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LOGGING AND SAWMILL OPERATIONS

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PREFACE

This manual serves as a guide and basic reference for engineer personnel planning and conducting logging and sawmill operations. Commanders of engineer forestry detachments and teams, including supporting staff, should use this manual as a guide. Additionally, this manual provides forestry operations, techniques, and procedures to assist engineer advisors and trainers during exercise deployments to third-world countries. This manual discusses forestry and logging crews and their equipment. It describes methods of estimating timber volume in concert with appropriate silvicultural practices. With this manual, the reader should be able to plan, layout, and construct logging and skid roads. This manual also includes timber-felling techniques, skidding, bucking, scaling, loading, and sawmill and lumberyard operations.

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The proponent for this publication is HQ TRADOC. Submit changes for improving this publication on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forward it to Commandant, US Army Engineer School, ATTN: ATSE-TDM-P, Fort Leonard Wood, MO 65473-6650.

Unless otherwise stated, masculine nouns and pronouns do not refer exclusively to men.

Chapter 1
Forestry and Logging Basics

Forestry and logging basics include silvicultural treatments to perpetrate and improve production while protecting forest values. Personnel equipment, and the logging operation play an important role in the proper management of the forest, the final product, and site rehabilitation.

1-1. Engineer Forestry Team.

a. *Capability*. The forestry team is organized under table of organization and equipment 05520LA00 (TOE 5-520LA). The TOE prescribes the personnel and equipment necessary for logging and sawmill operations. The engineer forestry team is divided into three sections: team headquarters, logging, and sawmill. If fully operational and stocked, the forestry team should be large enough to accommodate a lumber production of 1,000 board feet per hour.

b. *Basis of Allocation*. The forestry team is allocated as required. It is normally attached to a supply and service battalion of the general support group or to an engineer construction group. The forestry team may be used to support independent, large-scale operations.

1-2. Logging Operation. Logging is the process of converting standing timber into sawlogs or forest products and delivering them to the sawmill for manufacturing lumber, heavy timber, and other lumber products. Logging is divided into three major phases: cruising, felling, and transportation of sawlogs to the sawmill. Because various sections of the forestry team perform these operations, teamwork is necessary between all crews and sections. Logs must be prepared and delivered to the mill in large enough quantities to maintain sawmill operations.

Logging requires handling and moving heavy loads with heavy equipment. The logging crew will be responsible for the operational and organizational maintenance of most of the required mobile and heavy equipment. Safety is a priority. Logging crews engage in a hazardous operation, so strict safety rules must be established and complied with to prevent injuries to personnel and to avoid damage to equipment.

1-3. Logging Personnel.

a. *Foreman*. The logging foreman (construction section leader) is in charge of the crews. The foreman receives instructions from the commander (team leader) through the logging supervisor (senior construction supervisor). After the area to be logged is selected, the foreman is responsible for planning, laying out, and constructing haul and skid roads, including loading platforms. He is the expediter and ensures that enough logs of the correct size and type are delivered to the mill yard.

b. *Loggers*. The logging foreman supervises the loggers (carpentry and masonry specialists). Loggers, also called lumberjacks, are assigned to felling trees, limbing, and bucking. They may also be assigned to help load logs for transport. When a new logging operation starts, loggers may help construct roads and loading docks.

c. *Hauling Crew.* The hauling crew (construction equipment operator) is responsible for skidding logs from cutting sites to loading areas. The hauling crew may be assigned to use their equipment for road construction and other duties.

1-4. Logging Equipment. The equipment issued to the logging and hauling crews is adaptable for almost every type of logging operation and terrain requirement. Nonmotorized equipment is still used in logging operations; however, power and mechanized equipment is preferred.

a. *Transportation Equipment.* The following lists the logging equipment from TOE 5-520LA:

- Truck tractor, 10-ton, 6-by-6, 5th wheel.
- Truck bolster, 5-ton, 6-by-6 with winch.
- Trailer bolster, 9-ton, 4 duals, swivel bolster.
- Tractor, D8 diesel, full-tracked with angle blade, scarifier, and winch.
- Semitrailer, low-bed, 40 ton, 6 wheel.
- Truck forklift, 5-ton, rough terrain with grapple.
- Boom extension middle crane, 10-foot, 10-ton crawler.
- Crane, wheel-mounted, 20-ton with 30-foot boom.

b. *Skidding Equipment.* You can accomplish skidding operations using a variety of equipment. You can use the rubber-tired (4-by-4) and crawler equipment in the initial transport operation. The rough-terrain forklift (with grapple) is lighter than the full-tracked crawler tractor and can be used as a skidder. However, the crawler has better traction in mud and on slippery soils and has a larger tractive surface. You can also use the crawler in road construction and on other earthmoving jobs where using the rubber- tired skidder is limited.

c. *Chain Saw.* The gasoline-powered chainsaw is the most widely used and indispensable piece of equipment in logging operations. You will use the chain saw for most woodcutting operations, including timber felling, limbing, and bucking.

d. *Chain-Saw Sharpener.* Chain-saw teeth are generally chipper and chisel. Make sure the chain is sharp for best operation. The TOE equipment list includes a sawtooth grinding machine. You can hand sharpen the chain by using a guide bar and file.

e. *Supporting Equipment.* The TOE lists the following supporting equipment used in logging operations:

- A 250 cubic feet per minute (cfm), trailer-mounted air compressor for operating pneumatic tools.
- One 2-1/2 ton, 6-by-6 truck with a trailer-mounted welding shop used in maintenance operations.
- Weapons, tents and related material, protective masks, and radios.

1-5. Safety. Logging operations are hazardous. Personnel safety must be a priority for everyone involved. Safety must be considered from the early planning and layout stages to the later stage of off-loading logs at the sawmill. Safety equipment should be issued and worn by everyone. Helmets or commercially purchased hard hats and safety boots are highly recommended. Other safety issues and areas to consider are landings, skid roads, haul roads, direction of tree fall, grade, road width, visibility, turnouts, sharp curves, and bridge construction.

Chapter 2
Timber Cruising

Timber cruising is a procedure for determining the gross and net volume and value (timber quality) for a tract of timber. Cruising involves measuring tree diameter and height estimating defects, and making other determinations such as grade and form class. This chapter deals with the technical aspects of making essential tree measurements and the tools used The timber cruiser must be able to properly identify tree species. Stumpage rates and volume references are often species-related. Experience is required to identify tree species and correctly cruise timber.

2-1. Principles of Measuring Trees. Timber cruisers must know and adhere to the specifications the team leader gives them and those required for the final lumber products. In addition to minimum specifications, data must be recorded on the basis of end-product potential. End products are subdivided into the following categories:

- Material suitable for conversion into lumber.
- Material suitable for conversion into fuel.
- Material suitable for conversion into other products such as poles, pilings, rails, and ties.

Timber cruisers must record individual tree measurements in appropriate product categories. To do so, each timber cruiser must know the minimum piece specifications for each end-product required. Minimum piece specifications are based on the following:

- Length.
- Diameter inside the bark at the small end.
- Net volume, in percent, of gross volume.
- Other end-product specifications, as given.

Timber cruisers must also know what the minimum tree specifications are for each product category. Minimum tree specifications are based on the following:

- Number of minimum pieces a tree must contain to be considered useable.
- Minimum diameter at breast height (DBH).
- Piece net volume.

2-2. Tree Measuring Instruments.

a. *Diameter Tape.* This is the most common device used to measure tree diameters. Tapes are either 20 or 50 feet long, are made of steel, usually have a bark hook on the zero end, and arc graduated on the outside surface in inches and tenths of inches of diameter equivalents (3.1416 inches) of circumference. Many tapes also have linear graduations in feet or meters on the inside surface. Many logger's tapes are graduated on the backside in diameter equivalents of circumference.

Diameter tapes come in right- and left-hand models. This refers to the hand in which the tape case must be held so that with the tape around a tree the numbers are reading right side up. If used correctly, the diameter tape numbers arc right side up, and the tape is crossed on the face of the tree so that the index or zero mark lies along the graduated edge of the tape. Tapes may be graduated on the upper or lower edge (Figure 2-l).

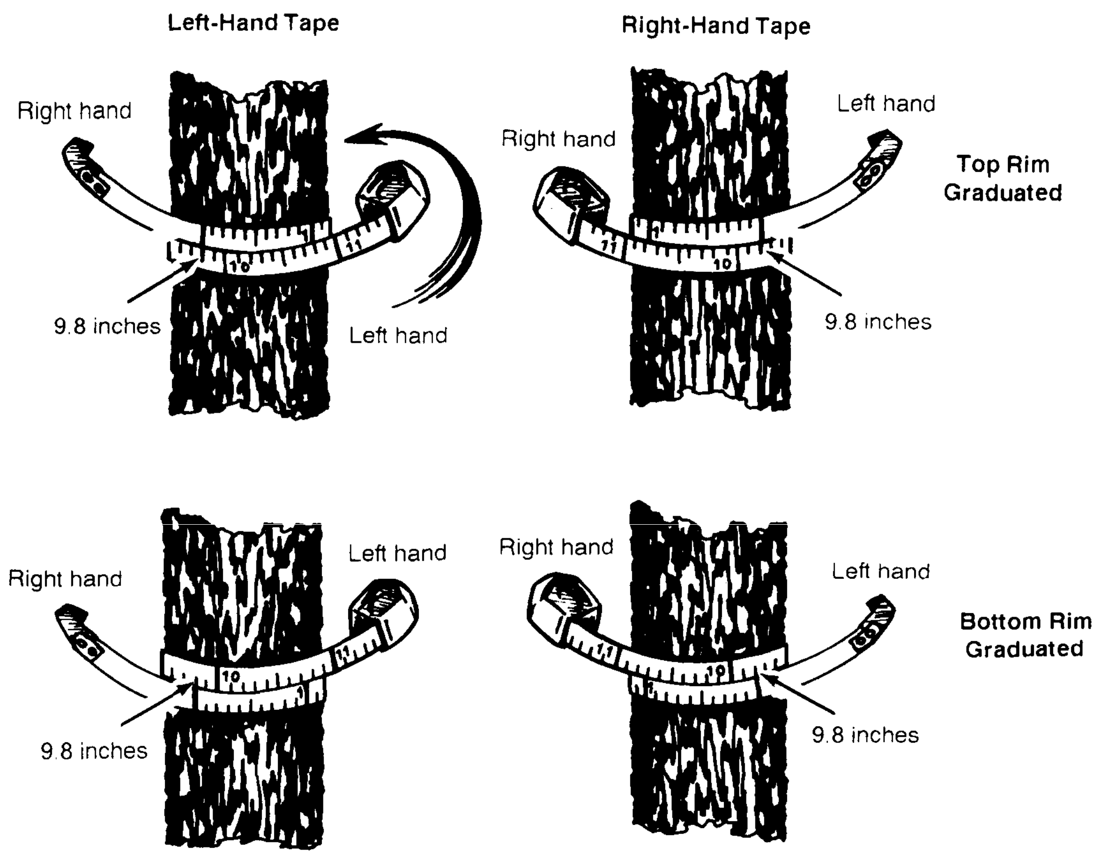


Figure 2-1. Using right- and left-hand diameter tapes

b. *Tree Calipers.* You can also use calipers to measure tree diameters. They are available in either wood or metal and are graduated in English or metric graduations. English graduations are in tenths of inches and metric graduations are in centimeters. Caliper sizes range from 18 to 60 inches. The arm is attached at right angles to the beam. When using tree calipers, take two measurements at right angles and average the readings (Figure 2-2).

2-3. Measuring the Tree. Measuring individual tree variables in a consistent and prescribed manner is essential. Use some or all of the following measurcments:

- DBH.
- Reference height, measured to a specific diameter inside bark (DIB) or diameter outside bark (DOB).

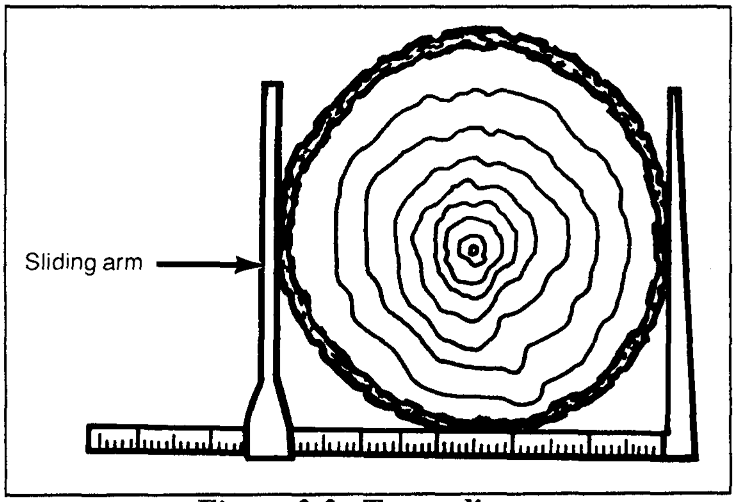


Figure 2-2. Tree calipers

- Total height.
- Stump height.

a. *Diameter.* Take diameter tape readings to the next lower one-tenth inch (Figure 2-3). This is to compensate for the positive bias incurred by measuring out-of-round trees with a tape. Some diameter measurements are made and recorded to the nearest 1- or 2-inch diameter class. This may occur when the precision of the measuring instruments can only be to the closest one or two inches, when specific volume references are based on 1- or 2-inch DBH classes, or when field tally documents do not provide for the recording measurements of less than the even inch. Standard 1- and 2-inch diameter classes areas follows:

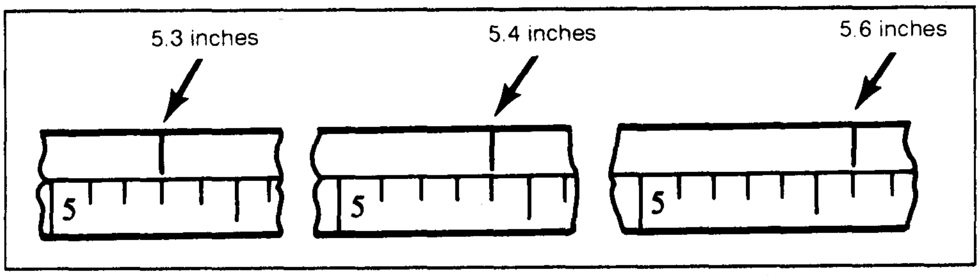


Figure 2-3. Diameter tape measurement readings

- One-inch diameter class: 5-inch class is from 4.6 to 5.5 inches, 9-inch class is from 8.6 to 9.5 inches, and so forth.
- Two-inch diameter class: 12-inch class is from 11.0 to 12.9 inches, 14-inch class is from 13.0 to 14.9 inches, and so forth.

You will not round off diameter measurements when absolute measurements are specified. For example—

- Minimum tree DBH specification = 7.0 inches. This means 6.95 would not be rounded to 7.0 inches.
- Minimum piece specification = 7.6 inches DIB. This means 7.55 would not be rounded up to 7.6 inches.

b. *Diameter at DBH.* Measure DBH from the high ground side of the tree at 4.5 feet above the forest floor (Figure 2-4, page 2-4). If the diameter cannot be measured at 4.5 feet because abnormalities exist, measure the diameter as follows:

- Leaning tree. Measure DBH with the diameter tape at a right angle to the centerline of the tree (Figure 2-5).

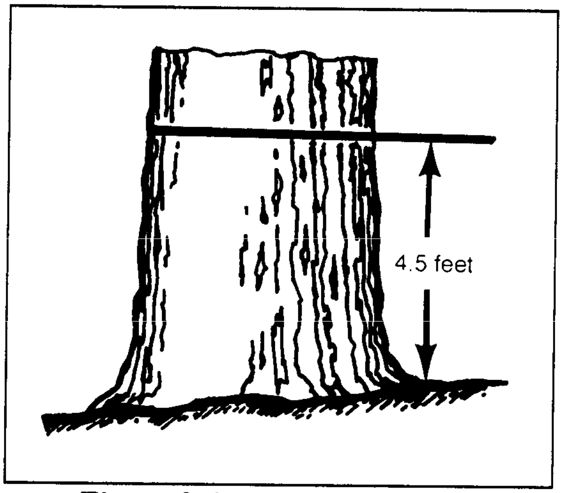


Figure 2-4. Measuring DBH, normal tree

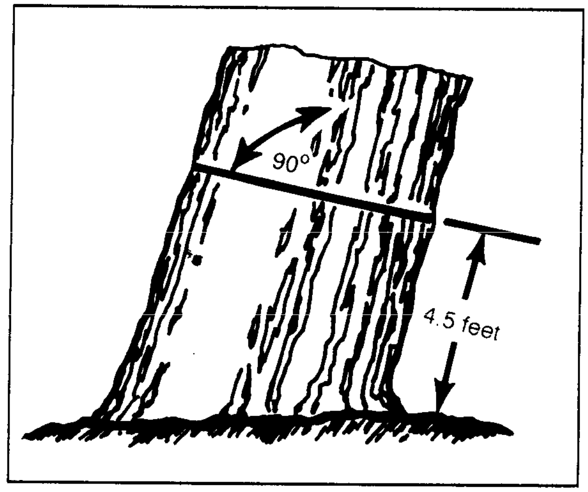


Figure 2-5. Measuring DBH, leaning tree

- Forked tree. This is a tree with two or more stems originating from one stump (Figure 2-6). Consider forking to start at the point where you can see daylight (beginning from the ground up). When a tree fork is below 4.5 feet, measure DBH on each stem at the 4.5-foot measurcmcnt. When a tree fork is above or at 4.5 feet, measure the smallest diameter at 4.5 feet or below (Figure 2-7).

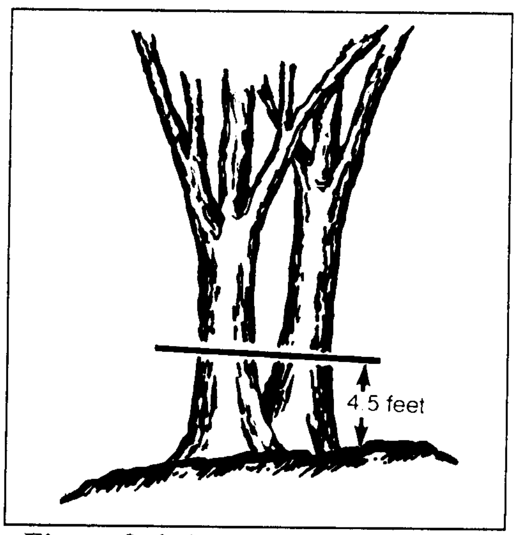


Figure 2-6. Measuring DBH, fork below 4.5 feet

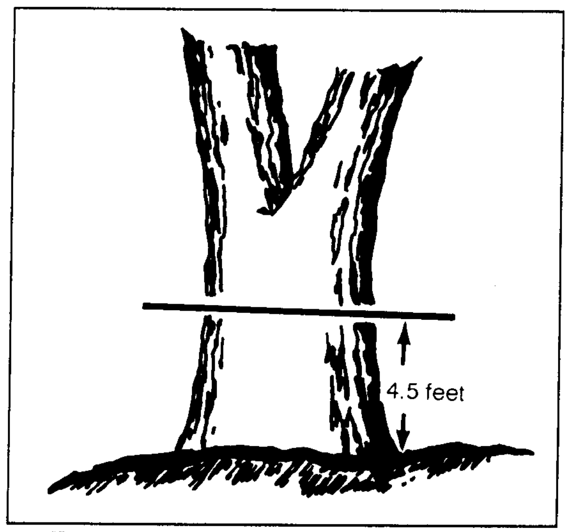


Figure 2-7. Measuring DBH, fork above 4.5 feet

2-4. Measuring Tree Heights. Height measurements are necessary for access to volume references. Errors in tree-height measurements will have a direct effect on final volumes. Since height measurements are based on similar triangles, any error in base distance measurements will be reflected in tree height measurements. You can use any height-measuring instrument when using the procedures described below. Usually, you will get a more accurate measurement if you measure the tree height from a point that is upslope from the tree or on the contour of the tree. Avoid measuring height downslope from the tree. Take tree height measurements to the tip of the tree on the high ground side of the tree.

a. *Total Tree Height.* This is the distance from the base of the tree on the high ground side of the tree to the tip of the tree. Measure total tree height to the nearest foot.

b. *Reference Height.* Reference height is the height above a standard stump height to a specific reference point (minimum DIB or DOB). Reference height is also the height above a standard stump height to a point where a tree will not yield any usable end products. The tree may not be merchantable because of the number and size of branches, defects, tree abnormalities, upper stem size, or log grade.

c. *Baseline Distance.* This distance is the horizontal distance from the center of the tree to the measuring instrument. The baseline distance must be adjusted when measured off a slope. Use the following procedure to measure baseline distance from a slope:

- Attach a tape at any convenient height on the tree (Figure 2-8). Back off to the baseline distance. Determine the percent slope of the tape using a clinometer.
- Multiply the baseline distance by the slope correction factor (Table 2-1, page 2-6).
- Measure the tree height from the corrected baseline distance.

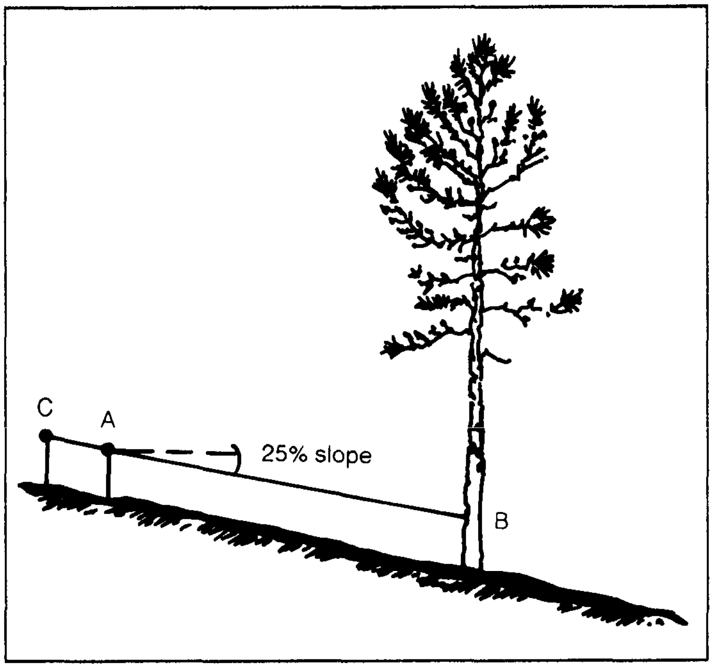


Figure 2-8. Correcting baseline distance

For example, if the initial measured baseline distance equals 66 feet and the percent slope of tape to tree equals 25 (1.03 correction factor), the indicated slope distance for 66 feet equals 68 feet (66x 1.03).

d. *Height of Vertical Trees.* Figure 2-9 (page 2-6) shows how to measure the height of a vertical tree on level ground and from the uphill side. The elevation angle from IB is a (+) and the depression angle is a (-). Add heights AB and BC to determine tree height. If both angles from the horizontal have the same sign, subtract the two readings to arrive at the correct tree height.

Table 2-1. Slope correction factor

Percent of Slope	Correction Factor	Percent of Slope	Correction Factor
0 to 9	1.00	70	1.22
10 to 17	1.01	71 to 72	1.23
18 to 22	1.02	73 to 74	1.24
23 to 26	1.03	75	1.25
27 to 30	1.04	76 to 77	1.26
31 to 33	1.05	78 to 79	1.27
34 to 36	1.06	80	1.28
37 to 39	1.07	81 to 82	1.29
40 to 42	1.08	83	1.30
43 to 44	1.09	84 to 85	1.31
45 to 47	1.10	86	1.32
48 to 49	1.11	87 to 88	1.33
50 to 51	1.12	89	1.34
52 to 53	1.13	90 to 91	1.35
54 to 55	1.14	92	1.36
56 to 57	1.15	93 to 94	1.37
58 to 59	1.16	95	1.38
60 to 61	1.17	96 to 97	1.39
62 to 63	1.18	98	1.40
64 to 65	1.19	99 to 100	1.41
66 to 67	1.20	101	1.42
68 to 69	1.21		

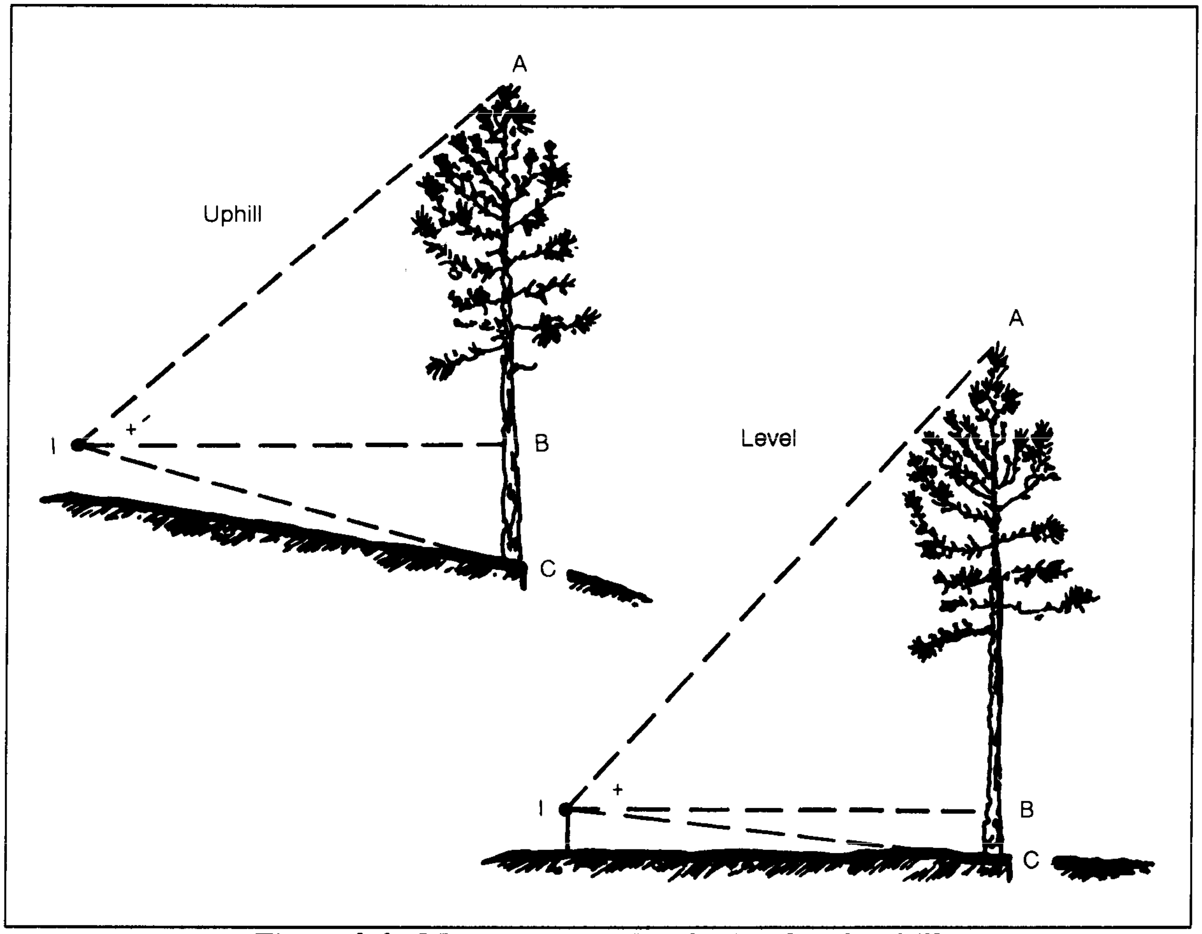


Figure 2-9. Measuring tree height, level and uphill

e. *Height of Leaning Trees.* Trees leaning 25 percent (about 15 degrees) or more from the vertical require special height-measuring techniques. Several measurements are necessary to determine tree height. Figure 2-10 shows a leaning tree on flat ground and where the direction of lean is along the contour of a slope.

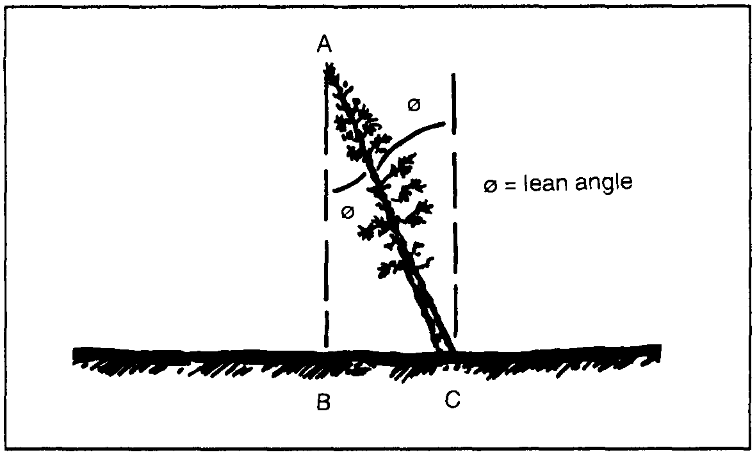


Figure 2-10. Measuring a leaning tree

Use the following procedure and Figure 2-10 to measure a leaning tree:

- Measure height AB.
- Determine tree-lean angle (percent or degrees).
- Multiply AB by the slope correction factor (Table 2-1) to get the leaning-tree height.

For example—

Lean percent = 40
Factor = 1.08
Lean angle = 22°
Secant = 1.08
AB = 65 feet
Leaning-tree height = 65x 1.08 = 70 feet.

f. *Forked Trees.* Deduct standard stump height when measuring reference height (Figures 2-11 and 2-12, page 2-8).

g. *Abney Level. The* Abney topographic hand level is issued to forestry teams for measuring height of trees.

h. *Percentage Reading.* The percentage method is the best method to use with the Abney hand level. The method is fast, simple to calculate, and accurate enough for most timber-cruising efforts. However, large vertical angles cannot be measured accurately because of the effect of retraction on observations of the level bubble. Use the following procedure and Figure 2-13 (page 2-8) to measure tree heights:

- Set the vertical arc of the Abney hand level in position of indicate slope percentage. If you have to reverse the arc, unscrew the axis screw holding the level vial and index arm. Remove the two arc-attaching screws and reverse the position of the arc. Reinstall the level vial and index arm with the axis screw. Tighten all screws.

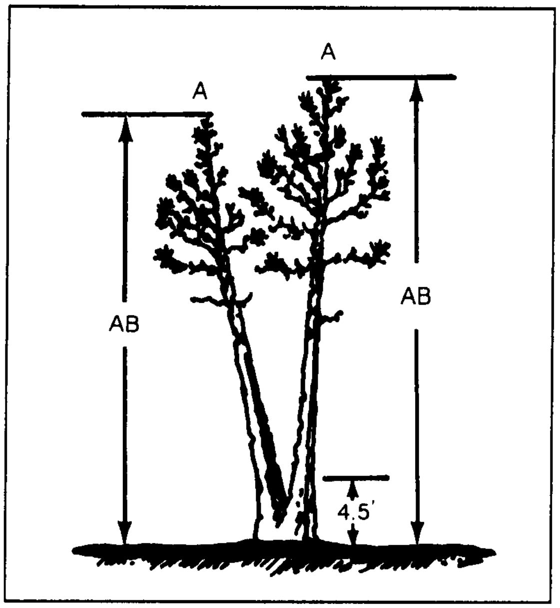


Figure 2-11. Measuring forked-tree height (below 4.5 feet)

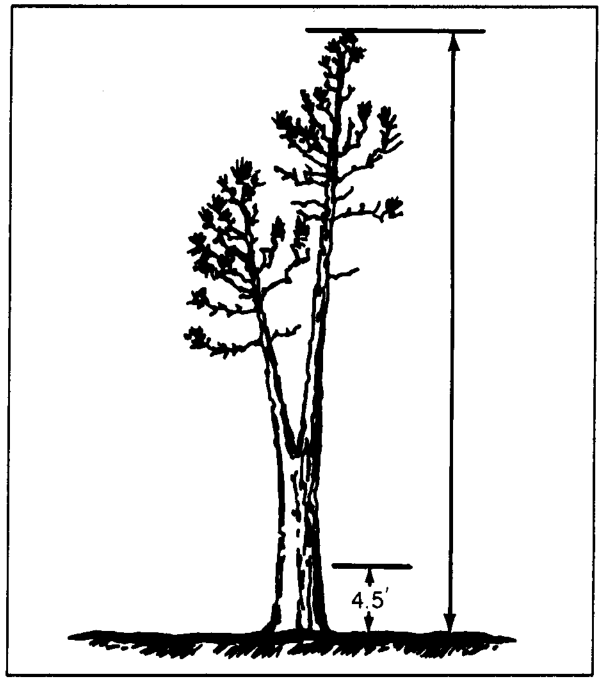


Figure 2-12. Measuring forked-tree height (above 4.5 feet)

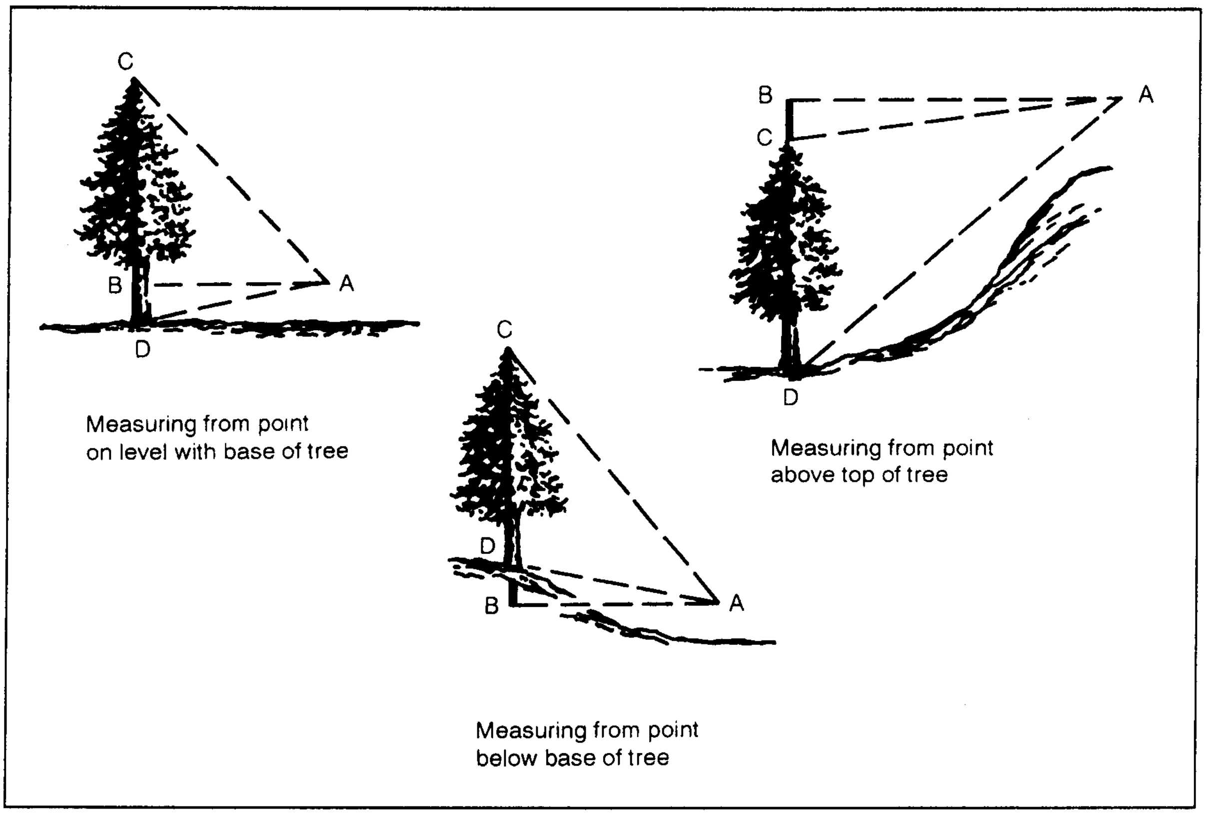


Figure 2-13. Measuring tree heights by percentage method

- Position yourself at any convenient point upslope from the tree. Measure the horizontal distance to the base of the tree. Using Figure 2-13, determine the vertical angles from the horizontal to the tip of the tree (BAC) and from the horizontal to the base of the tree (BAD).
- Determine the total angle (CAD) from the observer to the base of the tree and multiply this angle by the horizontal distance to the tree. Next, point off two decimal places because the readings are in percentages.

