U.S. Forest service California forest and
range experiment station.
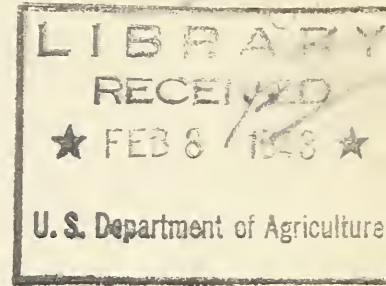
Summary of Office Report

on

A Proposed New Log Grade Classification
for California Pine Region Virgin Timber

by
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Introduction

The need for a clearly defined system of log grading has become
intensified by recent developments in the field of forest management.
The first development is the growing need for more accurate timber
appraisals. The second development is the need for basic information
concerning log values to be used as a tool in examining some of the
financial aspects of different selective cutting systems. Aside from
those present needs, there is the possibility that ponderosa pine logs
will be bought and sold on the basis of log grades.

The three grades of logs as defined by the earlier specifica-
tions are insufficient in number and in precision of definition to
meet the rather exacting demands of the more recent problems. The
classes are necessarily too broad to differentiate between types of
trees. Since a selection system of cutting is based upon the ability
of the timber marker to distinguish between types of trees, the values
used in the financial analysis of the system must be related to the
types of trees in question. From the standpoint of timber appraisals,
an increase in the number of grades employed will make the results of
mill scale studies based on these grades applicable to larger areas
within the same general timber type, than would be the case if only
three grades were recognized. Obviously, the results of one study
sample will not support broad general conclusions as to stand values
over an entire region, and the application of the results must be
limited to areas more or less like the area from which the study sample
was drawn. The system of log grades proposed herein attempts to meet
these needs by defining six log grades (seven, if the small-knot
common type of Grade 4 log is considered a separate grade), and by
defining the limits of these grades rigorously.

The "Knot-Counting" System of Log Grading

This system of log grading is based on the results of five mill
studies. In two of these studies the rough dry and surfaced lumber
could be identified as to the log from which it came. The follow-
through process permitted tallies of individual logs to be compared

with diagrams, photographs, and descriptions of the log surfaces. These tallies and descriptions were then sorted into classes having the same general grade spread, and upon investigation it was found that the number of knots, weighted according to their size was the most satisfactory foundation upon which to build log grade definitions.

Six classes of knots are recognized, two of which have absolute size limits, the size of the other four being defined as a fraction of the diameter of the bole at the point at which the knot occurs. Whether or not a knot is dead does not affect its counting weight. This factor is accounted for in the body of the specifications. While the knot count classification is provided for lower grades found in the top logs, in practice the counting process is confined to the butt 32-foot section of the tree, and principally to shop type and better logs. The cruiser will rarely be called upon to count above 8, which is the maximum number allowable on one side of a shop log. The knack of grading logs farther up the tree comes with practice in recognizing the several types by grading a tree while standing, and by checking the log grades immediately after felling. The practice should continue until the top logs can be graded at sight with an acceptable standard of accuracy.

Defects Other Than Knots

Brief comments will clarify the reasons for introducing lean, spiral grain, fire scar, lightning scar, sapsucker damage, bumpy or wavy surface, sweep, and crook as degrading factors.

Heavy lean: Mature trees. Butt-log lumber suffers appreciable degrade from warping and transverse checking. Not very noticeable until after surfacing. Not apparent at all in green lumber.

Spiral grain: Causes degrade from diagonal splitting, expecially along edges of boards, and diagonal breakage occasionally, but is most serious in the degrading of otherwise high class Shop lumber because of slope of grain. Log-by-log surfacing studies revealed the effects of this defect. No deductions are made for spiral grain in scaling. If spiral grain is serious enough to warrant degrading a log below its knot-count, or clear-surface grade, it will be indicated by the "lay" of the bark scales (not the ridges or grooves) visible on the lower logs, and by the long diagonal swellings below limbs on the upper logs. (See figures __, __, __, __, and __.)

Fire scar: The effects of fire scars in California pine region species usually extend beyond the portions discarded in the sawmill and deducted by the scaler. Here again the true extent of the damage is only brought to light after surfacing. The principal causes of degrade from the rough-dry are pitch and incipient rot, creating an excessive amount of No. 4 and No. 5 Common.

Lightning scar: Frequently causes degrade from pitchiness extending beyond the portion culled by the scaler and discarded in the sawmills.

