measure with a tape or by eye. Missing, bent or broken shoes, missing bolts and worn bolt holes are indicators of poor track maintenance. Track shoes should overlap slightly. If gaps are evident it indicates excessive wear or stretching.

c) GROUSERS

Grousers are made as part of the track shoe and are usually subject to severe use and wear. There are two types: square corner and bevel corner. There are two types: square corner and bevel corner. The size and heights of grousers may vary with different makes of tractors, but if only one inch or less of height remains on the grousers the tractor is not suitable for firefighting.

A visual inspection will indicate whether idler or roller flanges are broken or show excessive wear. Indications of excessive wear are worn spots, cracks or breaks. Flat spots on top rollers indicate generally poor condition or running tear.

Pins and bushings are checked for excessive wear by prying up on idlers with a steel bar to determine the amount of play.

It may be difficult to check lower rollers, as they are usually concealed by a respective line. Since the lower rollers carry the weight of the machine, the method of inspection is to have the operator drive the tractor up on blocks, fore and aft, so that the lower rollers can be inspected. Most rollers are now designed for long life and self-lubrication, but inspection for excessive oil leakage is warranted. If idlers, rails and sprockets are in good shape, it is a reasonable assumption that the lower rollers are as well.



d) SPROCKET

Sprocket wear shows mainly on the driving side of the teeth where they contact the track. If wear is excessive the tops of the teeth may be partially worn off or rounded; as a result, the sprocket may jump in the track causing a number of serious problems.

The sprocket should be inspected for cracked spokes and should fit snugly on its hub or spline. It is preferable to have a Mechanic or experienced person carry out this inspection.

4. BLADE

Visual inspection of the blade will show up any deficiencies. The main concerns are the cutting edge and corner gits, and the condition of the bolts holding them in place.

The cutting edge need not necessarily be sharp but must extend well below the mould board to be suitable for fireline work. Corner bits that are shortened, thickened or well-rounded from use will cause the tractor to push away from an obstruction, rather than "biting in" in normal operation.

5. WINCH

This may be checked by having the operator engage the winch and operate it. The length and condition of the cable should also be checked, as it may not be suitable for its intended use.

6. RADIATOR

It is usually only possible to make external checks of the radiator for obvious faults such as excessive dirt, debris or coolant leakage.

7. SCREEN GUARD

There should be substantial guard to protect the radiator, otherwise it is extremely vulnerable to damage which may render the machine totally inoperable on the fireline.

8. HYDRAULIC SYSTEM

There are two simple checks to determine the condition of the hydraulic system:

- a) The operator raises the blade off the ground about half way and sets the control to "HOLD" position. The blade should remain suspended; any downward drift indicates possible fluid leakage or other faults in the hydraulic system.
- b) The operator places the blade on the ground and raises the entire front end of the tractor and tracks clear of the ground. With the control set on "HOLD", the tractor should remain steady in this position.

Failure of either of these tests means the machine would be unable to work satisfactorily pushing uphill or pushing down tress, and if caught in soft, swampy ground would be unable to raise and hold itself in position for blocking.

BEST SIZE OF MACHINE

The range of sizes and types of tractors available in recent years has complicated the choice of the best machine to efficiently accomplish the job. Usually the urgency of need, availability, accessibility and location of alternate machines will be prime consideration in the actual choice of machines and the standard considered acceptable.

Tractors are commonly identified by manufacturer's letter prefix and series number. Usually series numbers are on ascending scale to indicate increase in machine size, while alphabetical letters indicate a modification or later model.

Manufacturers' Designations for Tractors

MANUFACTURER	PREFIX	EXAMPLES
Caterpillar	D	D7, D8K, D9G, D9H, D9K, D10
International	TD	TD20, TD25B, TD25C
Fiat Allis (Allis Chalmers)	FD or HD	FD30, HD21C
Terex (Euclid)	C and TC (earlier models) number only (later models)	82-20B, 82-80
Komatsu	D	D120A, D150A, D355A
Case	number and letter	450, 850, 1150, 1150B
John Deere	JD number series	JD 450C, JD 750, JD 850
Massey Ferguson	MF number series	MFD 600C, MFD 700C



If a selection is available, as a general rule, the minimum size machine dispatched for Initial Attack should be D[^], TD 15, HD9 or equivalent. Key factors are balancing the size of tractor large enough to do the job against the difficulties in speedily transporting it the fire scene.

In remote locations and back country where narrow, overgrown roads with numerous bridge crossings may present transportation obstacles, the maximum-size tractor hired should be limited to a D8 or equivalent. The time saving in off-loading and reloading the medium tractors far outweighs any size advantage or increased horsepower larger machines may have on the fireline.

TRACTOR RENTAL RATES

The Equipment Rental Rate Schedule is established annually by an interministerial committee of the Provincial Government and issued as a Regulation under the Forest Act by Ministry of Forests' Protection Branch. This schedule includes the current maximum rate for hiring the more common makes and sizes of tractors used for firefighting.

The rate and conditions of hire should be based on the Schedule and established with the owner/operator prior to use on a fire.

Have a current Copy of the Equipment Rental Rate Schedule on hand for students who wish to take a closer look at it.

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MAINTENANCE RESPONSIBILITY

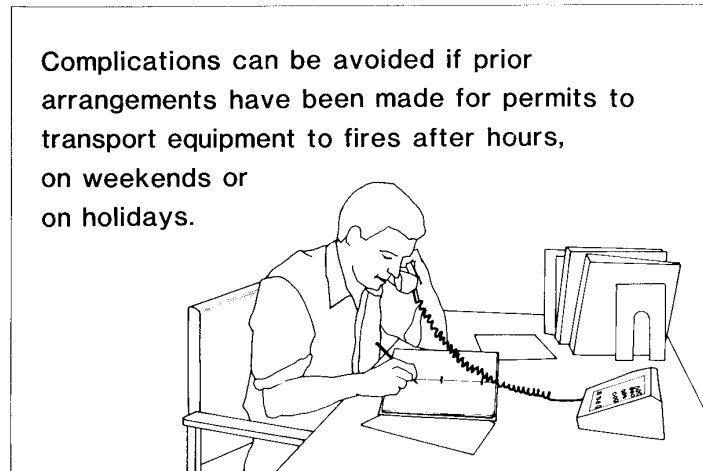
On small fires of short duration, the owner/operator services his own machine. On large fires, where a number of tractors are working in widely separated areas, the Equipment Function will be established. A service vehicle with Mechanic and tolls may be hired to handle to the servicing and maintenance requirements. In any case, proper facilities will be made available, at the fire camp or on the fireline, for refueling and servicing bulldozers.

TRANSPORTATION CONSIDERATIONS

Transportation of tractors is an essential feature of their hire and use in firefighting. Frequently machines will have to be transported considerable distances from their job sites to the fire area. This may involve the hire of low-beds for hauling the tractors, arranging for Permits and authorization to travel on public highways during weekends and holidays.

