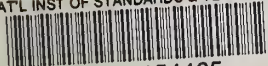


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NBS BUILDING SCIENCE SERIES 122

A Study of Lumber Used for Bracing Trenches in the United States

U.S. DEPARTMENT OF COMMERCE • NATIONAL BUREAU OF STANDARDS



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NBS BUILDING SCIENCE SERIES 122

114

A Study of Lumber Used for Bracing Trenches in the United States

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CONTENTS

	<u>Page</u>
Conversion Factors for (SI) Metric Units	vii
ABSTRACT	viii
EXECUTIVE SUMMARY (Includes Findings, Conclusions, and Recommendations)	ix
1. BACKGROUND AND PURPOSE	1
2. APPROACH AND SCOPE	3
3. FIELD INVESTIGATION	5
3.1 Purpose	5
3.2 Approach and Scope	5
3.3 Profile of Trenching Lumber Properties and Uses	7
3.4 Geographic Areas, Investigation Team, Sampling Plan	7
3.5 Description of Data Entries	8
3.6 Lumber Sampled	10
3.7 Summary - General Observations at Supply Yards	10
3.7.1 Wane	10
3.7.2 Species	10
3.7.3 Storage, Moisture Content, and Fungal Deterioration	11
3.7.4 Reused Lumber	12
3.7.5 Lumber Quality	12
3.8 Summary of Field Data Analysis	13
3.8.1 Lumber Grade Disregarding Wane, Damage and Decay	13
3.8.2 Regrading	14
3.8.3 Reduction of Cross-Sectional Area and Moment of Inertia	14
3.8.4 Decay	15
3.8.5 Trimming	15
3.8.6 Damage	16
3.8.7 Species	16
3.8.8 Slope of Grain	16
3.8.9 Moisture Content	16

	<u>Page</u>
4. RECOMMENDATIONS FOR ALLOWABLE DESIGN STRESSES	17
4.1 Introduction	17
4.2 Hardwood Allowable Properties	18
4.3 Softwood Allowable Properties	18
5. USE RECOMMENDATIONS	19
5.1 Introduction	19
5.2 Duration of Load	20
5.3 Damage	20
5.4 Wane	20
5.5 Bark	21
5.6 Decay	21
5.7 Insect Attack	22
5.8 Inspectability	22
5.9 Exposure	22
5.10 Storage	23
REFERENCES	25
GLOSSARY	27
APPENDIX A - Sampling Procedures and Description of Data Entries and Coding	A-1
APPENDIX B - General Observations and Descriptions of Yards Visited	B-1
APPENDIX C - Analysis of Field Investigation Data	C-1
APPENDIX D - Trenching Lumber: Stress Derivation and Use Recommendations	D-1

COVER: *In certain areas of the United States, lumber is used extensively to brace trenches against collapse.*

LIST OF TABLES

	<u>Page</u>
1. Trenching Lumber Sampled	30
2. Summary of Findings for the Strength Ratio Grades (G) for full length Wales and Sheeting	31
2a. Strength Ratio (SR) Values in Terms of Grade	31
3. Summary of Frequency and Economic Impact of Wane on full length Wales	32
4. Allowable Unit Stresses for Hardwood Wale and Strut Trenching Lumber	33
5. Grouping of Some Domestic Woods According to Heartwood Decay	34

LIST OF FIGURES

1. Components of a Shoring System	35
2. Wane in 12 x 12's	36
3. Lumber Storage	37
4. Sheeting Lumber	37
5. Lumber Storage	38
6. A Clean Lumber Yard	38
7. Reused Wale Material	39
8. Reused Sheeting Material	40
9. Lumber Defects	41
10. Slope of Grain	42
11. Lumber Defects	43
12. Lumber Defects	44
13. Lumber Defects	44
14. Reusable Timber	45

	<u>Page</u>
15. Relative Frequency of Strength Ratio Grade	46
16. Wane Example	46
17. Climate Index Map	47
18. Poor Storage Problems	48
19. Examples of Decay in Trenching Lumber	49
20. Insect Infested Trenching Timber.	50

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CONVERSION FACTORS FOR (SI) METRIC UNITS

In view of the presently accepted practice in this country in this technological area, common U.S. units of measurement have been used throughout this paper. In recognition of the position of the U.S.A. as a signatory to the General Conference on Weights and Measures, which gave official status to the metric SI system of units in 1960, we assist readers interested in making use of the coherent system of SI units by giving conversion factors applicable to U.S. units used in this paper.

Length

$$1 \text{ in} = 0.0254 \text{ meter* (m)}$$

$$1 \text{ ft} = 0.3048 \text{ meter* (m)}$$

Area

$$1 \text{ in}^2 = 0.000645 \text{ square meter (m}^2\text{)}$$

$$1 \text{ ft}^2 = 0.0929 \text{ square meter (m}^2\text{)}$$

Volume

$$1 \text{ in}^3 = 0.0000164 \text{ cubic meter (m}^3\text{)}$$

$$1 \text{ ft}^3 = 0.0283 \text{ cubic meter (m}^3\text{)}$$

Mass

$$1 \text{ lb} = 0.454 \text{ kilogram (kg)}$$

Mass/Volume (Density)

$$1 \text{ lb/ft}^3 = 16.02 \text{ kilogram/meter}^3 \text{ (kg/m}^3\text{)}$$

Temperature

$$\text{degree celsius (}^\circ\text{C)} = 5/9 (\text{}^\circ\text{F} - 32)$$

Pressure

$$1 \text{ psi} = 6895 \text{ pascal (Pa)}$$

*Exactly

ABSTRACT

In certain areas of the United States, lumber is used extensively to brace trenches against collapse. The life and safety of the workers in these trenches therefore depends on the structural adequacy of the lumber bracing used. This report presents a study of the properties and characteristics of trenching lumber which are critical to its structural performance. Using these properties and characteristics, allowable stresses and use recommendations are proposed.

The National Bureau of Standards (NBS) conducted a field study of trenching lumber and found that either ungraded eastern species, primarily hardwood, or graded Douglas-fir is used. For graded Douglas-fir, allowable design stresses and other properties are established by existing standards. The eastern species, however, are ungraded and no accepted guidelines are used to assign allowable design stresses and other properties. The results of the field study indicate that 80 percent of the eastern species trenching lumber, when graded by existing softwood grading rules (Southern Pine Inspection Bureau Grading Rules, 1977 edition) is No. 2 grade or higher; 60 percent is No. 1 grade or higher. These percentages do not reflect the effects of wane (deficiency in cross-sectional area) and decay, which are additional problems. NBS therefore recommends that, for hardwood wales and struts, allowable stresses and other properties be based on a No. 2 minimum grade with appropriate provisions to control wane and decay.

Use recommendations were developed, which consider duration of load, mechanical damage to lumber, presence of bark, decay, insect attack, inspectability, exposure, and storage for various aspects of trenching lumber applications. These recommendations reflect a severe trenching environment, possible reuse of structural members, and the need for structural integrity to protect life and property.

Key Words: Construction lumber; construction safety; excavation; hardwood; lumber grading; shoring; softwood; timber engineering; trench bracing; trenching.