Sapsucker damage: Sapsuckers select certain trees as permanent refreshment parlors, working on them year after year. When the holes in the bark are numerous, the wood will be full of pitch pockets.

Bumpy or wavy surface: Not to be confused with overgrown knots. This undulating surface, most frequently encountered on ponderosa pine, is definitely associated with pitchiness.

Sweep: Insufficient evidence is available with respect to the effect of log sweep on sugar pine lumber. It may be negligible. Sugar pine logs are not degraded, therefore, for sweep. But with other pine region species surfacing studies show unmistakably that many of the finished boards "follow" the sweep of the log, regardless of how straight they were when freshly sawed.

Crook and twist: Effects are similar to those from sweep, though usually worse both in degree and in frequency of boards degraded for warp and twist. Sugar pine is again omitted from degrade under this heading because of insufficient evidence one way or the other.

LOG GRADE SPECIFICATIONS
CALIFORNIA PINE REGION VIRGIN TIMBER

Ponderosa pine, Jeffrey pine, sugar pine, Douglas fir.

1. These rules define six log grades for intensive selection-cutting appraisals wherein dependability of comparisons between the estimated lumber selling values of different types or classes of associated trees is a major objective. The six grades may be reduced to four log grades for general woods-run standing timber valuation. While the stand appraised and the applied mill-study data should represent similar site quality and the same regional type, there may be appreciable local variations in other respects, such as stand structure, prevalence of visible defects, density, etc. The six-grade segregation is more adjustable to such variations than the four-grade.

2. Logs are classified on the basis of a knot-count or the proportion of continuously clear surface area, whichever gives the higher grade.

3. Opposite sides of a log are graded independently. A SIDE is semicylinder,- 50 percent circumference x length. Add the grade numbers of each side. Their average is the grade of the whole log.

Round a fractional average upward if both sides are high-line, otherwise downward. A log is first classified on the basis of size and number of knots, or proportion of continuously clear surface, then degraded for certain other defects, if any, as specified in the rules.

Examples of average grades:

One Side	Other Side	Average	Round to:
G 1	G 3	G 2	-
G 1+	G 2+	G 1-1/2+	G 1
G 1+	G 2(med)	G 1-1/2	G 2
G 4+	G 5-	G 4-1/2+	G 4
G 4-	G 5	G 4-1/2	G 5

Count-limits are specified for each grade on a one-side basis, 16-foot length, the standard length used in grading standing trees. "Count-limit" means the maximum count permitted on the lowest-line log of each class and is to be distinguished from number of knots, compensation for the smaller knot sizes being made by varying the counting weight. Thus, in counting a few scattered pin knots on a side, rated at 1/4 count each, 4 pin knots = 1 count, whereas 4 medium knots, rated at 1 count each, take a count of 4. 4 pin knots + 4 medium knots = a count of 5.

For simplification in grading shorter lengths on the mill deck, convert the actual count to a 16-foot equivalent by repeating the count on the top 6 feet, 4 feet, or 2 feet for 10 foot, 12 foot, and 14-foot logs, respectively. On 18-foot logs, omit the count of the base foot and the top foot.

4. Knot-count limits are specified for all grades so that logs in felled trees, no matter how numerous the knots, may be definitely classified for training purposes and checking. In STANDING-TREE grading, after preliminary training, knot counting is confined generally to the two or three lower logs having few knots, i.e., good Shop and Better logs. A proficient grader will soon learn to classify medium Shop and Common logs quickly and accurately by mental association with the down logs observed during the training period.

5. Knot-size abbreviations and definitions are:

PK = pin knots and bark knot-holes 1/2" and less in diameter.
*1"K= inch knots and bark knot-holes over 1/2" to $1\frac{1}{2}$" diameter.
    Knots larger than $1\frac{1}{2}$" are classed as small, medium, large, or very large with relation to the observed diameter of the log, D, where the knot occurs.
*SK = small knots over $1\frac{1}{2}$" to 0.1 D.
MK = medium knots over 0.1 D to 0.2 D.
LK = large knots over 0.2 D to 0.3 D.
VLX= very large knots, over 0.3 D.
*1"K becomes SK on logs under 15 inches diameter.