Wherever possible the hiring of a tractor should be arranged as a package deal with the owner, to include transportation of the machine to and from the fire.

When a package deal is not available, commercial trucking companies should be hired since they have the necessary equipment insurance coverage and are familiar with permit and safety requirements, and with load limits of the Ministry of Transportation and Highways.



YOU should be familiar with the basic regulations governing the movement of heavy and over-width equipment on provincial highways. The regulations are stringent to protect travellers on public highways. Ignorance or attempts to circumvent them cannot be condoned.

Complications can be avoided if prior arrangements for permits have been made with the local weigh-master of the Ministry of Transportation and Highways or with the R.C.M.P. to cover transportations of equipment to fires after hours, on weekends and holidays. It is essential good liason be maintained with these agencies and the established procedure followed during fire emergencies to avoid serious repercussions later on, or in the event of an accident during the hauling operation.

When tractors must be transported by water, other than by regular ferries, a commercial marine towing operator should be hired to handle the job to avoid serious and costly mishaps.

If commercial marine transporters are not available, the person in charge, if inexperience, should hire qualified local persons to do the job or seek advice of supervisors before attempting the task himself.



USE OF TRACTORS IN FIREFIGHTING

ROLE OF THE DOZER

Tractors perform two main functions on the fireline:

1. build fireline to stop the spread of fire;
2. carry out support and service functions
 - (a) building access roads;
 - (b) improving firelines for use as tote roads by four-wheel-drive (4WD) vehicles and skidders during mop-up and patrol.

These functions must be considered separately when selecting and deploying available machines.

MANPOWER VERSUS MACHINE

The use of manpower on fires must be organized to augment the bulldozers. Line construction with hand tools is usually slower and more arduous. It should normally be confined to swampy, boggy ground or rough rocky areas where the bulldozer has difficulty working effectively.

TRACTOR SIZE CONSIDERATIONS AT THE FIRELINE

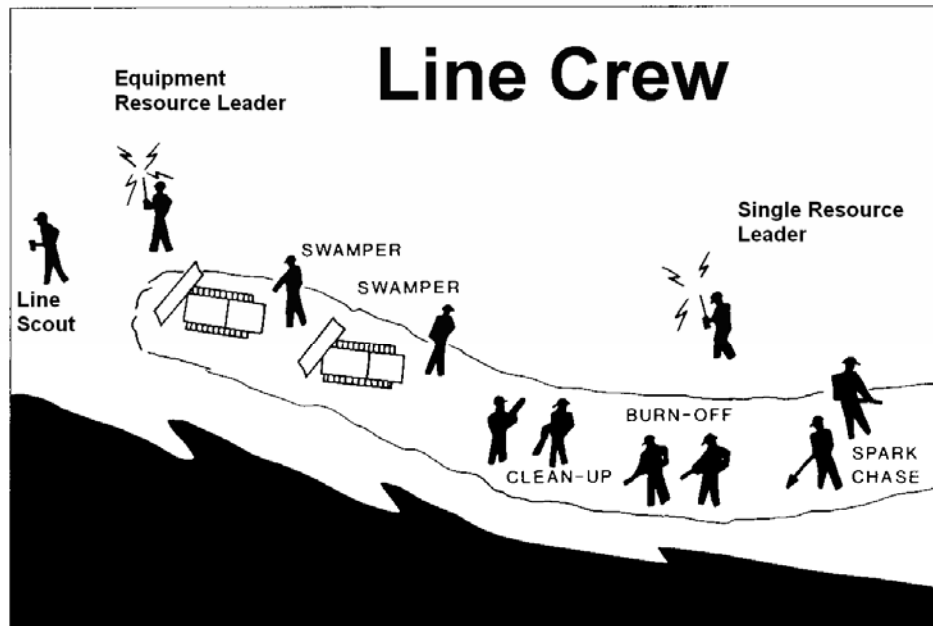
Small- and medium-sized tractors (D 6-7, TD 15-20, HD 11-15), are generally more effective in fire fighting situations, especially in close quarters and over steep terrain where large tractors experience trouble manoeuvring and create large piles of debris.

On wet or boggy ground a large tractor can become mired down, requiring a major salvage operation to be undertaken, possibly jeopardizing the success of the suppression effort. If large machines are to be used under these conditions, they should be equipped with extra-wide tracks.

ORGANIZATION OF TRACTORS ON THE FIRELINE

The operation, maintenance and transport of heavy equipment on a fire is the responsibility of the equipment Function. Its role in the Fireline Organization is to ensure that the right piece of equipment is used for the job, and that it is used efficiently. On small fires, the Equipment Function is usually handled by the Incident Commander.

TYPICAL DOZER UNIT ORGANIZATION



Available bulldozers and personnel are organized into equipment groups. Usually, each would consist of two bulldozers, Operators and Swampers, and a Line Scout, under the supervision of an Equipment Resource Leader.

In addition, small crews of three to five people burn-off and spark chase. The Single Resource Leader is responsible to the Division Supervisor, however he and the Equipment Resource Leader will work as a team to ensure efficiency and safety.

Most fire in which tractors are used are handled by one-equipment units, but occasionally larger or project-size fires require several equipment units. Access to the fire will be a determining factor when deciding on the number hired.

Each equipment unit should be assigned its own specific section of fireline to complete. Before hiring large numbers of Dozers, the Incident Commander should determine specific uses for each machine hired, with a few spares as back-up for the inevitable breakdowns.

In special situations, three tractors may work together in a unit, i.e. when:

1. Fireline construction through heavy fuels or debris where clean-up may bog down and delay burn-off;



2. The lead tractor is persevering to complete the link-up of fireline, and the third machine can speed up the clean-up and improve the pioneer fireline;
3. Frequent swampy, wet areas where the larger lead machine may be required to leapfrog and leave a gap in the fireline.

ACCESS ROADS

It may be necessary to build access to the fire area. Bulldozers used for this purpose should be organized separately from the machines hired for fireline construction.

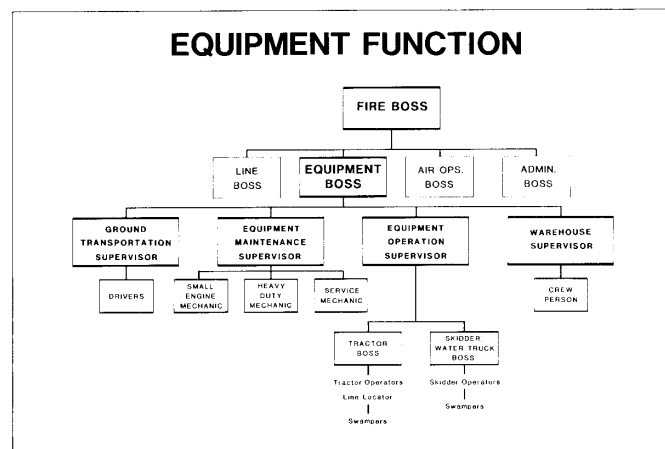
LIMITATIONS OF TRACTOR USE

The following may limit the effective use of bulldozers, even on large fires:

1. terrain- broken, rough terrain hampers safe operation of tractors.
2. Access routes - single access route to fire limits leapfrogging of tractor units.
3. The availability of sufficient qualified supervisory and overhead personnel.