Example 1. CAB - BAD = CAD
Example 2. CAB - BAD = CAD
Example 3. BAD - BAC = CAD

Sample calculation—

distance AB (1) = 100 feet
angle BAC (1) = 30 percent
angle BAD (1) = 4 percent

ADD: BAC + BAD = 34 percent
MULTIPLY: AB x (BAC + BAD) = 34.00 feet

The tree's height is 34 feet. (Note in the above calculation that if the angle readings are taken exactly 100 feet from the base of the tree, the calculation is reduced to a simple addition or subtraction of the two readings. Otherwise, a long multiplication problem results.)

2-5. Determining Tree Volume. The volume table is the best measurement standard for estimating the volume of standing trees. A volume table gives the average number of board feet a tree of a given size and type is estimated to contain. Tree size is its DBH (in inches) and its usable height (length) measured in number of 16-foot logs. Volume tables are not necessarily y interchangeable for different tree species. Table 2-2 (page 2-10) lists hardwoods (broad leaf) and Table 2-3 (page 2-11) lists softwoods (conifers).

The standard unit of volume measurement for logs in the US is the board foot (12-by 12-by 1-inch thick or equivalent). The timber cruiser should be prepared to take measurements and make computations in the standard of measure for the country or area where the logging is to be accomplished.

a. *Estimating with Volume Tables.* Volume tables are made to show the volumes of trees based on the diameters and number of logs in the trees. Prepare a tally sheet using the same units. After tallying all the trees, multiply the total number of each tree size by the number of board feet in that tree. For example, twelve 3-log white oaks that are 18 inches in diameter would contain 260 board feet each, according to the volume table (see Table 2-2, page 2-10), plus a correction factor of 10 percent.

Table 2-2. Volume table for hardwoods

Diameter of Tree, Breast High (inches)	Number of 16-Foot Logs									Diameter of Top (inside bark) (inches)	Basis for this Table (trees)
	1	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5		
	Volumes* in Board Feet										
8	20	27	35	43						6	
9	20	32	42	53						6	1
10	20	36	52	64	81					6	2
11	21	43	62	78	98	120				6	4
12	23	50	73	93	120	140	180			6	3
13	25	58	86	110	140	170	200			7	4
14	27	67	100	130	160	190	230	260		7	9
15	30	77	120	150	180	220	260	300		8	15
16	34	89	130	170	200	250	290	340	390	8	18
17	38	100	150	190	230	280	320	380	440	9	40
18	43	120	170	210	260	310	360	420	490	9	56
19	48	130	200	240	290	350	400	470	540	10	65
20	54	150	220	270	330	390	450	520	590	10	75
21	62	170	250	300	370	440	500	580	650	11	86
22	69	190	270	340	410	480	550	640	720	11	90
23	77	210	300	380	450	530	610	7000	790	12	67
24	85	230	340	420	500	580	670	770	860	12	80
25	93	250	370	460	550	640	740	840	940	13	56
26	100	280	410	510	600	700	810	910	1,020	13	89
27	110	300	450	560	660	770	880	990	1,110	14	68
28	120	330	490	610	720	830	960	1,080	1,200	14	81
29	130	360	530	660	780	900	1,030	1,160	1,300	15	61
30	140	390	580	720	850	980	1,120	1,250	1,400	15	47
31		420	630	770	910	1,050	1,200	1,350	1,510	16	45
32		450	690	830	980	1,130	1,290	1,450	1,620	16	40
33		480	740	890	1,050	1,211	1,380	1,560	1,730	17	49
34			800	950	1,120	1,290	1,480	1,670	1,860	17	30
35			860	1,010	1,180	1,380	1,570	1,790	1,990	18	22
36			920	1,070	1,250	1,460	1,680	1,910	2,140	18	17
37				1,130	1,320	1,550	1,780	2,040	2,290	19	24
38				1,190	1,390	1,640	1,890	2,170	2,450	19	11
39				1,250	1,460	1,730	2,000	2,300	2,600	20	16
40				1,310	1,540	1,820	2,120	2,430	2,760	20	15
41					1,610	1,910	2,240	2,570	2.930	21	6
42					1,680	2,000	2,360	2,720	3,100	21	3
43					1,750	2,090	2,470	2,860	3,270	22	3
44					1,830	2,180	2,590	3,010	3,450	22	2
											1,300

*Volumes of trees as sawed out in average practice.

Correction factors for different species.
Chestnut, for diameters from 8 to 40 inches, subtract 10 percent.
Chestnut oak, for diameters from 32 to 40 inches, add 10 percent.
White oak, for diameters from 18 to 40 inches, add 10 percent.
Other common hardwoods, for all diameters, use the table without change.

Table 2-3. Volume table for softwoods

Diameter of tree, breast high (inches)	Number of 16-Foot Logs / Volume* in Board Feet							Basis for this table (trees)
	1	2 1/2	3	3 1/2	4	4 1/2	5	
8	37	52	66	75	84			12
9	41	58	70	82	93			9
10	47	66	77	92	100	120		12
11	53	74	86	100	120	140		13
12	60	83	97	120	140	160	200	8
13	68	94	110	130	160	190	220	4
14	77	110	120	150	180	210	240	7
15		120	140	170	200	240	270	11
16		130	160	190	230	270	310	20
17		150	180	220	260	300	340	21
18		170	210	250	280	330	380	20
19		190	230	280	320	370	420	34
20		210	260	310	360	410	470	27
21			290	350	400	460	520	33
22			320	390	440	510	570	40
23			260	430	490	560	620	37
24			400	470	540	620	680	37
25			440	520	600	680	740	47
26			480	560	660	740	810	52
27				600	720	800	880	43
28				650	780	870	950	45
29					840	940	1,030	39
30					910	1,010	1,100	47
31						1,080	1,180	40
32						1,150	1,260	44
33						1,230	1,349	39
34							1,420	36
35							1,500	34
36							1,580	29

*Volumes of trees as sawed out in average practice.

Correction factors for different species.

Hemlock:
- For diameters 8 to 10 inches, add 10 percent.
- For diameters 11 to 20 inches, add 22 percent.
- For diameters 21 inches and up, add 29 percent.

Red spruce:
- For diameters 8 to 10 inches, add 5 percent.
- For diameters 11 inches and up, add 25 percent.

Short-leaf pine:
- For diameters 10 inches and under, add 15 percent.
- For diameters 11 to 19 inches, add 25 percent.
- For diameters 20 to 23 inches, add 25 percent.
- For diameters 24 inches and over, add 40 percent.

White pine and other common conifers, for all diameters, use the table without change.

b. *Estimating without Volume Tables.* When you do not have a volume table, you can estimate standing timber fairly accurately by measuring the diameter and length of the tree and using the Scribner Decimal C Log Rule (Table 2-4, page 2-12). Similarly to estimating timber volume with the table, a tally sheet must be designed to accommodate the person, method and species being estimated.

Table 2-4. Scribner Decimal C Log Rule

Diameter (inches)	Length (feet)											Diameter (inches)
	6	7	8	9	10	11	12	13	14	15	16	
	Contents in Board Feet (in tens)											
6	0.5	0.5	0.5	0.5	1	1	1	1	1	1	2	6
7	0.5	1	1	1	1	2	2	2	2	2	3	7
8	1	1	1	1	2	2	2	2	2	2	3	8
9	1	2	2	2	3	3	3	3	3	3	4	9
10	2	2	3	3	3	3	3	4	4	5	6	10
11	2	2	3	3	4	4	4	5	5	6	7	11
12	3	3	4	4	5	5	6	6	7	7	8	12
13	4	4	5	5	6	7	7	8	8	9	10	13
14	4	5	6	6	7	8	9	9	10	11	11	14
15	5	6	7	8	9	10	11	12	12	13	14	15
16	6	7	8	9	10	11	12	13	14	15	16	16
17	7	8	9	10	12	13	14	15	16	17	18	17
18	8	9	11	12	13	15	16	17	19	20	21	18
19	9	10	12	13	15	16	18	19	21	22	24	19
20	11	12	14	16	17	19	21	23	24	26	28	20
21	12	13	15	17	19	21	23	25	27	28	30	21
22	13	15	17	19	21	23	25	27	29	31	33	22
23	14	16	19	21	23	26	28	31	33	35	38	23
24	15	18	21	23	25	28	30	33	35	38	40	24
25	17	20	23	26	29	31	34	37	40	43	46	25
26	19	22	25	28	31	34	37	41	44	47	50	26
27	21	24	27	31	34	38	41	44	48	51	55	27
28	22	25	29	33	36	40	44	47	51	54	58	28
29	23	27	31	35	38	42	46	49	53	57	61	29
30	25	29	33	37	41	45	49	53	57	62	66	30
31	27	31	36	40	44	49	53	58	62	67	71	31
32	28	32	37	41	46	51	55	60	64	69	74	32
33	29	34	39	44	49	54	59	64	69	73	78	33
34	30	35	40	45	50	55	60	65	70	75	80	34
35	33	38	44	49	55	60	66	71	77	82	88	35
36	35	40	46	52	58	63	69	75	81	86	92	36
37	39	45	51	58	64	71	77	84	90	96	103	37
38	40	47	54	60	67	73	80	87	93	100	107	38
39	42	49	56	63	70	77	84	91	98	105	112	39
40	45	53	60	68	75	83	90	98	105	113	120	40
41	48	56	64	72	79	87	95	103	111	119	127	41
42	50	59	67	76	84	92	101	109	107	126	134	42
43	52	61	70	79	87	96	105	113	122	131	140	43
44	56	65	74	83	93	102	111	120	129	139	148	44
45	57	66	76	85	95	104	114	123	133	143	152	45
46	59	69	79	89	99	109	119	129	139	149	159	46
47	62	72	83	93	104	114	124	134	145	155	166	47
48	65	76	86	97	108	119	130	140	151	162	173	48
49	67	79	90	101	112	124	135	146	157	168	180	49
50	70	82	94	105	117	129	140	162	164	175	187	50

2-6. Cruising Operations. In timber cruising, the two types of estimates are total and partial. For a total estimate, record the size of every tree in the stand. For a partial estimate, record the size of only some trees that are distributed over the whole stand or that are grouped in plots or strips. A stand is a group of trees in a limited area that are uniform in composition and condition. Composition refers to the principle tree species in the stand. Condition refers to the origin, age distribution, and development of the stand. A limited stand should not exceed 200 acres. A forest type is a group of stands. There are many type classifications. Cover type, which is based on the vegetation of a specific area, is the most frequently used type in timber estimating. A cruising crew should consist of two to four people. One person is the recorder while the others are cruisers. A crew larger than four people is impractical because the recorder cannot keep up with all the cruisers. Single-man cruising is not recommended. When planning a cruising operation, include a map of the tract showing the location of roads, trails, buildings, lakes, streams, fences, power lines, and contours as well as the type of estimate to conduct.

a. *Total Estimate.* The principal task in a total estimate is accurately recording the measurements of every tree or log in a stand. Mark the trees and logs with chalk, keel, paint, scribe, whitewash, or blaze to avoid recording the same tree or log twice and to avoid missing any tree or log. Mark the tract boundaries clearly so that you mark and record only the trees inside the boundary. Divide the tract into strips to make marking and recording trees an easier job. The density of the tract should govern how wide or how narrow to make each strip.

b. *Partial Estimates.* In large timber areas, it is impractical to measure the diameter and height of every tree in the stand. Usually, you make a total estimate of several sample areas. To determine the entire timber stand volume, multiply the sample volume by the ratio of the entire stand area by the sample area. In partial estimates, ensure that the samples you take represent the whole tract. The size of the samples will depend on the variation in size and species of the trees in the area. When making partial timber estimates, the sample methods used are the sample-plot method or the parallel-strip method.

(1) Sample-Plot Method. This is the simplest method of getting a sample from a limited stand. With circular plots, the center Of the plot is definitely marked; therefore, you can determine whether or not borderline trees are in or out of the plot. A circular plot has less perimeter than a rectangular plot of the same area, so you will have less borderline trees to consider. With rectangular plots, you use a steel tape on the centerline of the plot so you can rapidly and systematically progress through the plot. You are able to work forward continuously with a rectangular plot.

(a) Baseline. When setting up the partial estimate, plot a baseline on a map of the area you will cruise. Project the cruise lines perpendicular to the baseline. Choose the baseline location so that the cruise lines cross streams and ridges perpendicularly.

(b) Location of plots. Plot location may follow various patterns, but locate the plots in an unbiased (random) manner. Select the location of the starting plot, randomly, if the sample plots are to be located on a grid. Identify cruise starting points and plot locations so the locations are highly visible for the check cruiser to find them later. Mark plot centers with a wooden stake or wire pin. Number tallied trees clockwise from the north or from the direction of travel on the side of the tree facing the plot center.

(c) Plot size. Samples about one-quarter acre or one-fifth acre are easier to measure. Results are likely to be more accurate on smaller samples. Round, dense, even-aged uniform stands require smaller plots. Older, uneven-aged stands of light density require larger plots. Establish plot boundaries by measuring, not by pacing. Determine circular plot boundaries by measuring the radius from the centerline defined by the chain stretched between the marked end-line centers. Table 2-5 lists the radii for a variety of circular plot sizes.

Table 2-5. Plot radii

Acre	Feet Radii
1	117.8
1/2	83.3
1/3	68.0
1/4	58.9
1/5	52.7
1/10	37.2
1/20	26.3
1/25	23.5
1/40	18.6
1/50	16.7
1/100	11.8
1/300	6.8
1/500	5.3
1/1,000	3.7

Problem trees, such as forked (Figure 2-14), leaning (Figure 2-15), or downed (Figure 2-16), will be counted in or out, depending on the location of the tree's DBH in relation to the plot boundary. Use the DBH as the point of reference rather than the base of the tree, particularly in the case of uprooted trees.

(d) Computing volume. Compute the total volume of the area sampled as follows:

- Convert the volume of each plot to a per-acre basis by dividing the plot volume, in board feet, by the area of the plot, in acres.
- Add the volumes per acre for all the plots in a type and divide the sum by the number of plots in the forest type to find the average volume per acre for the type.
- Multiply the average volume per acre by the total number of acres to get the estimated total volume for the forest type.

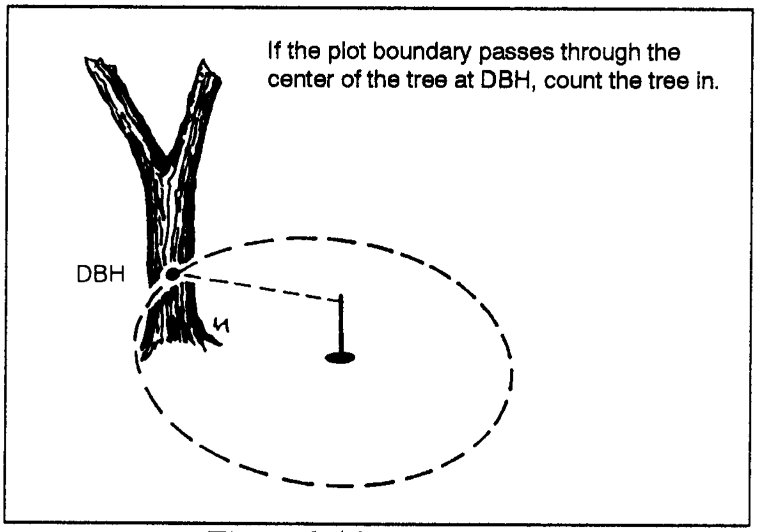


Figure 2-14. Forked tree

(2) Parallel-Strip Method. Use this method when making partial estimates of large timber stands. Establish a baseline with cruise lines perpendicular to the topography. Strip width will depend on the character of the timber being cruised. Timber density, size, and uniformity and brush amount are important criteria when making this choice. Make the strip as wide as is practical within the limits of speed and accuracy. Measure the trees in the strip using the same procedures as for the plot method. The number of trees you will measure will vary with every stand. The cruiser must decide which measuring system will yield the most accurate results. Compute the volume as for the sample-plot method.

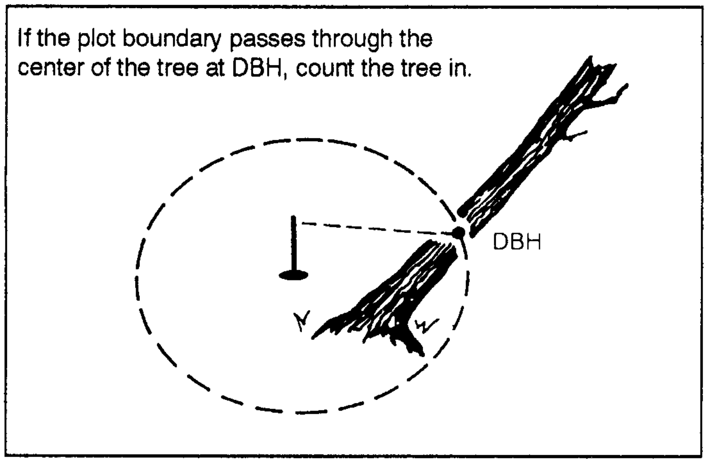


Figure 2-15. Leaning tree

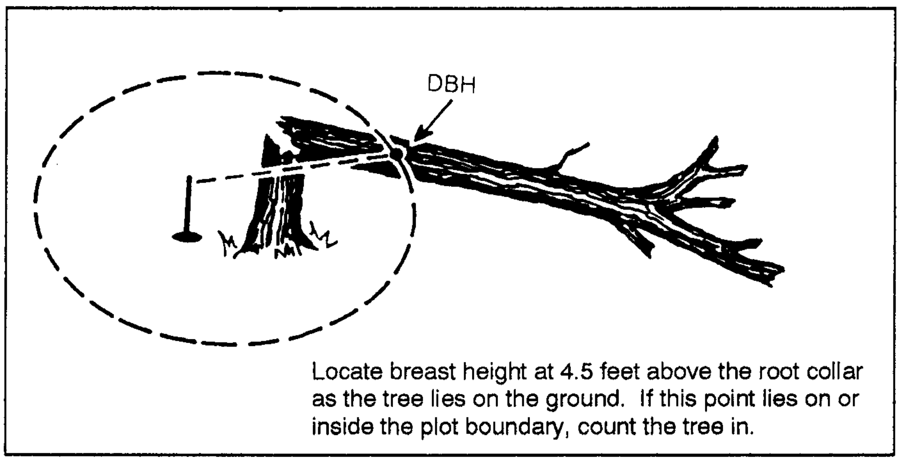


Figure 2-16. Downed tree

Chapter 3
Silvicultural Systems

Logging (timber harvesting) is a seemingly simple business of cutting down trees and transporting logs. Realistically, a tremendous variety of factors combine to make logging a very complicated operation. The forests may be inherently varied. A timber stand may be even-aged it may be composed of two or more distinct age classes, or it may be all-aged. The stand may be composed mainly of a single tree species or of a variety of species. Loggers must be aware of the effect a logging operation may have on erosion, streams, wildlife, and the forest's ability to regenerate. A silvicultural system is a program offorest treatments used for the continued production of the renewable forest resources.

3-1. Forest Systems. A forest system is composed of tree stands. Stand sizes usually vary, The minimum size of an even-aged stand is equal to the minimum mapping unit on forest maps used in administration. A forest could have many even-aged stands if the forest is set up for intensive management. Conversely, a forest could have only a few large uneven-aged stands if it is not feasible to designate small stands.

a. *High-Forest System.* This system has tree stands that originate from seed. The regeneration comes from the sexual reproduction by the parent trees whether from natural seeding, artificial seeding, or planting.

b. *Even-Aged System.* This system has stands that consist of trees that are the same or nearly the same age. A stand is considered even-aged if the range of tree ages does not exceed 20 percent of the rotation length. Age is usually measured from the time when the trees are first open to the sky and able to grow, in height, without restriction.

c. *Uneven-Aged System.* This system has created or maintained tree stands that include three or more different age classes. Stands with two age classes are usually not regarded as uneven-aged because the condition tends to be temporary. Generally, most trees regenerate after any disturbance and grow in even-aged aggregations. Therefore, the concept of an uneven-aged stand is desirable for management purposes because it better resists forest pests and hazards.

d. *Coppice or Low-Forest System.* This system has tree stands that originate from the vegetative sproutings from harvested trees. Coppicing usually involves short rotations with dense stands of short trees. In simple coppice cutting, the stands are kept almost perfectly even-aged. Coppice with standards applies to schemes in which scattered trees (standards) are left to grow through two or more coppice rotations. Sometimes the standards may be chosen from stems that originate from seeds. The term coppice selection applies to schemes in which stands of vegetative origin are treated so that they have three or more age classes.

3-2. Regeneration Methods.

a. *Clear-Cutting Method.* With this method, you remove an entire stand in one cutting and obtain reproduction artificially, by natural seeding from adjacent stands, or from trees cut in the clearing operation. In the silvicultural sense, clear cutting means virtually removing all woody vegetation as a preparation to establishing new trees. To avoid confusion, you can use *clear-felling* or *silvicultural* clear-cutting synonymously. However, you should not use clear-cutting to describe the cutting operation in which only the useable trees are cut. Such a cutting could be a variant of different kinds of partial cutting, including thinning. *High-grading* or *economic clear-cutting* describes these variants.

b. *Seed-Tree Method.* With this method, you remove an old stand in one cutting. However, you do leave a small number of trees in small groups or narrow strips as the seed source for natural regeneration. These seed trees do not cover enough ground to provide any significant shelter to the new trees. This method is sometimes viewed as a variant of clear cutting.

c. *Shelterwood Method.* With this method, you remove an old stand and establish a new, essentially even-aged stand from new trees started under the old stand. This new stand is established naturally or artificially before the old stand is removed. The shelterwood method may involve a series of three different kinds of cutting:

- Preparatory. This cutting is designed to foster the potential seed producers or speed up decomposition of litter.
- Seed. This cutting (true regeneration cutting) is designed to get the new crop established.
- Removal. This cutting could be in multiples. It is designed to release the newly established crop or to harvest the remaining old trees.

Regeneration by the release of natural advance growth could be described as *clear-cutting* but *one-cut shelterwood* or *overstory removal* are better descriptions because they focus attention on the nature of the source regeneration.

Sometimes you must delay removing overstory (longer protection to the new crop or additional growth on the overstory trees). If the delay induces irregularity in height growth of the new stand, the variant is called *irregular shelterwood cutting.* This regeneration procedure may have some selection management attributes, but differs if the new stand is essentially even-aged. Shelterwood cutting can be laid out uniformly throughout a stand or in groups or strips that are extended quickly through the whole stand.

d. *Selection Method.* You use this method in any high-forest or system designed to create or maintain uneven-aged stands. You usually remove old trees in groups or in strips wide enough to allow new trees to start and remain free to grow. However, you could remove large individual trees *(single-tree* selection method). A successful operation usually depends on enlarging the opening through subsequent cuttings. In the selection method, the stand always has some relatively old trees. You establish regeneration by periodic partial cuttings. The method requires regular entries on an indefinite basis. Some cuttings may be intermediate in immature age classes rather than true regeneration cuttings.

Do not use *selective cutting*, which is not a technical forestry term, to describe any kind of partial cutting. Some forms of selection management include establishing advanced growth regeneration in parts of a stand, which is an attribute of sheltervvood cutting.

3-3. Intermediate Cuttings. These are treatments that modify or guide the development of an existing crop of trees, but do not replace it with a new stand. The treatments involve selectively removing vegetation to allow the expansion of the crown and root systems of remaining plants. Vacancies created in the growing space are not large enough to allow height growth of any new trees that become established because of the treatments. The treatments do not always include *harvesting, so tending* better describes the process.

a. *Release Cutting.* This cutting type includes all operations designed to regulate the species composition or improve the growth of very young stands, ordinarily those not past the sapling stage. *Cleaning* occurs when the trees removed are of the same age as those favored. *Liberation cutting* occurs when the trees removed are older than those released. *Weeding* occurs when a cleaning is so intense that virtually all undesirable species are removed.

b. *Improvement Cutting.* This cutting type is done in mixed stands that are being put under silvicultural management for the first time. The method is similar to thinnings. Do not apply improvement cutting to partial, nonregenerative cuttings in stands older than the sapling stage. This is more of a release-type cutting when the desirable trees were in the seedling or sapling stage. The same kind of cutting applied to a pure, even-aged aggregation of trees would clearly be a thinning, often a selection thinning.

c. *Salvage Cutting.* In this cutting, you harvest dead, dying, damaged, or deteriorated trees mainly to use the wood before it becomes worthless.

d. *Sanitation Cutting.* In this cutting, you remove the same kind of trees and those susceptible to attack to reduce the spread of biotic pests. Salvage and sanitation cuttings could resemble one or more forms of regeneration or intermediate cutting. They may differ only in their intent or purpose rather than in the resulting development of the remaining vegetation. If the agent leading to death or damage is merely suppression of larger trees, the removal of the trees involved is best regarded as low thinning.

3-4. Thinnings. Thinnings are partial cuttings in even-aged stands of trees. Thinning is designed to improve future growth by regulating stand density. Sometimes it is best to harvest trees that might otherwise be lost to suppression. Thinnings can be classified in different ways. In commercial thinnings, some or all of the harvested wood is put to use. (Precommercial thinnings do not use the wood.) Thinnings are also grouped according to the crown classes of trees removed and reserved within the canopy stratum being thinned.

a. *Low Thinning.* In this method, you imitate or accelerate natural suppression losses by harvesting trees of the lower-crown classes and leaving the upper classes. The heavier the thinning, the higher the removals progress into intermediate codominant crown classes.

b. *Crown Thinning.* This thinning is the direct stimulation of crowns of the dominant trees. You remove codominant trees and leave overtopped and intermediate trees to die. These trees are removed in subsequent thinnings. Do not refer to crown thinning as *thinning from above;* that term is too easily confused with selection thinning.

c. *Selection Thinning.* In this thinning, you remove dominant trees and leave trees of lower-crown classes. One purpose of selection thinning is to remove malformed or otherwise undesirable dominant trees. Another reason is to limit the harvest to the larger and more valuable trees, which may or may not constitute *high-grading,* depending on judgments about subsequent stand development.

d. *Geometric or Mechanical Thinning.* In this thinning, you remove some trees and leave others in a predetermined spacing or pattern such as strips and groups. Do not refer to mechanical thinning as *thinning done with machines.* Row thinning is a special kind of geometric thinning in which whole rows of planted trees are removed.

Chapter 4
Roads

Carefully consider the location and design of roads and trails used in logging operations. Poor location and design may handicap operations and could cause soil erosion or stream siltation. Drainage is important when locating and constructing logging roads. Keep a road free of water as much as-possible. Erosion is another problem. During road construction, you remove vegetative cover and litter from the forest floor. Rain and surface water run over the exposed areas, building up energy as slopes and distance increase. Soil particles are torn apart and washed into the streams, resulting in muddy water and siltation. Muddy water is not suitable for human consumption, and most industries cannot use it. Water with a turbidity of over 5 parts per million (ppm) is considered unfit for domestic use, and 25ppm is undesirable for most manufacturing processes. Fish suffer at about 90 ppm; 400 ppm is the threshold level for most fish.

Section I. Planning and Laying Out Roads

4-1. Road Location.

a. *Basic Considerations.* Topography often dictates the approximate location and extent of a road system. Sometimes, property lines, economic limits on skidding, and other features may determine how far to extend a truck road into the timber. Generally, plan a haul road to the farthest point consistent with good economics and sound operating principles. Good appearance and safety are increasingly important in logging roads. Placing a curve near the main road could eliminate long tunnel views. Ideally, a logging road intersects the main road at right angles, thus providing good visibility in both directions. Items to consider in planning and locating logging roads follow:

(1) Grade. This is the slope of a road, usually expressed in percent. For example, a 10 percent grade goes up or down 10 feet for every 100-foot length. Excessive grades require more maintenance, and roads are harder to keep intact. Try to keep grades below 10 percent except for short distances where the maximum grade is 15 to 20 percent. On long, steady grades, drainage water builds up and erosion potential increases unless you install adequate drainage structures. To facilitate natural drainage, try to plan occasional breaks to level or adverse grade. Likewise, try to avoid long, level sections of road because such sections are difficult to drain properly. The most desirable grades are 3 to 5 percent.

(2) Slope. Sidehill locations allow good cross drainage. They also provide the construction advantage of balanced cross sections, which involve a minimum of earthmoving. Where slopes exceed 60 to 70 percent, you lose the advantage because you must place the road bed in solid material. The excavated earth goes over the side as waste.

(3) Obstacles. Try to avoid rock outcrops, ledges, highly erosive soils, swampy places, and other features that could present difficulties in construction. You must know the exact

location of the road. However, you may not encounter the problems until you make the preliminary location.

(4) Distance From Streams. Stream beds do not make good roads; try to avoid using them for that purpose, Keep road surface drainage out of streams by locating the road far enough from a stream to provide sufficient filtering area. Table 4-l lists recommended widths between roads and streams.

Table 4-1. Recommended widths between roads and streams

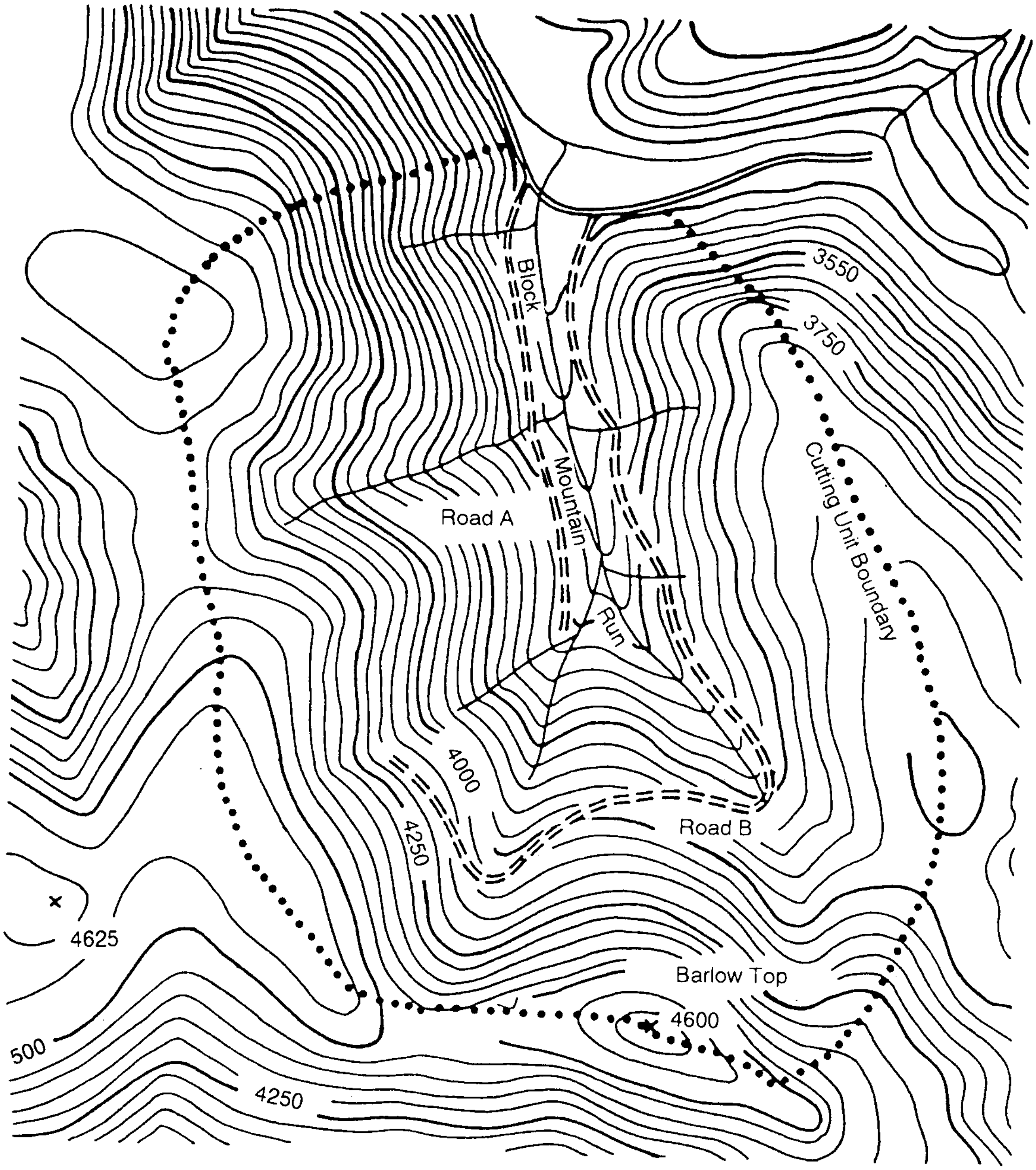
Slope of Land Between Road and Stream (percent)	Width of Filtration Strip (feet)
0	25
10	45
20	65
30	85
40	105
50	125
60	145
70	165

(5) Stream Crossings. Wherever possible, make stream crossings at right angles regardless if the crossing is by ford, culvert, or bridge, Where water values are high (as in domestic use), always bridge live-water courses. If you ford a stream, you should provide sufficient adverse grade on the lower approach section to confine the stream to its channel, even during periods of high water.