EXECUTIVE SUMMARY

I. SUMMARY OF CONCLUSIONS

In certain areas of the United States, lumber is used extensively to brace trenches against collapse. The life and safety of the men working in these trenches, therefore, depends on the adequacy of the lumber bracing. The National Bureau of Standards (NBS) conducted a field study of trenching lumber and found that either ungraded eastern species, primarily hardwood, or graded Douglas-fir is used. Allowable design stresses and other properties are readily available for Douglas-fir, but are non-existent for most of the eastern species. The NBS field study indicated that, based on softwood lumber grading rules (Southern Pine Inspection Bureau Grading Rules, 1977 edition) 80 percent of the eastern species trenching lumber is No. 2 grade or higher; 60 percent is No. 1 grade or higher. These percentages do not reflect the effects of wane (deficiency in cross-sectional area) and decay, which are additional problems. NBS therefore recommends that, for hardwood wales and struts, allowable stresses and other properties be based on a No. 2 minimum grade. It is also possible to base allowable stresses, etc., on a No. 1 minimum grade, depending on the level of quality control desired. In either case, quality control is necessary and can be implemented in two steps.

Step 1: A specification, as part of OSHA regulations, stipulating minimum quality, such as limits on wane, decay, defects, and exclusion of weak species. The specification would be based on a traditional strength ratio concept and be consistent with the stress level chosen.

Step 2: Introduction of a voluntary grading system by industry, which would ensure the Step 1 specification for trenching lumber.

II. BACKGROUND, PURPOSE, AND SCOPE OF STUDY

Prior to this study, criteria and guidelines on the use, quality, and performance of lumber bracing systems, particularly for hardwood, were virtually non-existent. Moreover, particularly for hardwood, very little was known about the actual size, species, grade, supply patterns, storage, moisture content, reuse patterns, defects, and structural strength of trenching lumber.

The purpose of this study was to investigate the properties and characteristics of trenching lumber which are critical to its structural performance. On the basis of this investigation, allowable stresses, minimum quality or grade requirements, and use recommendations are proposed.

This study was performed in three steps:

- (1) the identification of a profile of needed properties and critical structural uses of trenching lumber.

- (2) the determination of profiles of trenching lumber characteristics at selected trenching lumber distribution sites in Washington, D.C.; Houston, Texas; and southern California. Critical strength characteristics of trenching lumber were determined.
- (3) the development of recommendations concerning allowable stresses, minimum quality or grade requirements, and conditions of use for trenching lumber, based on steps (1) and (2) above.

This study was performed as a cooperative effort of NBS and the Forest Products Laboratory (FPL). FPL served in a consulting and advisory capacity for steps (1) and (2) and was primarily responsible for step (3).

III. FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

A brief summary of the findings, conclusions, and recommendations of each of the 3 steps follows.

Step (1) - A National Profile of Trenching Lumber Properties and Uses

Based on discussions with supply yards, contractors, and code authorities, the following conclusions were drawn prior to conducting the field investigation:

- o most of the hardwood and softwood lumber used is rough sawn and green.
- o the hardwood is ungraded (mill run) and consists of a variety of species, with a high frequency of oak.
- o much of the hardwood wales and struts used are left in place (not reused); most of the hardwood sheeting is left in place. (Sketches of wales, struts, and sheeting are shown in fig. 1, ch. 3.).
- o some softwood is used in Los Angeles, San Francisco, New York City, and Chicago.
- o the softwood used on the West Coast is primarily stress graded Douglas-fir; Southern Pine and Douglas-fir are sometimes used in New York City and Chicago.
- o for solid sheeting (fig. 1), where there is essentially no space between the sheeting, wales cause the most difficulty for contractors from a structural standpoint, struts next, and sheeting the least difficulty.

Step (2) - Field Investigation with Case Studies

The major findings of the field investigation, based on case studies for eastern species, primarily hardwood, in Washington, D.C., and Houston, Texas, and for Douglas-fir in southern California, are as follows:

Lumber grade disregarding wane, damage, and decay: The most important grade analysis disregarded the effects of wane, damage, and decay to emphasize the basic strength characteristics of the lumber. The resulting grades were termed the strength ratio (G) grades (see section 3.8.1). This concept, used for analysis purposes only, provided a basis for evaluating the effects of: (a) regrading by grading partial lengths or upgrading by hypothetical trimming, and (b) downgrading due to wane, damage, or decay effects.

Table 2 shows the major findings for the G grades. As shown in the table, 80 percent or more of the eastern species trenching lumber was No. 2 grade or higher; 60 percent or more of the pieces sampled were No. 1 grade or higher. The percentages of full length wales of eastern species (primarily hardwood) having strength characteristics of No. 2 grade or higher (col. 2, table 2) and No. 1 or higher (col. 3) were about 20 percentage points lower than for Douglas-fir. This is to be expected since stress grades for larger size material are generally limited to No. 1 or No. 2 in Douglas-fir. However, the percentages of eastern species sheeting of No. 2 or higher and No. 1 or higher were about 10 percentage points higher than for the Douglas-fir sheeting. The average strength ratio, SR, (col. 4 - defined in table 2a) and coefficients of variation for SR agree well for eastern species and Douglas-fir wales and sheeting.

Regrading: Wales were regraded by grading partial lengths--either 1/2 or the middle 1/3 of a full length wale. Partial length grading was used to assess the increased structural potential for wales, since loads may be non-uniform; may cause the maximum moment to occur in the center third; and may occur with load sharing.

Depending on major geographical area, the percentage of wales that was found to contain higher grade portions upon regrading ranged from about 15 to 45 percent if the partial length was 1/2 the full length and 12 to 30 percent if the partial length was the middle 1/3 of the full length. The degree of upgrading for both 1/2 and middle 1/3 length cases ranged from about 10 to 20 SR units. Using a No. 2 grade as a base (SR = 45), 10 SR units would represent an increase to a No. 1 grade (SR = 55); 20 SR units an increase to Industrial 65 or Select Structural grade (SR = 65).

Wane: The frequency of wane on wales was assessed by determining if the member was downgraded, relative to its G grade, due to wane. The potential economic impact of a wane limitation was measured by the frequency of downgrade from No. 2 or higher to lower than No. 2. The frequency of downgrade due to wane and the potential economic impact of a wane limitation were shown to be significant for eastern species wales. For Douglas-fir, wane was controlled by grading rules.

Decay: About 7 percent of the eastern species full length wales were downgraded to a non-stress grade status from their G grade due to decay. No downgrade due to decay was observed for 37 new Douglas-fir full length wales.

Trimming: The purpose of the trim analysis was to provide preliminary economic information on the potential upgrading due to trimming. The following trimming analysis is based on the choice of No. 2 as a minimum acceptable grade. Of the full length eastern species wales, approximately 125 (50 percent) were less than No. 2 in quality for strength ratio, wane, or decay. Of the 46 wales that could be upgraded by trimming and which were less than No. 2, 38 (83 percent) could be trimmed to a grade of No. 2 or higher.