DUTIES AND RESPONSIBILITIES OF UNIT PERSONNEL

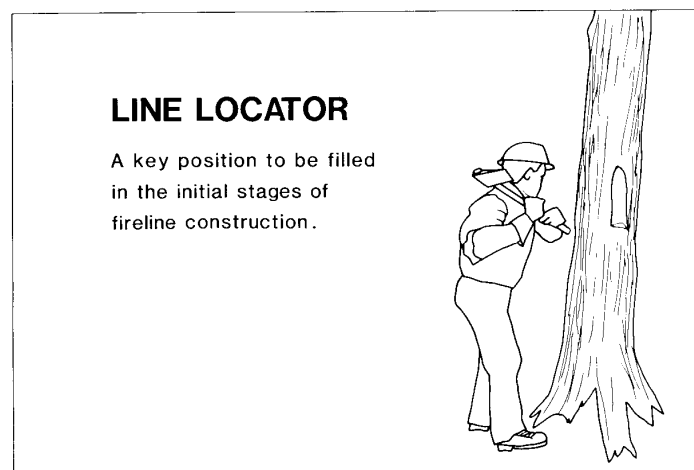
A tractor unit is part of the Equipment Function, which in turn is part of the overall Fireline Organization. For the tractor unit to function effectively, each member of the unit must be fully aware of his duties and responsibilities.



The Tractor Boss is responsible for the safe and effective operation of the entire tractor unit under his direction. His duties include:

1. construction of an assigned section of fireline, as per plan;

2. ensuring that the tractor unit functions as a team;
3. familiarity with the fire attack plan: timing for fireline completion, required width of fireline, when burning-off is to be done;
4. recording the operating times for equipment and manpower in his unit;
5. ensuring maintenance and servicing of machines is done;
6. arranging transportation for crew in his unit to and from job site.



LINE LOCATOR

The Line Locator is part of the tractor unit. During initial stages of line construction, he plays a key role in the Fireline Organization. Considering good firefighting principles, he locates and marks the fireline prior to construction, and keeps the Tractor Boss and Sector Boss informed of progress made and problems encountered.

A qualified Line Locator must:

- (a) possess a good understanding of fire behaviour;
- (b) be an experienced woodsman and firefighter;
- (c) have good knowledge of the capabilities and limitations of bulldozers;
- (d) be capable of exercising sound judgment.

The location of the fireline will depend on his assessment of the following:

- (a) rate of spread of the fire;



- (b) weather conditions and their impact on fire behaviour;
- (c) constraints imposed by topography and soil conditions;
- (d) volume and type of unburned fuel remaining within the fireline when line is completed;
- (e) line resistance of the forest cover along the fireline and the estimated time for line completion.

The success of the tractor unit in completing the fireline on time hinges to a great extent on the decisions and the judgment of the Line Locator. Normally he should not work more than a few hundred metres (yards) to half a kilometre ahead of the lead tractor.

In rough, broken terrain it may be advisable to have an Assistant Line Locator to reconnoiter farther ahead to avoid dead-ends and impassible obstacles necessitating back-tracking of tractors.

TRACTOR OPERATIONS

The lead tractor is usually the largest and best machine with the most experienced operator.

- (a) primary function is a clearing operation;
- (b) should not dig line to mineral soil;
- (c) must keep his machine moving steadily forward.

Second Tractor Operator must remove surface debris and complete line down to mineral soil.

Third Tractor Operator (when in use):

- (a) ensures fireline is constructed to mineral soil;
- (b) widens line to required width, where necessary;
- (c) breaks down and spreads excessively large piles or heavy accumulations of debris within line or just outside of it that may cause escape;
- (d) pushes down snags and leaners close to the line;
- (e) improves fireline to facilitate patrol and mop-up by 4WD vehicles and skidders.

SWAMPER

Workers Compensation Board regulation requires that a Swamper be assigned where a tractor is working alone or under dangerous conditions (e.g. fire suppression). The Swamper's job is to do whatever is required to assist the Tractor Operator. He must be alert, safety-conscious and physically fit in order to work effectively.

LINE CREW

As line construction is completed by the bulldozers, the Crew Boss responsible for that section of line will divide his crew into groups to carry out the required work to hold and complete the fireline.

CLEAN-UP

Their purpose is to clean up and reduce amount of fuel remaining along the edge of the fireline to reduce the possibility of their being ignited by radiant heat or flying sparks. The methods used are to:

- (a) fall snags both inside and outside along the fireline;
- (b) remove all leaners;
- (c) break down, flatten and scatter large piles;
- (d) lop and scatter tops and limbs;
- (e) remove branches from lower trees trunks to prevent ground fires "laddering" into upper foliage and "candling"

These functions are performed by a crew, usually three to five men, equipped with chain saws, axes, pulaski tools and shovels.

BURN-OFF

Their function is to burn off a strip along the inside of the fireline to reinforce it. Two or three Crewmen with torches and fuel supply follows along as closely as safe practice permits, torching strips of unburned fuel. An adequate number of Spark Chasers with hand-tank pumps and shovels are deployed on the outside of the fireline to extinguish any sparks that may fly over the line.

PLANNING, BRIEFING AND SUPERVISION

Building firelines with tractors may involve any combination of Direct, Parallel or Indirect Attack, according to the judgment of the Fire Boss. The Fire Boss must evaluate the fire and decide the general location of the line, its width and estimated completion time.

The Fire Boss must convey this information to key personnel of the Fireline Organization and obtain their input during briefing sessions, so all supervisory personnel are familiar with the fire control plan.

A suitable location and facilities must be provided for the briefing sessions. They should be scheduled on a regular basis at approximately the same time each day. Briefing should review achievements to date and plan for accomplishing the remaining work.



Supervision is a critical function of each level of the fire overhead. It must be carried out continuously to ensure that all features of the control plan are fulfilled properly, and to make adjustments, where necessary, to ensure success.

TECHNIQUES OF BULLDOZER ATTACK

Basic fire suppression principles apply when bulldozers are used to construct a fireline.

1. Fireline location is of prime importance.
2. When a fireline constructed with tractors is located some distance from the fire's edge, the remaining fuel between the line and fire **MUST BE BURNED OFF.**
3. Speed of fireline construction must be related to the rate of spread of the fire.
4. Line construction must not contribute an excessive amount of unburned fuel (debris) to the fire.
5. The wider the fireline constructed, the more debris is created.
6. Width of fireline constructed should bear relationship to the volume of fuel which will burn off inside the fireline.
7. Firelines located on steep slopes ahead of and above the fire are difficult to build and even more difficult to hold.