Trucks, skidders, and other logging equipment carry pollutants more dangerous than eroded soil. When fording streams, gasoline, oil, and grease are often washed from the wheels and undercarriages of vehicles, As little as 2 ppm of gasoline causes objectionable odor in domestic water supplies. The threshold for rainbow trout is about 40 ppm.

b. *Preplanning.* The person assigned as road locator should know something about the area the road will serve and the terrain and approximate location where the road will be built. Proposed roads may be tentatively located and plotted or sketched on aerial photographs or topographic maps. (Figure 4-1 shows a topographic map with roads plotted). Also, the timber cruiser should determine the distribution and volume of the timber that will feed into the road and provide this information to the road locator.

The proposed road may become a permanent improvement to serve either as a continuously passable road or to be used at periodic intervals. Planning should ensure adequate coverage of the whole area even though the area might contain blocks of inoperable timber.



Survey Data On--	Road A	Road B
Elevation at beginning	3,240 feet	3,240 feet
Elevation at upper end	3,510 feet	4,150 feet
Rise in elevation	270 feet	910 feet
Length of road	3,700 feet	10,510 feet
Average gradient	7.3%	8.7%

Figure 4-1. Topographic map with roads plotted

c. *Surveying.* The next step in road locating is to walk the entire length of the proposed road to become familiar with the topography and ground conditions. You should establish all control points and mark only the points necessary to indicate the route traveled. The preliminary location survey follows the walk and is accomplished best by a two-person crew. Work in a downhill direction for a better view of the terrain. The procedure usually followed is—

- The instrument man is at the starting point and has an Abney level. He lines in the headman or flagman at a visible point in the direction of the survey.
- The instrument man checks the grade with the instrument. If the grade between the points is excessive, the flagman moves uphill or downhill until obtaining the desired grade.
- The flagman ties the two points in with markers. He can use ax blades, paint, strips of cloth, or weatherproof marking tape fastened to trees as markers.
- The team repeats the process from the advanced station. As the survey progresses, they should mark the entire area, with the marked line constituting the centerline of the proposed road.

If the locator follows a predetermined fixed grade and misses the desired end location point, he should try to work back from that end and connect the two surveys at the most convenient point. However, it may be necessary to repeat the grade survey.

If a road locator has to work alone, he can establish and maintain a desired grade by tying a flag or leaving a readily visible mark at eye level at the starting point of the survey. Then, taking a backsight with the instrument from the next point, he clearly marks this point before proceeding. The locator repeats this method for every backsight between points along the course.

Curves and switchbacks must be of sufficient radii for trucks to negotiate easily, The minimum radius for a short-bodied vehicle is 35 feet and for a tractor trailer is 50 feet. Stake necessary curves and turnouts during the location survey. Try to plan curves and switchbacks on as level grades as possible. Provide turnouts so vehicles can pass and park. Turnouts should be intervisible. Use the topography in the survey area so as to require little movement of materials.

4-2. Equipment Needed. A hand instrument for grade estimating is essential, The Abney level is very convenient and easy to read. You will also need a measuring tape, flagging material, ax or brush hook, and a hand compass, if bearings are desired. Carry aerial photos or a map of the area for reference.

4-3. Grade and Slope Stakes. You may have to set grade and slope stakes if you need a more highly engineered road than is possible from the centerline location survey. If that occurs, place grade stakes along the location survey line at 50- or 100-foot intervals, depending on the uniformity of the topography. At sharp curves, set stakes as close as 25-foot intervals to ensure uniform curvature. On tangents, place the grade stakes in a reasonably straight line.

A grade stake marks the point on the ground and represents the point in the road's cross section where the *cut and fill* sections meet and are reduced to zero. Slope stakes mark the points in the cross section that represent the outer limits of construction (the top of the cut bank and the toe of the fill bank). However, slope stakes are normally set only on the cut side for the type of road considered. Slope stakes follow the grade survey as a separate operation. Place these stakes on the uphill side of every grade stake.

Section II. Constructing Logging and Skid Roads

4-4. Clearing. After the area has been surveyed, the road must be constructed properly. Usually, constructing logging and skid roads does not require the services of a highway engineer; however, you must follow certain basic construction principles. If you have a skilled and experienced equipment operator, you may not need supervision during construction. Before starting the operation, make sure that the road location is well marked and all preparatory work in the right-of-way is complete. Doing so will let you operate the equipment in a steady pattern, resulting in prompt completion and minimum interruption.

Cut down the useable trees in the right-of-way and buck them into logs ahead of the road construction, Move logs and tops far enough off the right-of-way so they will not interfere with construction. Stumps that are less than 3 inches in diameter should be cut low and covered with a foot or more of fill material. Stumps and roots over 3 inches in diameter should be dug out of the ground. Do this by leaving a stump about 3 feet high so a bulldozer can remove it. If the right-of-way supports only brush or young timber, or where a sufficiently heavy tractor dozer is engaged, no felling need be done. The heavy equipment will remove all materials.

Do not leave any trees that are moved by bulldozer leaning or suspended above the ground. They present a hazard that you should eliminate at the time of construction. Fell any snags which could fall into the road. On rare occasions, you may have to blast rocks and boulders. Once construction starts, you may have to bypass such obstacles by minor changes in alignment. If the road has a dead end, clear sufficient space and level it for easy equipment turn around.

4-5. Design and Standard. The desired width of single-lane truck roads is 10 to 12 feet, with greater widths at curves and turnouts. Cut road banks as steep as the material's stability allows. Bank slopes may range from 1/2: 1 on stable material to 2:1 on erosive soil.

a. *Military Road and Skid Road.* The primary differences between the military road and the skid road are in road width and roadbed construction. The minimum width of a military road is 18 feet; the minimum width of a skid road is 12 feet, The bed of the skid road is made entirely of material in place; the military road requires more elaborate preparation.

b. *Drainage and Slope Stabilization.* The importance of adequate drainage in road construction cannot be emphasized enough. You must make provisions for passage of surface water from adjacent slopes as well as for rapid drainage of the roadbed. Higher-class roads generally are crowned to provide surface drainage. Some cut-and-fill slopes require seeding and mulching.

c. *Culverts.* The most common method of road drainage is to install culverts (Figure 4-2). They are made of steel, concrete, logs, and lumber. Normally, a culvert is placed on a 2 to 4 percent grade to prevent clogging. Flow velocity should be at least 2.5 feet per second (fps) to prevent sedimentation but no more than 8 fps to prevent scouring. Generally, a 2 percent grade is sufficient to obtain velocity, Place the outlet end of the culvert at or below the toe of the fill. Lay an apron of rock for the outflow to spill on.

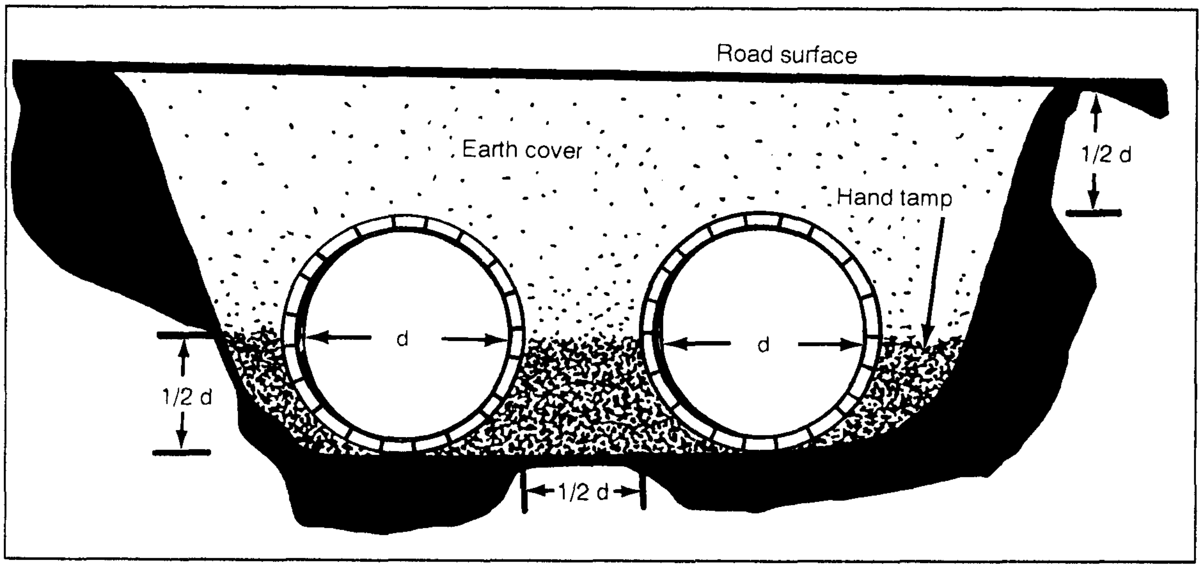


Figure 4-2. Culvert installation

Ditch-relief culverts are used to move water under the road before the flow gains sufficient volume or head to erode the ditch. On an 8 to 10 percent grade, space the culverts 200 to 300 feet apart; on a 5 percent grade, space the culverts about 500 feet apart. These figures will vary, depending on location, soil type, amount of rainfall, and road width. Ditch-relief culverts should cross the road at about a 30 degree angle for better entrance conditions on steep grades (Figure 4-3).

Open-top culverts or dips (Figure 4-4) are used to remove water from the road surface or for diverting it across the road. Open-top culverts are frequently used on logging roads. These culverts can be made from poles or sawn timbers, are quick to build, and are quite usable when properly maintained. If made of durable wood or treated material, box culverts last many years.

Thank-you-ma'ams (Figure 4-5, page 4-8) are frequently used on logging roads, especially where the water volume is not enough to wash out the roads. Place the thank-you-ma'am across the road at an oblique angle in the direction of the water flow. On mountain roads, this angle placement makes it possible for the culverts to clear themselves of dirt, stones, and debris. It also makes it safer for truck travel because the truck's two front wheels do not cross the drainage structure at the same time.

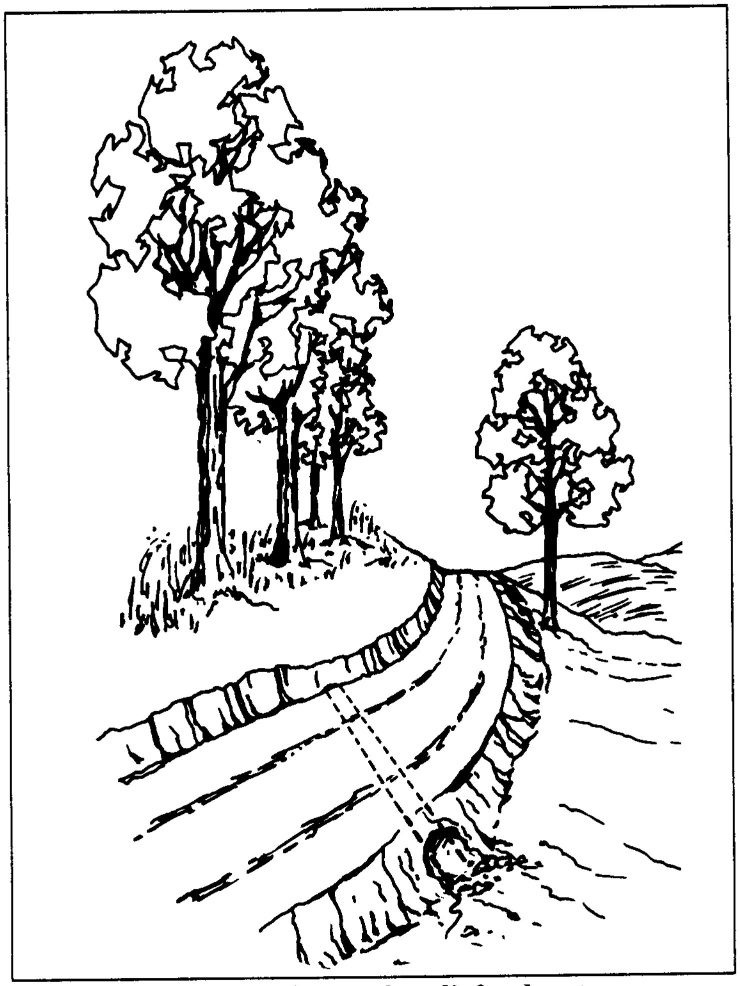


Figure 4-3. Ditch-relief culvert

4-6. Construction of Skid Roads.

a. *Roadbed.* The roadbed should consist of in-place material or material immediately adjacent to the road site. You can haul limited quantities of gravel and dirt fill to low or swampy sections of the road. Use slash, slabs, and logs as fill material. The skid road cannot be maintained as a crown-type road, so the entire surface of the roadbed should have a transverse slope for water runoff. Use a crawler tractor to compact the roadbed enough to maintain the equipment's weight and logs you haul.

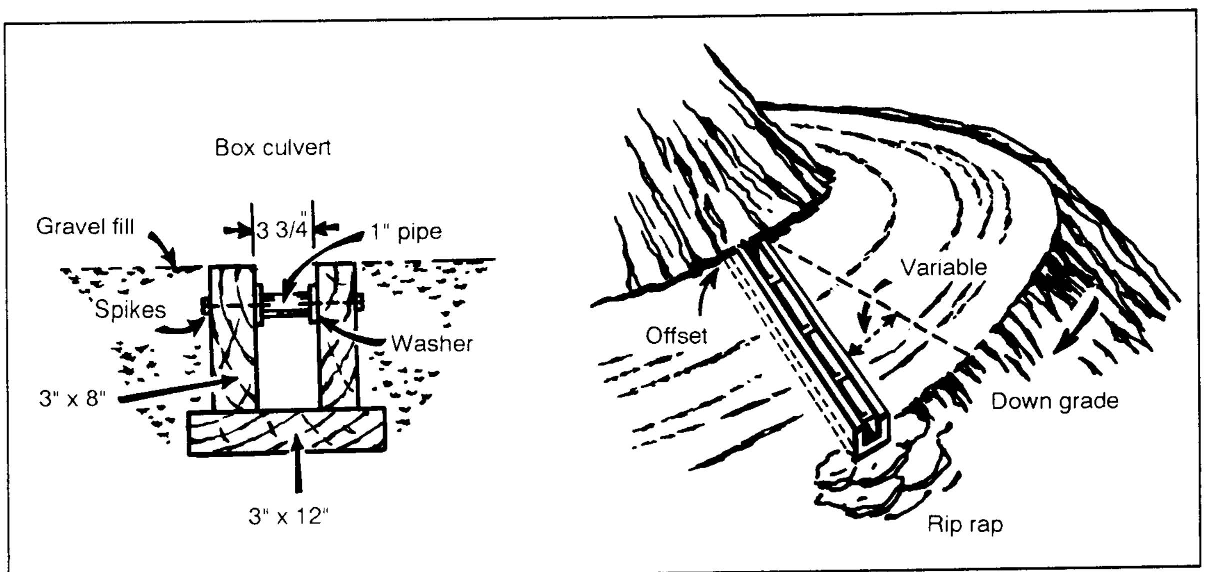


Figure 4-4. Open-top box culvert

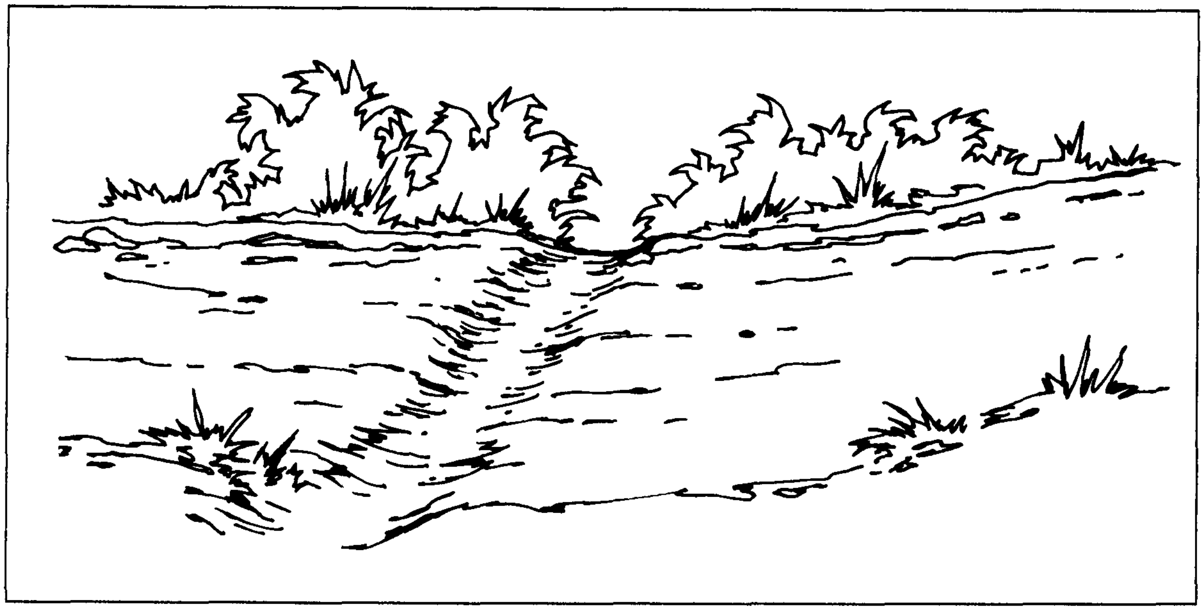


Figure 4-5. Thank-you-ma'am

b. *Method.* Use the following procedures to construct a skid road:

- Build the road from the top of the grade down, wherever possible.
- Do not chip down trees that can be pushed over by a bulldozer. Bulldozing saves time and eliminates the need for taking out stumps.
- Use a two-person crew. One person operates the bulldozer while the other cuts brush, warns the operator of any dangers, and performs other jobs as assigned.
- Give the skid road a slight transverse slope, whenever possible. Water drains off, preventing washouts in the road.

c. *Development of Switchbacks.* In mountainous terrain, you may have to develop switchbacks to ascend and descend the slope. The road will form a zigzag pattern along the side of the mountain. The slope of the road should not exceed 10 percent. Try to locate the switchbacks at convenient points. Allow sufficient turnaround space for the log skidding equipment which, when loaded, may exceed 70 feet. A 100-foot-wide switchback (Figure 4-6) provides enough room for vehicle turnaround.

4-7. Safety. You must consider safety in road building. Safety applies to construction standards and job construction.

a. *Standards.*

- Do not make road grades too steep for safe operation of the logging vehicles. Grades should not exceed 25 percent unless you have a power winch and cable system or other auxiliary means of lowering vehicles.
- Install sufficient turnouts on all roads, and maintain a safe side clearance. Clear all brush that might obstruct the view at an intersection or on extremely sharp curves.

- Build substantial bridges and crib work to withstand any side thrust or other force that might be imposed on them. Footings should be firm and adequately protected against the weakening effect of water and ice.
- Install adequate guard rails or wheel guards, and securely anchor them on all bridges and trestles.

b. *Construction.*

- When operating a tractor, do not work alone or be kept out of frequent contact with another person who could help in an emergency.
- Ensure that you have adequate lighting if you conduct road construction at night.
- Watch for cave-ins, rolling rocks, flying stones or branches, and other such hazards. Work should be laid out so that workers are not exposed to these hazards.

Figure 4-6. Development of switchbacks

Chapter 5
Felling and Cutting Trees

Felling (cutting down a tree) is probably the most difficult and dangerous part of the logger's job. The required skills and judgment cannot be attained by reading a few pages in a handbook. On-the-job training provides actual experience for the logger. This chapter provides the basic principles of felling.

5-1. Direction of Fall. Before starting felling operations, you must carefully decide where the tree should be dropped. Experienced loggers should make this determination because inexperienced loggers may not be as careful, resulting in injury to themselves and others. When felling trees, it is always dangerous to fell a tree into another one if either has dead branches. The branches are likely to snap off and fly through the air, These flying limbs are called *widow makers* (Figure 5-l). When beginning the felling process, look up, spot, and be aware of falling or flying limbs, or have another person spot for you. When the tree begins its fall, a cutter should pay attention to a safe exit zone. Cutters should avoid power and telephone lines.

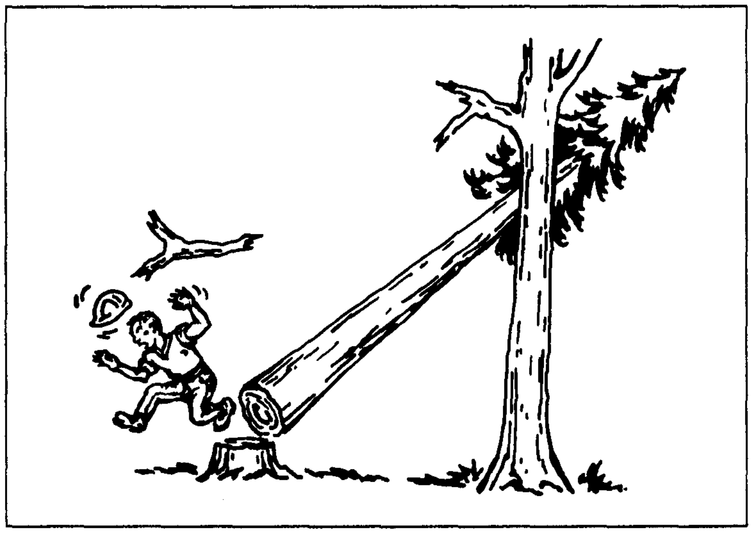


Figure 5-1. Widow maker

a. *Well-Balanced Trees.* If a tree is not leaning more than 5 degrees from the vertical, has about the same number of limbs all around, and is not being pushed by a strong breeze, you should be able to drop it in just about any direction. You do this by proper location and sequence of cuts and by judicious use of timing and wedges.

b. *Inclined Trees.* Trees with greater inclines call for stronger measures. You can push over small trees, but larger ones present more serious problems. Felling in a direction opposite the lean may call for the use of a jack or a *pull-by* cable. Using the jack or pull-by cable reduces the tension and will allow you to make a safer cut. Using all the available tools ensures the direction of the fall.

c. *Steep Upslope.* If possible, do not fell a tree straight up a steep slope. As the tree strikes the ground, it may bounce back over the stump or to either side. Since tree action is impossible to predict, the faller will have difficulty finding a safe place to watch the tree's fall. If the tree falls at a 45 degree angle on either side of an uphill slope, the faller can seek safety on the uphill side of the stump with less risk. Any other angle fall could be risky to the faller.

d. *Steep Downslope.* Trees felled straight down a steep slope are apt to be shattered by the fall, particularly if the ground is rough. Avoid felling a tree across a large rock, a stump, or a log. Such obstructions are likely to break the stem and cause much waste of good timber.

5-2. Directional Felling. Although not always possible, especially with larger timber, directional felling is more desirable to expedite the skidding job and to reduce logging damage to the trees left for future growth and reproduction. Directional felling works best in pole-sized stands being thinned and in improvement cutting.

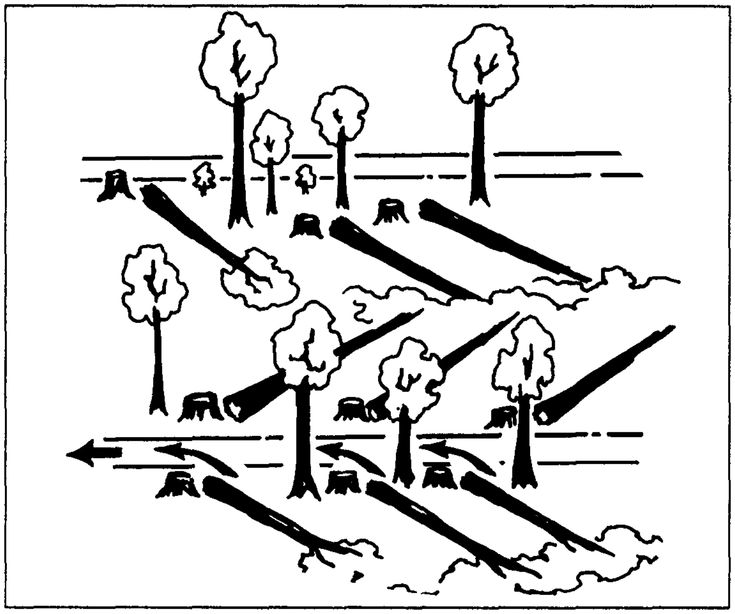


Figure 5-2. Felling, herringbone pattern

After felling, lay the trees down in a herringbone pattern so that they can be pulled out and away butt first onto the skid road (Figure 5-2). When you have to complete limbing on site, the above pattern leaves the majority of the limbs and tops away from the road and you will not have to handle the logs as often. In a full-tree logging operation, using the herringbone pattern works best.

In operations where you limb the cut stems where they drop, lay the stems down in the opposite direction so you can pull them out top first (Figure 5-3). The tops are smaller, making it possible to bring in a bigger load behind the skidder. On clear-cutting or row-thinning operations, this method reduces felled trees from lodging. Fallers should avoid leaving criss-crossed stems, which makes a skidding operation more difficult.

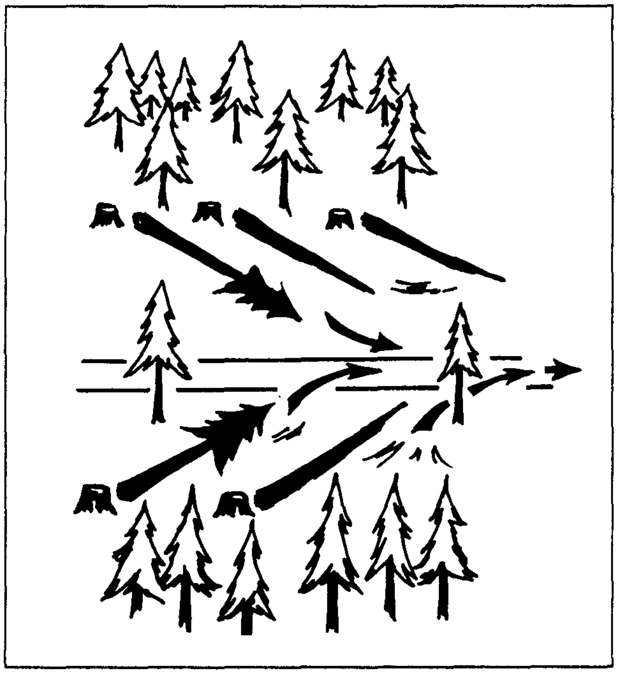


Figure 5-3. Felling, tops toward the road

5-3. Cutting Trees.

a. *Clearing Work Space.* Once you determine the fall direction, you should clear a working space around the tree's butt and prepare an escape path. Accidents could occur during an operation, and a clear working space could prevent tripping and falling.

b. *Brushing Out.* Clip off small brush close to the ground (Figure 5-4). Pulling on

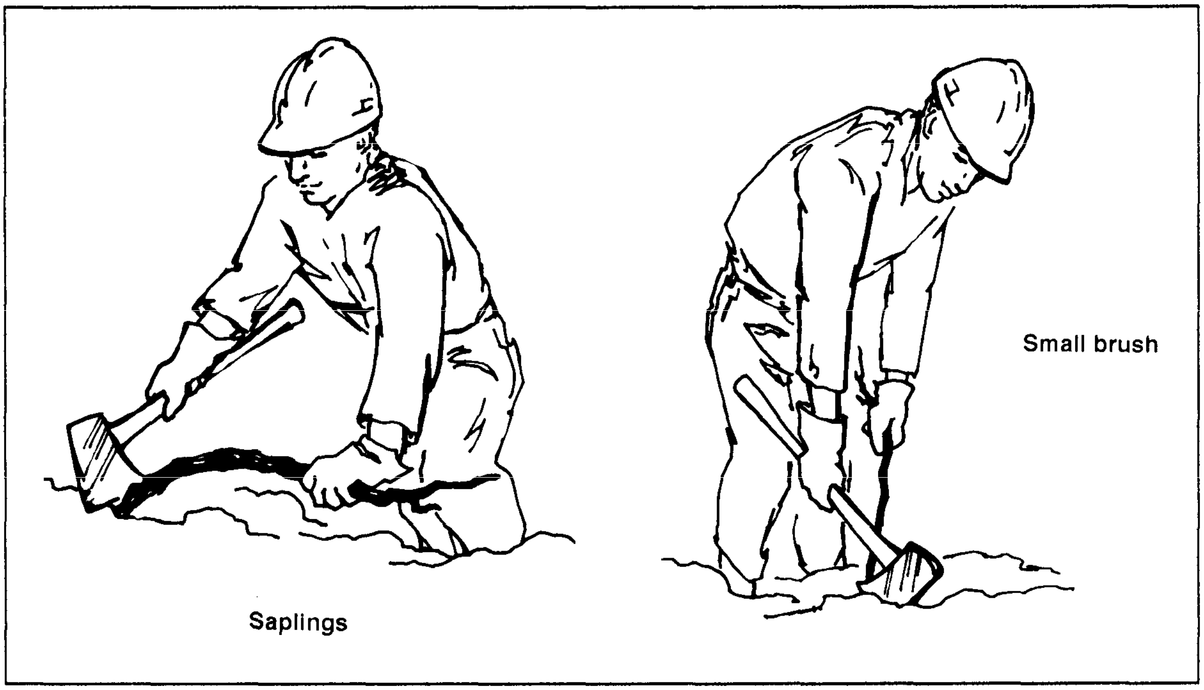


Figure 5-4. Clearing away small brush and saplings

the brush provides the necessary resistance to a slicing cut. Cut larger brush and small trees, and remove low-hanging limbs in this manner.

c. *Making The Undercut (Notching).* Undercutting provides a fulcrum and a hinge point on which to tip the tree off its stump in the desired direction. Make the undercut on the side toward which the tree is to fall. For saw timber, the stump should not be over 12 inches above the ground on the uphill side of the tree. Lower is better. High stumps waste timber and hinder skidding. On skid roads, stumps should just about be flush with the ground. At times you may have to leave a high stump because of rocks or some other obstruction that makes a low stump impossible. Use a chain saw when making all undercuts. Make undercuts deep enough to penetrate one-fourth of the diameter of the butt. For leaning trees, make the undercuts much deeper. The traditional undercut has a horizontal base and a top sloping down to it at about a 45 degree angle. Making an undercut requires experience to make the two cuts come out even and not pass each other. Careful undercutting is essential to control the direction of fall. Using a chain saw, fallers determined that they can easily make the undercut upside down with the sloping side coming up from below. This is called a Humboldt undercut (Figure 5-5). The cut makes a more nearly square end on the butt log.

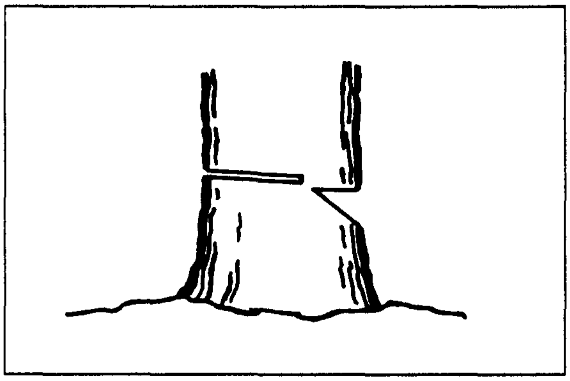


Figure 5-5. The Humboldt undercut

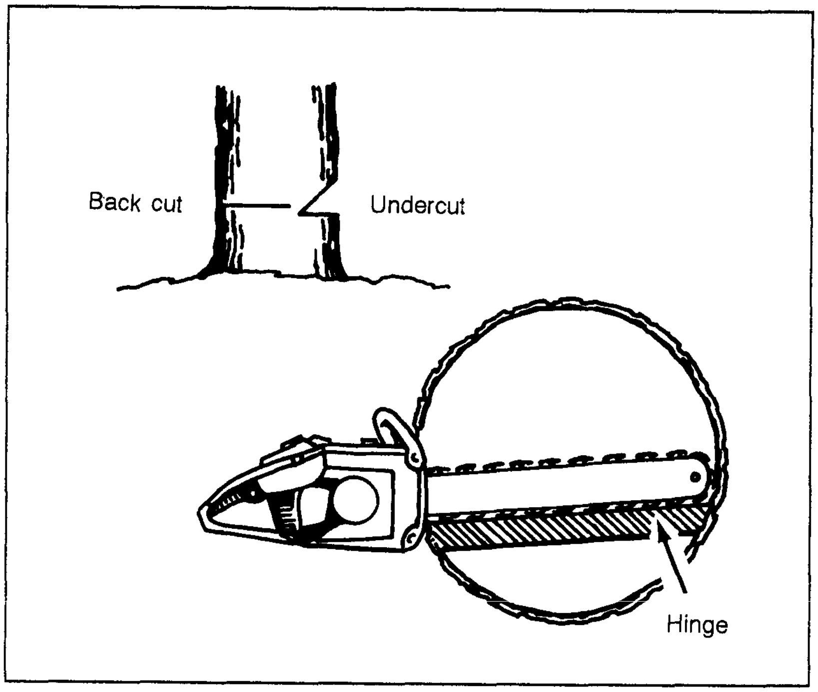


Figure 5-6. Back cut

d. *Making the Back Cut.* Make the back cut about 1 inch higher than the horizontal part of the undercut. Keep the back cut parallel with the back of the undercut, and do not let it penetrate closer than 2 inches (Figure 5-6). The back cut provides the hinge that guides the direction in which the tree falls. If the tree does not start to fall when you reach this point, start a wedge at the center of the back; remove the saw from the cut; pound home the wedge to start the tree tipping.

Often, you will encounter a tree with a diameter larger than the length of the chain-saw bar. Usually, making two cuts from opposite sides will suffice. For even larger trees, make a sequence of three cuts (Figure 5-7) to bring down the tree. First, make a semicircular cut in the middle of the back of the tree. Then, cut out the fins on both sides, ending up at the back of the hinge parallel to the undercut.

5-4. Leaning Trees. Most trees should be felled in the direction of the lean. However, when a tree leans from the desired direction of fall, you can change this direction a little by *holding a corner*. To do this, make the back cut closer to the undercut on the side toward the lean, and retain a little more wood in the hinge cm the side away from it (Figure 5-8). By holding a corner, you can help tip the tree to an upright position so it will fall in the desired direction.