Considering all grades, only 4 (11%) of the 37 new Douglas-fir full length wales could be upgraded by trimming; all of these were No. 2 or higher before trimming.

Damage: Very little mechanical damage, caused by handling or use, was observed. Only 1 percent of the eastern species full length wales were downgraded relative to their G grade. No eastern species sheeting was downgraded. For new and used Douglas-fir members, only 1 percent of the full length wales and struts and 3 percent of the sheeting were downgraded.

Species: At least 50 percent of the eastern species full length wales and sheeting were either red or white oak. The softwood in southern California was Douglas-fir.

Slope of grain: Only about 5 percent of all full length wales, struts, and sheeting had a general slope of grain of 1 in 10 or steeper. Thus, few pieces of No. 1 or 2 level were limited by slope of grain in the grading process.

Moisture content: Almost all the eastern species lumber sampled was green. The moisture content of the Douglas-fir varied from green to 10 percent.

Step (3) - Allowable Properties

Hardwood allowable properties: Formally approved allowable lumber stresses do not exist for most hardwood species. Applicable ASTM standards (D2555, D245) were followed in conformance with procedures recognized under the American Lumber Standard PS 20-70 to develop example allowable stresses (Table 4).

The allowable stresses in table 4 reflect the limiting defects of No. 2 grade as specified by the National Grading Rule and as listed in the Southern Pine Inspection Bureau Grading Rules, 1977 edition. FPL has suggested these rules as a basis for grading agencies to use in developing grades and properties for trenching lumber. A minimum grade of No. 2 was chosen based on the field investigation results which indicated that for the eastern species, 80 percent of the wales and 85 percent of the sheeting were No. 2 or higher when wane, damage, and decay were disregarded. It appears that eastern species lumber of grade No. 2 and higher is being used frequently and apparently performing satisfactorily. Example stresses in table 4 were based on several possible species groupings of potential economic feasibility.

Separate properties were developed for the white oak species group because of its relatively high occurrence as observed in the field investigation and its superior decay resistance. Properties for the mixed oak species group were developed to reflect the relatively high occurrence of mixed oak as compared to other species. The field investigation indicated that at least 50 percent of the eastern species sampled were mixed oak. Groups I and II (table 4) demonstrate properties for hardwoods in which the majority of the eastern species encountered are included and only a few of the weaker species are excluded.

Tentative specifications for wane for eastern species wales and struts are the wane requirements for a No. 2 grade, as given in the Southern Pine Inspection Bureau Grading Rules, 1977 edition. In retrospect, additional studies in the field are needed to evaluate the effect of the recommended wane requirements on mill yield.

Softwood allowable properties: A minimum grade of No. 2 is recommended for softwood wales and struts. The corresponding allowable stresses for species and grade combinations can be derived using traditional ASTM procedures.

Use Recommendations: FPL developed use recommendations covering duration of load, damage, bark, decay, insect attack, inspectability, exposure, and storage for various aspects of trenching lumber applications. The development reflects the severe trenching environment, possible reuse of structural members, and the need for structural integrity related to safety of both life and property for finite periods of time.

Facing page: A typical solid sheeting shoring system showing continuous vertical uprights against the soil (solid sheeting), longitudinal members (wales) and cross members (struts).



1. BACKGROUND AND PURPOSE

In certain areas of the United States, lumber is used extensively to brace trenches against collapse. The life and safety of men working in these trenches, therefore, depends on the adequacy of the lumber bracing to prevent collapse. Criteria and guidelines on the use, quality, and performance of hardwood lumber bracing systems are virtually non-existent. Moreover, particularly for the hardwoods, very little is known about: the actual size, species, grade, supply patterns, storage conditions, moisture content, reuse patterns, defects, and structural strength of the trenching lumber currently used.

One purpose of this study was to investigate the properties and characteristics of trenching lumber which are critical to its structural performance. On the basis of this investigation, allowable

stresses, minimum quality or grade requirements, and use recommendations are proposed.

Lumber is used in a variety of ways to brace trenches. In addition to economic considerations, two primary reasons for using lumber are:

- o Code requires that the bracing be left in place (lumber is economical).
- o Bracing needs special fabrication at the job site (lumber easily fabricated).

Trenching lumber consists primarily of three member types: wales, which act as beams; struts, which act as compression members; and sheeting, which act as beams and line the outside of the trench. Wales and struts form a structural framework over which the sheeting is placed; the sheeting transmits the soil pressures to the structural framework. Figure 1 shows two typical lumber bracing systems used for trenches.

Facing page: Trenching lumber. Prior to this study, no accepted design criteria existed for hardwood trenching lumber.



2. APPROACH AND SCOPE

This project was performed in three steps as follows:

- (1) the identification of a profile of needed properties and critical structural uses of trenching lumber.
- (2) a field investigation to profile the visual grade characteristics of trenching lumber.
- (3) the development of recommended allowable stresses, minimum quality or grade requirements, and use recommendations for trenching lumber.

Step (1) required the identification and investigation of:

- o critical lumber properties, such as size, species, and moisture content.

- o critical lumber characteristics, such as whether the lumber is used as a wale, strut, or sheeting member, and the configuration and spacing of the members of the bracing system.

Step (2) required the visual assessment of the lumber characteristics in the field for case studies in Washington, D.C., Houston, Texas, and southern California. Visual assessment included:

- o assignment of grade, based on existing visual grading rules for softwood lumber.
- o the measurement of size and moisture content, and the identification of species, and
- o the documentation of defects including knots, missing cross section, decay, damage, and slope of grain.

Step (3) involved the development of:

- o guidelines to be used by grading agencies to develop grading rules for trenching lumber.
- o allowable stresses and minimum quality or grade requirements for hardwood trenching lumber.
- o use recommendations considering load duration, damage, bark, wane, exposure, storage, reuse, damage, and decay.

This study was performed as a cooperative effort between the National Bureau of Standards (NBS) and the Forest Products Laboratory (FPL). FPL served in a consulting and advisory capacity for steps (1) and (2) and was primarily responsible for step (3).

Chapter 3 of this report treats the details of steps (1) and (2). Step (3) is discussed in chapters 4 and 5. Chapter 4 presents guidelines for developing allowable stresses and minimum quality or grade requirements; chapter 5 presents the use recommendations. Appendix A contains detailed descriptions of the sampling procedures, and data entries and coding used, as well as the coded data. Details of the grading methods used and of the data collection for wane and slope of grain are included in Appendix A. Appendix B describes the general observations and descriptions of the supply yards investigated. Appendix C presents the detailed analysis of the data collected in the field investigation.

Appendix D, written by FPL, presents a practical guide to the interpretation of ASTM standards which are applicable to the derivation of allowable stresses for hardwood. Appendix D also provides a commentary on use recommendations that relate to the severe trenching environment. The commentary provides the basis for assuring structural integrity in trenching when both new and used lumber are utilized. Chapters 4 and 5 represent a summary of the information in Appendix D.

Facing page: *Visual grading procedures were used to assess the strength of hardwood and softwood trenching lumber members.*



3. FIELD INVESTIGATION

3.1 PURPOSE

The purpose of the field investigation was to non-destructively profile those properties and characteristics of trenching lumber which are most critical to its structural performance in bracing trenches.