METHODS OF ATTACK

The basic methods of attack are Direct, Parallel and Indirect or a combination of any two or all three.

DIRECT ATTACK

The objective is to construct a maximum distance of secure fireline, along the fire's edge, in minimum time to control the fire spread.

WIDTH OF FIRELINE

The width of fireline required is determined by the conditions present:

- rate of spread;
- urgency to control before heat of day or increase in winds;
- proximity of fireline to fire's edge, risk of sudden increase in intensity.

Three main factors must be considered:

1. Volume and nature of fuel immediately ahead of the fire (heavy slash, windfalls versus open grasses and low bushes).

2. Height and density of canopy: Crowns of trees must be separated to prevent "candling" or, possibly "crowning" in dense pine or spruce stands. Where separation is required it may be feasible to limit the width of the tractor-built fireline and increase the width by falling trees along edges of the line with chain saw crews.
3. Steepness of the slope where the fire is burning: Heat and sparks will be carried upslope by convection currents to pre-heat unburned fuels ahead of the main fire. Personnel must gauge the volume of fuel (debris) adjacent to the potential fireline as well as that a safe, secure line can be pushed across the head of the fire to cut it off and control it.

As a rule, in Direct Attack using a bulldozer, the fireline should not exceed two blade-widths UNLESS VERY UNUSUAL CIRCUMSTANCES EXIST. BUILD THE NARROWEST FIRELINE THAT WILL CONTROL THE FIRE.



There are three types of fires on which Direct Attack is possible. Each situation employs a different technique in Direct Attack.

1. Direct Attack on a hot, fiercely-burning, small fire:

OBJECTIVE:

To contain the fire before it spreads.

METHOD:

The Bulldozer Operator moves right in on the fire, pushing all burning material from the edges towards the centre into a pile, smothering the fire by burying it with soil.



RESULTS:

- The fire has been stopped
- The area involved may be considerably expanded by the action of the tractor.
- The fire will be controlled, but not out. Mop-up of the smouldering plies may require hours, days or weeks,. Depending on the conditions.
- Patrol must continue until substantial rain has fallen or until no smoke has been observed for two days.

1. Direct Attack on a cool, quiet, larger fire:

OBJECTIVE:

To control the fire while it is quiet by encircling it as quickly as possible with a secure fireline.

METHOD:

A modified form of Parallel Attack is often used. The tractor works 5-10 feet from the fire, pushing debris to the outside and cutting across "fingers" to shorten the length of the fireline. Burning ends of bucked logs or windfalls are pushed into the fire. The clean-up and burn-off crews will follow to leave a clean, burned-off guard.

RESULTS:

- The fire spread is stopped.
- No accumulations of unburned fuel remains inside the fireline.
- Fire may be reduced to "mop-up and patrol" status.

2. Fire Burning Up-Slope

OBJECTIVE:

To construct a fireline ahead of a fire moving slowly upslope and cut off the fire spread into unburned timber.

CAUTION:

This procedure should only be attempted when:

- (a) the fire is relatively quiet in the early morning or evening when it has cooled down;

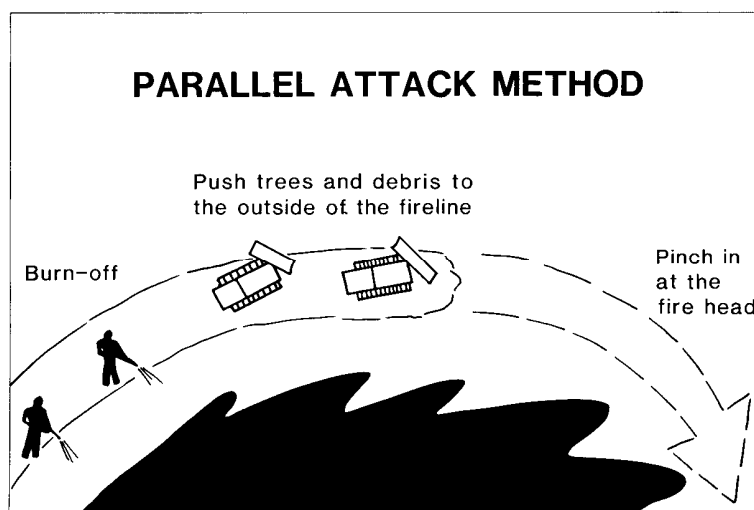
- (b) weather conditions are stable and local winds are calm or light;
- (c) the Tractor Boss has considerable fire experience and is familiar with fire behaviour and local weather conditions, especially unusual situations such as strong, gusty winds. There must be **NO CHANCE** of the fire taking a sudden run which would trap the tractor in its path.

METHOD:

The bulldozer may work right along the quiet edge of the fire, pushing all material inward, building a narrow line as quickly as possible. The clean-up and burn-off crews should work closely behind, burning off to minimise radiant heat and sparks. This procedure should be followed with hose lines or at least hand-tank pumps.

NOTE: This is also the method commonly used to complete the fireline, by linking up the two flanks, across the head of the fire.

As an alternative, although costly, air tankers can be used to lay down a retardant fireline along the upper edge of the fire to cool it down and ensure that the fire does not make a sudden run.



PARALLEL ATTACK

This method is used when the fire is burning too hot for a Direct Attack, but slow enough for the fireline to be established and burned-off before the fire reaches it.

FIRELINE LOCATION

Deciding on the distance that the fireline is constructed from the fire's edge will call upon the Line Locator's knowledge of fire behaviour and capabilities of bulldozers, and his assessment of the following factors:



1. rate of spread, risk of being outflanked before the fireline is completed;
2. fuel type and volume between the fire's edge and the proposed fireline;
3. speed at which the line can be constructed;
4. wind direction and speed;
5. topographic features - degree of slope, aspect;
6. time of day that fireline construction will be undertaken, fire weather build-up and fire danger indices.

METHOD OF CONSTRUCTION

Bulldozers construct a narrow fireline to mineral soil, a short distance from the fire (20 feet, 200 feet, 300 feet - depending on fuels, topography and raggedness of fire perimeter) and parallel to the fire's edge. Burn-off crews follow immediately behind the last tractor, igniting all unburned fuels that remain between the fireline and the fire.

In Parallel Attack, the general principle is to push all trees and debris from the fireline outside the line (away from the advancing fire), where topography conditions permit. Reasons are;

1. avoids adding additional fuel to the fire;
2. avoids problems in obtaining a quick, clean burn-off.

COMPLETING A PARALLEL FIRELINE ON A SLOPE

When constructing a fireline on a slope, ahead of a moving fire, the Tractor Boss must consider the same things as in Direct Attack in a similar situation.

As fireline construction along the flanks progresses, the strategy should be to gradually pinch in the firelines to leave as narrow a fire head as possible. As the fireline will be constructed along a contour on the hillside above the advancing fire, most of the debris from line construction will unavoidably be pushed or end up on the downhill side. The goal is to construct the narrowest width of line that will provide a secure base for the burn-off crew.