When felling a tree in the direction in which it leans, the tree is apt to start falling before you complete the back cut. When this happens, the tree butt could split some distance up from the stump, leaving a *barber chair* (Figure 5-9). The splitting reduces the value of the butt log and may throw the butt of the tree around in unpredictable directions. This is extremely dangerous. To reduce the possibility of this happening, *saw off the corners* before the completing the back cut (Figure 5-10, page 5-6). Make angling cuts through the sapwood, on both sides, to the undercut. Another method you can use to reduce the splitting is to fasten a log chain around the tree's base and tighten the chain by driving in a few wedges (Figure 5-10, page 5-6).

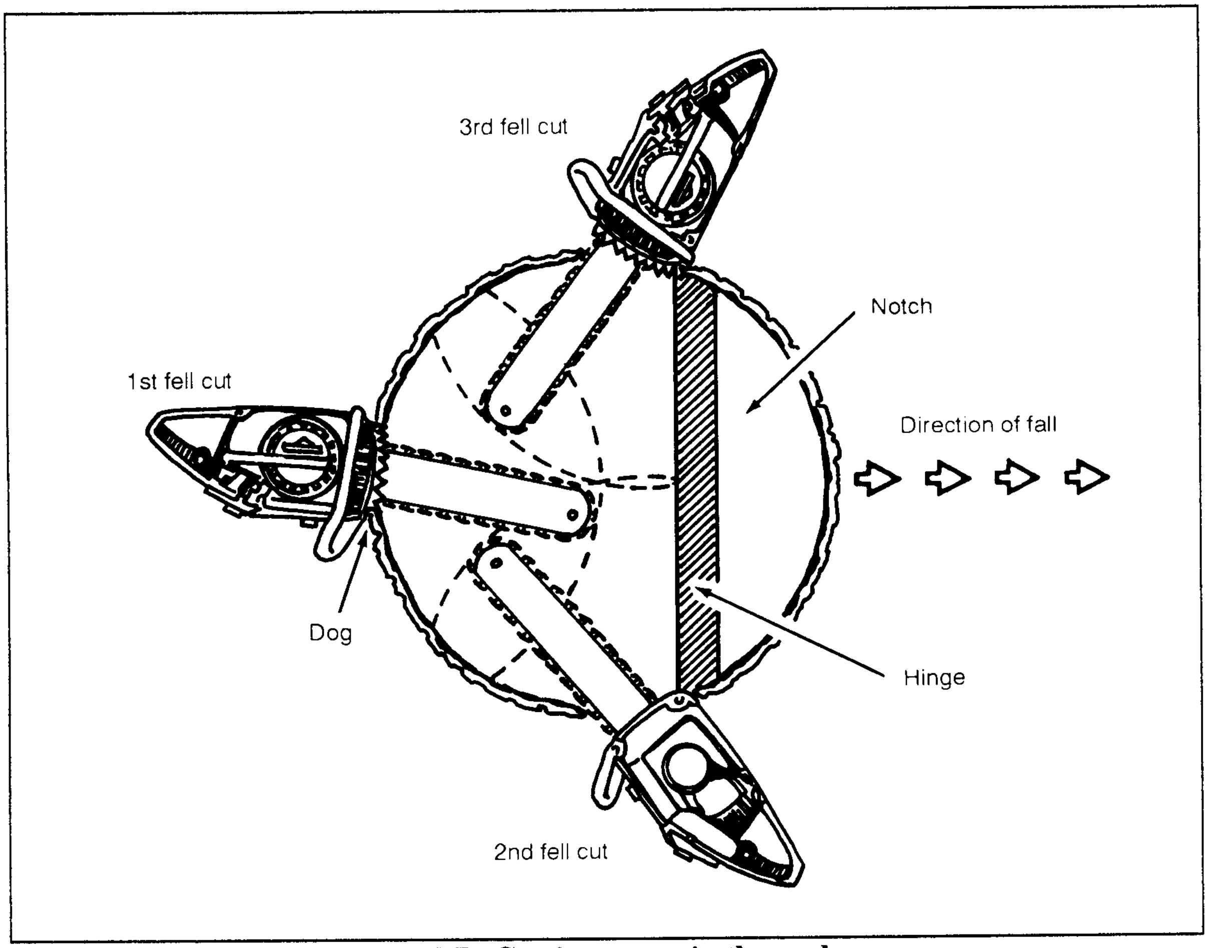


Figure 5-7. Cutting a tree in three places

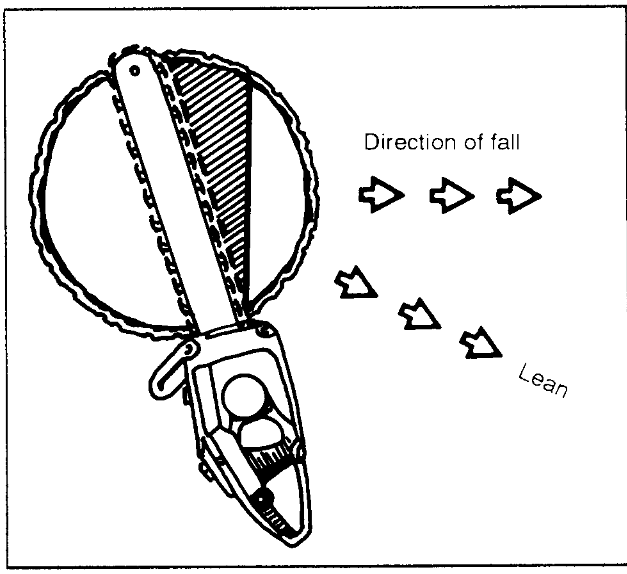


Figure 5-8. Holding a corner

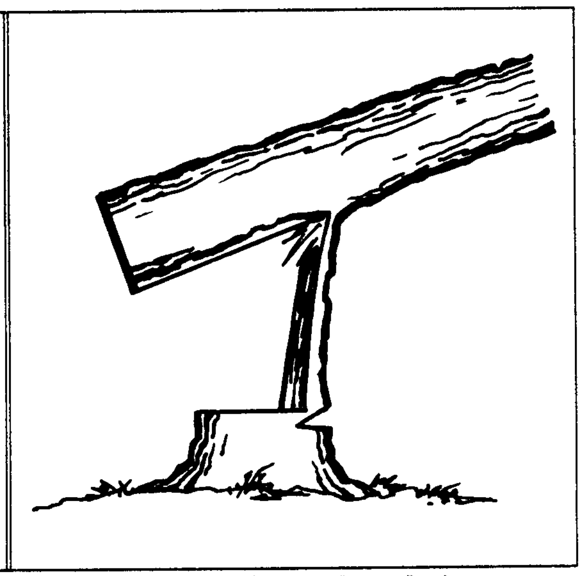


Figure 5-9. Barber chair

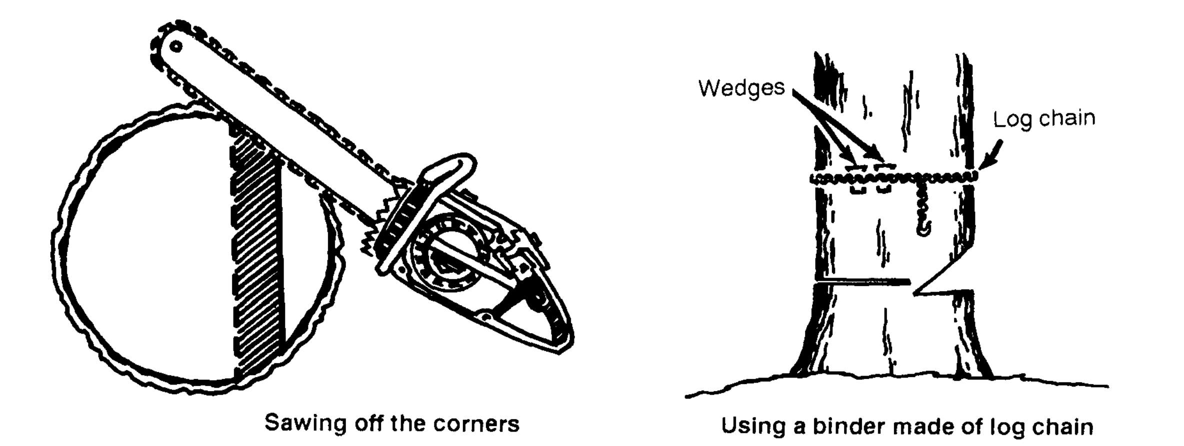


Figure 5-10. Methods to prevent splitting

Two new techniques have been developed for bringing down heavy leaners in the direction of their lean, without splitting. Both depend on the special cutting abilities of chain saws.

- Method One. Make an undercut, either the traditional or the Humboldt type. Instead of starting the back cut from the rear of the tree, start it with a boring cut several inches in from the back side. Continue the cut forward, leaving just the hinge to the rear of the undercut, and then go backward, leaving only two or three inches uncut at the rear. Pull out the saw and slice away the uncut fibers to allow the tree to fall (Figure 5-11, A).

WARNING
The plunge (boring) cut can be dangerous. Be very careful because chain-saw kickback can occur during the Initial cut.

- Method Two. Make a straight cut into the tree from the side toward which it will fall, about two-thirds through the trunk (Figure 5-11, B). Drive wedges in behind the saw when you feel the tree starting to pinch. After making the cut, remove the saw and complete the cut from the backside. Stay alert in anticipating the tree's fall; be ready to get out of the way. Tree-butt kickbacks are common with this method.

You can choose from several methods when you have to tip a heavy leaning tree in a direction other than the one in which it would normally fall. The most common method is to attach a cable high on the stem. A skidder, tractor, or hand-operated *come along* exerts pull on the chain. A second method is to use a jack that has been developed for use on the backside of such trees. The third and easiest method is to use a truck or house-moving jack that you insert in a square backed notch in the back of the tree (Figure 5-12).

5-5. Rotten Trees. Rotten butted trees present a special problem, and most serious accidents in felling result from trying to fell rotten butted trees. It is difficult to anticipate the time or direction of their fall. If possible, make felling cuts high enough to avoid the worst of the rot

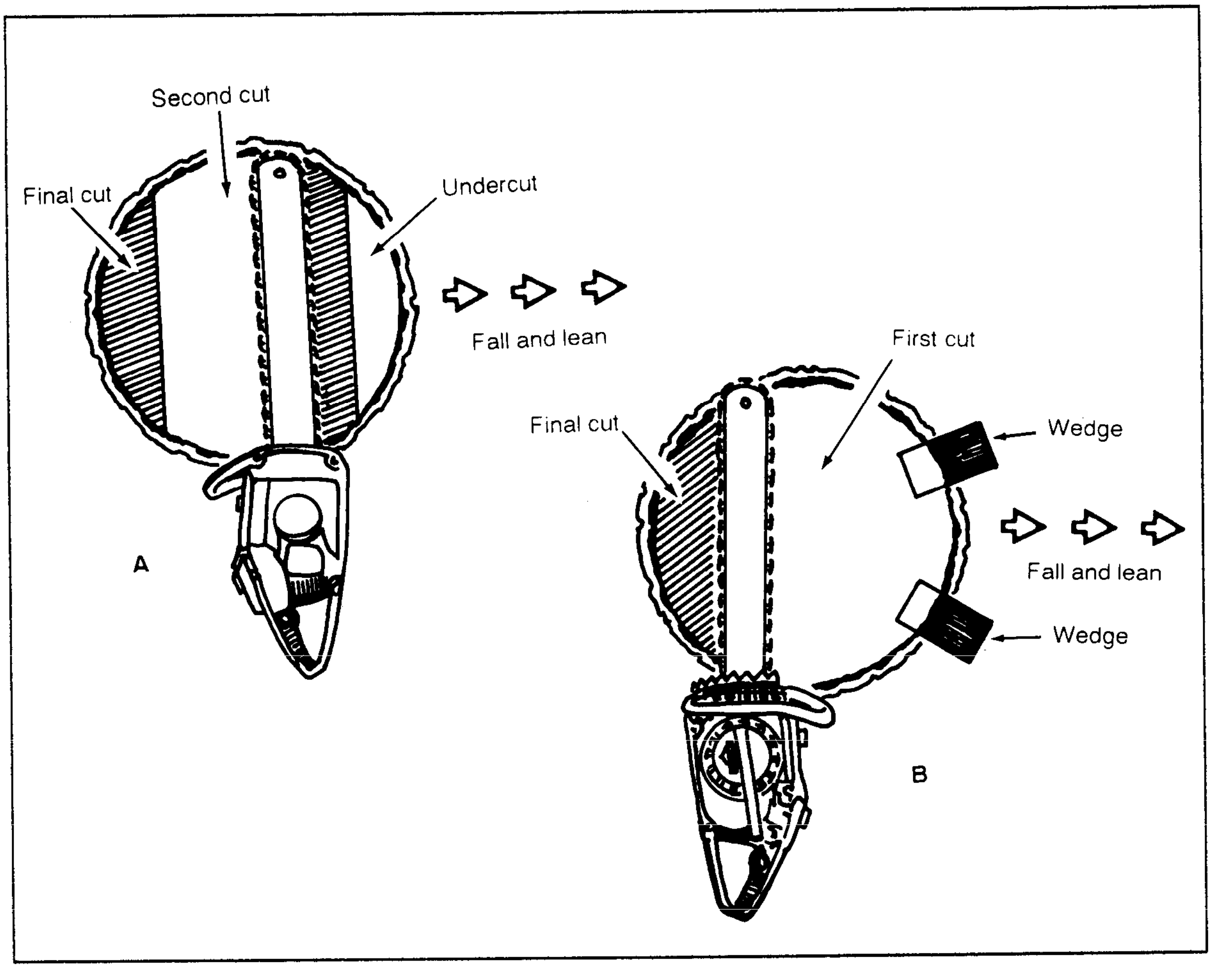


Figure 5-11. Special chain-saw techniques

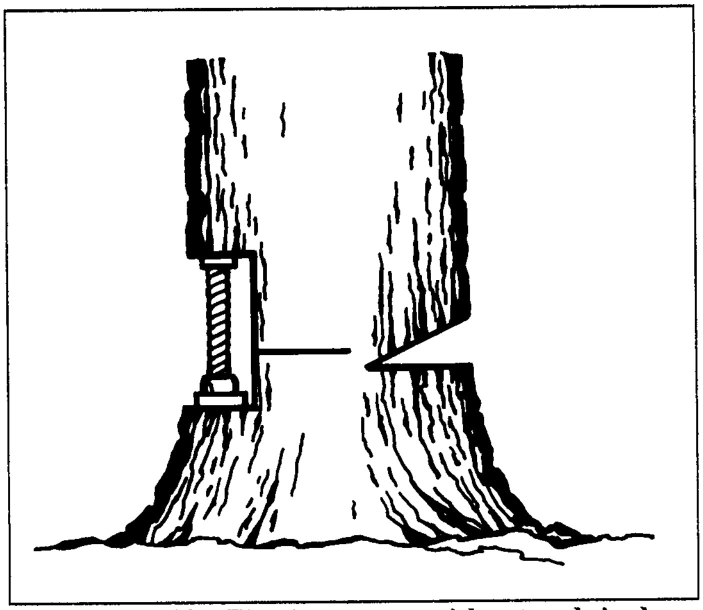


Figure 5-12. Tipping a tree with a truck jack

(Figure 5-13, page 5-8). Doing so results in safer felling. Also, you save time by not having to saw rotten wood off the butt, When the rot goes up too high, you may be able to saw around the rot with cornering cuts similar to those used for leaning trees (Figure 5-14, page 5-8). Remain extremely alert when felling a rotten tree.

5-6. Lodged Trees. Any tree faller can lodge a cut tree into a standing one. A sturdy limb on the tree being felled or the tree in its way may fail to bend as expected, or the cut tree may fall or twist a little out of line. More experienced felling crews will lodge fewer trees. Dislodging may be easy

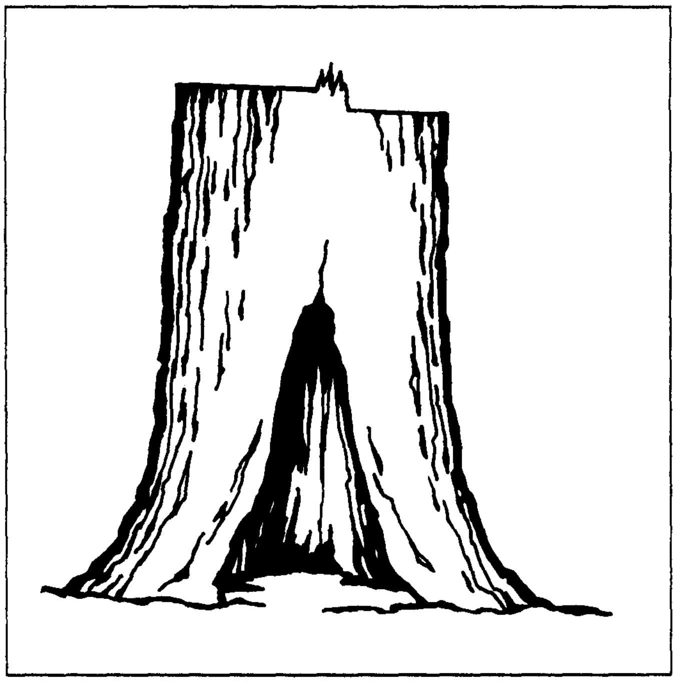


Figure 5-13. Cutting high to avoid rot

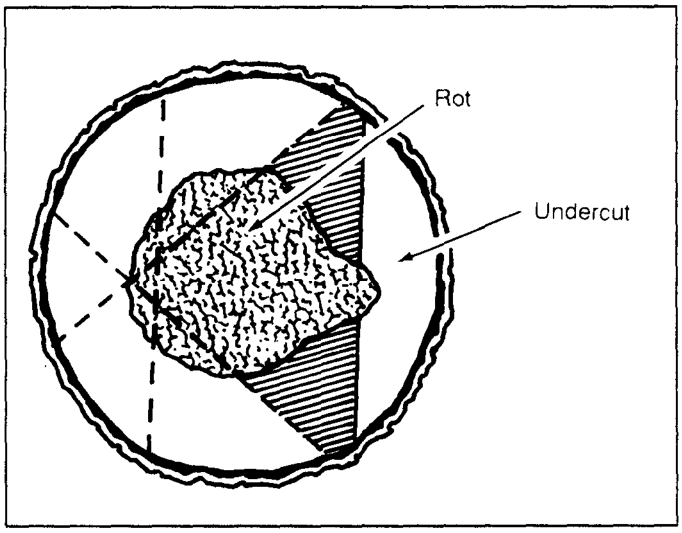


Figure 5-14. Sawing around rot

and safe or difficult and dangerous, depending on conditions. Cutters must be able to diagnose how firmly a tree is lodged and what method to use to get the tree down.

If the tree is lightly lodged, cutting it loose from its stump and prying the butt off to the ground may cause the tree to dislodge and fall. If only the ends of the limbs are caught, pushing or twisting the tree may dislodge it. Avoid climbing on the lodged tree and jumping up and down to dislodge it.

The safest and most practical way to free a lodged tree is to back the logging tractor to within a safe distance from the lodged tree, attach the winch cable around the butt, and pull the tree down. The most dangerous way to remove a lodged tree is to cut the tree in which it is lodged. Judging stresses and the direction of fall for either tree is not possible.

Chapter 6
Bucking and Scaling

This chapter discusses bucking (cutting the tree into log lengths) and scaling (measuring the log). It explains which tools to use to buck and scale and describes how to deal with common defects in logs. Because of technical advances and other forest practices, it is becoming more commonplace to hand skid whole tree lengths out of the forest. Bucking, scaling, and limbing, once done in the forest, are now completed elsewhere.

6-1. Bucking. A bucker must know the products that an operation supplies and the specifications the user or the sawmill prescribes. Specifications will include the acceptable species, diameters, lengths, knots, rot, other defects and growth rate of these trees, The bucker should put the maximum volume obtainable into the highest-value products. Generally these will occur in the butt sections of the trunk.

Sawlogs have several grades. You can use saw bolts that are shorter than the standard 8-foot minimum, Therefore, stockpile them for that possibility. Material that does not meet the specifications of the higher-graded products is acceptable as fuel wood or other products. Such material may include the remaining woody volume of the tree.

Because of mechanization, the bucking operation moved from the stump location to the loading or landing sites and the sawmill. Experienced bucking crews size up the tree stem and measure out the proper lengths for the various products prescribed. Softwood sawlogs are usually cut into 8-, 10-, 12-, 14-, and 16-foot lengths, with 3-inch trimming allowances. Hardwood sawlogs are accepted in odd and even lengths. Frequently, different grades of logs suited for different uses will be separated at the landing site and loaded separately. The following lists bucking tips:

- Make cuts at the points of most abrupt crook, leaving the cut logs as straight as possible.
- Group defects in one log, if possible. If defects are too widely dispersed, try to place them at or near the ends of the logs where they can be trimmed off.
- Make cuts at right angles to the axis of the log, when possible. Adhere to length requirements. Cutting logs too long or too short is the most serious cause of waste material.
- Avoid sawing too closely to the base of a crotch and showing a double heart at the small end of the log.
- Avoid splitting logs in bucking. If one end of the piece you are cutting is hanging free, make the first bucking cut from the underside up to about one-third of the diameter. Make a second cut from the top down to meet the first cut. In bucking a piece suspended at the two ends, make the first cut from the top and the second cut from the bottom. To avoid pinching, use a prop or a *Dutchman* underneath the cut you are making (Figure 6-1, page 6-2).

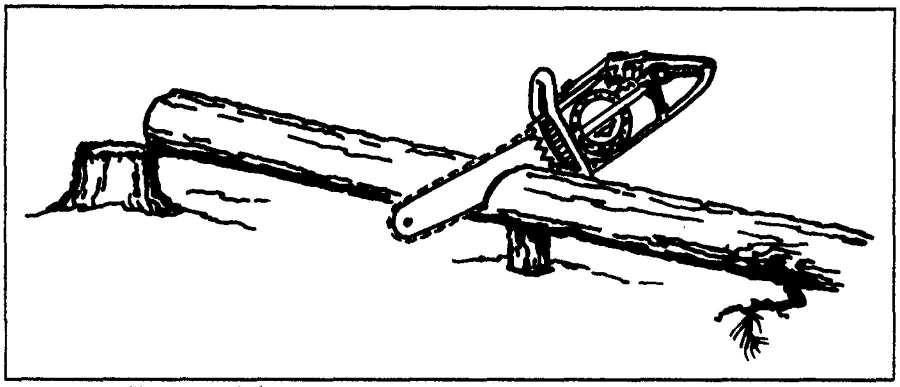


Figure 6-1. Bucking with a prop or a Dutchman

6-2. Log Grades. A *log grader* must be familiar with the log grading system for the species being cut. All grading systems are based on the grade of lumber needed as an end product. Logs suitable for sawing must meet the minimum standards of length, diameter, quality, and species. Many factors, such as defects, straightening, old age, and disease, influence lumber grades. The lead bucker should set up a grade system (Table 6-l). A separate table maybe necessary for timber needed in longer lengths. Also, it maybe helpful to develop and follow a bucking plan (Figure 6-2).

Table 6-1. Example of log-grading system

Log Grade	Small End Diameter	Requirements	Description
No. 1 (good)	Over 10 inches	All lumber cut from this log must be No. 1 common or better.	Surface and ends clear of defect, and sapwood bright in color. Two small limb knots are allowed, but two large knots on body knots make it a No. 2 grade. If the knots occur at each end, it is a cull log.
No. 2 (common)	Minimum 6 inches	Two-thirds of the lumber cut from this log must be No. 1 common or better.	Must not have more than three standard defects or be only slightly wormy.
No. 3 (cull)		One-half of the lumber cut from this log must be No. 2 common with a little of the better grades.	More than two limb or body knots. Some worm and knot defects.

NOTES:
1. Standard defects are knots, rot, shakes, season checks, frost cracks, sun, scald, fire scars, seams, wormholes, stain, spiral or crooked grain, cat faces, and crook in the log. Most exterior checking and shallow cat faces are not defects, since they go into the slab only.
2. No. 1 common—two-thirds of the surface of the board is clear-faced.
3. No. 2 common—one-half of the surface of the board is clear-faced.

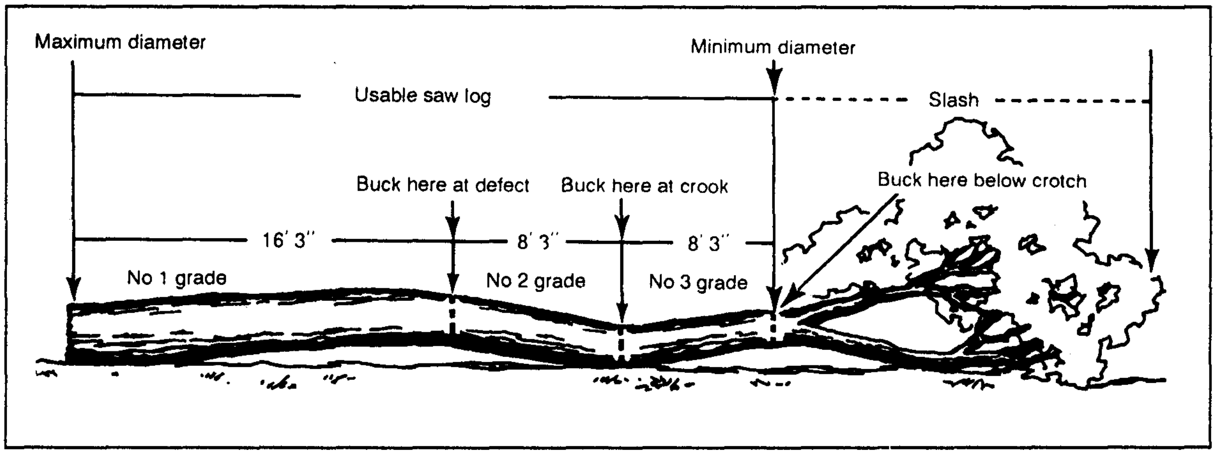


Figure 6-2. Log-bucking plan

6-3. Log Classification. The most important function of the log scaler is classifying uncut logs. Judgment of log quality determines the use of the logs.

a. *Bolts and Billets,* Bolts are short portions of logs. You get billets by halving, quartering, or splitting bolts or short logs along its length. Bolts and billets are used for cooperage and crating.

b. *Poles.* Pole specifications vary greatly. They must be of the best quality, and their dimensions are very specific. Defects to look for include crookedness, split tops and butts, sap, and rot.

c. *Piling.* Piling classification and grading depend on use, such as in fresh water or salt water or on dry land. If the kind of wood is not specified, the requirements of length, straightness, and butt diameter always apply.

d. *Railroad Ties.* The specifications for these ties usually are sound timber of good quality, stripped of bark, and free from imperfections that might impair strength and durability. Ties are classified according to the species of wood, wearing and lasting qualities, need for preservation treatment, and thickness and width of face or dimensions.

e. *Mine Timbers.* Most mine timbers are round or rough-cut materials other than finished lumber. Examples include mine props, caps lagging, sills, and mine ties. Rough-cut lumber is used for mine rails, collar timbers, brattice or partition boards, and stringers.

f. *Fuel Wood.* Any wood that is measured by the cord and is in the form of round or split sticks is fuel wood or cord wood. Firewood is measured in standard cords (4-foot lengths) or short cords of stove wood and other material (12-to 20-inch lengths).

6-4. Log Scaling. The log scaler can measure log lengths with an 8-foot long measuring stick. Add 2 to 6 inches to the length so that rough ends can be trimmed at the sawmill. For scaling purposes, the average diameter inside the bark at the small end of the log is the measured point. Measure several diameters, where necessary, to get a fair average. (Round measurements to the nearest inch.) After scaling a log, mark it to avoid repeating the scaling process. If systematic scaling is done, use a log-scale book to record measurements. Figure 6-3 (page 6-4) shows a sample log-scale recording sheet.

The log scaler uses either the Scribner Decimal C Log Rule (Table 2-4, page 2-12) or the International Scale Log Rule (Table 6-2, page 6-5) to determine the number of board feet in a log. The scale stick is 40 inches long and calibrated to show the board foot contents of logs up to 40 inches in diameter.

Log No.	Length (feet)	Diameter (inches)	Scale (sq ft)	Log No.	Length (feet)	Diameter (inches)	Scale (sq ft)
1.				12.			
2.				13.			
3.				14.			
4.				15.			
5.				16.			
6.				17.			
7.				18.			
8.				19.			
9.				20.			
10.				21.			
11.				22.			

Figure 6-3. Sample log-scale recording sheet

a. *Scribner Decimal C Rule.* Scaling is subject to many small differences in practice, depending on the region and the organization. The most common and the easiest system is the Scribner Decimal C Rule. The maximum and minimum scaling lengths are usually set for each timber-cutting operation. Logs that are longer than the minimum scaling length are scaled in 2-foot increments. With odd lengths, the logs are scaled to the nearest even 2 feet below the actual length. A trimming allowance of 3 inches is allowed over scaling length. A trimming allowance that is too large is corrected by scaling the log to the next longest 2 feet. Ordinarily, all logs over 16 feet are scaled as two or more logs as close to the same length as practical. Lengths of 16 feet or 12 feet are preferable when dividing a long log for scaling.

Measure the log’s length with a tape. The result of the average DIB at the small end is in inches. Figure 6-4 (page 6-6) shows a scale stick and a ruler that you use to measure logs. The scale sticks show the DIBs (in inches) on the bottom edge and the board-foot volumes (in tens) above them. Except where the small end of the log is perfectly round, measure the DIB the long and the short way, find the average, and round to the nearest inch, For example, if the DIB is 18.5 inches the long way and 16 inches the short way, the average is 17.2 inches. The log would be a 17-inch log.

Table 6-2. International Scale Log Rule

Diameter (inches)	Length (feet)												
	8	9	10	11	12	13	14	15	16	17	18	19	20
	Contents (board feet) in tens												
6	10	10	10	10	15	15	15	20	20	20	25	25	25
7	10	15	15	15	20	20	25	25	30	30	35	35	40
8	15	20	20	25	25	30	35	35	40	40	45	50	50
9	20	25	30	30	35	40	45	45	50	55	60	65	70
10	30	35	35	40	45	50	55	60	65	70	75	80	85
11	35	40	45	50	55	65	70	75	80	85	95	100	105
12	45	50	55	65	70	75	85	90	95	105	110	120	125
13	55	60	70	75	85	90	100	105	115	125	135	140	150
14	65	70	80	90	100	105	115	125	135	145	155	165	175
15	75	85	95	105	115	125	135	145	160	170	180	190	205
16	85	95	110	120	130	145	155	170	180	195	205	220	235
17	95	110	125	135	150	165	180	190	205	220	235	250	265
18	110	125	140	155	170	185	200	215	230	250	265	280	300
19	125	140	155	175	190	205	225	245	260	280	300	315	335
20	135	155	175	195	210	230	250	270	290	310	330	350	370
21	155	175	195	215	235	255	280	300	320	345	365	390	410
22	170	190	215	235	260	285	305	330	355	380	405	430	455
23	185	210	235	260	285	310	335	360	390	415	445	470	495
24	205	230	255	285	310	340	370	395	425	455	485	515	545
25	220	250	280	310	340	370	400	430	460	495	525	560	590
26	240	275	305	335	370	400	435	470	500	535	570	605	640
27	260	295	330	365	400	435	470	505	540	580	615	655	690
28	280	320	365	395	430	470	505	545	585	625	665	705	745
29	305	345	385	425	465	505	545	590	630	670	715	755	800
30	325	370	410	455	495	540	585	630	675	720	765	810	555
31	350	395	440	485	530	580	625	675	720	770	820	870	915
32	375	420	470	520	570	620	670	720	770	820	875	925	980
33	400	450	500	555	605	660	715	765	820	875	930	985	1,045
34	425	480	535	590	645	700	760	815	870	930	990	1,050	1,110
35	450	510	565	625	685	745	805	865	925	990	1,050	1,115	1,175
36	475	540	600	665	725	790	855	920	980	1,045	1,115	1,180	1,245
37	505	570	635	700	770	835	905	970	1,040	1,110	1,175	1,245	1,315
38	535	605	670	740	810	885	955	1,025	1,095	1,170	1,245	1,315	1,390
39	565	635	710	785	855	930	1,005	1,080	1,155	1,235	1,310	1,390	1,465
40	595	670	750	825	900	980	1,060	1,140	1,220	1,300	1,380	1,460	1,540

The inexperienced scalers should assume even tapers on all logs except butt logs. For example, a 40-foot log with a 16-inch DIB at the small end and a 21-inch DIB at the large end might be scaled as follows:

- One 16-inch log that is 12 feet long.
- One 17-inch log that is 12 feet long.
- One 19-inch log that is 12 feet long.

You acquire the above results in the following way:

- Total taper of the 40-foot log is 5 inches. That is large-end DIB (21 inches) minus small-end DIB (16 inches). If the log is even-tapered, figure 1/2 inch for every 4 feet.

- Top diameter of the 16-inch 12-foot log is the top diameter of the entire log (16 inches).
- Top diameter of the 17-inch 12-foot log results from 16 inches plus 1 1/2 inches (3 by 1/2) rounded to 17 inches.
- Top diameter of the 19-inch 12-foot log results from 17 1/2 inches plus 1 1/2 inches (3 by 1/2), which is 19 inches.

Inexperienced scalers should use the taper tables for butt logs. In some operations, you can use odd-length lumber. Scale the logs to the nearest whole foot in length below the actual length rather than to the nearest even foot.