The diagram below illustrates sections of four logs having the same log diameter but different relative sizes of knots.
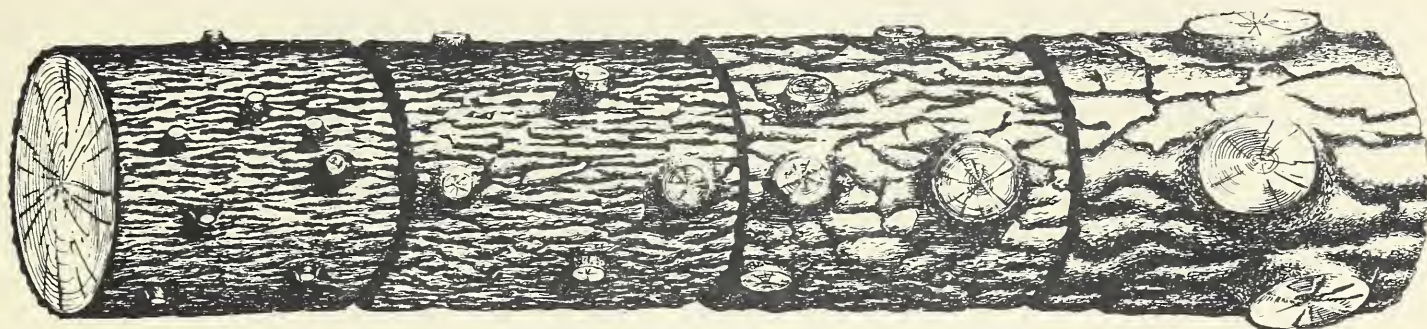
Small	Medium	Large	Very Large
Limit 0.1 D	Limit 0.2 D	Limit 0.3 D	Over 0.3 D

6. General rules for counting scattered knots:

  LOGS SMALLER THAN 18 INCHES DIAMETER: Count PK as 1/2 each.
   (2 PK = 1 count) Inch knots and larger, count 1 each.

  LOGS 18 INCHES AND LARGER: Count PK as 1/4, 1"K & SK as
   1/2 each, MK and larger, count 1 each.

  SHOP AND BETTER BUTT LOGS ONLY: Count knots within top 1-foot
   end zone as 1/2 the weight of the same sizes of knots else-
   where, i.e., 2 MK in 1-foot end zone are counted as 1, etc.

7. A. Grade specifications, knot-count, and small-knot common logs:

  One-side basis, 16-foot length, unless noted otherwise.
  Count limits for entire logs, both sides, are twice the
  limits given.

    GRADE 1. Extra-Select. Count of 1 per side but only
     1 LK or VLK is permitted on entire log except in
     top 1-foot end zone on butt logs.

    GRADE 2. Select. Count of 2 per side.

    ON GRADES 3 AND LOWER, the maximum allowance of LK and
     VLK is 3/4 of the total count limit, e.g., the count
     limit for Grade 3 is four per side, but only three
     may be LK or VLK.

GRADE 3. Shop-Select. Count of 4 per side, but not
     over 3 L & VLK.

GRADE 4. Shop. Count of 8 per side, but not over 6 L
     & VLK, and small-knot type: (segregate as Grade C
     if desired. See footnote 3/, p. 4). No knots
     larger than medium (.2D) on logs 15 inches and smaller,
     and none over 3 inches, on logs larger than 15 inches.
     More than a count of 8 per side. May have an unlimited
     number of MK and smaller provided 80 percent or more are
     green or appear to have died back so recently that they
     are intergrown to within an inch or less of the log
     surface inside the bark.

GRADE 5. Shop-Common. Count of 16 per side, but not
     over 12 L & VLK, and medium to small-knot type: knots
     all medium and smaller:
          (a) Unlimited live medium knots but larger than
              3" on logs 15 inches and larger. Less than
              20 percent dead and loose MK.

          (b) Mixture of MK, SK and 1"K, MK mostly green
              but SK and 1"K appearing dead to a depth of
              1/5 log diameter or more beneath the surface
              of the sapwood.

GRADE 6. Box-Common. Count of 24 per side, but not
     over 18 L & VLK, and medium and small-knot type:
     many MK, over 20 percent of which appear dead to a
     depth of 1/5 log diameter or more beneath the sur-
     face of the sapwood.

Four-grade system for rough appraisals:

     Grade 1. Specifications identical with Grade 1 of
          six-grade system.

     Grade 2. Composite grade composed of Grades 2 and 3
          of the six-grade system.

     Grade 3. Identical with Grade 4, six-grade system.

     Grade 4. Composite grade composed of Grades 5 and 6
          of the six-grade system.