SEPARATE THE TREE CROWNS

If the slope is such that the tree canopies on each side of the fireline still touch, Fallers must cut the trees (usually downhill) to separate the crowns and leave a clean break. The felled trees will run downhill away from the fireline and possibly into the fire. (This adds more fuel to the fire but sometimes the Fire Boss must take this calculated risk to close the fireline.)

A variation of this procedure, when the slope is very steep, is to leave a considerable window of soil on the lower edge of the fireline nearest the fire. This is accomplished by

the lead bulldozer pushing most of the trees and debris downhill with a minimum of soil mixed in. The second bulldozer follows, and since the machine fireline on a steep slope usually results in a hillside cut or road, the resultant soil can be deposited as a window along the fire side of the fireline.

WIDTH OF FIRELINE

The width of the fireline is always contentious, because conditions vary widely between fires and even on the same fire, if it is large.

Constructing an unnecessarily wide tractor line must not be a replacement for carrying out the essential burn-off function - it is seldom successful.

The construction of an unnecessarily wide fireline creates the following problems:

- (a) excessive debris and unburned fuel;
- (b) problems in rehabilitating the fire area;
- (c) environmental damage that may be more serious than the fire's impact on the forest resource.

IN THE USE OF BULLDOZERS, CONTROL MEASURES THAT ARE EXCESSIVE AND DAMAGING ARE CONSIDERED POOR FIRE CONTROL MANAGEMENT.

BURN-OFF

1. Burn-off, in this situation, is particularly risky, so fire behaviour expertise and experience is required. The crew must be instructed in safety measures and shown escape routes in case the fire takes a run.
2. Timing of burn-off fires and humidity conditions are critical.
3. When water or retardant is available, it can be laid down on the upper side of the fireline to reduce the possibility of sparks or radiant heat igniting the upper side of the slope.
4. Spark Chasers with hand-tank pumps and tools must patrol above the line on the uphill side for errant sparks.

REMEMBER:

The fireline is only a base for burning off. The remaining fuel must be burned-off before the control line is considered adequate. A fireproof swath must be created in the path of the fire, robbing it of the fuel and momentum it needs to spread.

If the fire is burning-up-slope, it presents special problems and the safety of the crew become the paramount consideration; CAUTION IS REQUIRED.



INDIRECT ATTACK

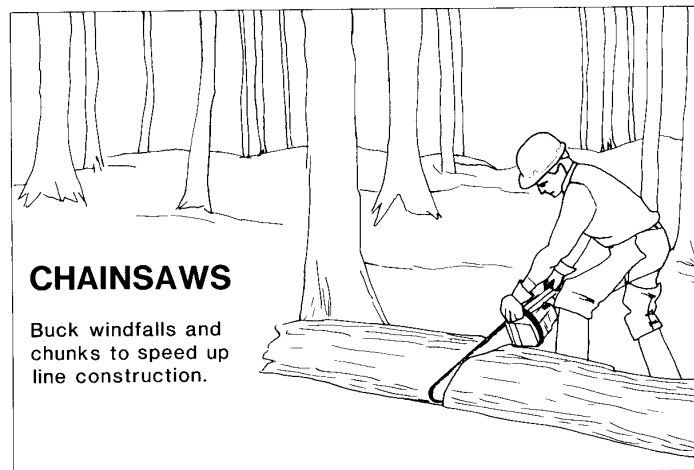
The Indirect Method is used on larger, fast-moving fires that cannot be contained by the Direct or Parallel Method and usually require desperate measures by the suppression forces before they are brought under control. A control line is established some distance ahead of the advancing fire, and the intervening fuel is backfired.

This method is seldom used - 95% of fires in B.C. are fought using Direct and Parallel Attack.

METHOD:

The use of bulldozers in Indirect Attack is very similar to their use in Parallel Attack. A bulldozer fireline connects natural fire breaks (lakes, swamps, roads, rivers, barren rocky areas) to establish a good control line across the head of the fire, connecting firelines that extend along the flanks. The intervening fuel is then burned off from the line in as wide a strip as time permits until the backfiring is met by the advancing fire front.

Use of Chainsaw with Tractors



If windfall or slash is thick and tough, crewmen with chain saws, working ahead of the lead bulldozer building the fireline, can speed up line construction.

The objective is to simplify the job of the Bulldozer Operator by bucking windfalls and chunks which may slow down fireline construction.

Factors to be considered:

- Large bulldozers seldom require chain saw operators, as they have sufficient power to handle any situation encountered.
- The fireline location must be well-marked and clearly visible to the lead bulldozer.
- For safety, no more than a two-man chain saw crew (saw operator and helper) should be working ahead of the lead bulldozer at any time.
- Chain saw crewmen must wear brightly-colored hard hats and clothing.
- The chain saw crew only bucks windfalls and chunks, not standing trees or snags.
- The procedure is one cut near the fire side of the marked line. The bulldozer can push debris to the outside of the fireline, leaving a minimum of debris for clean-up and burn-off crewmen.

USING EQUIPMENT FOR MOP-UP

Mop-up must commence as control is established along the line to ensure that the fire has no chance of escaping. When it isn't possible or practical to mop-up the entire fire, mop-up is carried out on a wide strip within the fireline.

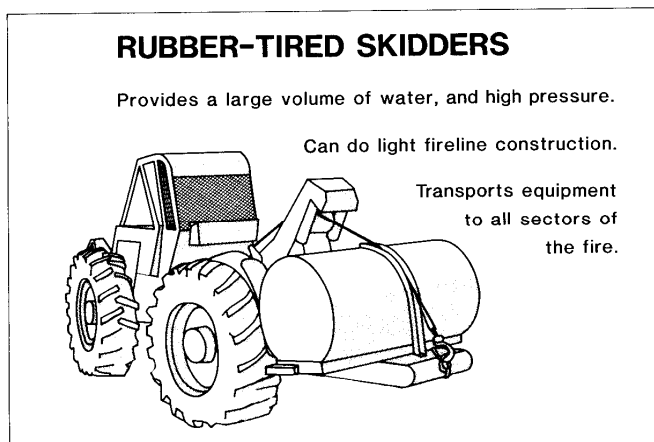
MOP-UP WITH BULLDOZERS

Bulldozers can be used advantageously for mop-up, especially in heavy fuels and snag areas. They can push over snags, uproot burning stumps and roots, roll logs over, break up large piles of smoldering fuel exposing hot spots, and in some instances bury burning chunks in mineral soil. Small machines, equipped with brush blades, are desirable as they minimize the moving of soil.

The use of bulldozers in mop-up should be closely controlled. Excessive use will lead to high suppression costs and irreparable environmental damage. One small bulldozer can work effectively with several mop-up crews.

Use of Rubber Tired Skidders





Rubber-tired skidders have proved a real boon in fire suppression activities because of their extreme versatility, economy of operation and effectiveness. The skidder's articulated frame, four-wheel drive and ground clearance provides a highly maneuverable machine which can operate efficiently and rapidly in very rough terrain.