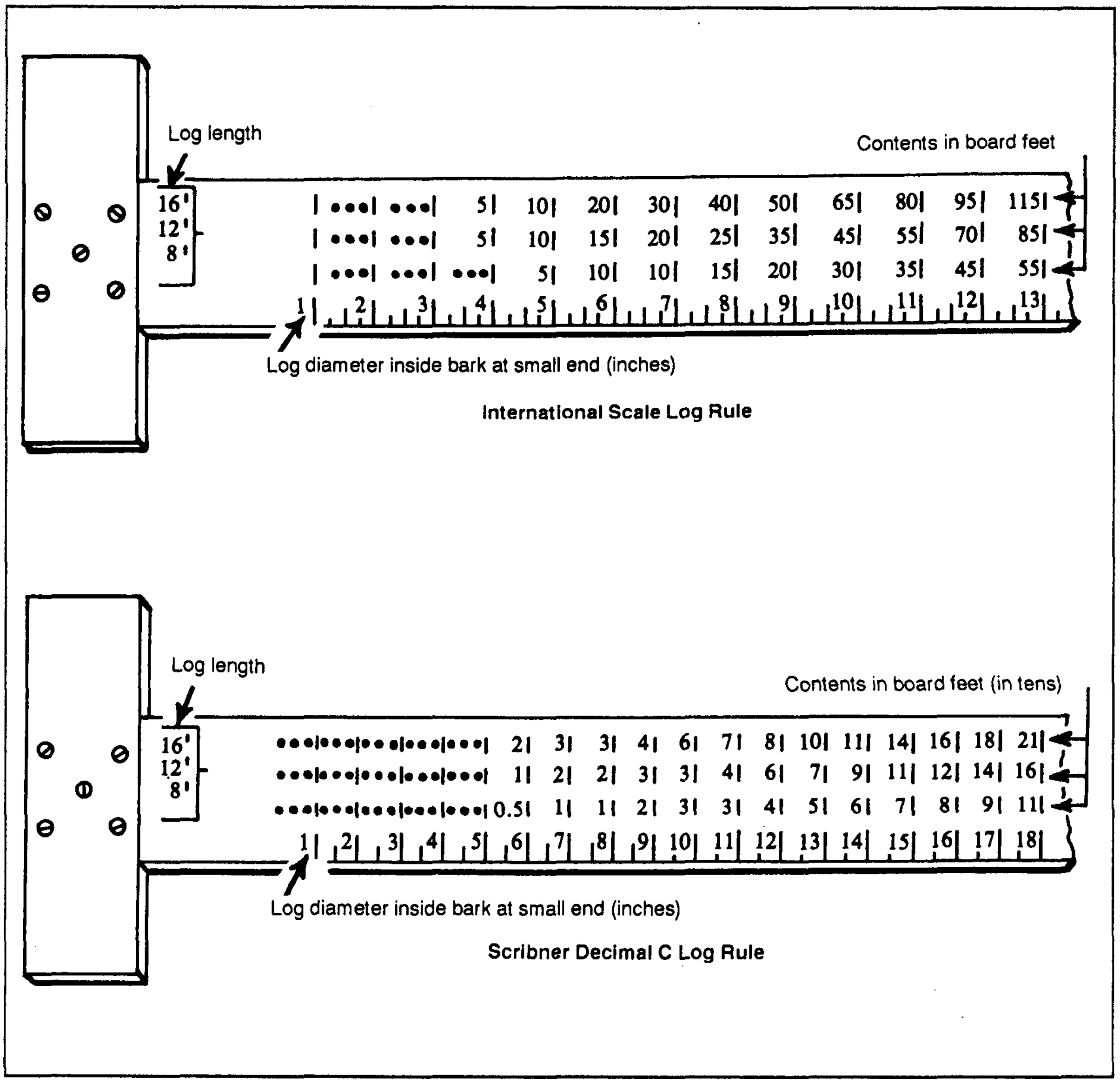


Figure 6-4. Log rules

Inexperienced scalers should usc the taper tables for butt logs. In some operations, you can use odd-length lumber. Scale the logs to the nearest whole foot in length below the actual length rather than to the nearest even foot.

(1) Deductions. The Scribner C Rule is measured from the diameter of the small end of the long inside bark and allows for boards l-inch thick with a saw kerf (width of cut made by a saw) of 1/4 inch between boards. No allowance is made for taper. However, in the tables, a certain amount of solid wood around the edges is allowed for slabbing. Be careful about allowing for the same defects twice. For example, if you allowed for any part of the defect falling in the slabs that you deducted by the rule or in the saw kerf already deducted by the rule, do not allow the deduction in scaling. When the defect is in the center of the log, reduce the deduction by the amount of saw kerf only. When the defect comes in from the surface of the log, the deduction is reduced by the amount of taper and slabs as well as by the amount of saw kerf.

(a) Right cylinder. The Scribner Rule treats the log as a right cylinder with the diameter equal to the average DIB at the small end and the length scaled to the log's length. A right cylinder is a cylinder whose ends are perpendicular to the length. Disregard all defects outside the log's right cylinder because, generally, no wood outside the right cylinder is included in the log's gross scale. Also, a certain amount of slabbing is usually omitted from the gross scale. The amount varies with the size of the log. However, when allowing for defect, assume that the amount is equivalent to a 1 -inch- thick collar that is just inside the edge of the right cylinder. Figure 6-5 shows defects in logs.

The standard rule for allowing for defects within the right cylinder and the inside edge of the slab collar is —

$$d = \frac{abL}{15}$$

where—

d = deduction, in board feet.
a = defect depth or thickness, in inches
b = defect width, in inches.
L = defect length, in feet.

Divide the deduction by 10 to obtain tens of board feet corresponding to values given by the Scribner Decimal C Log Rule. The denominator in the rule is 15 instead of 12 because 15 reduces the amount already deducted in the rule for saw kerf by 20 percent.

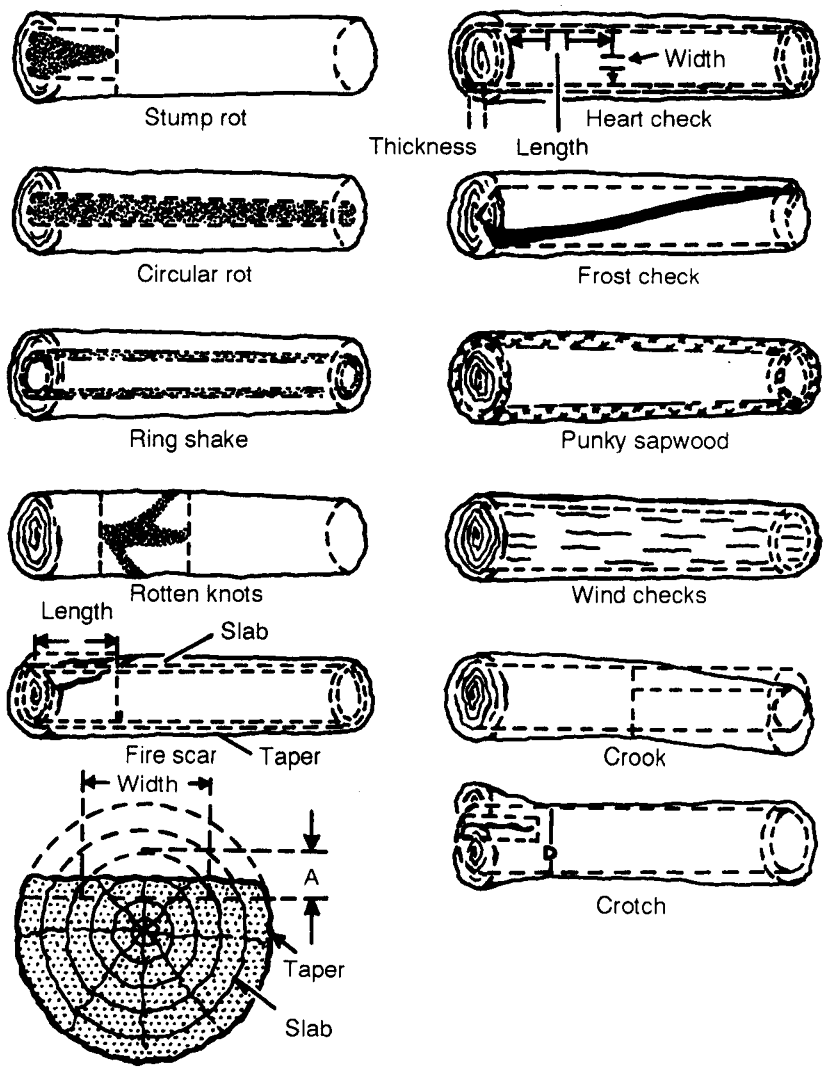


Figure 6-5. Defects in logs

(b) Circular logs. For circular defects in the center of the log, use the following formula:

$$d = \frac{(D^2 + 1)L}{15}$$

where—

d = deduction, in board feet.
D = actual average diameter of the circular defect, in inches.
L = defect length, in feet.

(c) Rectangular logs. For defects in a rectangular log piece, use the following formula:

$$d = \frac{(a + 1)(b + 1)L}{15}$$

where—

d = deduction, in board feet.
a = actual rectangular defect thickness, in inches.
b = actual average defect width, in inches.
L = defect length, in feet.

(d) Cull logs. The amount of defect necessary to classify a log as a cull log varies in different localities and usually is specified for each timber-cutting operation. Generally, valuable species with less than 33 percent merchantable gross scale (read from the scale stick or log table) are considered cull logs. Less valuable species with less than 50 percent merchantable gross scale are considered cull logs.

(2) Defects. Defects may be grouped as interior defects (stump rot circular rot, ring shake, and heart check), side defects (fire scar, frost check, punky or broken down sapwood, and wind checks), and other defects (crook or sweep and crotch). Figure 6-5 shows defects in logs. No deductions are made for seams, stains, scalds, and sun damage.

b. *International l/4-Inch Log Rule.* In scaling logs using the International l/4-Inch Log Rule, the procedure is the same as for the Scribner Decimal C Rule, with modifications required because of the differences in construction of the two rules. The International Rule has a deduction of 1/16 inch for shrinkage and the l/4-inch saw-kerf deduction. The standard rule for defect deductions becomes—

$$d = \frac{a\,b\,L}{16}$$

where—

d = deduction, in board feet.
a = defect thickness or depth, in inches.
b = defect width, in inches.
L = defect length, in feet.

Unlike the Scribner Rule, you do not have to add 1 inch to the dimensions for sawing around the defect. Because of this, the formula for the circular defect becomes—

$$d = \frac{D^2L}{16}$$

where-

d = deduction, in board feet
D = average defect diameter, in inches.
L = defect length, in feet.

Since the International 1/4 Inch Rule allows for a taper of 1/2 inch per 4 feet of length, average the diameters of any defect appearing at both ends of the log when calculating for D, regardless of log length.

The International 1/4 Inch Rule does not set up a right cylinder for deductions. The rule does set up a cone frustum (a cone with its top cut off by a plane parallel to the base). The top diameter of the frustum is the top DIB of the log. The frustum has a uniform taper of 1/2 inch for every 4 feet. A collar of l-inch radial thickness is allowed for slabs in the frustum. Any defect or part of a defect falling outside the frustum or is slab collar is disregarded in scaling by the rule. Round off all deductions for defect to the nearest 5 board feet.

Chapter 7
Transportation Operations

This chapter discusses transporting logs from stump to landing to sawmill. Log transportation involves skidding and loading. There are many method involved. Whatever method or combination of methods you use, moving timber requires its own type of skid trail, machinery, or specialized equipment. The method you use depends on the size and weight of the timber to be handled, the terrain to be crossed, the cut per acre, and the total amount to be transported.

7-1. Landing and Skid Roads. Pay special attention to proper drainage and soil stabilization. Consider the following points when developing a landing location and road system:

- Locate landings first. Road approach should have a low grade. The timber length (whether short log or tree length), the loading method, and the type of hauling equipment will dictate landing requirements.
- Keep skid-road grades as low as topography will permit. Do not construct straight up the slope.
- Avoid stream beds, rocky places, and adverse grades.
- Cross streams at right angles.
- Break the grade occasionally to avoid long, straight grades that permit water to build up and cause erosion.
- Where possible, build the skid roads from the top down.
- Install water turnouts on main skid roads, if possible.
- Construct small bridges or install culverts at live stream crossings, particularly on the main skid roads and especially where water values are very important. (Water quality is always important.)
- Protect all roads against erosion.

7-2. Equipment for Skidding. A variety of equipment may be used to skid logs. The following paragraphs describe the special support tools and equipment used to move logs from stump to landing. See Chapter 1 for a discussion on heavy-moving equipment.

a. *Hooks.* Chokers and choker hooks (Figure 7-1, page 7-2) are common in logging operations. A choker is a short length of flexible wire rope. One end is fastened to the log by means of a sliding loop attached to a swivel. The other end is fastened to the tractor, Always use a swivel because choker cables (Figure 7-2, page 7-2) without swivels deteriorate rapidly due to the rolling and the turning action of the towed logs. The choker hook is the best device for securing logs for skidding. Its construction allows the cable to move freely through the sleeve when the log is secured. A conventional hook on the end of the choker makes the choker easier to attach to the log. Also, using a hook causes less wear on the cable. However, a hook may become disengaged, causing the loss of all or part of the load.

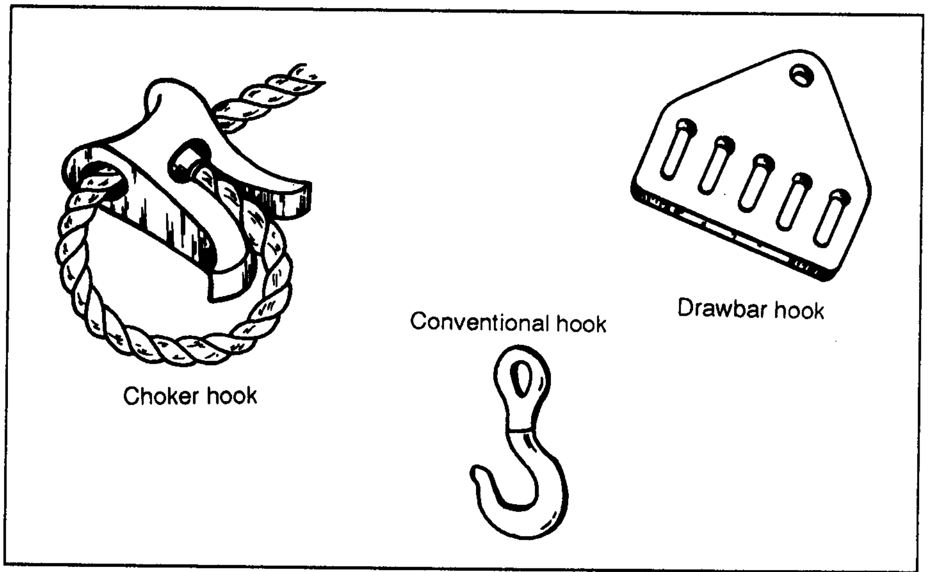


Figure 7-1. Choker and choker hooks

The draw bar hook can be attached directly to a tractor drawbar or secured at the end of the logging winch cable. The chokers are attached to the hook. One or more of the choker hooks can be attached to an eye loop. Using three or four short pieces of chain multiplies the number of chokers attached.

b. *Chains, Tongs, and Grabs.* Slip chains, skidding tongs, crotch grabs, and grabs are other pieces of equipment used for skidding logs (Figure 7-3).

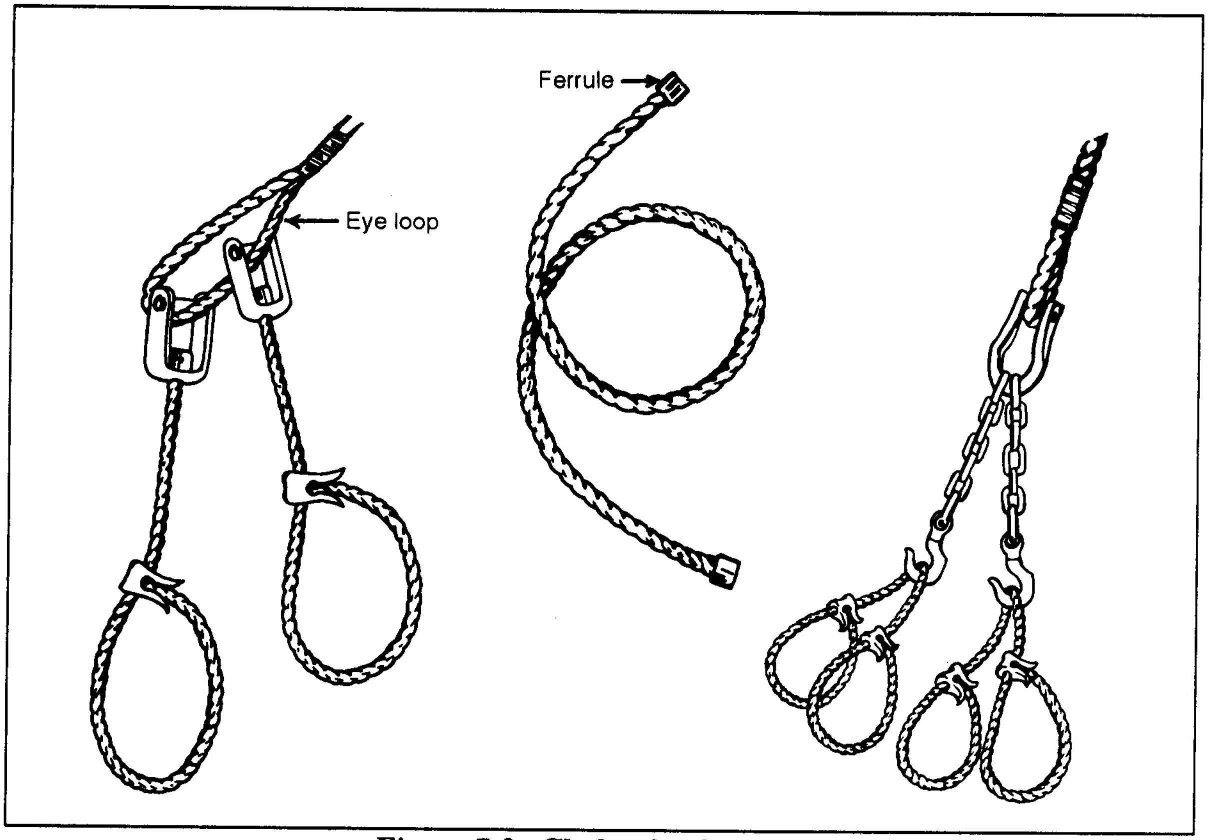


Figure 7-2. Choker hook rigging

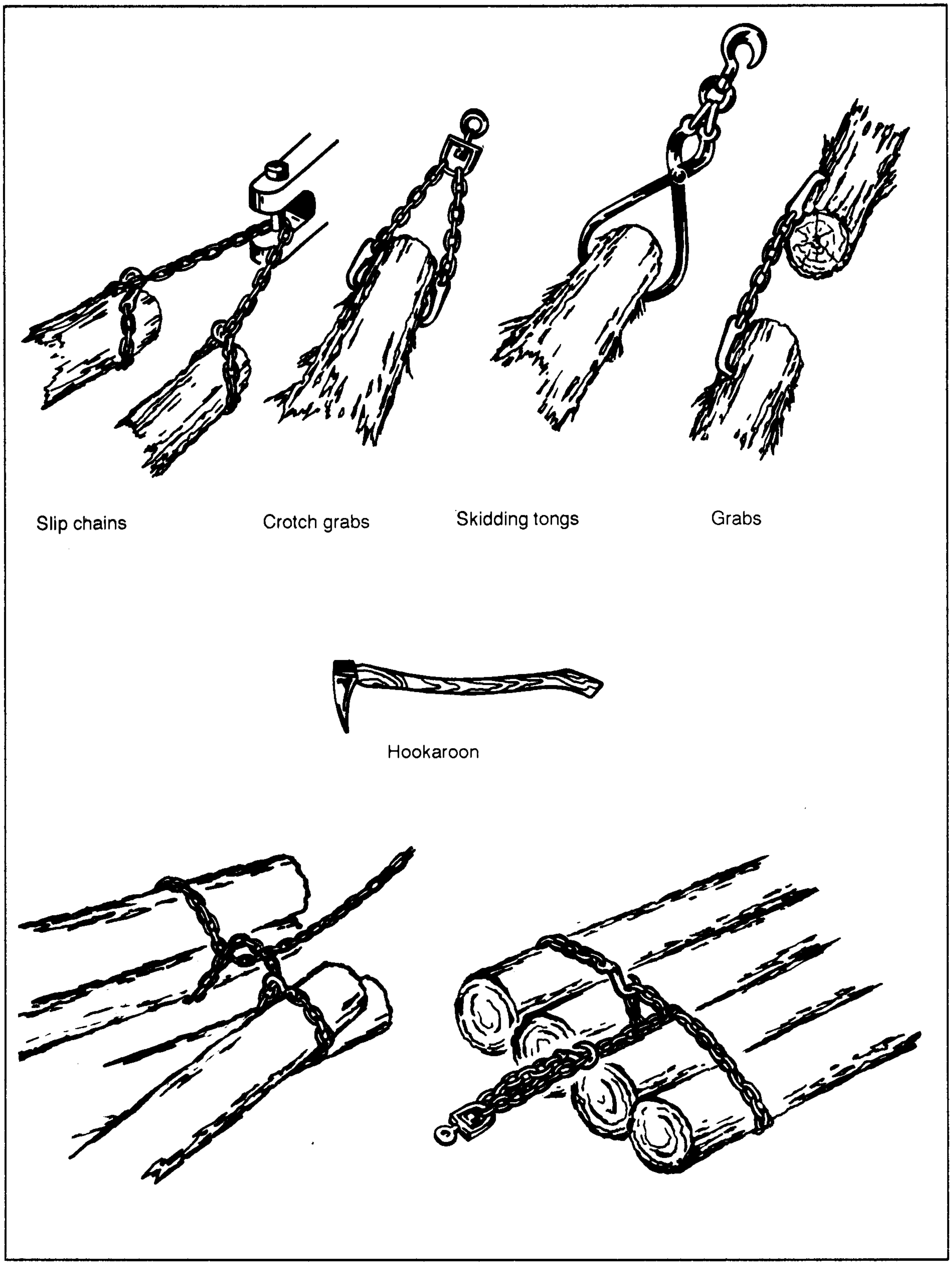


Figure 7-3. Chains, tongs, and grabs for skidding logs

(1) Chains. You can use a slip chain to skid light and heavy logs. Place the chain far enough down the log so that is does not slip off when pulled tightly. Keep the towing chain as short as possible to raise the ends of logs slightly when pulled.

(2) Tongs. Skidding tongs are set in position on the log with sufficient *bite* to take hold when movement begins. You may have to set the tongs with a maul or hammer. To remove the tongs, slacken the strain on the towing chains. The tongs will fall free with a small amount of prying.

(3) Grabs. The crotch grab is more adaptable to heavy work. Position the grabs on the side of the log, and use a hookaroon or grab skipper to drive them in the log. The grabs must be located down-the log far enough so that they will not slip out when skidding begins. To remove the grabs, use the sharp end of the hookaroon to pry them free. You can use grabs to form a train of logs. Set the grabs in position the same as you did the crotch grabs. Be careful when locating the grabs so that when skidding begins, the logs do not roll over and become fouled in the ground.

7-3. Ground-Skidding Procedure. (Ground-skidding devices are not available through military supply channels; however, you can fabricate them.) Start the load slowly to avoid jerking loose the slip chains or grabs. On curves and turnarounds, always keep the tractor on the outside so that the logs will have enough space to trail the tractor on the skid road. Turning the tractor sharply on the inside of curves will cause the logs to trail off the road. In a muddy area or on a steep grade, pay out the winch cable while driving the tractor forward to better ground. Use the winch to pull the load toward the tractor. Logs raised a few inches above the ground level at the hitch will move over obstructions more easily than if logs are skidded lying flat on the ground. Avoid or remove the larger obstructions, Avoid skidding logs on the ground for distances over 500 feet. Use an improvised antifriction device for such distances.

7-4. Cable Logging. Cable logging is another form of moving logs from the stump to the landing. Cable systems are not recommended because of the high cost of installation and maintenance. Cable systems are far more dangerous to the personnel working around them. However, you may have to use cable systems because of the logging area. Some places may be too rough or swampy to use other types of logging equipment to remove logs.

7-5. Loading. When you have moved a sufficient number of logs from the stump to the landing, start loading operations to move the logs to the sawmill. Loading for the haul to the mill may present problems in the design of the loading facilities for each location and each type of log handled. The variety of conditions under which loading has to be done adds to the number of systems and devices developed to help do the job. Loading can be either *hot* (logs placed on trucks as they are skidded from the forest) or *cold* (logs accumulated at the landing or yard and then loaded).

Loading is one of the most accident-prone operations in logging. Lifting heavy, irregularly shaped logs from the ground to the top of a load on the truck and securing them in place for travel over rough terrain is a difficult and dangerous task. Hand loading generally works well when loading small amounts of short logs. When loading larger amounts, use loading equipment. Improvise, as needed, to get the job done. Using forklifts, grapples, cranes, improvised conveyor systems, and trucks and trailers will save manpower and greatly increase the speed of the operation.

Sawlogs are generally too heavy to handload. Usually these larger logs must be rolled or hoisted on the bed of the truck or trailer. In steep country when loading equipment is unavailable, the best method to use is the double-deck skidway (Figure 7-4). With this method, you can load logs at different heights.

On level ground, use the cross-haul method to load logs. Figure 7-5 (page 7-6) shows a small crawler tractor pulling the logs up the skid onto the bed-of a truck. To load a large number of logs at a landing location, consider using a more permanent type of loading device. Crawler-mounted cranes, when available, or grapple-mounted forklifts are about the best. Currently, the bulk of the loading is done with hydraulically controlled knuckle-boom loaders (Figure 7-6, page 7-6).

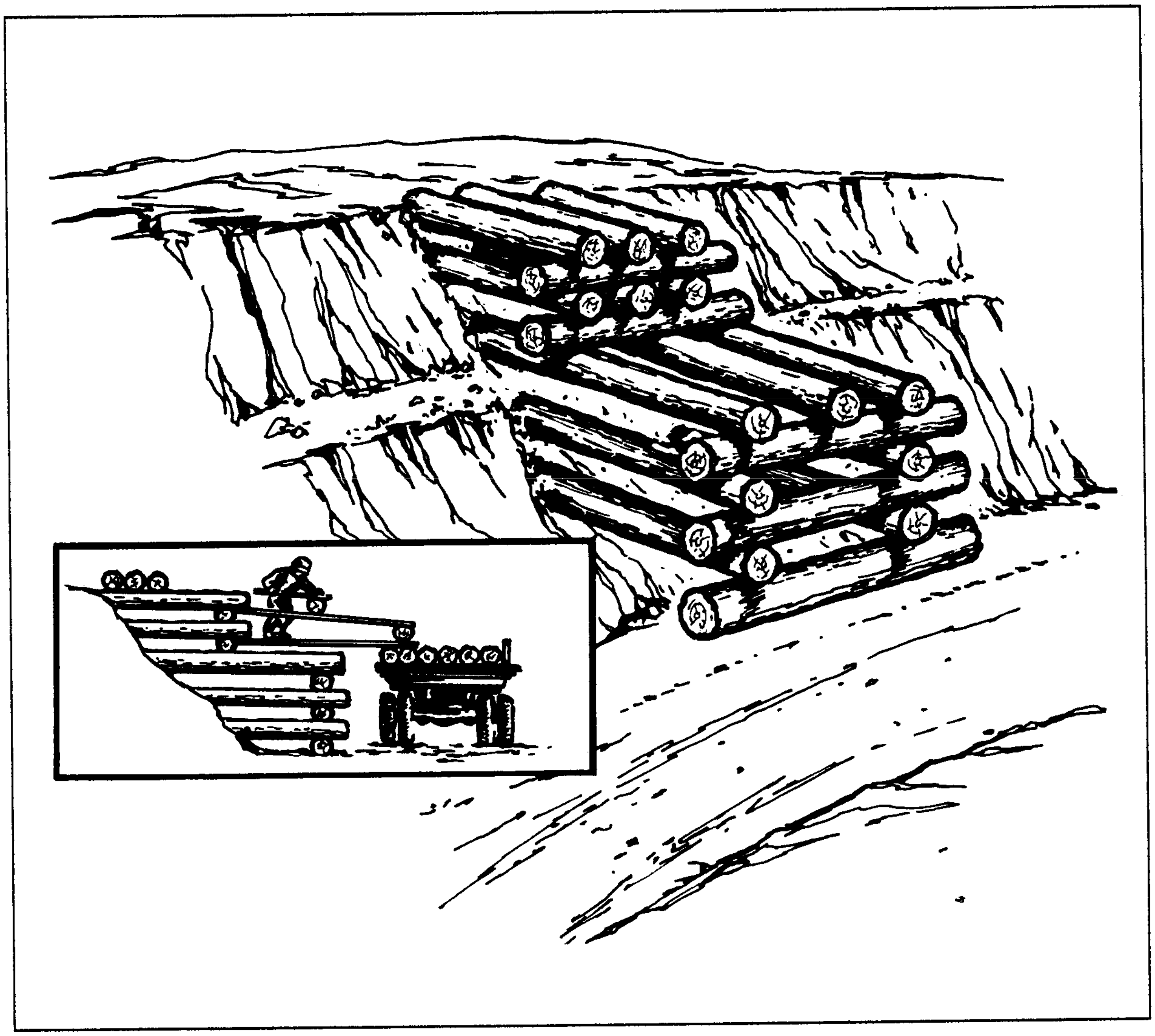


Figure 7-4. Double-deck skidway

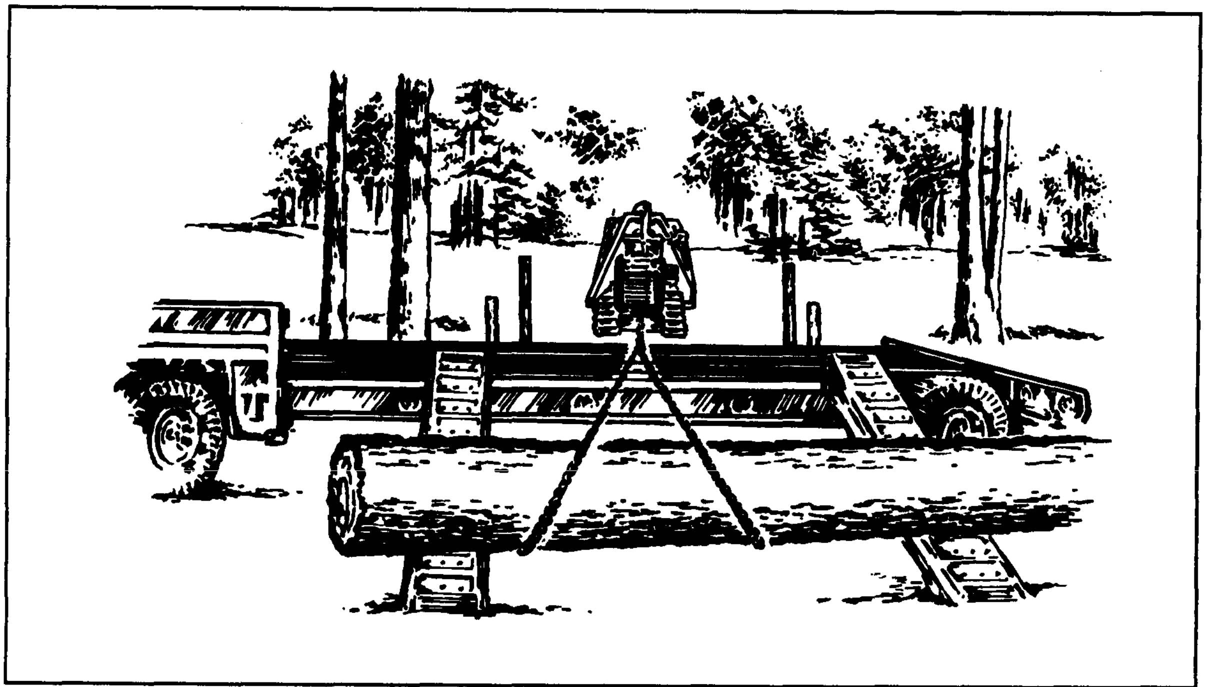


Figure 7-5. Cross-haul method of loading logs

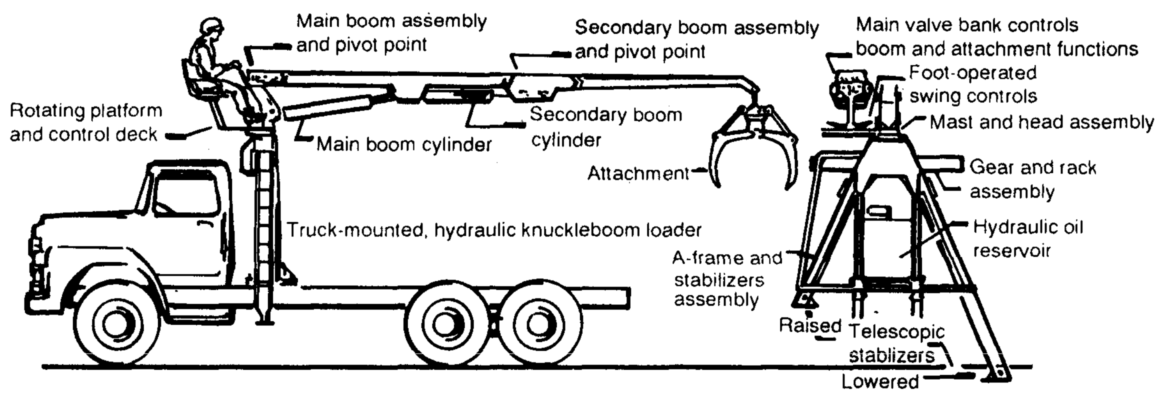


Figure 7-6. Knuckle-boom loader

7-6. Unloading. Long logs are usually unloaded by driving the load along side the landing place or pond on a tilt, releasing the stakes or bindings, and allowing the logs to simply roll off. You may have to roll off some logs by hand. When rolling logs off to level ground, be careful to avoid breakage. Where space is limited and there is no pond, you can use a crane, grapple, or grapple-mounted forklift to deck the logs in the yard.

Chapter 8
Sawmill Equipment and Operation

Military portable sawmills generally come in two configurations, the 50-inch, trailer-mounted sawmill and the 60-inch, semitrailer-mounted sawmill. The trailer-mounted mill is adapted to a single axle. The sawmill cuts softvood and hardwood logs. It is powered by a separate diesel or gasoline engine. The semitrailer-mounted mill is designed to saw rough lumber from softwood and hardwood It is also powered by a separate diesel engine. Both mills have similar features. (When discussing any cutting operation, the sawyer is the crew member being addressed.)

8-1. Sawmill Components.

a. *Headsaw.* This saw cuts the log into boards. The circular headsaw is the most common type of headsaw in use. It consists of a flat, steel disk with the teeth cut around the circumference. The saw is mounted on a shaft, which supplies the power. A log is cut into boards by successive passes through the saw.

b. *Headsaw Guide.* This guide (Figure 8-1) is used on circular saws to steady the saw. When properly adjusted, the guide clears the saw by about 1/32 inch on both sides of the saw-blade rim.