3.2 APPROACH AND SCOPE

In order to develop an appropriate plan for the field investigation, the properties and conditions of use of lumber most critical to its structural performance were identified; the details are summarized later in this chapter. Properties identified included size, species, moisture content, and defects such as knots, slope of grain, decay, damage, and missing cross section. Conditions of use characteristics included:

- o intended use (wale, strut, or sheeting - fig. 1).

- o configuration and spacing of the bracing system.
- o type of soil and soil pressure exerted on the bracing system.
- o the length of time the lumber bracing member is subjected to load.
- o typical failure modes for lumber members.

Based on the critical properties and conditions of use, a plan to investigate trenching lumber in the field was formulated. Visual grading procedures, based on the Southern Pine Inspection Bureau (SPIB) grading rules [1]*, were used to assess the equivalent softwood lumber grade, thus estimating the strength of trenching lumber. Measurement of cross-sectional dimensions was performed and data on moisture content defects, including wane, knots, and slope of grain were collected. Information on species, reuse, damage, decay, storage conditions and duration, method of sawing (rough sawn or dressed) and supply patterns was also documented. In the field investigation, case studies were conducted in three geographic areas. Washington, D.C. and Houston, Texas were chosen to assess primarily hardwood and southern California was chosen to study softwood.

A field investigation team sampled about 500 full length pieces of lumber in the three areas. In addition, about 250 partial lengths of these full length members were assessed. The sampling and measurement procedures as well as a description of the lumber sampled and the data collected in the field investigation are summarized in this chapter; the details are given in Appendix A. The field data for the full and partial length pieces were coded and computerized; the coded data and a description of the coding is given in Appendix A. Appendix A also contains a discussion of the data collected for wane and slope of grain. General observations and descriptions of the lumber supply yards investigated are summarized in this chapter and the details are given in Appendix B.

Appendix C presents the details of the analysis of the field data taken for the 750 pieces sampled. This chapter contains a summary of the results and findings of the analysis.

It should be noted that about seven percent of the full length wales sampled in Washington, D.C. and Houston, Texas were ungraded southern yellow pine. Thus, in this report the wales, struts, and sheeting sampled in D.C. and Houston are referred to as "eastern species" rather than hardwood.

*Numbers in brackets refer to references at end of Chapter 5.

3.3 PROFILE OF TRENCHING LUMBER PROPERTIES AND USES

Based on discussions with supply yard personnel, contractors, and code authorities, the following conclusions were drawn prior to conducting the field investigation:

- o most of the hardwood and softwood lumber used is rough sawn and green.
- o the hardwoods are ungraded (mill run) and consist of a variety of species, with a high frequency of oak.
- o the hardwoods are primarily sawn and marketed locally through small mills. In contrast to the softwood industry, the production of hardwood trenching lumber is not well organized.
- o much of the hardwood wales and struts (fig. 1) used are left in place (not reused); most of the hardwood sheeting (fig. 1) is left in place.
- o some softwood is used in Los Angeles, San Francisco, New York City, and Chicago.
- o the softwood used on the west coast is stress graded Douglas-fir; Southern pine and Douglas-fir are sometimes used in New York City and Chicago.
- o in many areas in the United States materials other than lumber are used for bracing trenches.
- o for solid sheeting (fig. 1), where there is essentially no space between the sheeting, wales cause the most difficulty for contractors from a structural standpoint, struts next, and sheeting the least difficulty.
- o for spot bracing (fig. 1), where there is considerable spacing between the sheeting, the strut is more critical than the sheeting from a structural standpoint (wales are not often used in spot bracing).

3.4 GEOGRAPHIC AREAS, INVESTIGATION TEAM, SAMPLING PLAN

Based on the use profile gathered, NBS, FPL, and the field team together planned the geographic locations, specific sites to visit, the formulation of the data to be collected and the questions the investigation would address, etc. Three geographic areas were chosen for sampling. Due to financial restrictions, only limited case studies could be performed in the three areas. The Washington, D.C. area was chosen in an attempt to represent New York City and Washington, D.C.-- both areas do, to a certain degree, draw on similar hardwood sources. Houston, Texas was chosen in an attempt to represent the Houston-New

Orleans area. Moreover, both D.C. and Houston use relatively large quantities of hardwood trenching lumber. For softwood, southern California was chosen as a typical example of the use of Douglas-fir. With the exception of visiting one trenching job site in D.C., lumber was sampled in distribution yards in each of the three geographic areas, so that a thorough study of individual members could be made.

The field team consisted of a wood technologist, who was responsible for coordinating and conducting the field effort, and a professional licensed softwood lumber grader, who was responsible for grading. One week was spent in each of the three geographic areas.

Guidelines for selecting lumber to be sampled included the following:

- o wales and struts were given a higher priority than sheeting.
- o where possible, two sizes (cross-sectional dimensions) of wales and struts were sampled at each yard visited. These sizes were chosen to reflect typical trenching lumber sizes used in each geographic area (see table 1).
- o preference was given to 20 ft. long stock for wales and struts. This permitted both full and partial length grading. The purpose of partial length grading was to determine a more accurate profile of strength, since the load can occur at several locations on a wale. Appendix A provides further details of the sampling plan.

3.5 DESCRIPTION OF DATA ENTRIES

Appendix A contains a detailed description of the data collected for each piece sampled; the coded data and a description of the coding are also given.

The following is a summary of the more significant data entries.

- o actual width and thickness measured at each end
- o species
- o use--wale, strut, sheeting
- o moisture content
- o wane (missing cross-section)
- o damage
- o decay

- o warp
- o slope of grain
- o defects, including knots, holes, checks, splits, and shakes
- o storage conditions

In addition to these data entries, one or more grades, based on the Southern Pine Inspection Bureau grading rules, were assigned to each piece sampled. The most important grade assigned, which was used for analysis purposes only, was the strength ratio grade, called G, in which the effects of wane, damage, and decay were disregarded. (One exception to this was that limited rot in or around the periphery of a knot, knothole, or wormhole, see Appendix A, was included in the G grade.) The G grade provided a basis for evaluating: (a) regrading by grading partial lengths or upgrading by hypothetical trimming of defective material and (b) downgrading due to wane, damage, or decay effects. Where applicable, a grade called GW was assigned which took wane into account, disregarding damage and decay. Similarly, where applicable, a grade called GDA was assigned, which took damage into account, while disregarding wane and decay; a grade called GDE was assigned where applicable, which took decay into account, while disregarding wane and damage.

The middle one-third of each wale was assigned a grade called GM3. This was done to see if the middle one-third of the length could be regraded relative to the G grade for the full length. The intent of assigning the GM3 grade was to reflect that, in many instances, wales will have their maximum bending stress imposed within the middle one-third of the wale rather than at some point nearer the ends of the wale.