DEGRADE FOR OTHER DEFECTS. Above knot-count of the six-grade system
        grades are to be degraded for other surface-visible defects
        as follows:

|	Drop 1 Grade	Drop 2 Grades
CROOK, SWEEP, TWIST, (except sugar pine)	Scale ded. 10%+	Over 20%
FIRE SCAR exceeding 25% of length	26 to 50% L	Over 50% L
LIGHTNING SCAR, FROST CRACK	Straight	Spiral over 1 in 3
SPIRAL GRAIN exceeding slope of 1 in 3	Sl. 1/3+to 1/2	Over 1/2
BUMPY OR WAVY SURFACE)		
SWELLINGS AROUND KNOTS)	Moderate	Severe
SAPSUCKER DAMAGE	Moderate	Severe
LEAN butt logs of trees over 24" d.b.h.	Over 20% (12°)	--

IF ANY TWO or all of these defects are in combination on the
        same log, use judgment in estimating total degrade but
        ordinarily the total drop should not exceed 2 grades in
        the six-grade system. If using the 4-grade system, make
        allowance for the combination grades, e.g.,

6-Grade System		4-Grade System
Grade 2 & 3	=	2
Grade 2	=	high-line 2
Grade 3	=	low-line 2

        Drop of 1 Grade, #2 to #3 = high 2 to low 2 = no change,
           but if log is low-line 2 to begin with, 1 grade drop =
           2 to 3 in 4-grade system.

        The same kind of correction applies to Grade 4 of the
           4-grade system, equivalent to #5 and #6 combined of the
           6-grade system.