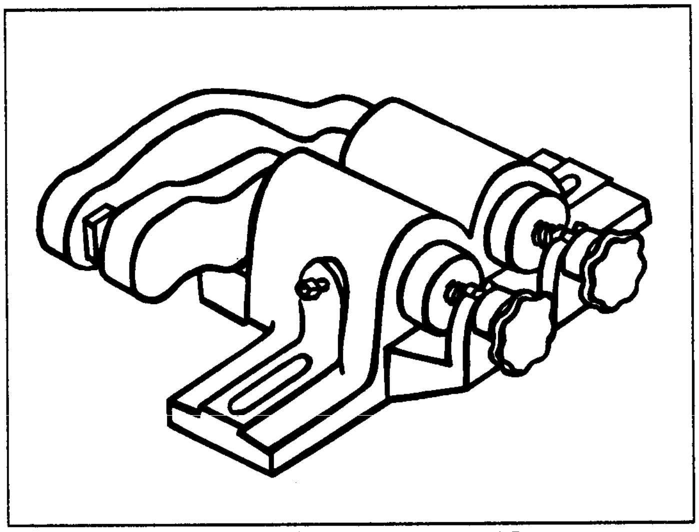


Figure 8-1. Headsaw guide

c. *Carriage and Trackway.* The carriage is a movable track on which the log travels to the saw. The carriage consists of two main parts: the frame with wheels and axles and the superstructure, which controls the lateral movement of the log toward the saw. There are two types of superstructures, the log beam and the headblock.

(1) Log-Beam Type. The log-beam mechanism (Figure 8-2, page 8-2) operates on several bases made either of light metal or timber beams. The mechanism moves at right angles to the length and travel direction of the carriage, thus pushing the log into the saw according to the desired cut thickness.

(2) Headblock Type. The headblock type (Figure 8-3, page 8-3) consists of two or more bases fastened to the frame. In each base slides a knee; each knee is connected to a mechanism for pushing the log into the saw.

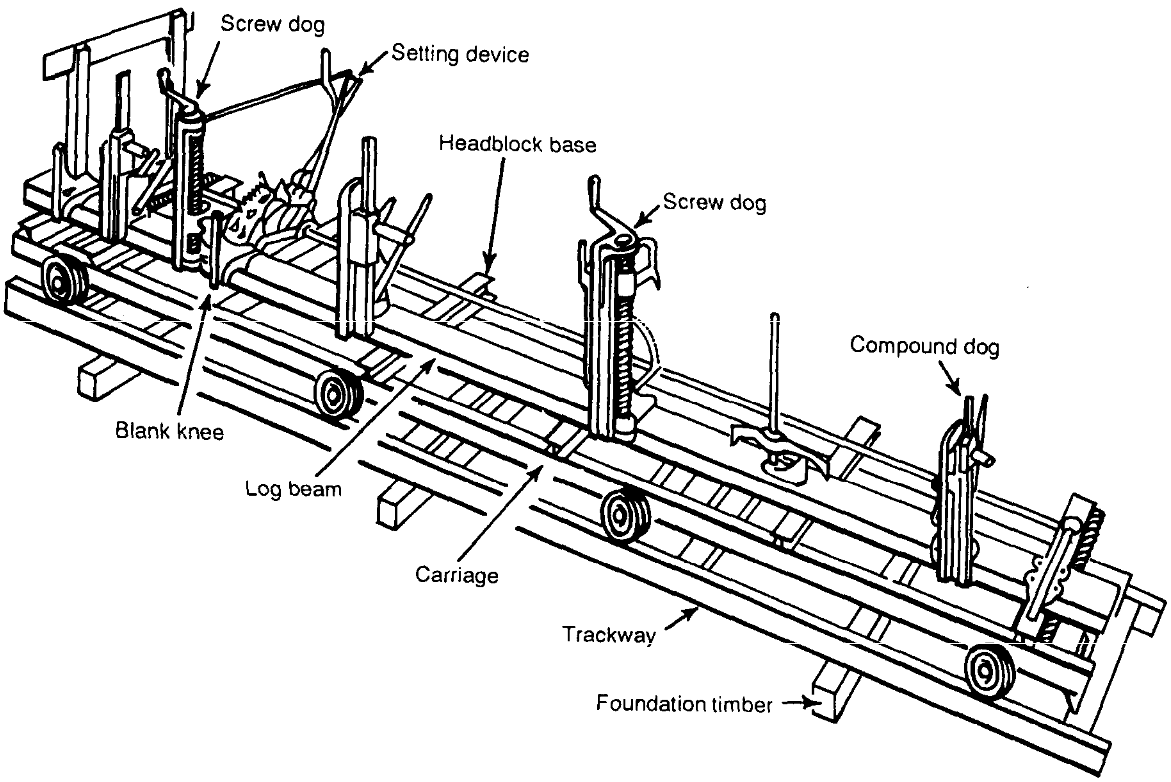


Figure 8-2. Log-beam-type carriage

d. *Feed Works.* Small sawmill feed mechanisms used to control the rate of log feed to the headsaw may be operated in several configurations: straight friction; friction combined with belts and pulleys; belts and pulleys; belts, pulleys, and clutches; gears and clutches; and electric, hydraulic, or steam-piston drives. Except for the steam piston, electric, and hydraulic types, the feed works are geared to recede the carriage about twice as fast as advancing it. On all types, try to adjust the advance rate to the load capacity of the saw or power source. In the straight friction mechanism, the braking action and power transmission depend on the friction where the wheel and disk are touching. Carriage reverse is normally sluggish.

e. *Dogs.* Dogs are used on small mills to hold the log firmly on the carriage. Figures 8-4 through 8-7 (pages 8-4 through 8-6) show different dogs used in sawing operations. Dogs use either a spike or a hook to grip the log. The basic types are the fixed post with spike attached, the sliding post, the hammer dog with spike arm, and the boss dog with lever-actuated hooks.

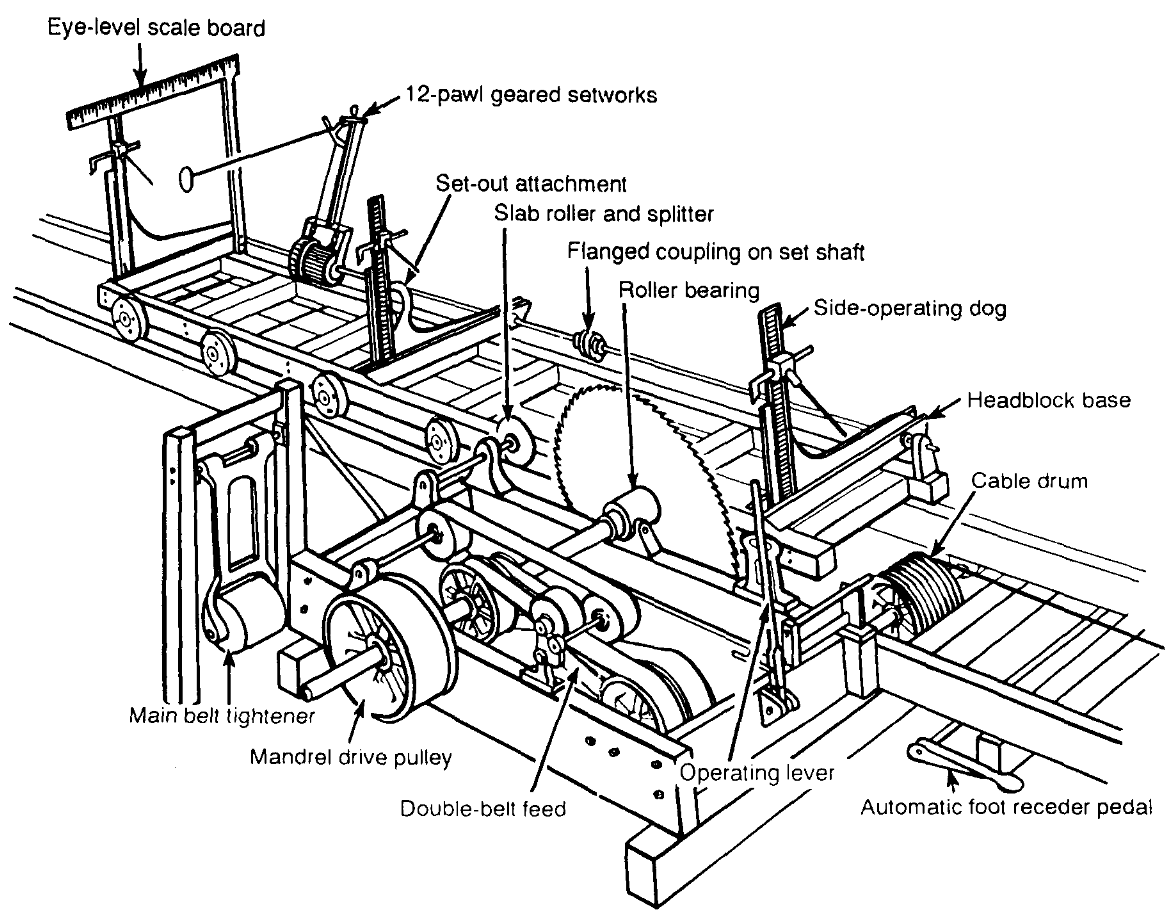


Figure 8-3. Headblock-type carriage

f. *Setworks and Receders.* The function of the setworks (Figures 8-8 and 8-9, page 8-7) is to advance the log quickly toward the saw line by intervals, accurately held to the thickness being cut, and to reverse the process speedily. Precision in reversing the carriage is not vital. Setworks and receders may be lever-operated or power-operated. Figure 8-10 (page 8-8) shows two power receders.

g. *indicators.* Indicators (Figure 8-11, page 8-8) show the distance between the face of the log and the saw line, giving the thickness of the board being cut.

h. *Log Turners.* Portable-sawmill operations rarely use mechanical log turners. An experienced deckhand, with a cant hook, can turn logs under 20 inches in diameter as quickly as power turners can, and with less shock to the carriage. Semipermanent sawmill setups and mills, which run larger diameter logs, may install mechanical log turners.

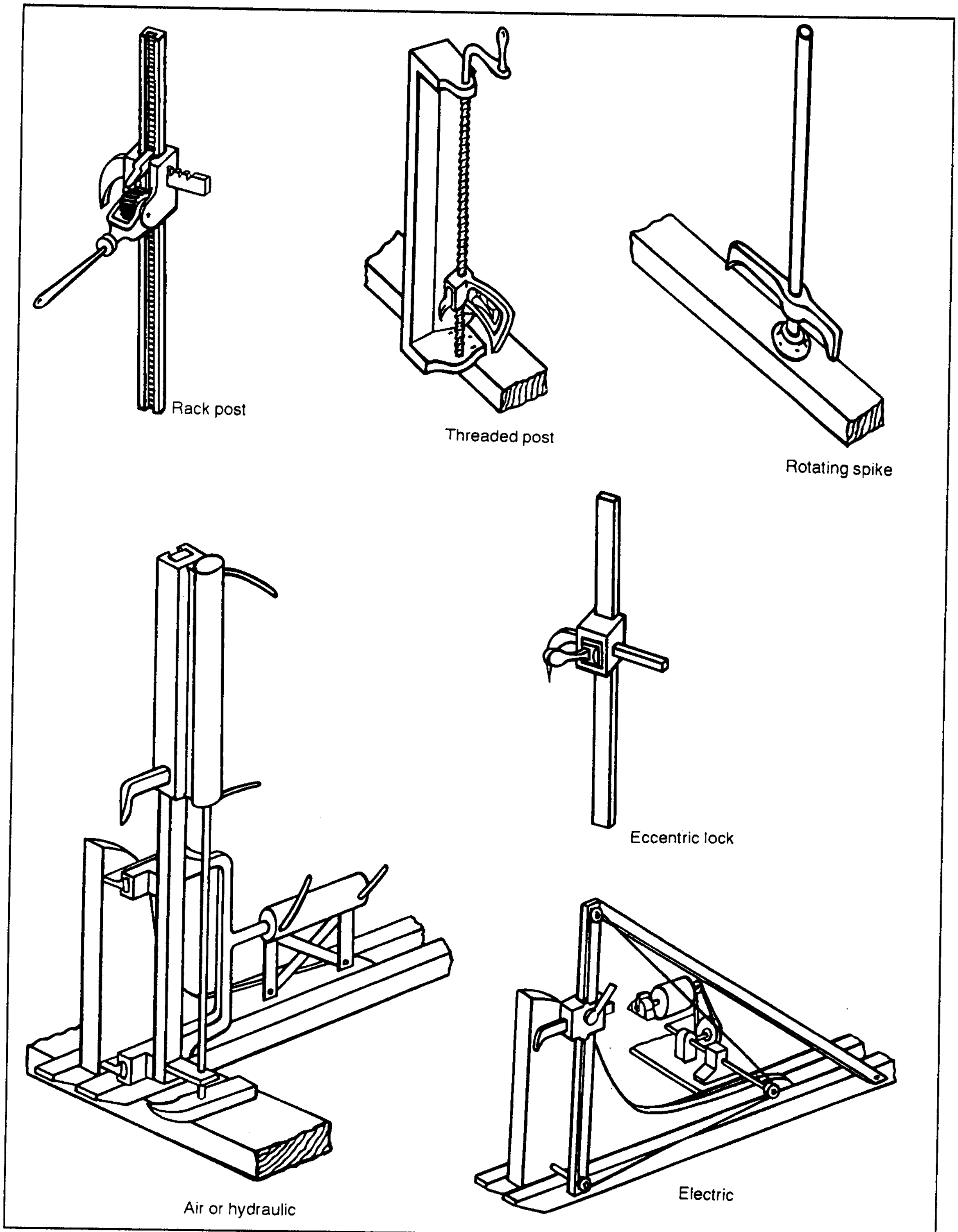


Figure 8-4. Fixed-post, manually operated dogs

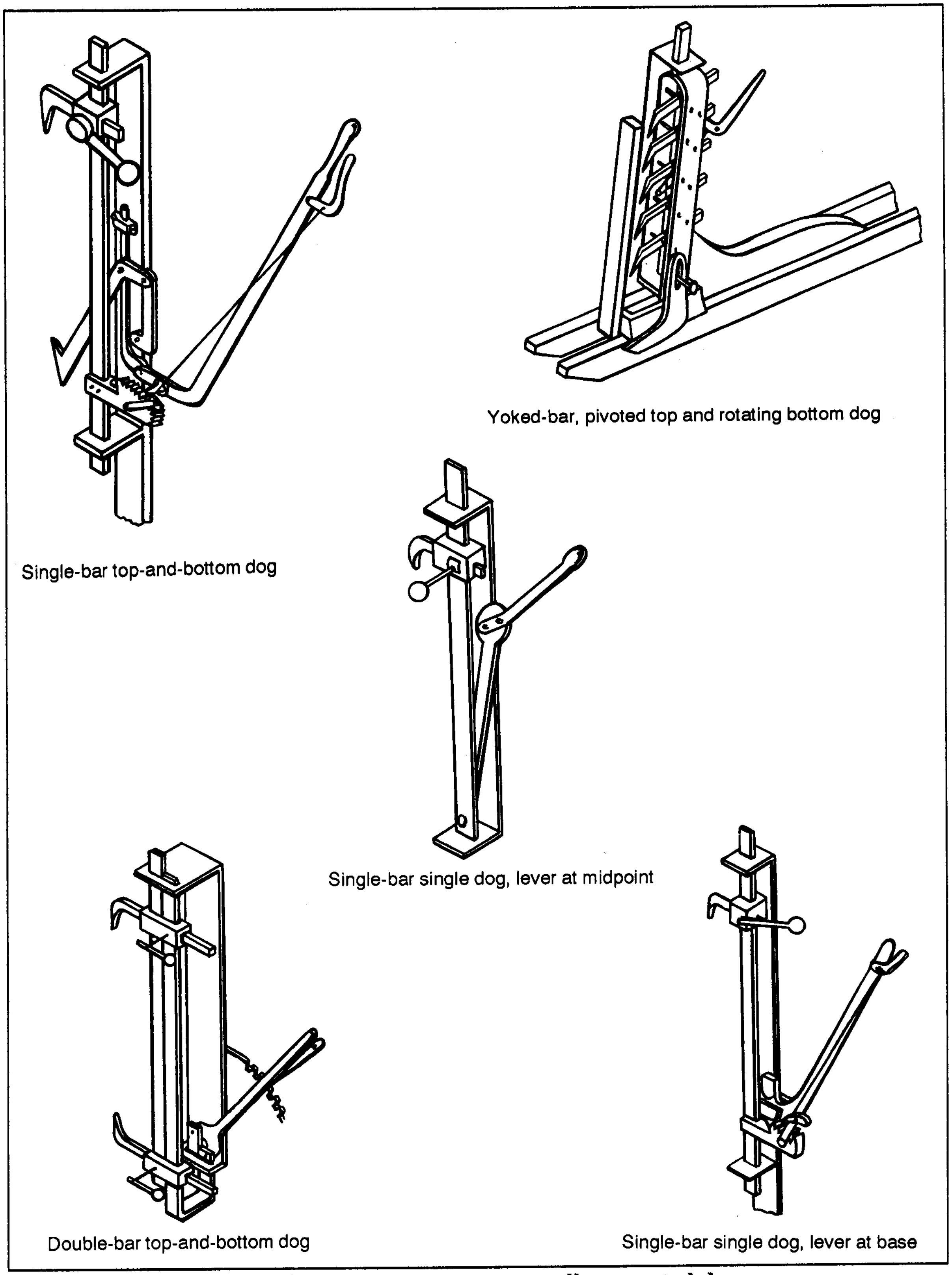


Figure 8-5. Housing-post, manually operated dogs

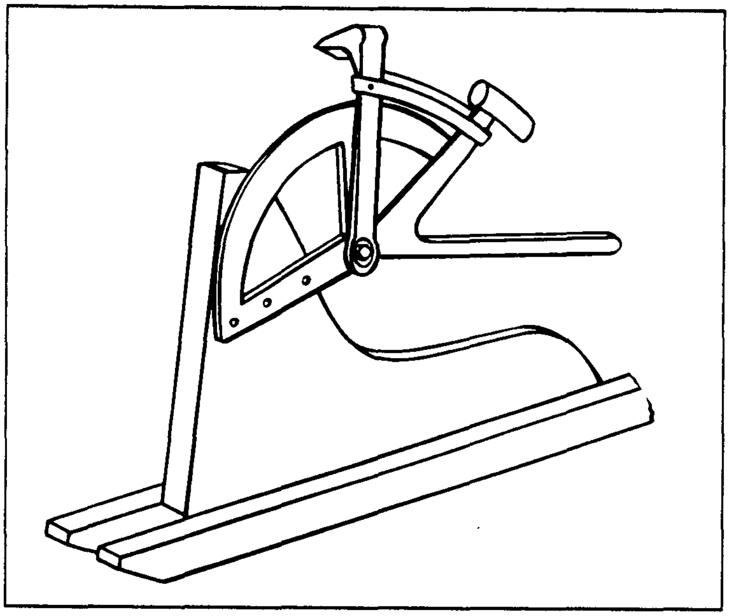


Figure 8-6. Hammer dog

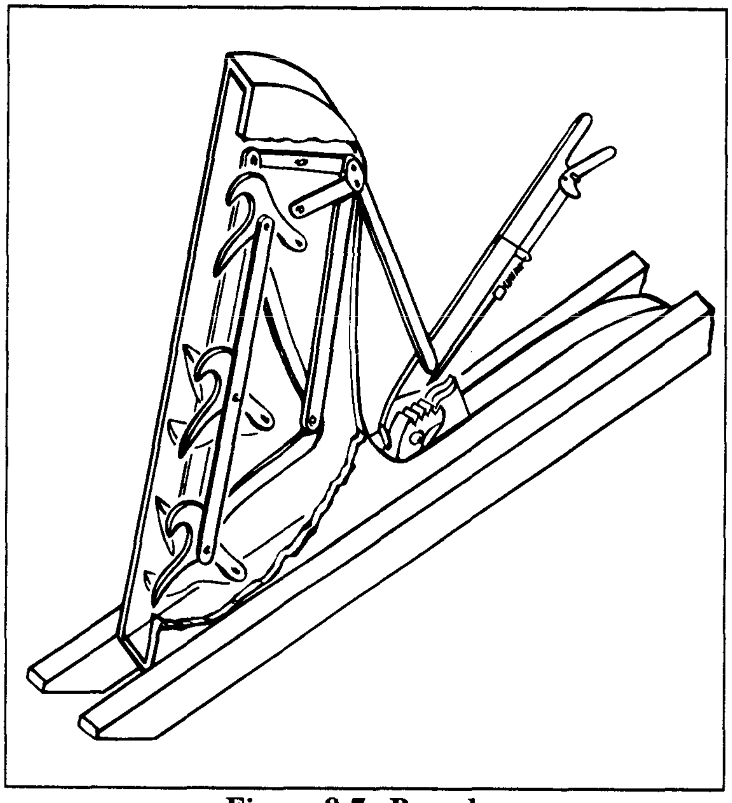


Figure 8-7. Boss dog

8-2. Crews. The efficient operation of the sawmill and associated facilities depends on the crew. Personnel and their duties vary; changes may be due to local factors.

a. *Portable-Sawmill Crew.* The crew of a portable sawmill will vary, depending on local conditions. When handling large, uneven logs, additional crew members may be needed on the log skids. Small- and medium-sized straight logs may require only two crew members to handle the skids. Two to four members are required to take the lumber from the edger and cutoff rig, depending on the sizes of lumber and the distance to the yard. One member may have to perform more than one operation when the crew size is limited. The following describes the various jobs performed by a sawmill crew:

- The sawyer is usually the sawmill foreman and is responsible for the crew's safety as well as for production.
- The block setter works closely with the sawyer, operating the setworks and the dogs on the front headblock.
- The dogger operates the dog levers on the center and rear headblock knees.
- The log skidder, working on the deck, keeps a supply of logs ready to be rolled onto the headblock base. This crew member also holds the log against the headblock knees when the log is being secured to the knees. If logs are heavy or crooked, one or two extra members may be needed on the log skids.

- The off bearer is stationed at the tail of the headsaw to handle the boards sawed from the log. In most cases, the off bearer puts the board on the lumber rollers and moves the freshly sawed board to the edger. If boards do not require edging, the off bearer passes the board along the lumber rollers to the cutoff rig.

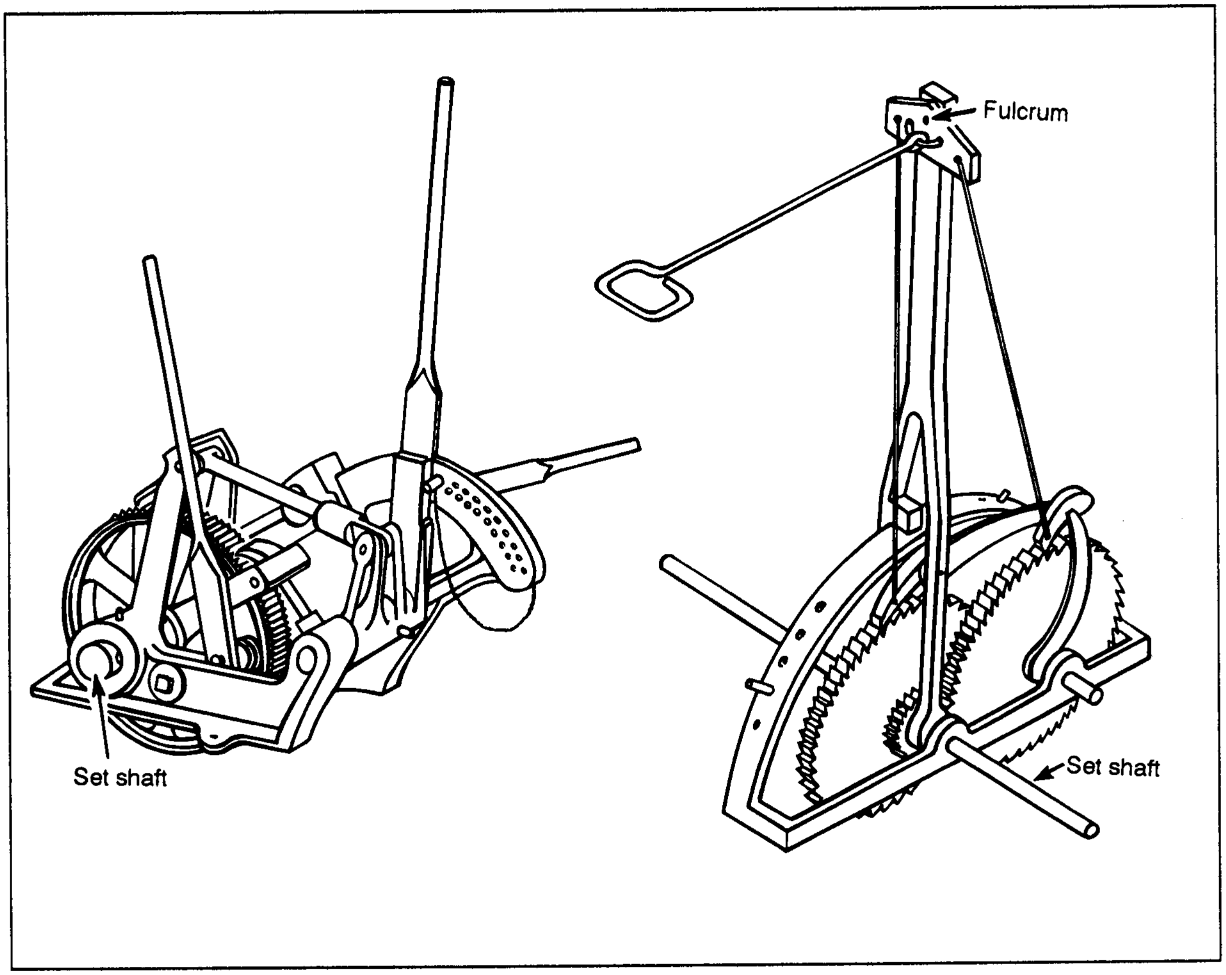


Figure 8-8. Lever-actuated setworks

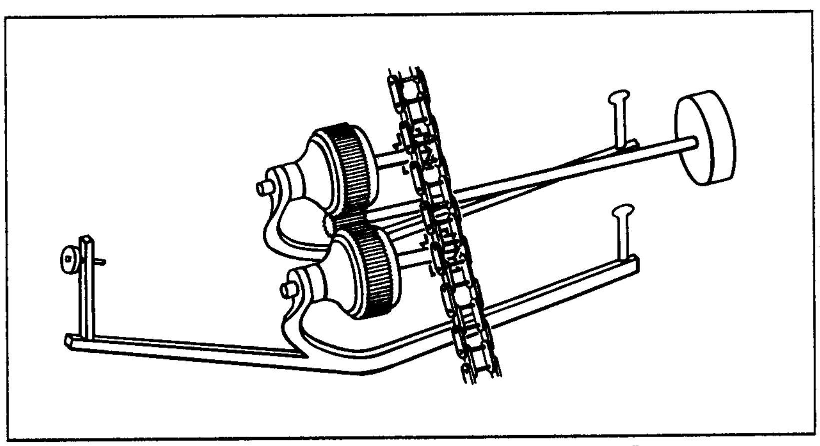


Figure 8-9. Power-actuated setworks

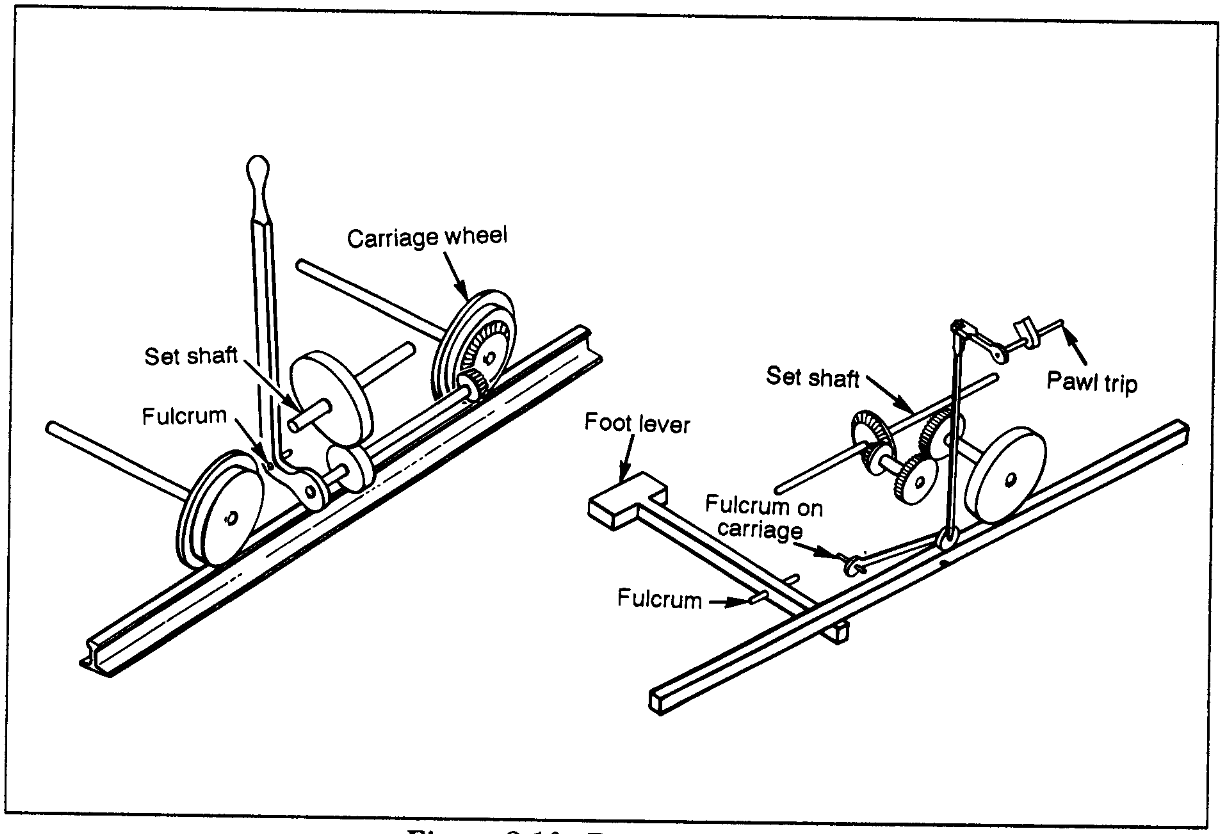


Figure 8-10. Power receders

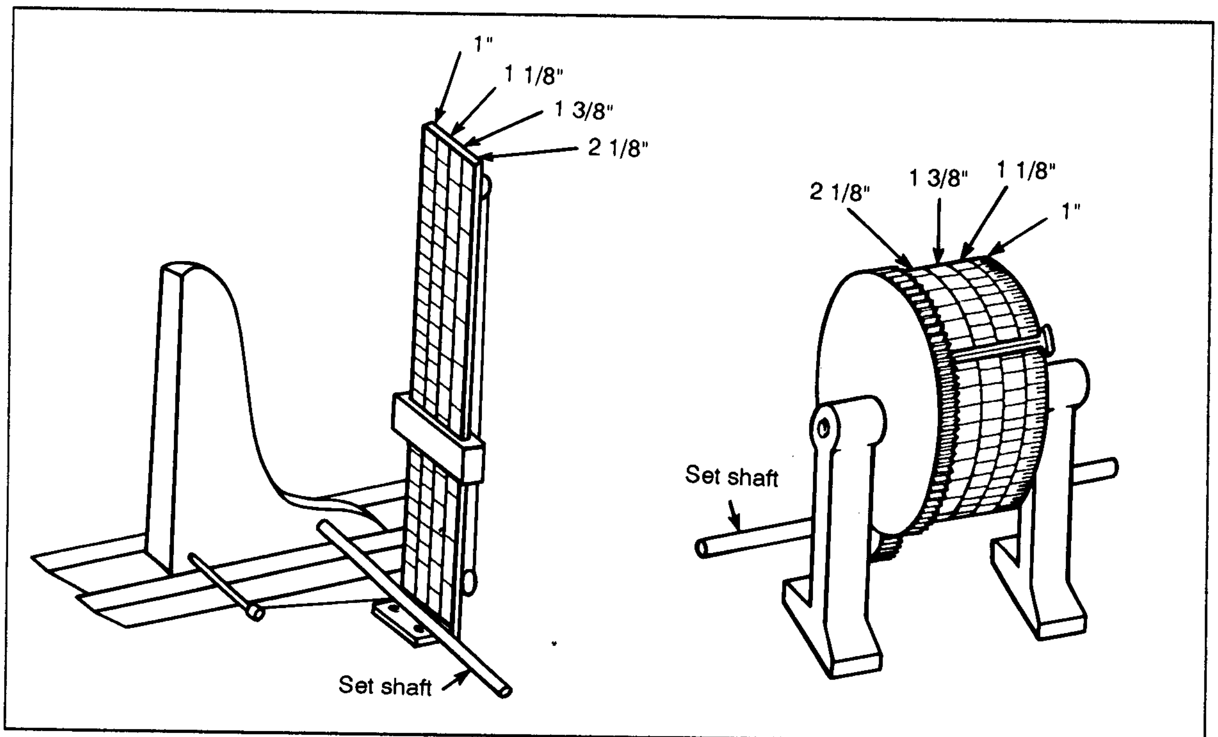


Figure 8-11. Indicators

- The edger operates the mechanical edger to remove the bark edges or defective edges from the board.
- The edger tailer removes the board, strip, end, and bark edges from the rear table. If a board requires end trimming, the edger tailer passes the board along the lumber rollers to the cutoff operator at the cutoff rig.
- The cutoff operator runs the cutoff rig to square the uneven ends of the boards.
- The lumber stackers carry the lumber from the edger or cutoff rig to the yard.
- One or two members keep the cutoff rig and edger free from the accumulation of strips, slabs, knots, and ends. They also keep sawdust from accumulating in the dust holes under the edger and cutoff rig.
- The millwright keeps the belts, accessories, tools and spare saws in good operating condition. He continual y checks the power-unit engines and cutoff engines for satisfactory operation. The millwright and an assistant help replace saws and check their operation.
- The millwright assistant helps the millwright. He also keeps the fuel tanks and radiators filled, as required.

The minimum crew size for the trailer-mounted sawmill is one sawyer, two log deckhands, and two off bearers. Their duties and responsibilities are the same as those above. For effective sawmill operation, crew members must understand their duties. Training must be sufficient to promote efficiency among crew members. It is especially important that the sawyer and block setter work closely together when scaling logs, preparing for cuts, and making cuts. Working as a team, the sawyer and block setter will adopt a few simple operating signals for figuring, turning, and sawing the log.

b. *Yard Crew.* The yard crew's responsibilities will depend on the type of operation taking place. If lumber is not being stacked and dried but is being shipped as soon as it is sawed, three or four yard workers can keep the lumber moving onto the haul trucks. If lumber must be stacked, sorted, and stored, the crew size should be increased to handle stacking and shipping.