Further, for selected wales, one or two 10 foot partial lengths were assigned their own G grade, called G10. If a wale was 20 feet long, each 10 foot half was assigned a G10 grade. For wales greater than 10 feet but less than 20 feet, a 10 foot piece measured from one end was assigned a G10 grade. The purpose of the G10 grade was to see if the 10 foot partial length grade could be improved relative to the G grade for the full length. The intent of assigning the G10 grade was to reflect that, in many instances, the wales would be supported at about 10 foot intervals.

A trimmed grade, called GT, was assigned to any full length piece that could be upgraded by hypothetically trimming one or both ends. Trimming (of one or both ends) was limited to 20 percent of the length.

Wales were graded as beams and stringers while struts were considered as compression members and graded as posts and timbers. As table 1 shows, many pieces were graded first as wales and then as struts. With only limited exceptions, the wale and strut grades were the same.

3.6 LUMBER SAMPLED

Table 1 lists the location, member size, use, and sample size of the lumber sampled.

3.7 SUMMARY--GENERAL OBSERVATIONS AT SUPPLY YARDS

Appendix B presents the details of the general observations of the supply yards investigated. The following is a summary of the findings of those observations.

3.7.1 Wane

Wane, which is missing wood on the cross-section, was observed to be a major problem for the eastern species sampled. Wane was very widespread among the pieces sampled and extremely variable as to the location and extent along the length of a piece. (For further detail see the section entitled WANE in Appendix A.)

For example, a vast majority of the larger 12 x 12 and 10 x 10 stock seen in Washington, D.C. had extensive wane. Many pieces had wane on all four edges and in numerous cases, as shown in figure 2, at least the small end of a piece of 12 x 12 was completely encircled by bark. Thus, wane poses very serious problems in developing allowable design stresses and corresponding grades for these pieces.

One approach would be to require that the large sizes with wane be manufactured to a smaller size. For example, a 12 x 12 could usually be cut to a 10 x 10 size to eliminate all, or at least most of the wane that was present. It is, of course, possible to limit the amount of wane in any hardwood grading system for trenching lumber, as is done now in the softwood lumber grades; however, this undoubtedly would waste material and reduce the availability of 12 x 12 material in the Washington, D.C. area.

3.7.2 Species

Hardwood species are presently used interchangeably in trenching for convenience and simplicity. Efficiency in trenching practices, particularly for wales and struts, could be improved if the weaker species were excluded. In the Houston area, yellow poplar was said to be excluded in at least one yard. Yellow poplar also was reported not to be a "preferred" species in the Washington, D.C. area.

However, a problem with excluding certain species is the accompanying need for accurate species identification. Identification of many species would have to be made either in the forest or possibly at the mill before the log is sawn. If the identification is delayed until the member is delivered to the yard, it is highly doubtful that anyone there could accurately distinguish among the many species.

There are some species that are considerably stronger than others. The average "green" modulus of rupture for clear material of hardwoods commonly used in trenching ranges from about 6,000 to 12,000 psi [2]. Certain hickories and oaks have bending strengths approaching 12,000 psi but other oaks have modulus of rupture values as low as 7,000 psi. Other high strength species include honey locust, about 10,000 psi, and white ash, about 9,600 psi. Intermediate strength species include cherry, of which there were several pieces found in the Washington area at 8,000 psi, beech at 8,600 psi, and elm at 8,000 psi. Lower strength species would include hackberry, 6,500 psi, red and black gum, 7,000 psi, magnolia, 7,400 psi, birch (this was probably gray or river birch) at 6,400 psi, and sassafras and poplar, both 6,000 psi. Maples, which are essentially impossible to segregate in lumber form, have bending strength values ranging from 5,800 psi for silver maple to 9,400 psi for sugar maple.

3.7.3 Storage, Moisture Content, and Fungal Deterioration

Drying of trenching wales and struts, due to their large size, is highly impractical. Also, its one-time use (reuse does not occur that often) implies that there is no need to dry this material. However, in areas like Houston, Texas, and Washington, D.C., deterioration due to fungal and insect attack during the warm summer months can be a significant problem (fig. 3). In one sample location, surface mold growth was widespread (fig. 4), indicating conditions favorable for decay. In the Washington, D.C. area, there was staining of the wood surface and a darkening of the wood which frequently made species identification difficult. It would be possible to reduce the amount of deterioration due to stain and decay fungi by stickering all of the material. (Stickering is a special stacking arrangement which encourages air movement between the pieces.) However, this may not be practical if lumber is tiered for forklift operations. There is undoubtedly a great need for yard orderliness and cleanliness which in some yards seemed to be sacrificed for convenience.

It was observed that in all yards trenching lumber is stored out-of-doors and uncovered (fig. 5). The lumber is sometimes kept up off the ground, being placed on stickers. The lumber is subdivided into smaller stacks by 4 x 4 material; this is done not so much to allow the material to dry but rather to facilitate its movement by a forklift truck. All the material is purchased in a green moisture condition. No attempt is made to enhance the drying rate of the material. Generally, it was contended that the material does not stay in the yard long enough to dry appreciably or to rot. Although desirable, covered storage may be impractical since in many yards it was observed that higher quality and higher grade material used for purposes other than trenching, is also stored in the open. This was particularly evident in southern California where some very high quality, long length Douglas-fir was stored in the open. However, in southern California most of the yards (fig. 6) have asphalted surfaces and the climate is much more conducive to drying than in Houston or Washington, D.C.

3.7.4 Reused Lumber

A problem was observed with reused Douglas-fir lumber because continued drying led to checking and splitting which resulted in significant seasoning degrade (fig. 7). This was extensive, but not so damaging as to prevent reuse (fig. 8). Regrading is possible, but may not always be economical.

3.7.5 Lumber Quality

Several contractors and site inspectors were consulted about problems with trenching lumber. Uniformly they believe there is no problem with trenching lumber, either in quality of the material or how the lumber is used. Accidents are apparently due to poor judgment (mistakes) in installing trenching lumber or in neglecting to install it at all. A possible exception to this observation was the use of board road* for sheeting in Texas; this was uniformly agreed to be a poor practice.

It was commonly expressed in Texas, and implied in southern California, that each trenching job is relatively unique and that construction standards and lumber grades would be impossible or very difficult to impose fairly or satisfactorily from the construction and engineering point of view. Yet in California, yards purchase the required grade. In contrast to hardwoods, existing softwood grades are used by an industry which is traditionally used to talking in terms of structural grades.

All yard managers interviewed, stated or implied that business was quite good and there was no need for improved quality of material. There were, however, several comments regarding a need for stricter adherence to size standards, particularly in Texas. A common opinion among yard managers was that saw mills cut trenching lumber from lower quality logs which do not produce good furniture lumber yield. Some of these mills have trouble maintaining tolerances and appeared financially marginal in their operation.

Imposing strict standards of production on these mills may cause them to go out of business or to divert lumber from the trenching market to some other market, such as the growing pallet industry.

In southern California there is a small problem with white speck in Douglas-fir. This is a form of decay which often appears on the surface of pieces and which does not tend to spread once the piece is dried below fiber saturation point. Job inspectors and contractors may react against white speck. However, it was observed in a large percentage of the pieces graded on the west coast. White speck is controlled in softwood grading rules.