Diagrammatic samples of one-side log grades. Each log is 30 inches in diameter by 16 feet long. Weighted knot-count is indicated below each log.
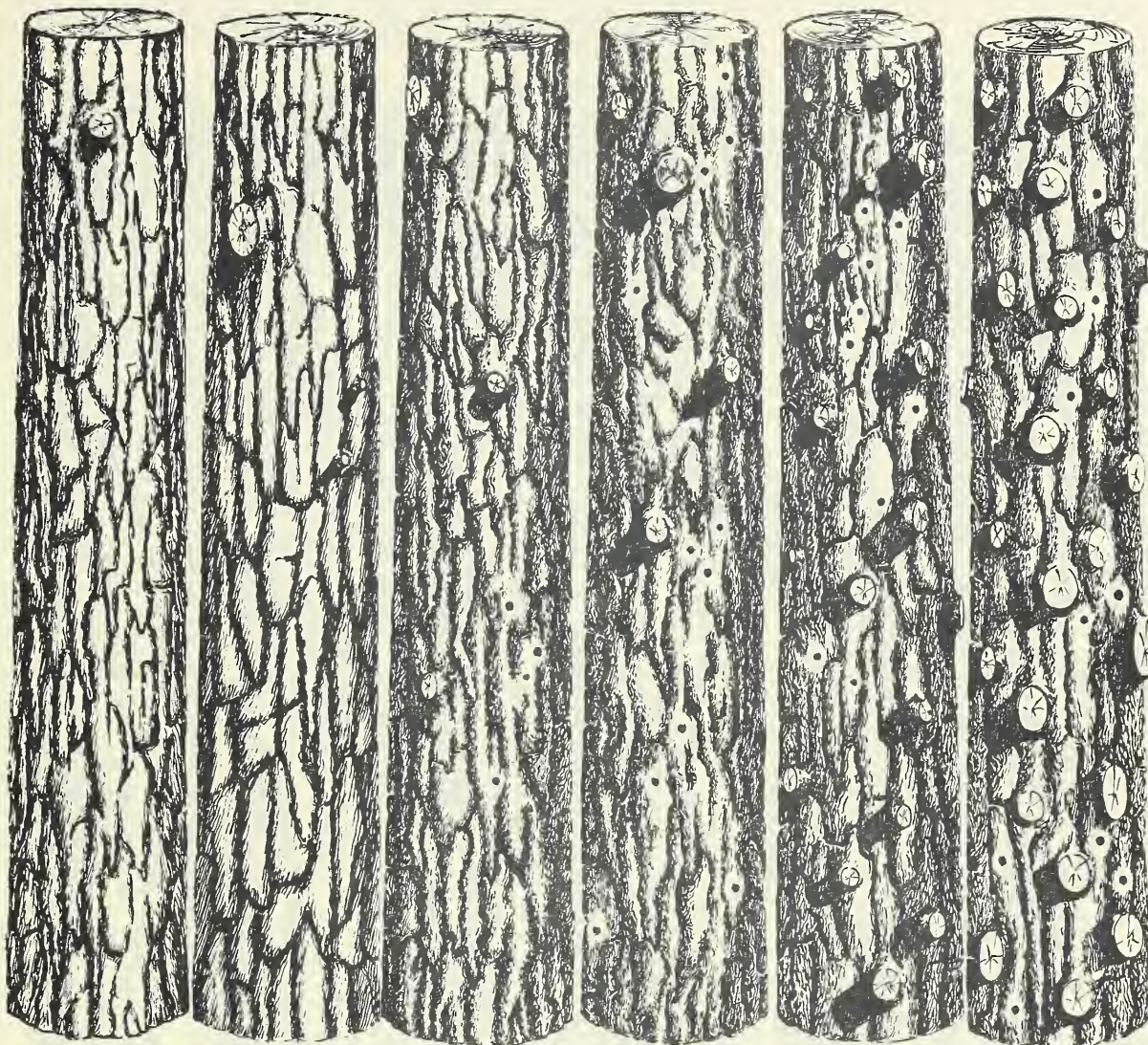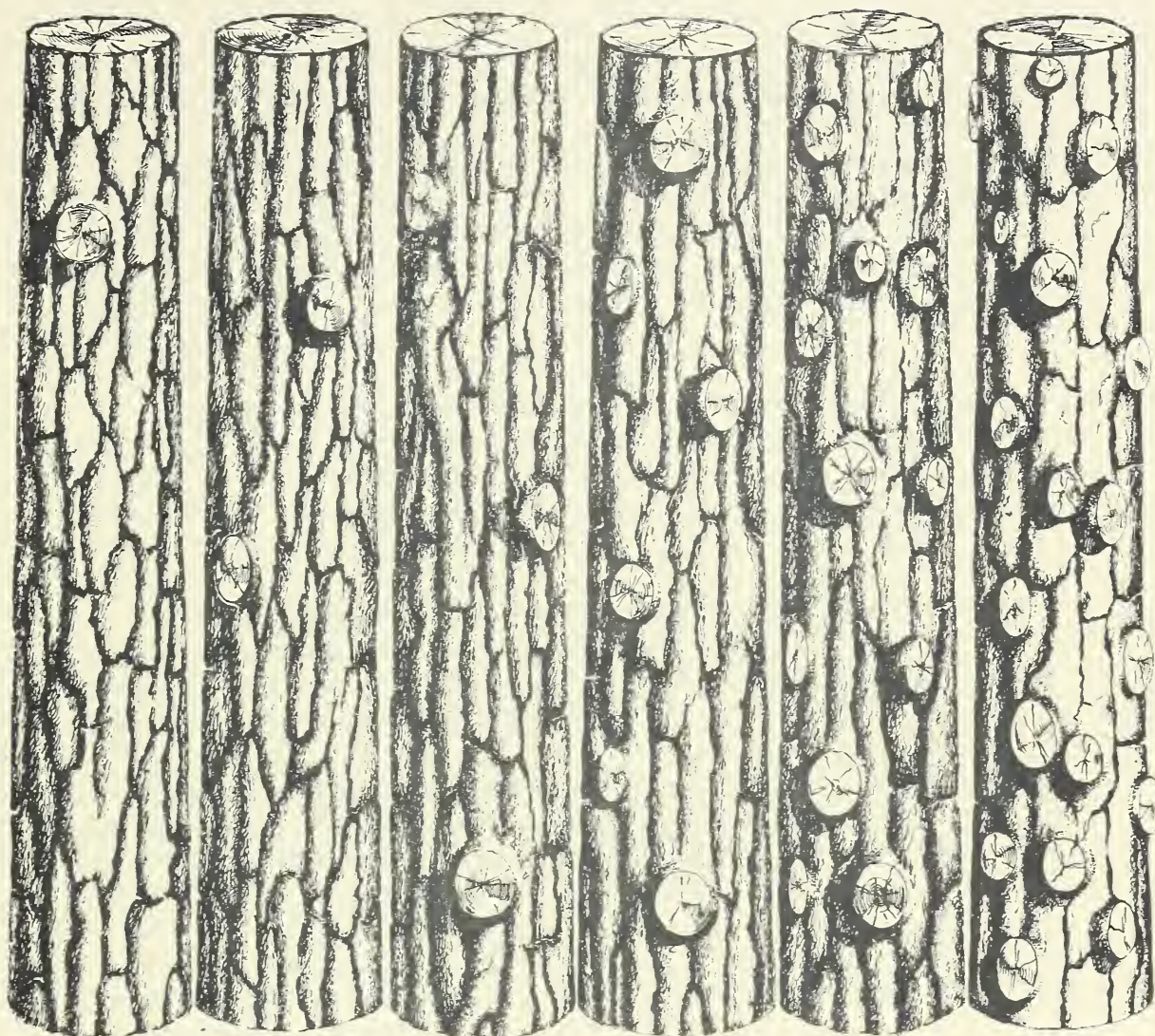