8-3. Sawmills.

a. *Trailer-Mounted Sawmill.* The 50-inch, trailer-mounted sawmill usually is set up daily. During large operations, the mill is moved ahead to other skidways and away from the lumber, the slabs, and the sawdust. Ten to twenty thousand board feet is an average cut per setting.

(1) Setting Up the Trailer-Mounted Sawmill.

(a) Place the trailer-mounted unit within 3 feet of its desired position, longitudinally. Dig a hole about 6 inches deep in front of each wheel, so that when the sawmill is leveled, 50 percent of its weight will be removed from the tires. The base must be rigid for proper operation. Check for proper alignment of the drive belts, conveyor, and power unit.

(b) Secure a brace from the frame of the sawmill to the ground or power unit to compensate for drive-belt tension. If this brace is put between the sawmill and power unit, there should be some means, such as a jack, for increasing its length to have proper belt tension.

(c) Set up the sawdust chain and anchor it. Use a steel bar that is 3 or 4 feet long and about 1 1/2inches in diameter. Sharpen one end of the steel bar and drive the bar into the ground at a slight angle so the top leans away from the center of the sawmill. This will prevent mill vibration from loosening the anchor.

(d) Secure the feed rope by passing the one end through the loop at the bottom of the feed lever. Hook the end of the rope securely on one of the hooks that is on the side of the lever used for tightening the rope. Pass the other end of the feed rope toward the log end of the frame under the carriage above the cross shafts. Pass the end down through the pulley on the extreme log end and back toward the center through the idler loop and over the top of the large feed drum. Make two complete coils around the feed drum from the side of the drum toward the saw. This will bring the rope end in alignment with the pulley close to where the frame hinges. Pass the rope up through this pulley and back toward the long end of the frame again. Be sure that the feed rope is above the cross shafts and under the carriage to the extreme log end of the carriage. Pass the rope up through the loop provided, and secure it through the hook bolt in the pipe winch. By tightening this winch, you can adjust the rope to the proper tension.

(e) To thread the reverse rope, proceed as with the feed rope except pull the rope in the opposite direction with only two coils around the drum. Feed the reverse rope from the bottom of the drum, not the top. After threading the feed rope and the reverse rope, tighten the winch on each end of the carriage until the feed lever is in a vertical position. Leave enough slack for at least 1 foot of movement when applying a reasonable amount of pressure. If you leave the ropes in overnight, slacken them at each end.

(f) After threading the ropes into the sawmill and checking the tension, be sure that the neutral position lock on the feed lever and the hand brake are set before operating the power unit and sawmill. Be sure that the lock pin, which prevents the carriage from traveling, is in a locked position. Remove the pin only after the sawyer is ready. Test the slack in the feed lever. Look for a slight forward or backward movement of the carriage as you move the set lever. With a little experience, you should be able to determine the proper tension on the ropes before releasing the lock pin.

(g) Make several short travels of the carriage. Increase the travel length until you have made several full length travels before attempting to take on the first log. Practice after every shutdown of the lumber sawmill to make sure that the carriage is in the clear and that the ropes are properly threaded and tightened.

The feed rope is usually 64 feet long and the reverse rope 56 feet long. With the longer feed rope, you can splice it once it is worn and use the feed rope as a reverse rope. One set of ropes should last through 40,000 board feet of sawing or about one week's sawing, after the drums are worn smooth.

(2) Operating the Trailer-Mounted Sawmill. The controls for operating this sawmill are located on the sawmill carriage. They consist of the feed lever, the set lever, and the trip-release lever. The operator rides the carriage and stands facing the headsaw with all operating controls located to the rear. The dogs are adjustable to different size logs. Although the trailer-mounted

mill will saw logs up to 30 inches in diameter, the maximum desirable log diameter is 26 inches. Heavier, longer logs may tip the opposite end of the entire sawmill frame.

The husk of the sawmill does not have a clutch. If the power unit is in gear, the headsaw will be running and the carriage will operate. Before starting the headsaw, make sure that all personnel are clear of the drive belt and the headsaw. Ensure that the feed-set and trip-release levers are in NEUTRAL. Before placing a log on the carriage, test the carriage operation by moving it along the full length of the trackway several times. Make sure that the saw blade is running true.

To stop the mill, set all levers to NEUTRAL and either stop the engine or set the engine clutch in NEUTRAL. If the unit is to be shut down for an extended period, slacken the drive belt, the feed rope, and the reverse rope. Protect all mechanical parts of the sawmill from weather, ensuring that all belts and ropes are not exposed to rain or snow.

b. *Semitrailer-Mounted Sawmill. This* is a 60-inch sawmill that is operated about the same way as the trailer-mounted unit. You can saw larger-diameter logs with the mill.

c. Movement. Tactical situations, as well as the daily operation of the mill, may require movement to a new location. When this occurs, do the following:

- Remove the sawdust from around the auger, retracting the legs.
- Disconnect the power unit drive belt.
- Remove the guide rail and fold the frame.
- Remove the sawdust and soil that is in front of the wheels.
- Repair and or replace all worn, damaged, or missing parts.
- Lock down the carriage; check that all tools and equipment necessary for operation of the sawmill are with the unit and in good condition and move.

8-4. Sawing Procedures. The best methods of sawing logs in any operation depend on the demand for different grades and the desired thickness within each grade. A sawyer must know a few critical details relative to lumber grading to get the most from a log. Some details are the—

- Minimum width and length provisions of each grade, as a guide when slabbing.
- Defect allowance of a clear-face requirement of the grade, as a guide in log turning.
- Grade provisions applying to the lowest desirable grade, to avoid wasting time or making undesirable stock.

The edger must know the following details of grading:

- Minimum width and length provisions of each grade.
- Amount of permissible waste.
- Provisions covering standards of manufacture, particularly the standards applying to the crook.

The sawyer and the edger operator should consider the following details of grading:

- Minimum thickess, width, and length provisions for the grade rules that apply to dry lumber.
- Allowance for shrinkage in thickness and width in cutting green lumber.
- Edging of hardwoods to give the widest possible board in any fraction of an inch above the minimum required.
- Sizing of softwoods to give the widths in 1- or 2- inch intervals.

The following recommendations apply to milling hardwoods and softwoods:

- Clear faces should be taper-sawed to get the maximum possible footage in the upper lumber grades.
- Thin stock should be taken next to the slab to minimize edging waste.
- The centermost continuous core of the log (pith) should be sawed so it is enclosed in the center of the heartwood, where splits and checks are not considered a degrading characteristic.

8-5. Milling.

a. *Softwood.* The methods of sawing softwood logs differ mainly in the sequence used in turning. The two objectives of a sawyer are to recover maximum grade values and get maximum volume production per hour. It is not possible to get both by any one method. Either the frequent turning required to recover the maximum grade values reduces volume or the minimum turning necessary to get maximum production sacrifices grade. To get a balance between grade values and production volume, the turning procedure must be varied according to log qualities and sizes and mill facilities. No rigid set of instructions can be applied.

In the turning sequence, refer to the first log face to be sawed as Face 1, with Faces 2,3, and 4 proceeding from top to bottom. Figure 8-12 (A and B) shows the faces of a log. Face 3 is opposite Face 1; Face 2 is opposite Face 4. Greater production volumes are possible by using the 1-3 sequence. Better grades usually result from some combination of 1-2-3-4 sequence. Heartwood will appear only in the last few cuts.

The sequence in which faces can be sawed is limited because adjoining sawed faces must be at right angles. To ensure this, turn the first face sawed to the bolsters or to the knees. On mills equipped with dogs incapable of preventing the log from turning while Face 1 is sawed, take a slab from Face 4 and turn the log that Face 4 rests on the bolsters. In the following instructions, assume that the dogs will hold the log firmly. If the dogs do not hold the log, change the procedure so that Face 3 is slabbed and turned to the bolsters before Face 1 is worked.

(1) For logs of common grade quality that are 12 inches or less in diameter, use the 1-3 sequence, sawing near center from Face 1 and then turning the log 180 degrees and finishing it. If Face 1 is not worked to near center of the log, most types of dogs will not hold the piece as you work Face 3 past center.

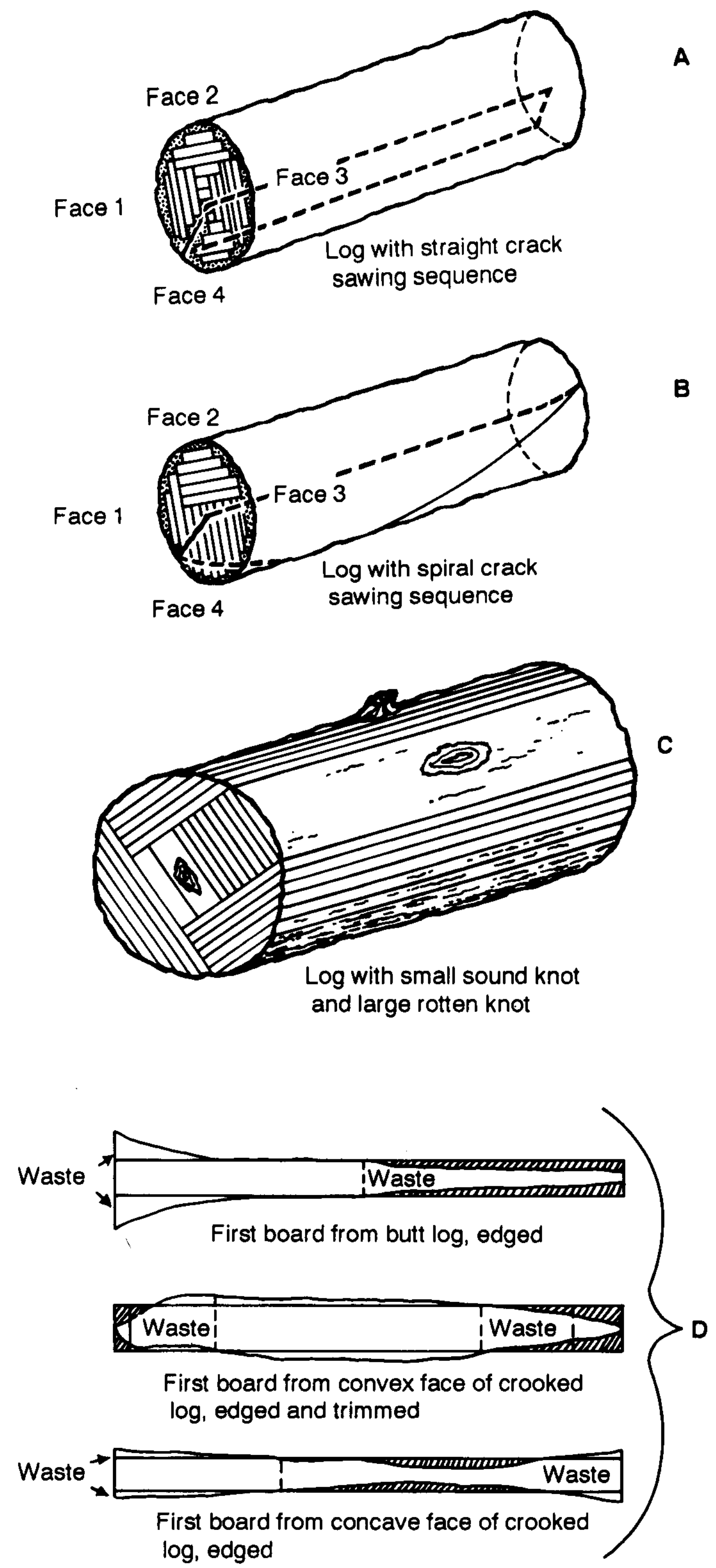


Figure 8-12. Log faces and sawing procedures

(2) For logs of common-grade quality that are more than 12 inches in diameter, the 1-3 sequence has disadvantages. The edger operator can lose potential footage in the wide center boards through improper ripping. Lumber from near the center of the log tends to crook during drying. For these logs, use a 1-2-3 sequence if you use cant hooks for turning or a 1-2-3-4 sequence if you use powered equipment that turns the log up and over. When using the 1-2-3 sequence, Faces 1 and 2 are slabbed to produce boards of minimum width and Face 3 to end with a dog board (final board) of proper size. The 1-2-3-4 sequence produces the following results:

- Face 1 is slabbed to produce boards of minimum width.
- Face 3 ends with a cant thickness of 6, 8, 10, or 12 inches instead of a dog board.
- Face 2 produces a face of minimum width.
- Face 4 produces a final board of proper size as sawing is completed.

(3) A secondary refinement when sawing common grades is that knots should be toward the center and away from the edges of sawed stock. Try to place the logon the carriage so that the visible knots will be toward the center of the face rather than at the margin. Turn the log to bring Face 3 to the saw, which is slabbed and sawed the same as Face 2. By slabbing Face 1 as instructed, Face 3 will be taper-sawed without setting out the small end. Turn the log to Face 4 with the small end set out as for Face 2. Saw this Face 4 until common lumber develops. Before turning to another face, take out the taper by retracting the taper blocks, bringing the cant against the knees, and sawing the wedge to produce a cant thickness of 6, 8, 10, or 12 inches. If short pieces are usable, one or more short boards are taken in, straightening the cant. To end up with a dog board of proper size, the sawyer adds the thickness of the remaining saw kerfs and then slabs accordingly on Faces 3 and 4 of the log.

(4) If a log has two clear adjoining faces, place the log so that one poor face is to the saw and the other is up. Face 1 is slabbed and may be sawed lightly; Face 2 is brought to the saw and treated the same. Faces 3 and 4 are successive y taper-sawed deeply without use of taper blocks.

(5) If a log has two clear opposite faces, place the log with a clear face on top. After working Face 1 as described above, bring Face 2 to the saw, with the small end of the log set out, and work this face until common lumber develops. Next, saw Face 3 the same as Face 1. Taper saw Face 4 after the small end is set out. Before the cant is turned to another face, straighten the log.

(6) If a log has one clear face, place it on the carriage with the clear face against the knees. Doing so allows the clear face to be taper-sawed without using taper blocks.

The following instructions are for mills using equipment that turns down logs. For mills that turn up logs, turn the log either 180 degrees or 270 degrees after working Face 1, and modify the procedure to conform to this different turning system. For small mills having no demand for upper grades, saw around large logs as described except that the small end is not set out.

(7) Rough softwood lumber that is to be either surfaced or surfaced and patterned must be edged and trimmed to widths and lengths that allow for the manufacturing of finished lumber of definite size standards. Usually, nominal widths are 2, 4, 5, 6, 8, 10, and 12 inches with even foot lengths. A slab that can be edged and trimmed to produce a 9-inch nominal width 11-foot long board should normally be sized to 8-inch nominal width 10-foot length. Since waste usually is excluded from surfaced or patterned material, edging and trimming should remove waste that will not be surfaced out.

(8) A simple rule to guide the edger operator is that material should be edged to get the widest stock possible and the maximum even foot length but that the width should be reduced by 2 inches wherever 4 feet or more can be gained in length. The edger operator tentatively estimates the even foot length for a board of a given maximum width and decides if a width reduction of 2 inches allows for a length extension of 4 or more feet.

The edger operator should have definite instructions on the green width required for each width class manufactured in the mill. Basically, these widths depend on an allowance for planning, usually 1/16 inch per face planned. These allowances are added to the actual width standards set up for yard items by military specifications.

(9) The edger operator should rip wide pieces into any series of widths that will raise the grade of one board above that of the wide piece. If no grade rise is possible, he should rip the piece to produce one board that is 12 inches wide. Other boards should be as wide as possible, avoiding the 7-, 9-, and 1l-inch rip. Doing so avoids intersecting a knot that may fallout during seasoning and avoids ripping material so that the pith is at the edge.

The trimmer operator trims to produce a desirable board of the maximum even foot length possible. Usually a 2-inch allowance in excess of the even foot length is made when trimming.

b. *Hardwoods.* When grade sawing random-size hardwood lumber, work the high-grade material from the better faces by taper sawing. Turn to a different face as the grade drops below that promised by adjoining faces. This process of working around the log is usually profitable if it results in raising the grade from No. 1 common to No. 2 common.

As the log is transferred to the carriage, the sawyer should decide how to divide it into four cutting faces and what the probable sawing sequence will be. A mirror at the deck end of the track allows the sawyer to see any end defects, which helps him determine the faces and the sawing sequence.

(1) For clear, straight, sound logs with the pith as the approximate center, face division is not important, and the cutting sequence should be one that will not delay sawing operations. Therefore, at mills that turn down, the cant is down 90 degrees; at mills that turn up, the cant is turned at least 180 degrees from the first face. If the pith is off center, the log should be placed so that one face is perpendicular to the longest radius.

(2) Logs with a straight crack are placed so that the crack is at the board edge that will be taken out in edging (Figure 8-12, A, page 8-13). The log is placed so that the crack coincides with the radius that is 45 degrees to the bolster and toward the saw. However, if Face 2 promises high-quality material, a slab is taken from Face 4 before turning to Face 1. Face 2 is taper-sawed

so that a board of minimum useful width can be taken from the full length of the log. At right-hand mills turning down, the cutting sequence is usually 1, 2, 3, and 4. At right-hand mills turning up, the sequence is usually 1, 3, 4, and 2.

(3) Logs with spiral cracks (Figure 8-12, B, page 8-13) are placed so that one end of the crack is in the same position as logs with straight cracks. The damaged zone is downward and back toward the knees. At mills that turn down, Face 1 is usually sawed until the crack appears on a board edge, then the other faces are successively worked.

Where spiral cracks extend one-third or more of the circumference, the unaffected faces are sawed deeply before short pieces are cut from affected faces. At mills that turn down, Face 1 is worked lightly, Face 2 deeply, and the cant is finished on Face 3. At mills that turn up, Face 1 is worked lightly, Face 3 is slabbed, Face 2 is worked deeply, Face 1 is worked close to the pith, and Face 3 is finished.

(4) Shake, rot, or spider heart (several splits radiating from the pith) that is restricted to the center does not influence how the log is divided into faces or the sawing sequence. The undesirable core is boxed and discarded. Logs with shake or rot in the out zone are placed on the carriage so that a cutting face is parallel to the straight line, thus connecting the ends of the arc of shake or the long axis of the rot area. The face affected is sawed last. Logs with wormholes should be placed on the carriage so the faces that are visibly free from holes are sawed before the log is turned to the affected areas.

The defects listed above usually are detected from the ends of the log. Defects detected by surface inspection, such as bud clusters, bird pecks, bulges, bumps, burls, butt scars, cankers, conks, holes, knots, overgrowth, and wounds, can be treated as a group, depending how they influence the face divisions and the sawing sequence. Defective logs range from those with few localized defects to those with many defects spread over the entire surface.

(5) Surfaces free of defect indicators are the basis for initially placing the log. The log is turned so as to cut the faces that produce the high-grade material before making deep cuts into the defective faces. For example, if a log has three high-grade faces, slab the defective face and then either turn down 90 degrees or up 180 degrees, depending on mill practice. Saw the defective face last.

If a log has one high-grade face, place this face against the knees. At mills that turn down, use a 90-degree turn for successive faces. At mills that turn up, saw the first face and then use the following turning sequence: 180 degrees, 90 degrees, and 180 degrees.

If a log has a clear face that joins another face having one or more defects that could be removed in edging, place the log so that these defects will be near the edge of the defective face. However, cankers, conks, holes, and large dead knots indicate extensive defects not likely to be removed by edging. Center them on the poor face (Figure 8-12, C, page 8-13).

(6) Place logs with sweep on the carriage with the sweep facing out. Work the four faces successively in the sequence dictated by the turning equipment. Better grade recovery usually results when the widest boards are cut from the faces that are at the top and bottom with reference to the first face sawed.

(7) Face locations must be according to the factors just outlined. High-grade faces are usually sawed parallel to the bark. Low-grade faces are sawed in the most convenient way to speed up the work. If a high-grade face is opposite a low-grade face, saw the good face parallel to the bark. Do so either by placing the poor one against the knees and setting out the small end of the log or by placing the good face against the knees and slabbing the poor face first.

If high-grade faces are opposite each other and the log is characteristically free of defects almost to the pith, place one good face against the knees and partially saw the other good face without regard to parallelism. By doing so, you will taper-saw each good face and get high-grade log length boards. If the log has interior defects that extend beyond the pith zone, set out the small end enough to permit cutting a slab of uniform width the full length of the log. When the opposite good face is turned to the saw, repeat this process. After cutting this face and before turning the log to another face, straighten the cut by retracting the taper levels, setting the small end back against the knees, and sawing the face to produce a cant with opposite faces parallel. The purpose of this is to take out the taper from the low-grade material in the core instead of from the high-grade material in the outer zone.

(8) When slabbing parallel to the bark, the face of the slab should be the minimum width required: 6 1/2 inches for grades above No. 1 common and 3 1/2 inches for grades No. 1 common or lower. With any face, a 4-to-4 cut is usually taken next to the slab to minimize edging waste, but if the face is opposite a previously sawed one, slab it so that the final piece will conform to the intended item. Saw the faces of high-grade material deeply and the faces of low-grade material lightly. (The usual practice is to continue sawing the face until the grade drops to that of the adjoining faces.) Continue this turning either until the central portion is sized to meet construction item specifications or until the grade of lumber becomes substandard. For small mills that specialize in cutting factory lumber, such turning is justified as long as lumber better than No. 3 common can be cut.

8-6. Edging. Normally, material for random-size use is edged to get the maximum width possible in inches and fractions. For construction items, lumber is edged to conform to definite width specifications. Items, such as boxcar flooring and construction boards, may be made from a limited number of tree species and sized to a restricted series of widths, thicknesses, and lengths. The sawyer, edger operator, and trimmer operator must know the size, species, and allowable defect provisions of grading rules for such items. They should make the l/16-inch allowance per inch of width to take care of shrinkage from the green-to-dry condition. Material more than three inches thick is normally edged on the headsaw. Most construction items are produced by the headsaw from squared cants and require no edging. The items that require edging are edged according to the size and quality specifications for the particular product. Because of the variety of products, general edging instructions cannot be given.

8-7. Trimming. Trim each piece two inches over the nominal foot. Trim boards below firsts and seconds so that the surface area of the waste or rot remaining on the board is about equal to the area of the sawed sound face of the trim (Figure 8-12, 4, page 8-13). For firsts and seconds, you must trim waste or rot in excess of one-fourth of the affected area within 1 foot of the end. At least one-half of the area of this last foot must have a clear face. For specific construction jobs, trim each item so it conforms to the specific length requirements with defect provisions as listed in the applicable grading rules.

8-8. Sawing Oversized Logs. There is no efficient way to saw logs that are too large for the headsaw, The diameter of the saw should not exceed that needed to saw the larger logs. Table 8-1 shows the relationship between saw and log diameters. If you are sawing logs with diameters larger than any listed in Table 8-1, turn the logs about 1/8 inch instead of 1/4 inch. You should be able to square and saw the logs as with normal procedures. However, this method of turning wastes material and time. If you are sawing logs with diameters nearly twice the height of the portion of the saw above the bolsters, use the following procedure to reduce the log:

Table 8-1. Saw and log diameters

Saw Diameters (inches)	Log Diameters (inches)
48	28
52	30
56	33
60	36

- Set the log and make the initial cut as shown in Figure 8-13, 1. Use dogs to firmly hold the log; feed the log slowly.
- Turn the log up 90 degrees and saw stock items. Stop sawing before reaching the log center (Figure 8-13, 2).
- Turn the log up another 90 degrees with the small end set out so that the ensuing saw lines will follow planes parallel to the first saw line taken. Stop sawing stock items before reaching the center (Figure 8-13, 3).
- Turn the log down 90 degrees and saw stock items beyond the center (Figure 8-13, 4).
- Turn the log down another 90 degrees and finish sawing (Figure 8-13, 5).

NOTE: You can use powered dragsaws and chain saws to reduce oversized logs to moments that you can cut on the head rig.

8-9. Size Standards. Lumber, timbers, and ties must meet the precise size standards give in military specifications. Inaccurate sawing can result in failure to produce standard-size timber and ties. Inaccurate shrinkage (green to dry) and sawing can result in failure to produce standard-size lumber and light framing material. The causes of inaccurately sawed lumber are—

- Faulty condition of the saw due to teeth being out of line, dull teeth, or incorrect saw tension.
- Worn bearing on the mandrel, the carriage wheels, or the setworks.
- Poor installation of the carriage and saw.
- Chips lodged between the log and headblock or on the tracks.
- Careless setting or miscalculation.
- Inaccurate manipulation of the dogs or using dogs that are mechanically unfit to hold the log firmly.
- Frozen timber or unequal stresses in the wood.

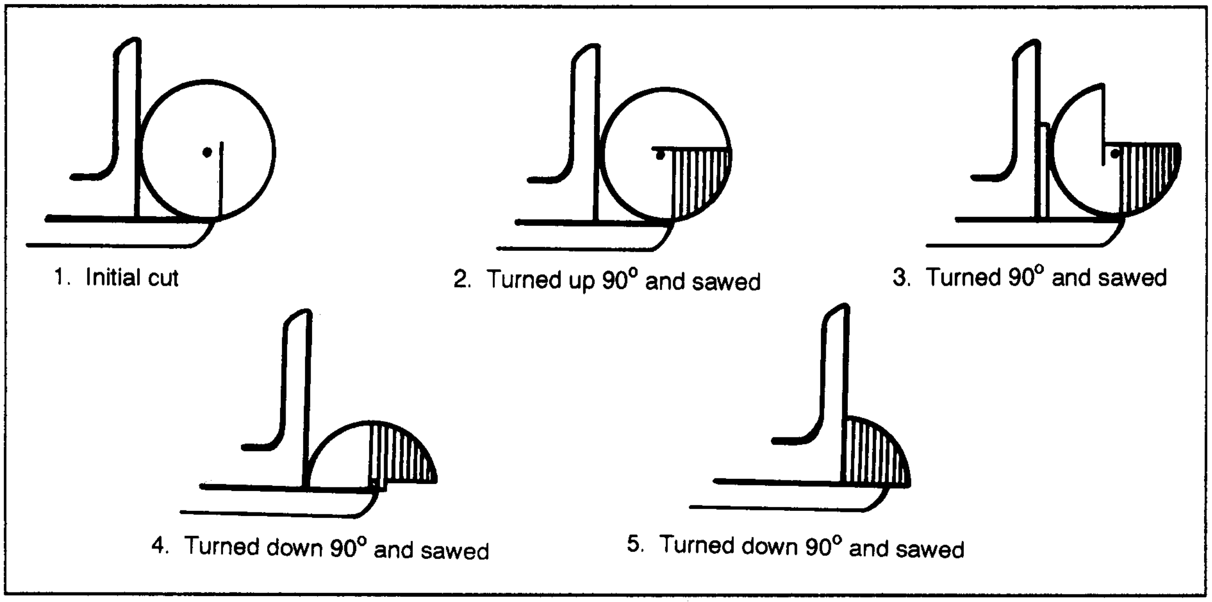


Figure 8-13. Sawing oversized logs

8-10. Safety. When selecting a sawmill site, avoid soft or spongy ground. The trackway, husk, and foundation timbers must remain absolutely level after the sawmill is erected. Safety should be the first consideration in sawmill operation. The sawyer, as well as the entire crew, must constantly be alert to avoid accidents that may cause injury. Every crew member should avoid forming careless operating habits that cause unnecessary wear and tear on the working parts of the mill. To prevent accidents, the sawmill crew should follow these safety suggestions:

- Always secure the sawyer's lever in NEUTRAL before leaving an operating headsaw. Swing the neutral stop rest to the left and against the sawyer's lever. This prevents the lever from being accidentally moved to either of the engaged positions.
- Make sure there is proper clearance between the headsaw and the three headblock bases before operating the carriage past the headsaw. Push the carriage past the saw by hand to check the clearance. Make sure that the head is stopped when checking the clearance between the headblock bases and headsaw.
- Use heavy gloves when removing or installing the headsaw. Watch your footing.
- Never apply nonslip dressing to the feed belt or backing belt. These belts must slide freely on the pulleys when the sawmill is idling.
- Keep trash, rags, and tools secured a safe working distance away from the mill.
- Do not allow slabs, waste, or sawdust to accumulate around or under the mill equipment. Keep the trackway clear.
- Avoid wearing loose clothing or working too close to drive belts, feed belts, pulleys, and the saw.
- Do not pile too many logs on the log skid.
- Use cant hooks and peavies to move and handle logs. Do not use hands, feet, or timber sticks for this purpose.

- Do not use broken, damaged, or dull cant hooks.
- Do not use a dull saw.
- Make certain that all logs are securely dogged before sawing begins.
- Stop the engines before starting any repairs on the sawmill. Remove the battery connections to prevent accidental or unauthorized starting of the mill.
- Stay alert concerning fires and fire hazards because the frequency of fire in and around sawmills is very high.
- Use the appropriate personal safety equipment to protect eyes, hands and feet.
- Use precautions when operating the sawmill under unusual conditions like mud and water because the foundation could settle unevenly. Check the sawmill to ensure that it is level. If needed, excavate under the foundation and block up the mill using solid building material.
- Distribute lighting evenly around the entire sawmill for night operations. Mount the lights high enough so the lights will not reflect in crew member's eye or cast shadows on equipment. Place a small spotlight on the sawmill so that the sawyer can easily see the butt of the logon the carriage.
- Do not run wires for night lighting on the ground or above the ground where loading or unloading equipment may damage them. Protect all lights near the saws from flying chips and debris.

Chapter 9
Lumberyard Operations

Lumberyard operations are just as important to an efficient logging and sawmill operation as are the other operations discussed in this manual. The layout and construction of a lumberyard and the use of props for loading lumber on trucks, including sorting and piling of lumber, are important procedures for proper yard operation.

9-1. Layout. Figure 9-1 (page 9-2) shows a sample lumberyard layout. The yard should be easily accessible from the mill. A lumberyard should be on ground that is suitable for hauling lumber and for pile foundations. The yard should have air currents for drying lumber. Good air circulation and soil drainage and a level or slightly rolling surface are essential to meet these needs. Uneven or steeply sloping surfaces require excessive cribbing for pile foundations and grading of roads.

Green lumber, principally in the sapwood, will deteriorate unless treated with chemical fungicides and insecticides. The speed and extent of deterioration depend largely on temperature. Fungi and insects are most active during warm weather. Generally, when the moisture content of wood falls below 20 percent, fungi cannot develop, and the wood is less attractive to most insects. Therefore, to avoid fungus and insect attack dry the lumber quickly.

In a clear area, construct a road or an 8-foot fire lane around the perimeter of the yard. In a timbered area, construct a 30-foot lane area around the perimeter of the yard. Keep this area clear of vegetation as a safeguard against fire. In general, yard layout should provide wide alleys and ample spaces between piles to ensure good air circulation and adequate room for handling and hauling lumber. The layout should provide a clear space of 30 feet from temporary milling operations and 50 feet from semipermanent installations. Main alleys should be 16 feet wide to accommodate hand stacking and 30 feet wide for forklift hauling and stacking.

9-2. Lumber Prop. A lumber prop (Figure 9-2, page 9-2) is a quick and efficient aid when loading a truck. The yard supervisor should always emphasize the need for safety when using a lumber prop because it could spill the load if mishandled or bumped by a truck. As lumber comes from the mill, it is placed on a prop, one size to a prop. The prop is just high enough so that the vehicle's rear bunk contacts the load about 1 inch ahead of the prop. The load is then loaded on the vehicle and transported to the drying yard.

9-3. Pile Construction. Improving air-drying techniques will vary. Generally, the larger the mill, the more exacting piling stock according to species, grade, thickness, length, and width can be. For air drying, it is almost universal to pile stock flat so that most of the weight bears on the wide faces and not on the edges or ends. A flat pile may be level both crosswise and lengthwise. With this piling method, the drying rate is relatively slow, but the weight of the pile tends to keep the stock from warping. Flat piles maybe hand-stacked in a continuous pile from bottom to top or may be made up of several unit packages separated by bolsters. To prevent excessive warp, it is best to sort for length or to box the overhanging ends.