* See discussion in Appendix B of board road (a ground surfacing lumber) in Houston, Texas.

Although much of the trenching lumber observed was well manufactured (with the exception of wane), the overall quality of the logs from which this material is manufactured is not high, most particularly in hardwoods. The material is stored in a green condition and is subject to deterioration in the yard. It is also subject to abuse and deterioration at the trenching site. As a consequence, both hardwood and softwood lumber may have become structurally impaired by the time it is put into use, or reuse, in a trenching operation.

One purpose of this study was to observe the type and extent of defects which may be anticipated in lumber used for trenching. Defects may be put into two broad categories: defects which naturally occur in wood and defects which are the result of use. The first category would include excessive knots, checks, splits, slope of grain, wane, and limited decay (figs. 2, 4, 9, 11, 12, 16). Figures 7 and 10 show examples of checks and slope of grain which are not excessive. The second category would include various types of damage including forklift splitouts (fig. 13) and punctures; splits and breaks due to installation or reuse (fig. 14); brooming on the ends due to driving during installation (fig. 14), insect damage (fig. 20) and decay, (fig. 19) among others.

3.8 SUMMARY OF FIELD DATA ANALYSIS

The major results of the field investigation, of the eastern species, (primarily hardwood) in Washington, D.C., and Houston, Texas, and Douglas-fir in southern California, are given as follows. Appendix C presents the details of the analysis.

3.8.1 Lumber Grade Disregarding Wane, Damage, and Decay

The most important grade analysis was based on the strength-reducing characteristics (such as knots, slope of grain etc.) of the lumber disregarding wane, damage, and decay. This is called the strength ratio grade (G). The G grade provided a basis for evaluating: (a) regrading by partial length grading or upgrading by hypothetical trimming; and (b) downgrading due to wane, damage, or decay effects.

Table 2 shows the major findings for the G grades. As shown in the table, 80 percent or more of the eastern species trenching lumber was No. 2 grade or higher; 60 percent or more of the pieces was No. 1 grade or higher. The percentage of eastern species full length wales having strength characteristics of No. 2 grade or higher (col. 2, table 2) or No. 1 or higher (col. 3) are about 20 percentage points lower than for Douglas-fir. This is to be expected since stress-grades for larger size material are generally limited to No. 1 or No. 2 in Douglas-fir. However, the percentage of eastern species sheeting having grades of either No. 2 or higher or No. 1 or higher are about 10 percentage points higher than for the Douglas-fir sheeting. The average strength ratios, SR, (col. 4--defined in table 2a) and coefficients of variation for SR agree well for eastern species and Douglas-fir wales and for sheeting.

Figure 15 shows the relative frequency of eastern species wales graded over their full length in the various G grades.

As previously discussed, the wale and strut grades were the same for those pieces which were graded as both wales and struts (table 1). Thus, for the most part, the G grade results for wales in table 2 should apply as well to struts.

3.8.2 Regrading

Wales were hypothetically regraded by assigning a G grade to a partial length--either 1/2 or the middle 1/3 of a full length wale. This was done to assess the increased structural potential for wales, since loads may be non-uniform, may cause the maximum moment to occur in the center third, and may occur with load sharing.

Depending on major geographical area, the percentage of wales that was found to contain higher grade portions upon regrading ranged from about 15 to 45 percent if the partial length was 1/2 the full length and 12 to 30 percent if the partial length was the middle 1/3 of the full length (see Appendix C, table C4). The degree of upgrading for both 1/2 and middle 1/3 length cases ranged from about 10 to 20 SR units. Using a No. 2 grade as a base, (SR = 45) 10 SR units would represent an increase to a No. 1 grade (SR = 55); 20 SR units would represent an increase to an Industrial 65 or Select Structural grade (SR = 65).

3.8.3 Reduction of Cross-Sectional Area and Moment of Inertia

Three methods were used to assess the effects of missing cross-section on the reduction in cross-sectional area and bending moment of inertia. The first method used average end dimensions (width and thickness). The second method was based on using data on the extent of wane occurring at the worst affected corner (e.g., wane on 1/2 the width and 1/3 the thickness) and assumed that the wane was triangular in shape. The third method was based on the amount of downgrading due to wane. The first and second methods were quantitative, while the third was not.

For the first and second methods, the ratio (A) of the actual cross-sectional area to the nominal ("as sold" - see "Member Size" in table 1) cross-sectional area was calculated. Similarly, the ratio (I) of the actual to nominal bending moment of inertia was also calculated.

Due to the assumptions used, the results for the first and second methods needed to be interpreted in a relative, rather than absolute, sense (see discussion in Appendix C). Further, of the first two methods, only the end dimensions method could be applied to both eastern species and Douglas-fir members.

The results based on the end dimensions methods showed the following trends. The average area and inertia ratios (\bar{A} and \bar{I}) were similar for eastern species and Douglas-fir wales; the coefficients of variation for

the A and I ratios for eastern species wales, however, were over three times larger than for Douglas-fir wales. For both spot bracing and solid sheeting (solid sheeting based on end thickness only, see Appendix C), the A and I ratios for the eastern species exceeded those for Douglas-fir; there was one exception—that of board road sheeting, which had very low A and I ratios. For spot bracing, the coefficients of variation of the A and I ratios for eastern species members were larger than for Douglas-fir members. Tables C5 and C6 in Appendix C show average and coefficient of variation values for A and I.

The results of the third method show that the frequency and economic impact of downgrading due to wane are significant for eastern species full length wales. The frequency of wane on full length wales was assessed by determining whether the wale was downgraded from its G grade due to wane. Table 3 shows the high frequency of downgraded wales for the eastern species.

The potential economic impact of a wane limitation was measured by the frequency of downgrade due to wane from No. 2 or higher to lower than No. 2. The frequency, shown in table 3, is the ratio of the number of wales downgraded (col. 4) to the total number sampled (col. 1). As shown, there would be a high percentage of eastern species wales which could not be used if No. 2 wane restrictions were required. For Douglas-fir, wane was controlled by the grading rules.

3.8.4 Decay

About 7 percent of the eastern species full length wales were downgraded relative to their G grade due to decay. Because decay is not acceptable in significant quantity in high structural grades, the wales downgraded were generally either No. 3 or None. No downgrade due to decay was observed for 37 new full length Douglas-fir wales.

3.8.5 Trimming

The purpose of the trim analysis was to provide preliminary economic information on the potential upgrading due to trimming. The following trimming analysis is based on the choice of No. 2 as a minimum acceptable grade. Of the full length eastern species wales, approximately 125 (50 percent) were less than No. 2 in quality for strength ratio, wane, or decay. Of the 46 wales that could be upgraded by trimming and which were less than No. 2, 38 (83 percent) could be trimmed to a grade of No. 2 or higher.

Considering all grades, only 4 (11%) of the 37 new Douglas-fir full length wales could be upgraded by trimming; all of these were No. 2 or higher before trimming.