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
1 MK - 1	1 VLK -1	1 VLK -1	2 LK - 2	5 LK - 5	4 VLK - 4
or could	2 SK - 1	2 MK - 2	2 MK - 2	9 MK - 9	17 LK - 17
have	Count -2	4 PK - 1	2 SK - 1	4 SK - 2	3 MK - 3
2 SK or		Count -4	2 1"K -1	Count -16	Count - 24
2 1"K or			8 PK - 2	1"K & PK not counted	
4 PK			Count -8		

Count limit, both sides combined					
2	4	8	16	32	48

Grade 1. May have only 1 LK or 1 VLK on entire log below 1-foot end zone.
The count limit of 2 in this grade implies only MK or smaller in the
extra count. May have 1 VLK and 1 MK but not 2 VLK or 2 LK. The log
illustrated would be Grade 1 with 4 PK, or 2 1"K, or 2 SK, in addition
to the 1 MK on the same side if the other side is 100% clear.

Grades 2 to 6. If opposite sides are 100% clear on the logs illustrated
(very unlikely in connection with the Grade-6 side), the second log will
be Grade 1, the third will be Grade 2, the fourth will be Grade 3, and
the last two will be Grade 4. (See rules for logs with knots grouped.)

Limits in large and very large knots.

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
1 LK or	2	3	6	Twice	3 x
1 VLK on	each	each	each	grade 4	grade 4
one side	side	side	side	limit	limit
only					

Grade 1. Cannot have another LK or VLK on either side except in top
   1-foot end zone on butt log but could have 1 additional MK or 2 SK,
   or 2 1"K, or 4 PK, below 1-foot end zone.

Grades 2, 3, & 4. When side has limit in very large knots, no smaller
   knots are permitted.

Grades 5 & 6. 1"K and PK are not counted. Limit in large knots only
   (.2 to .3 log diam.) is $1\frac{1}{2}$ times limit of MK.

7. B. Specifications for Logs with Knots grouped.

Logs meeting the specifications below in percent of cir-
cumference continuously clear for the full length, or linear
footage of length continuously clear all around shall be
graded as indicated regardless of an excess over the knot-
count specified for the same grade of logs of the scattered-
knot type.

Percent of circumference is based on the top diameter of
the log. "75% of clear circumference, full length" means
the knots must be confined to a strip straight down one side
between two parallel lines spaced 25% of the circumference
apart at the smaller end.

Maximum length of knotty portion in end zones may be
measured from one or both ends. For example, 3 feet of
knots at one end = 1 foot at one end plus 2 feet at other
end, or 1½ feet at each end, etc.

Clear portion may have 1 MK or 1 SK or a number of 1½"
and smaller knots not exceeding the grade number - thus, a
log 75% circumference clear full length is Grade 2 and the
clear portion may have 2 PK or 2 1"K.

Bucked logs 10 and 12 feet long are graded on a clear-
circumference x full-length basis or a knot-count basis but
not on an end-zone basis.

	Clear full length		Knots at ends		
	Minimum	Maximum	16 ft. log		14 ft. log
Grade	percent	percent	Min.	Lgth.:	minimum
	clear	strip of	cir.	knotty	clear
	circumference	knots	lgth.	ends	length
1	92	8 (1/4 D")	15'	1'	13'
2	75	25 (3/4 D")	13'	3'	12'
3	60	40 (5/4 D")	10'	6'	9'
4	50	50	8'	8'	3'
5	25	75	6'	10'	6'
6	-	-	-	-	-