The Forest Service developed a 300-gallon (1365-litre) tank complete with a low-volume pump and hose, and fitted with a universal hitch to permit its use with any make/model skidder. This has resulted in a very useful and effective mop-up vehicle, as it provides a large volume of water and high pressure. Other adaptations of various sizes of tanks and pumps have also been used and have proven effective.

Some other uses:

1. Fireline construction in light fuels, tidying up of firelines pioneered by bulldozers, yarding windfalls, logs, and chunks along the edge of the fireline to reduce fuel loading prior to burn-off.
2. Rapid transportation of equipment to all sectors of the fire, and delivery of supplies in trailers to and from camp.
3. Patrolling of firelines.

FIRE AREA REHABILITATION

Both bulldozers and skidders can serve a useful role in rehabilitation of the area after the fire has been controlled. In the mop-up state this is accomplished by flattening soil and debris piles to facilitate subsequent reforestation, by cutting channels and installing water bars to reduce water run-off and soil erosion in firelines and on steep slopes where cover has been burned off. They clean up accumulations left behind along access routes, that had been constructed in haste, to gain access to the fire.

SAFETY CONSIDERATIONS

RESPONSIBILITY

Safety is everybody's business. However, additional responsibility belongs to key fire overhead personnel:

1. All bosses-Fire Boss, Crew Boss, Tractor Boss;
2. The Fire Boss monitors to ensure all bosses at the various levels brief their crews and follow through;
3. Bulldozer operator, who is responsible for the operation of this machine around fire crews and for the safety of the machine.

BULLDOZER SAFETY

- All bulldozers must be equipped with ROPS and FOPS (rollover and falling object structures).
- All bulldozers should be equipped with a winch, especially if working alone. (On larger fires, avoid working bulldozers alone in case of breakdown or becoming trapped in swampy ground, on excessively steep slopes, or due to sudden wind shifts).
- Bulldozers should not operate on slopes so steep they cannot back up (unless a second machine is there to winch the first up the slope again).
- A Bulldozer operated in darkness must be equipped with headlights or floodlighting equipment.
- Extra caution should be exercised when the bulldozer is used to push down snags. The snag top can snap and fall back over the machine.
- Any time a bulldozer is parked, the blade must be lowered to the ground. When an operator must leave his tractor with the engine running, it is also essential that he set the brake.
- Bulldozers should be parked in a safe open area, and preferably on bare ground over night.
- When the bulldozer is shut down or parked overnight, the operator must make a circuit around the machine before starting it up and moving out. Fatalities have occurred due to Firefighters having gone to sleep in the shade or protection of the machine.

CREW SAFETY

Most men who regularly work around machinery or in the woods are safety-conscious, but in firefighting operations many crewmen may not be familiar with safety



requirements nor experienced with the emergency environment related to fireline work and the associated confusion during its initial sates.

- Swampers and other crewmen must keep clear of a bulldozer in operation.
- Bright-colored hard hats and safety clothing should be worn by crewmen working around bulldozers.
- Gloves must be worn when handling winch cables or chokers.

The swamper must NEVER straddle the winch line or stand in the bight of a line.

No one is to mount or dismount from a moving bulldozer.

- Crewmen must keep off an operating machine.
- Persons wishing to approach an operating machine must first attract the operator-s attention.
- The bulldozer operator work shift should be limited to 12 hours, except in an extreme emergency.



APPENDIX 1

Exerts from “INFORMATION FOR COMMERCIAL TRUCKERS”, a pamphlet produced by the Ministry of Transport and Highways, Motor Vehicle Department.

SECTION 1: MAXIMUM LEGAL DIMENSIONS AND WEIGHT

Size:

- (a) a vehicle having a total outside width, with or without load, in excess of 2.6 m, except the loads of loose hay, loose straw, or loose fodder may project over the sides of the vehicle such a distance as results in a total outside width not in excess of 3.1 m.
- (b) a vehicle having a height, with or without load, in excess of 4.15 m;
- (c) a single vehicle having an over-all length, with or without load, in excess of 12.5 m, except as provided in clauses (d) and (e);
- (d) a trailer, the over-all length of which exceeds 12.5 m, except the over-all length may be extended to include refrigeration and/or heating unit, or air deflector;
- (e) a semi-trailer, the over-all length of which exceeds 14.65 m, except the over-all length may be extended to include the refrigeration and/or heating unit, or air deflector*;
- (f) a combination of vehicles having an over-all length, with or without load, in excess of 20 m, except as provided in clauses (g) and (h);
- (g) a combination of two vehicles that has a single articulation point, with an over-all length, including its load, of no more than 21.5 m and is carrying a non-reducible load of logs, wood poles or wood piling;
- (h) a combination of vehicles that contains more than one articulation point, and has an over-all length, including its load, of no more than 23 m.

NOTE: There are restrictions on such items as drawbar lengths, front kingpin to rear distance, projection, overhangs, lift axles, etc.



On specific concerns reference must be made to the regulations.

*Notwithstanding 1 (e), a person shall not operate a semi-trailer that is in excess of 14 m on a highway where the semi-trailer has more than 2 axles in contact with the ground.

Weight:

- (a) Single Axle.....9100 kg
- (b) Tandem axles:
 - (i) less than 1.5 m.....16500 kg
 - (ii) 1.5 m to 1.8 m.....17000 kg
- (c) Allowable maximum licensed gross vehicle weight is governed by tire size and the number and spacing of axles as shown in Table 1 on page 13 (page 35 of this Appendix).

NOTE: During spring break-up, load limitations are imposed by the Ministry of Transportation and Highways. These limitations are usually fixed at legal axle loads on the main numbered highways (no overload permits will be issued) and 70 percent or 50 percent of legal axle loading on the secondary highways and side roads throughout the Province.

SECTION 2: PERMITS (ALL TYPES)

Overload permit: Must be obtained for any vehicle or combination of vehicles, with or without load in excess of the weight allowed by Table 1 of the regulations made pursuant to the COMMERCIAL TRANSPORT ACT or in excess of the gross mass for which the vehicle is licensed. Overload permits are only issued when loads are not reducible or when a vehicle is not licensed up to its allowable weight.

NOTE: The maximum allowable weight on tandem axles granted by an overload permit is limited to 23000 kg (on specific routes only).
See part 8 on page 13 of the pamphlet "Information for Commercial Truckers: re fixed tri-axles.

Oversize permit Must be obtained for vehicles and/or loads in excess of the legal dimensions (see page 4 of the pamphlet), and are only issued for loads not readily reducible in size. Permits are not normally granted for loads or vehicles in excess of 4.4 m wide. Should it be necessary for an operator to move a load wider than 4.4 m he must write to the Manager, Commercial Transport Division, giving details of the commodity to be moved and reasons why it cannot be reduced in size.