3.8.6 Damage

Very little mechanical damage, caused by handling or use, was observed. Only 1 percent of the eastern species full length wales were downgraded relative to their G grade. No eastern species sheeting was downgraded. For new and used Douglas-fir members, only 1 percent of the full length wales and struts and 3 percent of the sheeting were downgraded.

3.8.7 Species

At least 50 percent of the eastern species wales, struts, and sheeting sampled were either red or white oak. The softwood lumber sampled in southern California was Douglas-fir.

3.8.8 Slope of Grain

Only about 5 percent of all full length wales, struts, and sheeting had a general slope of grain of 1 in 10 or steeper. Thus, few pieces of No. 1 or 2 level were limited by slope of grain in the grading process.

3.8.9 Moisture Content

Almost all the eastern species lumber sampled were green. The moisture content of the Douglas-fir varied from green to 10 percent.

Facing page: A large percentage of trenching lumber comes from hardwoods, which traditionally have not been stress-graded.



4. RECOMMENDATIONS FOR ALLOWABLE DESIGN STRESSES

4.1 INTRODUCTION

Lumber often is the key structural member in trench bracing, having to withstand soil pressure during excavation and subsequent construction. Thus, safe and efficient trenching requires a knowledge of lumber properties. Apparently a high percentage of trenching lumber comes from hardwoods, which traditionally are not stress graded.

This chapter presents recommendations for allowable stresses. Chapter 5 presents use recommendations with particular reference to trenching lumber and trenching applications. In combination, the derivation of allowable properties and use recommendations provide the basis for assigning use-oriented properties to trenching lumber. Appendix D provides detail on

both the derivation of the allowable stresses and the commentary on the use recommendations.

4.2 HARDWOOD ALLOWABLE PROPERTIES

Applicable ASTM standards (D 2555, ref. [3], D 245, [4]) were followed in conformance with procedures recognized under the American Lumber Standard PS 20-70, [5] to develop allowable properties. The allowable properties, developed for wales and struts, are shown in table 4.

The allowable stresses in table 4 are for a No. 2 grade. A description of this grade, including the maximum allowable defects permitted, is given in the Southern Pine Inspection Bureau Grading Rules, 1977 edition. Allowable properties for No. 2 are presented because the field investigation results indicated that for eastern species, 80 percent of the wales and 85 percent of the sheeting were No. 2 or higher when wane, damage, and decay were disregarded (table 2). Thus, eastern species lumber of grade No. 2 and higher is used frequently and apparently performing satisfactorily.

Separate properties were developed for the white oak species group (table 4) because of its relatively high occurrence in the field investigation and its superior decay resistance. Properties for the mixed oak species group were developed to reflect the relatively high occurrence of mixed oak as compared to other species. Field investigation results indicated that at least 50 percent of the eastern species sampled were mixed oak. The remaining mixed hardwood groups I and II represent the majority of the hardwoods encountered, excluding a few weaker species.

Tentative specifications for wane for eastern species wales and struts are the wane requirements for a No. 2 grade, as given in the Southern Pine Inspection Bureau Grading Rules, 1977 edition. In retrospect, additional studies in the field are needed to evaluate the effect of the recommended wane requirements on mill yield.

4.3 SOFTWOOD ALLOWABLE PROPERTIES

A minimum grade of No. 2 is recommended for softwood wales and struts. The corresponding allowable stresses for species and grade combinations can be derived by the appropriate rules-writing agencies following standard ASTM procedures.

Facing page: Trenching lumber can be subjected to a variety of conditions when it is stored and used.



5. USE RECOMMENDATIONS

5.1 INTRODUCTION

Trenching lumber often is large in cross section, green, and marketed locally. Trenching is a somewhat unique application for structural lumber since, in most cases, the lumber is in contact with the soil and is subject to an environment more severe than that for which most wood products are specified. The following recommendations reflect the unique circumstances of trenching and are assumed to apply to lumber after the visual grading standards have been considered.

This chapter also discusses damage, decay, and insect attack that can be anticipated in structural trenching lumber and includes suggestions for categorizing damage where reuse is of interest. Particular emphasis is placed on decay and insect damage, with recommendations on effective

service life under trenching conditions. The recommendations are specific to trenching and should not be adopted for other uses without careful review.

Structural properties of lumber are predicated upon controlled use in which no degradation of properties occurs. The following sections consider various aspects of trenching lumber applications assuming severe environment, some reuse of structural members, and the need for structural integrity related to safety of both life and property, for finite periods of time. Additional detail and specific discussion of recommendations are found in appendix D.

5.2 DURATION OF LOAD

For new lumber, increases in allowable stresses for short-term loading conditions are specified in the National Design Specification (NDS) [6]; otherwise normal loading is assumed for all use not exceeding 10 years. For used lumber, the uncertainty of actual loadings in trenching applications and the difficulty in accurately accumulating load duration history suggest a conservative approach; thus, it is recommended that normal loading stresses be used in all reuse applications not exceeding 10 years.

5.3 DAMAGE

All lumber is graded under the assumption that strength-affecting characteristics may be present in a piece provided they do not reduce the grade level assigned. Thus, some mechanical damage may be tolerated without a grade change. However, if the damage has the equivalent effect of a grade reduction, the piece must be regraded. Thus, it is recommended that used lumber with visible evidence of mechanical damage be regraded before reuse. Regrading should be according to ASTM D 245 guidelines based on loss of cross-section, except where damage may be hidden. More detail for interpretation is given in appendix D.

If a member is judged to have potentially severe structural damage, it should be: (a) designated for resawing to remove damaged portions and then regraded, (b) designated for nonstructural use, or (c) discarded. Figure 14 shows examples of damage where the timbers could be resawed and be reused as structural members.

5.4 WANE

Successful use of essentially full-round timbers in much trenching lumber, particularly wales and struts, suggests that wane may not be critical unless a flat surface is required for fastening other materials. It is desirable that wane restrictions for trenching lumber be related to demonstrable need for cross-sectional area as defined by the strength ratio for the grade or by design requirements. Pieces not meeting wane restrictions may be treated as a smaller size. Figure 16 shows an example of a timber that probably would not meet the wane restriction.

5.5 BARK

Traditionally, a substantial amount of trenching lumber is used with the bark remaining on the piece. This practice is not recommended as the bark will prevent the sapwood underneath from drying out, thus encouraging decay and maintaining a haven for insect attack. Further, removal of bark is essential for adequate grading of the members.

5.6 DECAY

Dry wood does not decay. In fact, if kept below approximately 20 percent moisture content, wood will last indefinitely. On the other hand, if wood is kept continuously submerged in water (probably comparable to underground, below water table exposure) even for long periods of time, it is not decayed significantly by the common decay fungi regardless of the wood species or the presence of sapwood.

The heartwood of some common native species has varying degrees of natural decay resistance. Untreated sapwood of all species has low resistance to decay and usually has a short service life under conditions conducive to decay.

Precise ratings of decay resistance of heartwood of different species are not possible because of differences within species and the variety of service conditions to which wood is exposed. However, broad groupings of many of the native species based on service records, laboratory tests, and general experience are helpful in choosing heartwood for use under conditions favorable to decay. Table 5 shows such groupings.