7. C. Abbreviated Log-grade Specifications.

Knots in 1-foot top end zone are counted as 1/2 weight on Shop & Better butt logs only.						
KNOT CLASS	: PK	1"K	SK	MK	LK	VLK
SIZE LIMIT, Maximum	: ½"	1½"	.1D	.2D	.3D	Over .3D
LOGS 18"D & UP, COUNT	: ¼	½	½	1	1	1
LOGS UNDER 18"D COUNT	: ⅓	1	1	1	1	1

WEIGHTED COUNT LIMITS. ONE-SIDE BASIS. 16-FOOT LOGS:
GR. 1 Count of 1, but only 1 LK or 1 VLK entire log.
GR. 2 Count of 2 per side.
GR. 3 Count of 4 but not over 3 LK & VLK.
GR. 4 Count of 8 but not over 6 LK & VLK; if no L or
     VLK, may have unlimited MK and smaller if 80%+
     are green or sound and tight. Logs over 15", no
     knots larger than 3" allowed if count exceeds 8.
     (GR. 5 if several SK & 1"K appearing dead and
     loose. MK must be sound and tight.)
     (GR. 6 if MK are dead and loose.)
GR. 5. Unlimited MK over 3" on logs 15" and up if
     sound and tight. If VLK or LK present, double
     count limit above for Gr. 4.
GR. 6 Many dead and loose MK; three times count limit
     for Gr. 4 if LK & VLK present.
CULL Exceeds Gr. 6 Count, or has many dead LK

CLEAR AREA TYPE LOGS. KNOTS OVER COUNT LIMIT
C = CIRCUMFERENCE. L = length. Cl. 1 clear

	Gr.1	Gr.2	Gr.3	Gr.4	Gr.5
Min.% Cl.C full L	92	75	60	50	40
Min. Cl.L 16-foot	15'	13'	10'	8'	6'
Min. Cl.L 14-foot	13'	12'	9'	8'	6'

4-GRADE SYSTEM AS RELATED TO 6-GRADE SYSTEM
Gr.1 = 1; Gr.2 = 2 & 3 combined; Gr.3 = 4; Gr.4 = 5&6

AFTER GRADING AS ABOVE DEGRADE FOR DEFECTS; 6-gr.system

*	Drop 1 grade	2 grades
CR.,SW.,TW.(not S.P.) :	Ded. 10% :	Ded. 20%+
FIRE SCAR :	26 to 50% L :	Over 50% L
LIGHT. SCAR, FR. CRACK :	Straight :	Spiral 1/3+
SPIRAL GRAIN :	Slope 1/3-1/2 :	Over 1/2
BUMPY, WAVY SURFACE) :	Moderate :	Severe
SWELLINGS, KNOT BASE) :		
SAPSUCKER HOLES :	Moderate :	Severe
LEAN BUTT LOGS, OVER 24" d.b.h. 20%+ :	—	

*Also 4-grade system, but compensate for composite
  Grades 2 and 4.

Summary

The grade of a log is a measure of its value in much the same way that the grade of a piece of lumber is a measure of its value. Just as the term "No. 2 Common" creates a definite picture in the mind of a lumber user of a tight-knotted board of medium value, the term "Grade 2 logs" should mean a high-quality log which will produce a fairly large volume of No. 2 Shop and Better lumber. In other words, there is a need for a recognized standard of value for the raw material closely paralleling the long established lumber grades for the finished product. The need for a recognized standard becomes more pressing as the tendency on the part of the logger to experiment with different systems of timber harvesting becomes more evident.