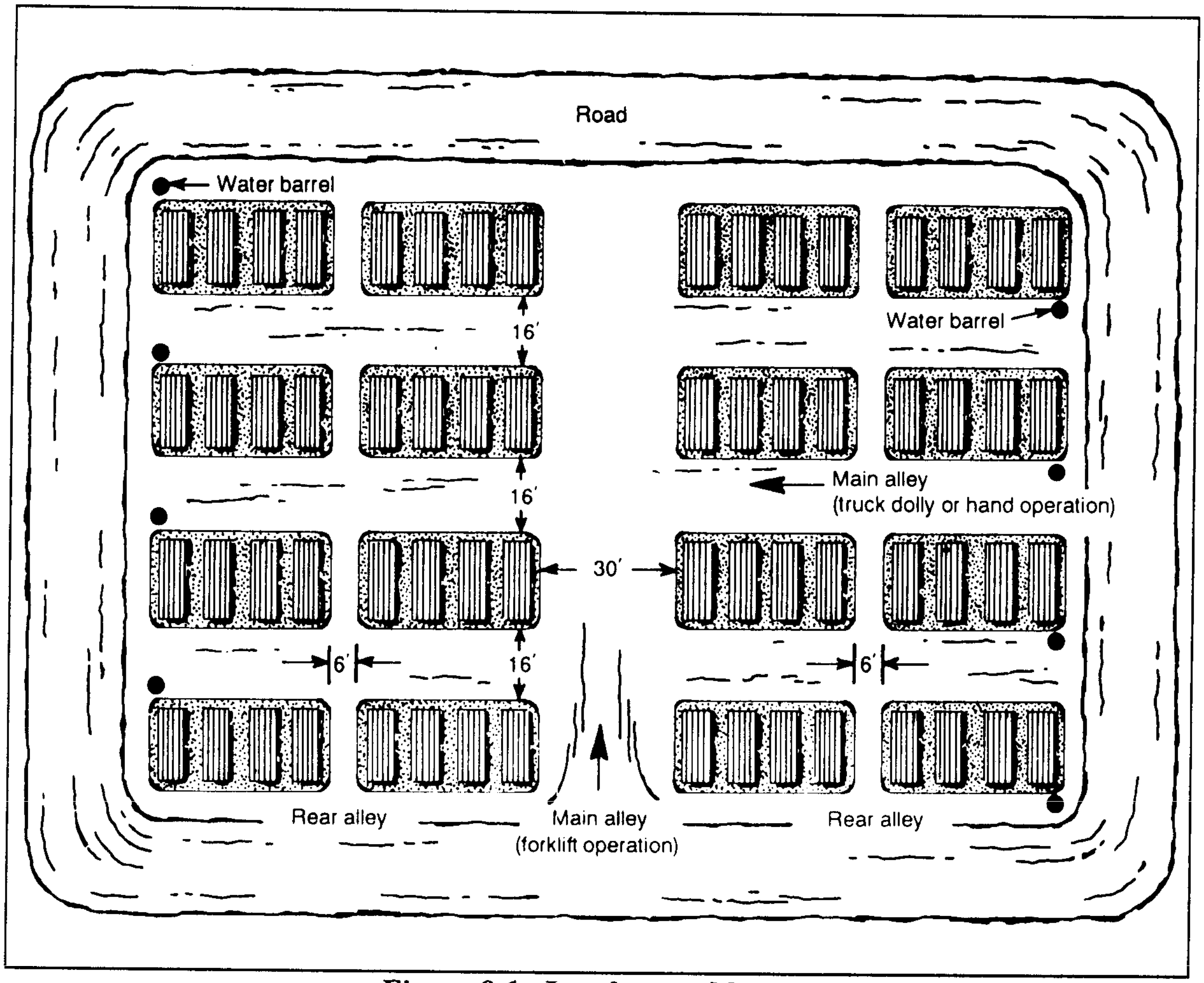


Figure 9-1. Lumberyard layout

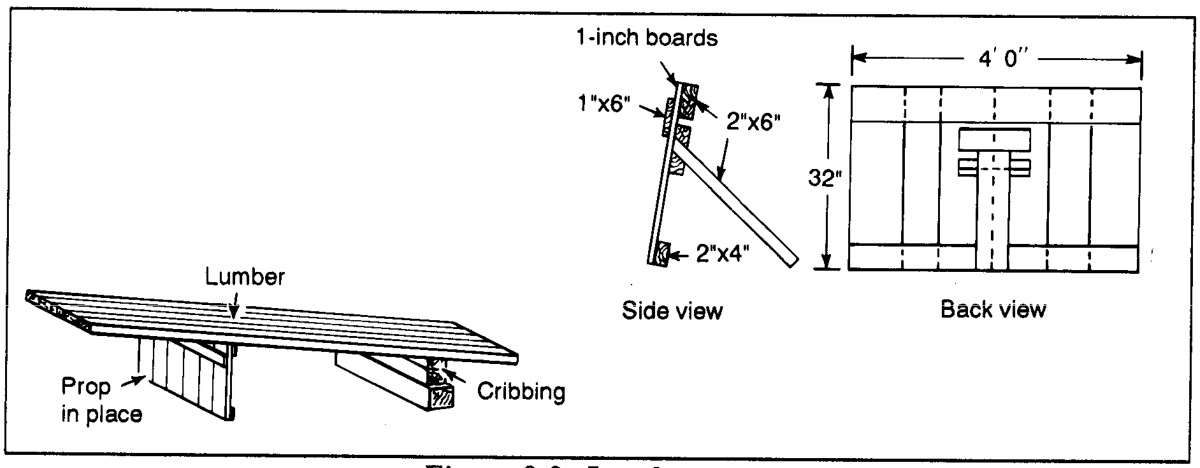


Figure 9-2. Lumber prop

For lumber that is susceptible to sap stain, you can use special piling methods that promote rapid partial drying: end piling, end racking, and crib piling. Figure 9-3 shows these three methods. With end piling, leave wide spaces between boards. (One person can handle end piling.) A disadvantage to end piling is that it may cause nonuniform drying from top to bottom and severe end-checking and surface checking in the upper parts of the boards, particularly in thick stock. End racking can cause excessive checking and warping. Once the stock has become dry enough to prevent sap stain, pile it flat to minimize checking and warping. Depending on the temperature and weather, drying should occur in 30 to 45 days. End-racked boards, however, are likely to stain where they cross. Crib piling may result in excessive stain where the boards cross, as well as warping.

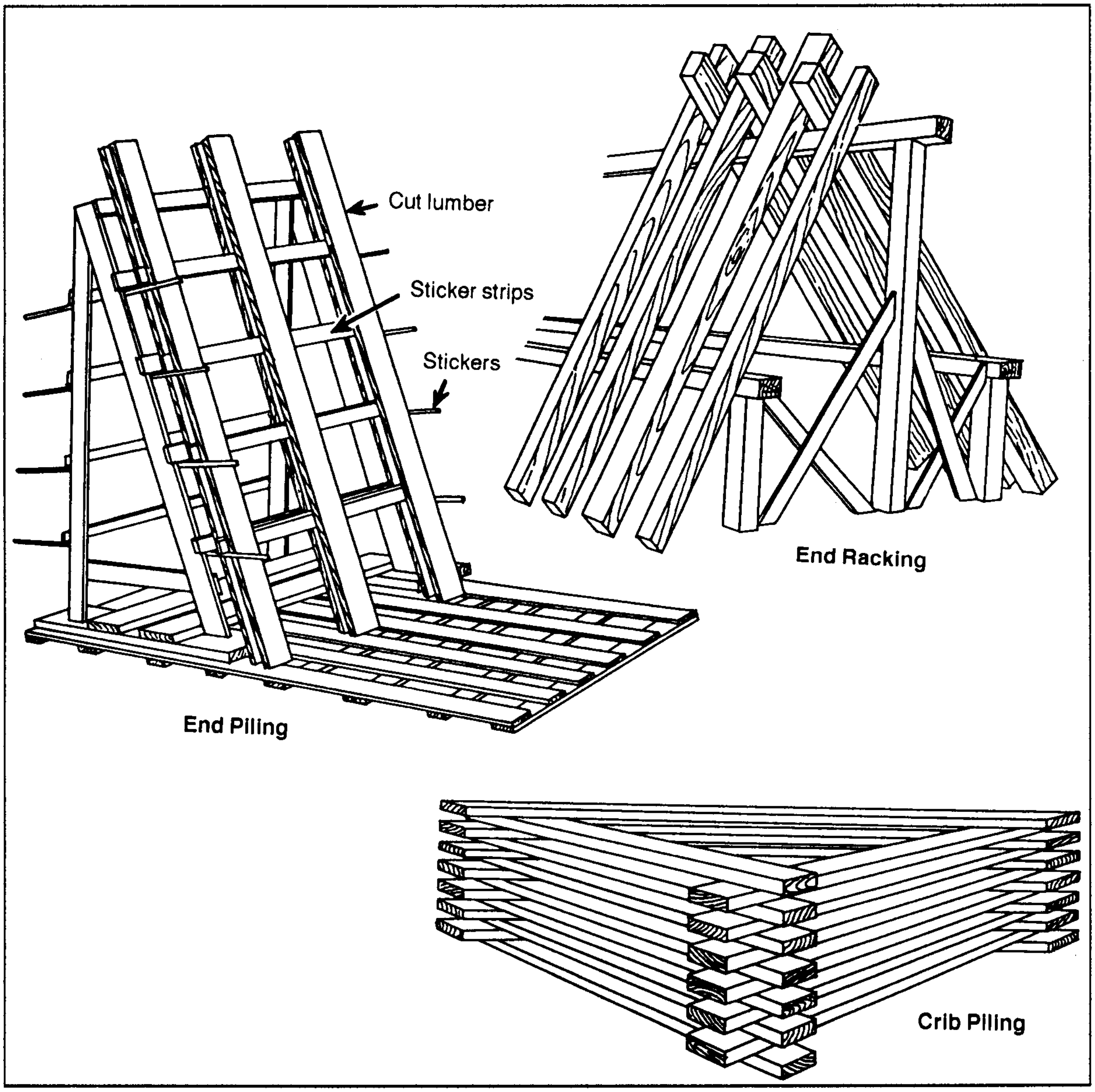


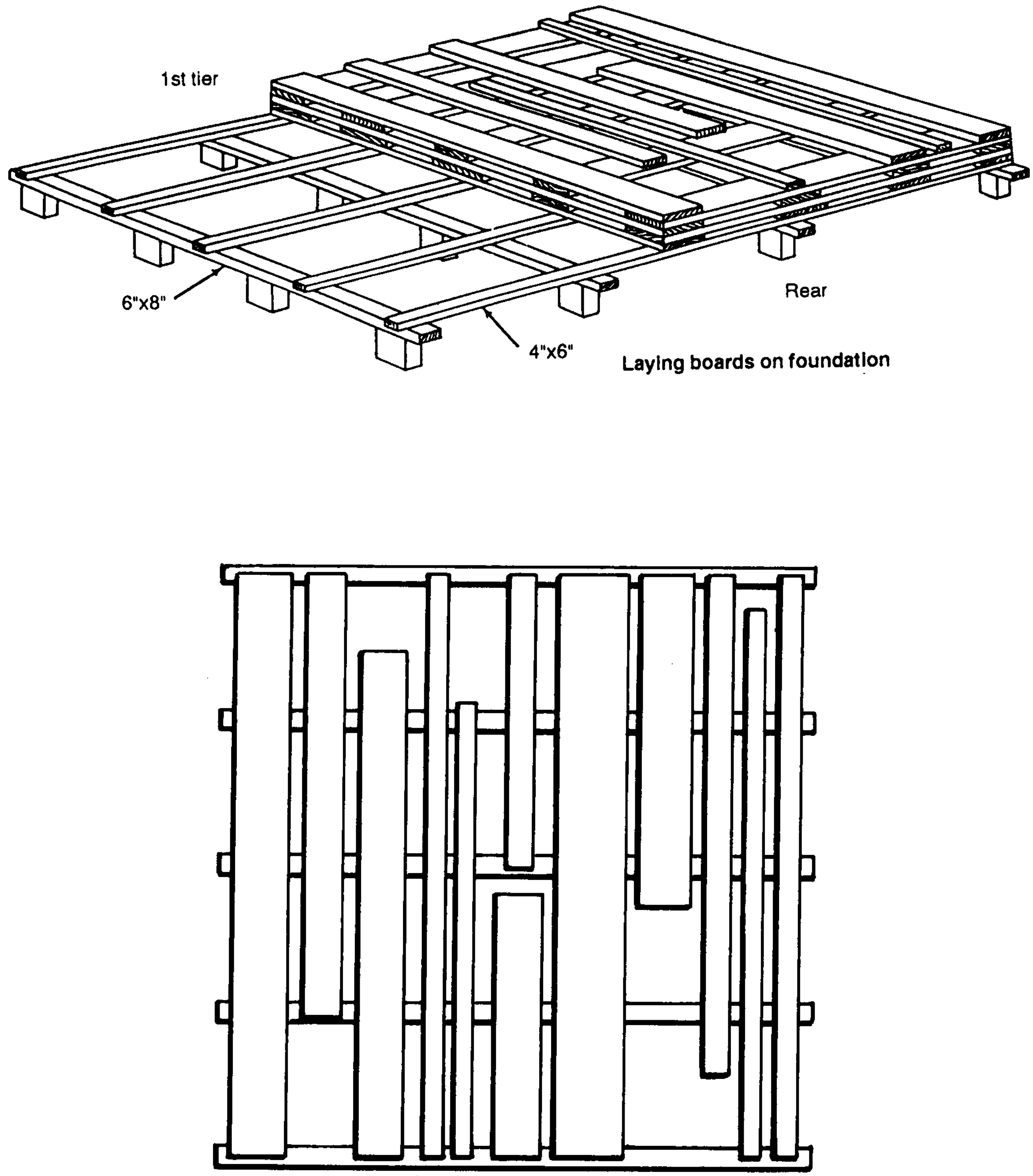
Figure 9-3. Piling methods for rapid partial drying

9-4. Box Piling. Box piling is recommended for hardwoods. To make a box pile, lay a sticker over each foundation crossbeam and place a full length board in each of the outside tiers. If enough stock is available for more than two full length boards to the course, place long boards regularly in the course. Figure 9-4 shows box piling. Place shorter boards in the inside tiers, with the ends alternately flush with the front and back of the pile. Since each tier is about 12 inches wide, it can contain an 8-inch and a 4-inch board or two 6-inch boards. One end of each board can rest on the sticker at either end of the pile. Tiers should be truly vertical, 4 to 6 inches apart. The front of the pile should be given a pitch of 1 inch per foot of height, This method of piling results in vertical flues that allow a free downward airflow from the top to the bottom of the pile. Both ends of the pile should be square with no projecting board ends.

9-5. Sorted Length Piling. Sorted length piling, which closely resembles box piling, is recommended for softwoods. To make such a pile, lay a sticker over each crossbeam and place the first course of boards so that the front end of each board is flush with the front edges of these stickers. Space the boards in this course 2 to 3 inches apart. If there are two or more in the same pile, place the longest ones in the outside tiers and mix other long ones regularly in the course to give a well-supported pile. Succeeding courses are the same as the base course.

The front of the pile should pitch toward the main alley, 1 inch per foot of height. Each tier of stickers within a tier should be aligned parallel to the front one. Stickers within a tier should be directly above one another except for the slight, progressive offset required to follow the pith of the pile. The front of the pile should be free of projecting ends that would catch water and cause it to flow into the pile. If the boards are of uniform lengths and the piling has been well done, the rear of the pile will also be free of projecting ends.

9-6. Safety. Personnel handling rough lumber should always wear heavy gloves. Lumber should only be stacked on a proper foundation at moderate levels. Lumber stacked too high is hazardous. Smoking should not be allowed in the lumberyard. Lumberyard personnel should be reminded about sound safety practices on a steady basis.



Placing boards according to length (top view)

Figure 9-4 Box piling

Glossary

A-frame Two poles lashed together with a cross piece that form an *A* with a block hung at the apex; used as a spar in cable logging or as a stiff-leg loader.

Abney Level Device used to measure tree heights.

air drying Seasoning lumber in the open air as opposed to seasoning it in a kiln.

angle dozer Heavy steel blade mounted across the front of a standard crawler tractor. The blade can be raised or lowered, and each end can be advanced or retracted. This places the blade at various angles so it can push dirt to either side. *See also* **bulldozer.**

arch Supporting device mounted on or towed behind a skidding vehicle; used to lift one end of a log or logs to reduce sliding resistance and/or transfer the weight of the load to a skidding vehicle.

articulated Hinged at the center, when referring to a vehicle such as a wheeled skidder.

ATTN attention

backcut In felling, the final cut made on the side opposite the direction of fall.

barber chair Stump that has a splintered slab left as a result of felling. Also called a **tombstone.**

bardon hook Hook used with wire rope slings for gripping trees or logs to be skidded.

barker Logger who peels bark; a machine that peels bark.

beaver Poor axman, especially one who chops all around a tree.

bed piece Timber or similar flattened piece, such as lumber piles and sawmill parts, laid on the ground to support a load.

bicycle Carriage or trolley used on a skyline.

big-stick loader Simple truck loading rig, consisting of an upright mast with a short, swinging horizontal boom fastened to the top; a wire rope is strung through the device and powered with a winch.

binder Chain or wire rope used to bind a load of logs. Also called a **wrapper.**

blaze To mark trees with&shallow axe cut, which indicates those to be cut or the course of a boundary, road, or trail action. Also referred to as **spot.**

block In wire-rope logging, a pulley used to change direction of motion or increase pulling power.

board *See* **lumber.**

board dog Same as **carriage dog.**

board foot Unit of measure for lumber and sawlogs; refers to a board that is 1 by 12 by 12 inches or a segment of a log that will produce boards totaling such measurement.

bobtail Two-axle truck.

bolster *See* **bunk.**

bolt Any short stick between 2 and 8 feet long.

boring In a chain-sawing operation, starting the cut in the center of a log using the nose of the blade. Also called **plunge cutting.**

boss dog Dogging device on the knees of a sawmill carriage consisting of lever-controlled talons that can be brought to grip the face of a log, cant, or timber.

boxed heart Term used when the sawmill cuts boards from all sides of the heart and leaves the center as apiece of timber.

box lumber Lumber from which boxes are manufactured.

box piling Lumber-drying method in which boards of different widths and lengths make up a course.

brush out To clear an area of brush for a trail, survey line, or road; to clear an area in which to work.

buck To saw felled trees into shorter lengths.

bucker One who saws felled trees into logs or bolts.

bucking chute Device used to move long lengths into position for cutting into shorter lengths.

bucking ladder Series of short skids laid parallel to each other at regular intervals on which tree sterns can be bucked.

bull block Large yarding block with a throat large enough for the butt rigging to pass through it.

bull buck One who runs a felling and bucking crew.

bulldozer Steel blade mounted across the front of a standard crawler tractor. The blade can be raised and lowered but cannot be angled to either side; all pushing is straight forward.

bunch To gather trees or logs into small piles for subsequent skidding by other equipment.

bunk Cross beam on which logs rest on a truck or trailer; a logger's bed in a logging camp.

burl Large, wartlike excrescence growing on a tree trunk that contains the dark piths of a large number of buds which rarely develop. The formation of a burl apparently results from an injury to the tree.

butt Base of a tree or large end of a log.

butt cut First cut above the stump.

butt hook One of a variety of hooks on the end of a mainline to which chokers are attached.

butt off To cut off a piece of a log because of a defect; to square off the end of a log. Also called **long butt.**

butt rigging Assembly of swivels, shackles, chains, and hooks used to connect main and haulback lines in cable yarding; also provides for attachment of chokers at this point,

cable logging Yarding system using winches in a fixed position.

cant Log squared on two or more sides.

cant dog. Same as **peavey.**

cant hook Stout wooden lever used in rolling logs. A cant hook differs from a peavey in that it does not have a spike in the end of the stock.

capstan Drum providing power to a cable by friction rather than by attachment.

carriage Frame on which are mounted the headblocks, setworks, and other mechanisms for holding a log while it is being sawed and for advancing the log toward the saw line after it has been cut. The frame is mounted on trucks that travel on tracks. It is actuated by a steam feed, a cable, or a rack-and-pinion device that propels it back and forth past the head saw.

carriage dog Steel toothlike projection, several of which are attached to a carriage knee and operated by lever. Carriage dogs are used to hold the log firmly on the carriage. Also called **board dog.** *See also* **dog.**

carriage feed Device used to drive the sawmill carriage back and forth. The feed may consist of rack and pinion, cable and sheaves, or large steam cylinder equipped with piston that actuates the carriage. In large mills, a steam cylinder is used for short carriages and cable for long carriages. In portable mills, rack and pinion or cable feed is used.

catface Partly healed fire scar on the face of a tree, often the place where the rot enters.

cfm cubic foot (feet) per minute

chain saw Saw powered by a gasoline, hydraulic, or an electric motor; the cutting elements are on an endless chain.

chaser Logging crew member who unhooks the logs at the landing and does other odd jobs.

cheek Lengthwise separation of the wood in logs or lumber, commonly caused by shrinkage during seasoning.

chimney Opening left from top to bottom of a lumber pile so air can circulate to hasten seasoning.

chipper Machine used to reduce logs or trees to chip size for use at paper mills or wood energy installations.

choker Short length of wire rope or chain that forms a noose around the end of a log to be skidded.

choker setter One who attaches the choker to logs before skidding.

chopper Same as **faller** and **cutter.**

clear cutting Regeneration method in which an entire tree stand is removed in one cutting and artificial reproduction starts from natural seeding from adjacent stands or from trees cut in the clearing operations. *See also* **regeneration methods; seed tree; selection; shelterwood.**

cold deck Logs piled for future loading and hauling.

cold loading Loading logs that have accumulated at the landing or yard.

come along Device with an attached cable used to pull a heavy leaning tree in a direction other than the one in which it would normally fall.

conk Visible fruiting body of a wood-destroying fungus, indicating rot in the underlying wood.

coppice. Same as **low-forest system.**

cord Unit of measure of stacked round wood; a standard cord occupies 128 cubic feet of space (4 x 4 x 8 feet).

corduroy To build a road by crosslaying it with saplings or small poles.

corner Cutting through sapwood on both sides to prevent splitting.

course Single layer of boards in a pile of lumber.

crook Abrupt bend in a tree or log.

cross haul Loading logs by rolling them onto the load with a cable loop. One end of the loop is attached to one side of the vehicle and the other end to a source of power.

crosscut Cutting a piece of wood at right angles to the grain.

crotch Natural fork on a tree, log, or piece of wood.

crown thinning Type of thinning that is the direct stimulation of crowns of the dominant trees; codominant trees are removed and overtopped and intermediate trees are left to die. *See also* **geometric thinning; low thinning; selection thinning; thinning.**

cruise Survey of forest land that includes the location of timber stands, their volumes, species, sizes, quality, and so forth.

cruiser Timber estimator.

cruiser's stick Instrument used to measure timber.

cull Thinning out trees, logs, or bolts or deducting volumes in measurement because of defects.

cut Output of a sawmill forgiven period of time. Also called **running.**

cutter One who fells, limbs, tops or bucks trees. Also called a **chopper.**

DA Department of the Army

DBH diameter at breast height (4 1/2 feet above the ground).

deadman Anchoring point buried in the ground to which a guy line or anchor line is attached.

deck Pile of logs on a landing; an area or platform on which wood is placed.

deckhand In a sawmill, one who aligns logs on the deck and rolls them down for loading onto the carriage.

defects Blemishes in logs. Defects are classified as interior (stump rot, circular rot, ring shake, and heart check), side (fire scar, frost check, punky or broken down sapwood, and wind checks), and other (crook or sweep and crotch).

DIB diameter inside bark.

DOB diameter outside bark.

dog Short, heavy piece of steel; one end has an eye or ring and the other end is pointed. Also called a **log grab.** A metal-toothed plate on a chain saw.

dogger One who rides on the sawmill carriage and handles the lever that operates dogs that hold the log. The dogger on the front end of the carriage is sometimes called the head-end dogger; the dogger on the rear end, rear-end dogger.

donkey In cable yarding, a portable engine mounted on a vehicle and equipped with cable and winch drums.

double-acting setworks Device on the carriage of a sawmill that feeds the timber at both the thrust and return stroke of the activating lever.

drag Device for leveling roads; may be a framework of railroad rails.

dray Single sled used for yarding logs.

drum Revolving cylinder on which the cable imparting motion to the carriage is wound or unwound.

Dutchman Object placed under a log to avoid splitting the log when bucking.

ecology Relationship between living organisms and their environment.

edger Machine used in sawmills to square-edge waney lumber and to rip lumber. An edger consists of a frame-supporting arbor on which are mounted several circular saws, feed rolls, press rolls, and transmission gears. One who feeds boards into the edger.

even-aged system Forest system that has stands of trees that are the same or nearly the same age, *See also* **forest system; high-forest system; low-forest system; uneven-aged system.**

face Side of a hill or mountain being logged; one side of a tree, log, or cant.

failer One who fells trees. Also called a **chopper, cutter, feller,** or **stumper.** *See also* **sawyer.**

falling wedge Wedge used to throw a tree in the desired direction or to release a pinched saw.

fbm foot board measure (measured in board feet).

feed In sawing lumber, the length of log (in inches) that is cut at each revolution of the saw.

feed rolls (rollers) Live rollers with smooth, corrugated, or rough surfaces that are used to feed lumber into the edger, resaw, planer, or other machine.

feed works Mechanism that moves the carriage past the saw.

feller. Same as **faller.**

felling Cutting down a tree.

flat pile Lumber piled so that each piece rests on its wide face.

FM field manual

forest system Area composed of tree stands. *See also* **even-aged system; high-forest system; low-forest system; uneven-aged system.**

fps foot (feet) per second

ft foot (feet)

GCW Gross combination weight of the tractor, trailer, and maximum load.

geometric thinning Thinning method whereby some trees are removed and others are left in a predetermined spacing or pattern. Also called **mechanical thinning.** *See also* **crown thinning; low thinning; selection thinning; thinning.**

grade (noun) Designation of the quality of a manufactured piece of wood; slope of a mad, usually expressed in percent. **(verb)** To sort lumber and classify it according to quality; to cull, inspect, and survey.

grader One who inspects and classifies lumber according to defects present.

grain Arrangement or direction of wood elements in relation to the width of growth rings. To have specific meaning, the grain must be qualified.

grapple Tonglike device used in skidding and loading logs and wood.

guide Device used to steady a saw.

guy line Line that supports a spar or loader boom.

GVW gross vehicle weight (includes payload).

hang-up In felling, a tree that catches on another so it becomes Iodged; in skidding, a load that gets stuck in the mud or behind some obstacle.

hardwood Generally, abroad-leaved deciduous tree.

headblock Portion of a sawmill carriage on which the log rests. Each headblock consists of a base, knee, taper set, dogs, and rack and pinion gear or some similar device for advancing the knees toward or withdrawing them from the saw line.

headsaw Log cutting saw in a sawmill. Also called a **log saw.**

herringbone felling Timber felled in herringbone fashion leading to the center of the skidding road.

high-forest system System that has tree stands that originate from seed. *See also* **even-aged system; forest system; low-forest system; uneven-aged system.**

highlead logging Wire-rope system that involves yarding in logs or trees using a rope that passes through a block at the top of a spar.

holding a corner Changing the felling direction back to the desired direction by making aback cut close to the undercut on the side of the tree toward the lean and retaining more wood in the hinge on the side away from it. The tree can be tipped upright and felled in the desired direction.

hot loading Placing logs on trucks as they are skidded from the forest.

HQ headquarter

Humboldt undercut Notch that is made upside down: the horizontal cut is on top and the sloping cut goes up to it. This cut is easier to make when using a chainsaw. The cut makes a better square end on the butt log.

hypsometer Device used to determine tree heights.

improvement cutting Type of cutting done in mixed stands that are under a first-time silvicultural management. *See also* **intermediate cutting; release cutting; salvage cutting, sanitation cutting.**

in inch(es)

intermediate cutting Treatment that modifies or guides the development of an existing crop of trees but does not replace it with a new stand. *See also* **improvement cutting; release cutting; salvage cutting; sanitation cutting.**

jackpot Unskillful piece of logging work; area where logs or trees are criss-crossed and difficult to remove.

kerf Width of cut made by a saw.

kiln Heated chamber for drying lumber.

kiln drying Process of drying wood in a kiln (use of artificial heat).

knee Part of a sawmill carriage headblock that bears the carriage dogs, which hold the log being sawed. A knee also supports the levers used to operate the carriage dogs and the taper set.

knot Portion of a branch or limb that has become incorporated in the body of a tree.

landing Place where logs are gathered and sorted before loading and hauling.

limb To remove the limbs from a felled tree.

limber One who limbs a felled tree.

log (noun) Tree segment, 8 feet or longer, that is suitable for processing into lumber, veneer, or other wood products. **(verb)** To harvest trees from an area.

log deck Pile of logs on a landing or mill yard.

log grab. Same as **dog.**

log jack Tool used to raise a log off the ground during bucking.

log saw. Same as **headsaw.**

log scale Board foot content of logs as determined by a log rule.

log turner Device usually attached to beams over the log deck. It consists of a drum driven by friction gearing, on which is wound a chain or cable. A turner is used to turn logs on a sawmill carriage. Device actuated by a steam piston. It consists of two or more arms or skids and a hook, which are used to shove or turn logs on a sawmill carriage. The sawyer controls its movements.

logging Felling trees, cutting them into logs, and transporting them to the sawmill; timber harvesting.

long butt. Same as **butt off.**

low-forest system System of tree stands that originate from the vegetative sproutings from harvested trees, Also called **coppice.** *See also* **even-aged system; forest system; high-forest system; uneven-forest system.**

low thinning Thinning method whereby natural suppression losses are accelerated because lower-crown class trees are harvested and upper-crown class trees are not. *See also* **crown thinning; geometric thinning; selection thinning; thinning.**

lumber Product of the saw and planing mill not further manufactured other than by sawing, resawing, and passing lengthwise through a standard planing machine, crosscut to length and worked.

main line In cable yarding, the line used to bring logs to the landing; on a skidder, the winch line.

marking In timber, selecting and indicating the trees to be cut or not cut.

mechanical thinning. Same as **geometric thinning.**

merchantable Portions of trees or stands that can be marketed (used) under given conditions.

millwright Mechanic who keeps a sawmill in repair.

MO Missouri

notch Making an undercut before felling a tree in a given direction.

peavey Stout wooden lever used for rolling logs. It has a curved hook on the side and a spike in the end. Also called a **cant dog.**

plunge cutting. Same as **boring.**

ppm part(s) per million

prelogging Cutting specified high value wood products, such as poles and piling, before cutting the rest of the trees.

prime log Log that is above a given size and free from defects.

pull-by cable Device used to fell a tree in a direction opposite the lean; using the cable reduces tension and allows for a safer cut.

pulley Small wheel with a grooved rim through which a rope runs.

rack and pinion Form of carriage drive used in portable sawmills.

receder Device on a sawmill carriage for receding the knees away from the saw line; it may comprise either a coiled spring properly adjusted on set shaft or a system of gears and friction pulleys by means of which set shaft can be revolved.

regeneration methods Ways to remove tree stands to promote new tree growth. *See also* **clear-cutting; seed-tree; selection; shelterwood.**

release cutting Type of cutting designed to regulate the species composition or improve the growth of very young stands (those not past the sapling stage). *See also* **improvement cutting; intermediate cutting; salvage cutting; sanitation cutting.**

rick Pile of cord wood, stave bolts, or other short-length wood evenly stacked.

ring Breaking up hard soil and even soft rock by a toothed tool pulled behind a tractor; cutting wood parallel to the grain.

roller Cylindrical body movable about its longitudinal axis; one of a series-mounted cylinders used in moving lumber from the front to the tail end of a mill.

rosser Machine that peels bark with knives.

running. Same as **cut.**

salvage cutting Cutting type whereby dead, dying, damaged, or deteriorated trees are harvested so the wood can be used before it becomes useless. *See also* **improvement cutting; intermediate cutting; release cutting; sanitation cutting.**

sanitation cutting Cutting type whereby the same kinds of trees and those susceptible to attack are removed to reduce the spread of biotic pests. *See also* **improvement cutting; intermediate cutting; release cutting; salvage cutting.**

sap Tree fluids, that is secretions and excretions.

sap stain Stain on sapwood of logs and lumber caused by fungi.

saw arbor Shaft and bearings on which a circular saw is mounted.

saw timber Trees suitable for the production of sawlogs.

sawyer One who controls the carriage and other machinery used in sawing logs into lumber; quality and quantity of lumber sawed depends on this person’s judgment, skill, and speed. *See also* **feller.**

scale To measure a log.

seed tree Regeneration method in which an old stand is removed in one cutting but a small number of trees in small groups or narrow strips are used as the seed source. *See also* **clear cutting; regeneration methods; selection; shelterwood.**

selection Regeneration method in which old trees are removed in groups or in strips wide enough to allow new trees to start and remain free to grow. This method is used in any system designed to create or maintain uneven-aged stands. *See also* **clear cutting, regeneration methods; seed trees; shelterwood.**

selection cutting Cutting only a portion of the trees in a stand, usually those marked during cruising.

selection thinning Thinning method whereby dominant trees are removed and lower crown class trees are left standing. *See also* **crown thinning; geometric thinning; low thinning; thinning.**

setworks Mechanism on a sawmill carriage by which a block setter can advance knees and logs toward the saw line after apiece has been cut from a log.

shake Separation along the grain, the greater part of which occurs between the rings of annual growth.

shelterwood Regeneration method in which an old stand is removed and a new even-aged stand is established from new trees started under the old stand. *See also* **clear cutting; regeneration methods; seed tree; selection.**

silvicultural system Program of forest treatments used for the continued production of the renewable forest resources.

skid To drag logs or tree lengths wholly or partially on the ground; one or more poles placed on the ground to support logs or bolts.

skidder Machine used to skid logs or trees to a landing.

skidding pan Plate of heavy steel rounded in front and placed under the front end of logs being skidded to prevent hang up.

skidding tongs Tongs used to grab a log for skidding.

skyline Cable suspended between spars, serving as a track for an overhead carriage, used for cable yarding.

slab Exterior portion of a log that is removed to get a fiat face for sawing lumber.

slash Debris remaining after logging.

snag Standing dead tree; sunken log or submerged stump.

softwood Botanical group of trees (conifers) that usually have needlelike or scalelike leaves; the wood produced from such trees.

spar tree Tree usually selected for its height, size, and location; used to provide height for the head block used in cable logging.

spot. Same as **blaze.**

stick To place lumber in a pile with stickers separating each course of lumber.

sticker Piece of lumber that separates the different courses of lumber in a pile.

stump wood Wood cut into short lengths and piled at the same location where it was cut.

stumpage Value of timber as it stands uncut in the forest; standing timber.

stumper. Same as **faller.**

swamping To clear an area of brush, saplings, and debris as a working area.

sweep Gradual bend in a log, pole, piling, or tree.

swing To control the direction in which a tree falls other than the one towards which it inclines.

tending To modify, direct, or guide the development of an existing crop of trees toward a particular god.

thank-you-ma'am Dip and hump across a haul or skid road that is installed to divert water from flowing down the road surface.

thinnings Partial cuttings in even-aged stands of trees that are de-signed to improve future growth by regulating stand density. *See also* **crown thinning; geometric thinning; low thinning; selection thinning.**

timber Term loosely applied to forests and products; specifically, a sawed piece of lumber more than 4 inches by 4 inches.

TM technical manual

TOE table(s) of organization and equipment

tombstone. Same as **barber chair.**

TRADOC United States Army Training and Doctrine Command

tree length Entire tree except the tops and limbs that are not merchantable.

turn Logs yarded in any one trip.

turning Turning a log about on its longitudinal axis.

turnout Wide place in the road or trail to allow vehicles to pass.

undercut In felling, the notch made in a standing tree to guide the direction of fall.

uneven-aged system Forest system that has tree stands that include three or more different age classes. *See also* **even-aged system; forest system; high-forest system; low-forest system.**

US United States (of America)

wane Bark, lack of bark, or decrease in wood from any cause on edges of board, plank, or timber.

warp Any variation from a true or plane surface.

waste Residual portion of log (sawdust and refuse used for fuel) that has merchantable value but is not used right away; those portions of logs, slabs, edgings, and trimmings used for laths, shingles, cooperage, and other products; leavings that are of no use.

wedge Tapered steel, plastic, or wooden tool that can be driven into a saw cut to relieve binding or to tip a tree in the direction it is to fall.

widow maker Limb in a tree that can fall at any time; a tree that is lodged against another and can fall at any time.

wrapper. Same as **binder.**

yard Place where logs are accumulated; the process of accumulating such logs.

yard lumber Lumber that has been air-dried in a yard; collectively, those grades of lumber usually air dried; lumber that is manufactured and classified into the sizes, shapes, and qualities required for ordinary construction and general purpose uses; lumber that is less than 5 inches thick and less than 8 inches wide.

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