Temporary operation permit: This type of permit is issued for the movement of unlicensed vehicles from one point in the Province to another point and is valid for one trip only. Insurance coverage is also required.

Nonresident single-trip permits: Operators of nonresident commercial vehicles may operate in British Columbia by obtaining a single-trip non resident permit which is valid for one trip into and out of the Province for a period not exceeding 30 days. Nonresident permits may be obtained from any weigh-scale station or motor license office. The fee for such a permit is one-twelfth of the annual fee for a vehicle of like gross weight. Only two such permits are allowed per vehicle per year.

Should a company or individual require motor carrier authority to operate in British Columbia, the exemption granted by section 1.1 (j) of the regulations to the motor carrier act ceases to exist after the company or individual has received six single-trip nonresident permits during the year and the party would not be entitled to any further exemptions.

Quarterly nonresident commercial permit: A commercial vehicle registered and licensed outside the Province may be granted a permit, valid for a period of three months, upon payment of a fee equal to one-quarter of the annual fee for a vehicle of a like weight. Quarterly permit holders are limited to transporting passengers or pick up and deliver within the province excepting a commercial vehicle carrying specialized equipment, provided such equipment will be exported out of the province on the same vehicle.

A quarterly period shall commence on the first day of January, April, July, and October and shall terminate on the last day of March, June, September, and December respectively.,

Holders of quarterly permits are subject to the provisions contained in the following statutes:

SOCIAL SERVICE TAX ACT	see Part 9 of the pamphlet.
MOTOR CARRIER ACT	see Part 3 of the pamphlet.
MOTIVE FUEL USE TAX ACT	see part 4 of the pamphlet (if using diesel-powered equipment).

Highway crossing permit: A person or company wishing to cross a public highway from an industrial road, ie., a logging road, with an unlicensed vehicle on a regular basis, must first apply to the local office of the Ministry of Transportation and Highways for a crossing permit. If the application is approved, a permit will be issued. Insurance coverage is also required and may be obtained with the permit.



SECTION 5: PILOT CARS

Each pilot car must be equipped with at least one roof-mounted flashing amber lamp with a light source capable of emitting a beam of light clearly visible for a distance of 100 m in normal daylight. This lamp must always be operated when the pilot car is escorting an oversize vehicle or load. When a vehicle or load is in excess of 3.5 m the accompanying pilot car must display a roof-mounted “wide Load” sign of the following design:

COMMERCIAL TRANSPORT ACT Regulations, Div. 8

- (a) Box shall be 180 cm by 35 cm by 10 cm of mild steel. Inside surface shall be baked enamel (white) to give a good reflective quality. Eight lamps shall be mounted in the box, spaced to give even lighting of the sign background. This box shall house all wire connectors, switches, flashers, etc.
- (b) Sign shall be double-faced of 3 mm yellow plexiglass background with 28 cm by 4 cm black letters.
- (c) Lamps shall have a rating of 12.5 volts, minimum 5 candela design amps.³.
- (d) Mounted on top of this sign box shall be two amber lamps (one at each end) of two-way light design, of at least 15 cm in diameter which meets C.S.A. Standard D-106.1 1972, flashing at 60-90 flashes per minute.

This sign unit, as shown below, must be designed to mount on car-top carriers or equal mountings, and be capable of folding horizontally when not in use.

When escorting an oversize vehicle or load on a two or tree-lane highway, the pilot car shall precede the oversize vehicle or load at a distance of not less than 100 m and not more than 500 m. When travelling on a four-lane or divided highway, the pilot car shall follow not less than 100 m and not over 500 m.

Oversize loads of 3.2 m in width or less are permitted to travel during the hours of darkness provided they are properly lighted.

Loads in excess of 3.2 m in width are restricted to daylight travel only and also as outlined in Part 10 of this booklet.

Motor Carrier (I.C.C.) authority is not required for the operation of pilot cars in the Province of British Columbia.

A permit is not required to install amber flashing lamps on pilot cars, providing these lamps are only used while escorting oversize vehicles or loads.

NOTE: At the time of printing, regulations respecting the use of the “D” sign were under consideration. For further information contact any Provincial weigh scale or the Commercial Transport Division in Victoria.

SECTION 8: AXLE WEIGHT-SPACING OF

The number and spacings of axles to carry maximum legal mass are shown below.

TABLE 1-MAXIMUM WEIGHT

Column 1 Distance between the centres of the first axle of any group of axles of a vehicle or combination of vehicles	Column 2 Maximum gross weight of axle group
Less than 1.5m	16500 kg
1.50 m up to but not including 1.90 m	17000 kg
1.90 m up to but not including 2.30 m	18000 kg
2.30 m up to but not including 2.60 m	19000 kg
2.60 m up to but not including 3.00 m	20000 kg
3.00 m up to but not including 3.40m	21000 kg
3.40 m up to but not including 3.80 m	22000 kg
3.80 m up to but not including 4.20 m	23000 kg
4.20 m up to but not including 4.60 m	24000 kg
4.60 m up to but not including 5.00 m	25000 kg
5.00 m up to but not including 5.30 m	26000 kg
5.30 m up to but not including 5.70 m	27000 kg
5.70 m up to but not including 6.10 m	28000 kg
6.10 m up to but not including 6.50 m	29000 kg
6.50 m up to but not including 6.90 m	30000 kg
6.90 m up to but not including 7.20 m	31000 kg
7.20 m up to but not including 7.60 m	32000 kg
7.60 m up to but not including 8.00 m	33000 kg
8.00 m	34000 kg

Multi-axle trailers, such as those used in the transportation of mobile homes, much have brakes on at least two axles.

Maximum allowable spacing for tandem axles in British Columbia is 185 cm unless the first and/or last is a steering axle or one that articulates in the manner of a steering axle.



SCHEDULE 111

OVERLOAD PERMIT FEES

Overload in Kilograms	Fee for each 10 km of operation or fraction therefore (minimum \$10.00)
250-1900	\$0.75
1901-2800	.90
2801-3700	1.10
3701-4600	1.25
4601-5500	1.45
5501-6400	1.60
6401-7300	1.75
7301-8200	1.95
8201-9100	2.35
9101-10000	2.65
10001-10900	3.00
10901-11800	3.40
11801-12700	3.95
12701-13600	4.45
13601-14500	5.00
14501-15400	5.55
15401-16300	6.05
16301-17200	6.60
17201-18100	7.30
18101-19000	8.05
19001-20000	8.70
20001-20900	9.45
20901-21800	10.15
21801-22700	11.05
22701-23600	11.95
23601-24500	12.85
24501-25400	13.75
25401-26300	14.80
26301-27200	15.85
27201-28100	17.10



The fee payable for overload permits issued to vehicles exceeding 28100 kg is \$17.10 plus \$1.45 for each 900 kg or portion thereof exceeding 28100 kg, for each 10 km of operation or fraction thereof.

The amount due for each overload permit issued shall be rounded to the nearest dollar and any amount ending in fifty cents shall be raised to the next highest dollar.