The proposed classification of logs gives weight to some of the many factors which cause logs to differ in lumber yield, and therefore in value. The effect of knot-size which is equally important as that of number of knots is evaluated by defining the knot in terms of the diameter of the bole where the knot occurs. The percent of clear area basis of classification is introduced to cover those cases where the defects are confined to strips or zones on the log. Visible defects other than knots have been assigned weights on an empirical basis. The specifications for the several log grades as drafted are a compromise between the conditions that the grades be defined with sufficient clearness to guide the grader's judgment on one hand and that the definitions be relatively simple and relatively easy to learn and to apply on the other.
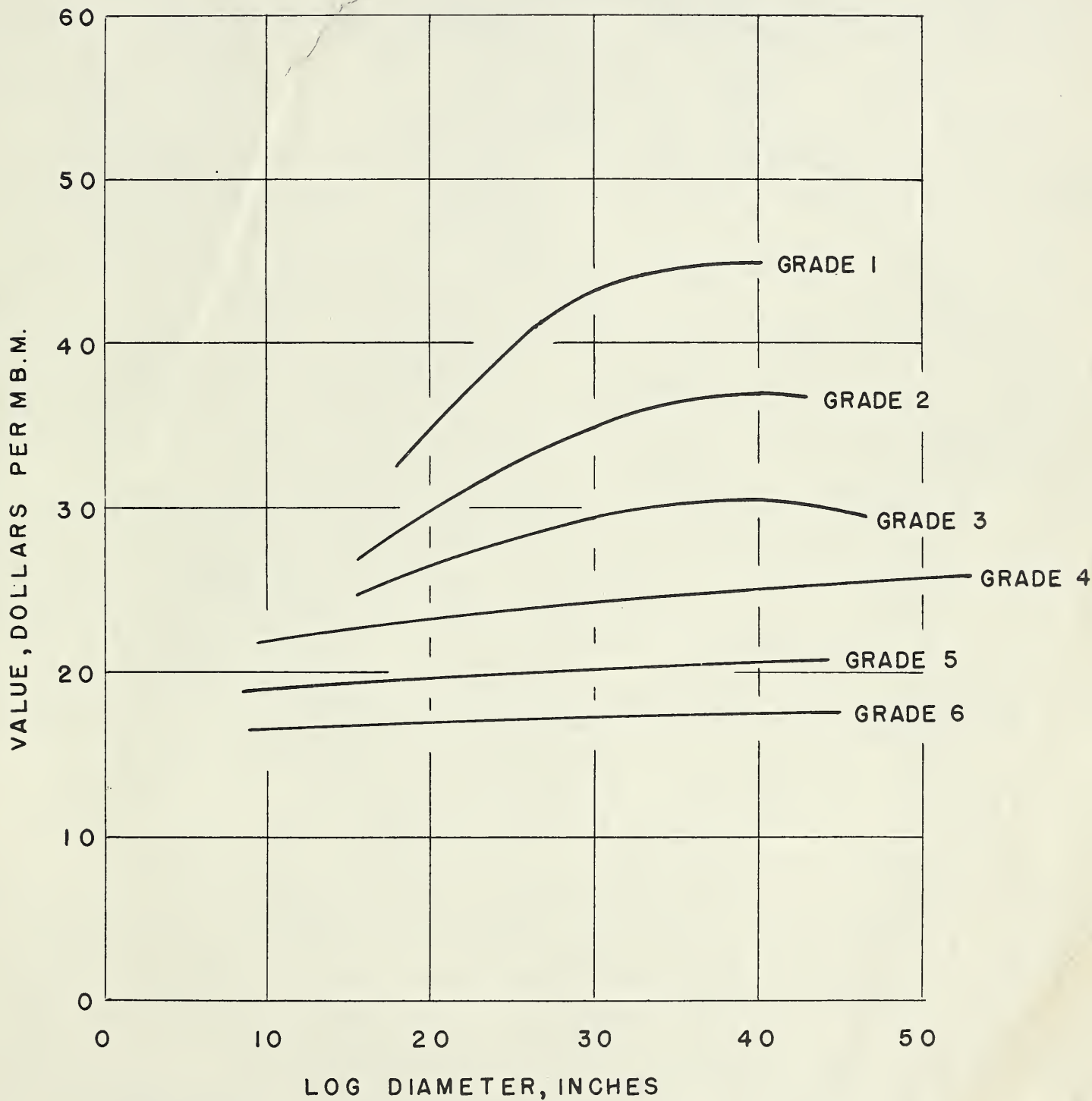
The two systems of log-grading proposed are designed to meet two different objectives. The four-grade system is intended to supplement routine timber cruises by providing a measure of quality which cannot be so accurately evaluated on the basis of a tree diameter tally alone. This system is applicable to relatively large areas, and is essentially an administrative tool. The six-grade system, on the other hand, is intended for rather intensive analyses of the returns from different systems of timber harvesting and would usually be applied to sample plots or other relatively small timber areas. The six-grade system is essentially an experimental tool. It is an obvious advantage to be able to express the results of the six-grade system in terms of the four-grade system by combining entire log grades.

There is little doubt that the growing tendency to experiment with systems of cutting will lay more emphasis upon the classification of logs in terms of value or quality. A recognized standard definition of these quality classes is indicated, and will provide a basis to compare results if such standards can be established.

CHART I= ROUGH DRY LUMBER SELLING VALUES

PONDEROSA PINE LOGS

LASSEN STUDY