OVERSIZE PERMIT FEES

- (A) For each single-trip permit..... \$10.25
- (B) For each term permit not exceeding one month.....\$25.00



APPENDIX 2

Exerpts from Section 26 of “INDUSTRIAL HEALTH AND SAFETY REGULATIONS”, produced by the Workers’ Compensation Board of British Columbia.

MOBILE EQUIPMENT

26.00 Scope

- (1) For the purposes of these regulations “mobile equipment” means wheeled or tracked vehicles together with attached or towed equipment, but excluding vehicles operating upon fixed rails or tracks, or under the jurisdiction of the MINES REGULATION ACT or the COAT MINES REGULATION ACT of British Columbia.

GENERAL REQUIREMENTS

26.02 Operation and maintenance

- (1) All mobile equipment shall be maintained in safe operating condition. Operation, inspection, repair, maintenance, and modification shall be carried out in accordance with manufacturer’s instructions, or in the absence of such instructions, in accordance with good practice.

Servicing

- (2) Servicing, maintenance, and repair of mobile equipment shall be done only when the equipment is not in operation, except that equipment in operation may be serviced if the continued operation is essential to the process and a safe means is provided.

Compliance with Standards

- (3) The design, fabrication, use, inspection, and maintenance of the following types of equipment shall be in compliance with the following applicable standards or other standards acceptable to the board:

EQUIPMENT	APPLICABLE STANDARD
Powered Industrial Trucks	CSA B3335.1, ANSI B56.1
Vehicle-mounted Aerial Devices (except firefighting equipment)	CSA C225
Aerial Devices (firefighting equipment)	NFPA 1904

*Mobile equipment operated under the jurisdiction of the MOTOR VEHICLE ACT or the INDUSTRIAL TRANSPORTATION ACT of British Columbia is subject to these regulations in respect of matters not specifically governed by those Acts and Regulations pursuant thereto.

26.04 Warning Signal Device

- (1) All mobile equipment shall be equipped with:
 - (a) an audible warning signal device, and
 - (b) exterior lighting-means of illuminating the path of travel, both forward and reverse, when operated during the period from ½ hour from sunset to ½ hour before sunrise, or at any time when, because of insufficient light or unfavorable atmospheric conditions, persons or vehicles are not clearly discernible at a distance of 500 feet (152 m). Headlight and backing light installations shall be in conformity with SAE Standard J1029 “Lighting and Marking of Construction and Industrial Machinery” or other standards acceptable to the board.

26.16 Operator Protective Structures (OPS)

- (1)
 - (a) Operators of mobile equipment shall be protected where necessary*, against falling, flying, or intruding objects or material, by means of suitable cabs, screens, grills, shields, deflectors, guards, or structures.
 - (b) On equipment manufactured after 1 January, 1979 the means of protection shall conform to the requirements of the applicable standard* listed hereafter, or to such other standards as are acceptable to the board.
 - (i) WCB G601 “Standard for Log Loader and Log Yarder Backstops”
 - (c) Existing Equipment-Mobile equipment manufactured on or before 1 January, 1979 may remain in service except when, in the opinion of the board, modification is required to ensure the safety of workers.

Rollover Protective Structures (ROPS)

- (2)
 - (a)
 - (1) The following types of mobile equipment manufactured after



1 July, 1972 shall be provided, when put into service, with rollover protective structures (ROPS)

Crawler tractors, loaders, and skidders
Wheel tractors, dozers, loaders, and skidders
Motor graders
Self-propelled wheel scrapers

*For further amplification refer to Scope Sections of WCB-G600 series Standards as listed in clauses (1)(b)(i)-(viii).

- (II) The following types of mobile equipment, manufactured after January, 1979, shall be provided, when put into service, with rollover protective structures (ROPS):

Self-propelled rock drills
Compactors/rollers

- (III) Except as provided for by clause (3), the ROPS requirements of this regulation shall apply to all types of mobile equipment listed in subclause (2)(a)(I) irrespective of any additions or modifications to the basic machine.

- (1V) Notwithstanding the foregoing, the Board may require the installation of ROPS on any mobile equipment where the design of the equipment or circumstances of use indicate the need for such a structure.

- (IV) ROPS shall be designed and fabricated to meet the requirements of any of the following criteria as applicable:

- (i) Recommended Practice of the Society of Automotive Engineers, SAE J1040b "Performance Criteria for Rollover Protective Structures (ROPS) for Construction, Earthmoving, Forestry and Mining Machines", or
- (ii) "Earth-moving Machinery-Rollover Protective Structures-Laboratory Tests and Performance Requirements ISO 3471-1975", or
- (iii) Other standards acceptable to the board.

- (b) Damaged ROPS-Damaged or deteriorated ROPS shall be replaced by an acceptable ROPS, except as permitted by subclause (2) (f).

ROPS Identification

- (4) The following information shall be permanently marked upon the ROPS:
- (a) Name and address of the manufacturer or the registered professional engineer who certified the ROPS, and
 - (b) Model number or other effective means of identifying the machine for which the ROPS was designed, and
 - (c) Serial number or other effective means of identifying the ROPS, and
 - (d) Standards to which the ROPS conforms.

Additions and modifications

- (5) (a) No addition, modification, welding, or cutting of ROPS shall be permitted except in accordance with the instructions of a registered professional engineer.

Effects of ROPS on Visibility

- (6) ROPS and other structures required by clause (12) for the protection of the operator shall be so designed and fabricated as to provide an adequate field of vision for the operator.

OPERATION OF EQUIPMENT

26.26 Operator's Responsibility

- (1) The operator of any mobile equipment shall be directly responsible for the safe operation of that equipment. He shall maintain full control of the equipment, and shall comply with all laws and regulations governing the operation of the equipment.
- (2) When the operator has reasonable cause to believe that the equipment or the load is hazardous he shall take action as required by regulations 8.24.



SUPERVISOR'S RESPONSIBILITY

- (3) No supervisor shall issue any order to proceed until he has determined that the hazard did not exist or has been remedied.

26.30 Reporting Equipment Defects

The operator shall examine his equipment before initial daily operation and thereafter as required. He shall report those defects and conditions affecting the safe operation of the equipment to his supervisor or other authorized person. The person receiving the report shall act as required by regulation 8.10.

26.32 Fuelling Restrictions

The fuel tanks of mobile equipment shall not be filled with gasoline or vaporizing liquids:

- (a) while the engine is running, or
- (b) while anyone is smoking in or about the vehicle, or
- (c) while there is any known source of ignition in the immediate vicinity.

26.38 Unattended Equipment

- (1) The operators of mobile equipment shall not leave the controls of such equipment unattended, unless the equipment has been secured against inadvertent movement by setting parking brakes and transmission locks, lowering any blades, buckets, or forks to ground and by chocking wheels where necessary.

Securing of elevated parts

- (2) When a worker is required to work beneath elevated parts of mobile equipment, the elevated parts shall be securely blocked.