In a few species, such as spruces and the true firs (not Douglas-fir), heartwood and sapwood are so similar in color that they cannot be easily distinguished. Marketable sizes of some species, such as southern pine and baldcypress, are largely second growth and contain a high percentage of sapwood.

Sapwood and the heartwood of nonresistant species should only be utilized for service where the potential for decay is low or moderate or where the exposure time is limited. Alternatively, nonresistant material can be treated with preservatives for severe exposure conditions.

Even very decay-resistant species may require preservative treatments for important structural uses. A general overview of preservation is available in the Wood Handbook [2].

Decay is prohibited in members for all structural uses if identifiable by visual inspection. An exception may be pieces in which decay occurs in a knot but does not extend into the wood. Identification of decay is discussed in appendix D. Borderline cases should be judged to contain decay and, along with pieces containing decay, should be designated for nonstructural use or should be discarded.

Surface mold and stain is an indication that conditions are extremely favorable for strength-reducing decay to take place, although the extent of the decay is difficult to assess [2]. The presence of the mold also suggests that the storage procedure is inadequate to prevent decay even at the surface.

5.7 INSECT ATTACK

Grading rules for stress-rated lumber do not permit lumber containing insect attack to be rated for critical structural use. Insect damage can occur in seasoned or unseasoned lumber. In trenching operations, the concern includes attack during storage where established large colonies of insects are in existence.

No method is known for estimating from appearance the amount of reduction of strength from insect damage. If damage is evident, critical members should be removed from service and the piece resawn and regraded or placed in a noncritical use. Additional discussion of insect attack is found in Appendix D and the Wood Handbook [2].

5.8 INSPECTABILITY

Members that are encased with mud or dirt or otherwise rendered nongradable because growth characteristics and other defects are not visible should be downgraded to nonstructural use or discarded. Alternatively, they may be hosed clean with water or surfaced clean (planed) if feasible and then graded.

5.9 EXPOSURE

Trenching lumber will often be exposed to decay organisms and insects in the use environment. This use exposure determines the useful life of the trenching material if, during the storage period, it is protected from moisture and provided with adequate ventilation. If, on the other hand, the trenching material is close piled and not shielded from rain or splash during storage, this storage period then becomes part of the effective life of the trenching material from the perspective of decay and insect exposure. In essence, close piling, and lack of moisture and insect control during storage reduce the effective potential life of the trenching lumber at the trenching site.

Decay in structural members depends upon mean temperatures, moisture content, and time. Using recorded weather conditions, Scheffer and Verrall [7] developed climate indexes, fig. 17, which define decay potential for general areas in the United States. Based upon FPL staff judgments, the following exposure periods for different various climate indexes are recommended:

Climate indexMaximum exposure

(months)

>65	9
35-65	12
<35	24

Climate data can be used to develop a more specific local index.

These recommendations are for nonresistant to moderately resistant species. If the anticipated exposure period exceeds the periods listed, resistant or very resistant species (table 5) or pressure treatment with preservatives is recommended. Because heavy timbers dry very slowly (partially dried timber can support decay activity), exposure periods must include allowance for storage during processing, at holding yards, and onsite unless rapid drying is assured. When trenching completion is delayed, a plan must be developed for onsite inspection to assure that structural integrity is maintained.

The exposure periods recommended above should be considered as rule-of-thumb. Additional interpretation may be appropriate for specific onsite conditions, season of the year, and the geographical location within a broad hazard zone.

Protection from insect attack depends upon inspection procedures, good housekeeping, and onsite treatment. Attack generally is not rapid, but regular inspection for insect attack is recommended in critical regions where exposure will be over 6 months on the job site. In reuse, any evidence of attack should be regarded as damage and requires inspection before use in critical applications.

5.10 STORAGE

As a general rule, trenching lumber with moisture content above the fiber saturation point should be stickered to permit adequate ventilation and discourage surface decay and insect degradation. Stickered lumber such as that used for railroad ties may be a practical option.

The importance of proper lumber storage cannot be overemphasized. Rapid deterioration of wood strength can be traced to incipient fungus infections originating during poor storage. Figure 18 shows examples of poor storage practices which encourage decay and insect infestations. Examples of decay and insect infestations which can result are shown in Figures 19 and 20. Trenching lumber should be protected against wetting from the ground and, as noted, should be stickered to promote drying, particularly after wetting from rain. In permanent or long-term storage, lumber should be placed under a roof for protection or provided with other protection from rain; lumber at these sites should be above the ground, preferably on foundations of concrete, asphalt, or treated wood. These recommendations apply particularly when reuse is anticipated.

REFERENCES

- [1] Southern Pine Inspection Bureau Grading Rules, Pensacola, Florida, 1977 edition.
- [2] Wood handbook, U.S. Forest Products Laboratory, USDA, Agric. Handb. No. 72, rev. (1974).
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- [4] Standard methods for establishing structural grades and related allowable properties for visually graded lumber, D 245-74, American Society for Testing and Materials, (1977).
- [5] American softwood lumber standard, voluntary product standard PS 20-70, National Bureau of Standards (1970).
- [6] National design specification for stress-grade lumber and its fastenings, National Forest Products Association, Washington, D.C. (1977 edition).
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GLOSSARY

- Allowable Properties - Properties, such as strength and elastic modulus, recommended for designing with lumber. Allowable properties are identified with grade descriptions.
- Board Road - Mis-cut, odd-size sheeting lumber used for ground surfacing.
- Check - A lengthwise separation of the wood that usually extends across the rings of annual growth and commonly results from stresses set up in wood during seasoning.
- Damage - Mechanical damage to lumber such as gouges, splits, or punctures.
- Decay - The decomposition of wood substance by fungi.
- Dressed Lumber - Machine planed or surfaced on one or more sides.
- Eastern Species - In this report, refers to species encountered in Washington, D.C. and Houston, Texas; over 90 percent of the pieces sampled were hardwood.
- Exposure - Time duration that trenching lumber is exposed to decay organisms, insects, and damage in the use environment, including storage.
- Fiber Saturation Point - The stage in the drying or wetting of wood at which the cell walls are saturated and the cell cavities are free from water. It applies to an individual cell or group of cells, not to whole boards. It is usually taken as approximately 30 percent moisture content, based on oven dry weight.
- Grade - The designation of the quality of a manufactured piece of wood or of logs.
- Green - Freshly sawed or undried wood. In this report, if moisture content was greater than or equal to 30 percent, lumber was considered "green."
- Hardwood - The botanical group of trees that has broad leaves in contrast to the conifers or softwoods. The term has no reference to actual hardness of the wood.
- Heartwood - The wood extending from the pith to the sapwood, the cells of which no longer participate in the life processes of the tree. Heartwood may contain phenolic compounds, gums, resins, and other materials that usually make it darker and more decay resistant than sapwood.
- Knot - That portion of a branch or limb which has been surrounded by subsequent growth of the stem.

Moment of Inertia - Measure of the contribution of shape and orientation to the strength and stiffness of a member.

Rot - see decay.

Rough Sawn - Not dressed (not a smooth finish).

SPIB - Southern Pine Inspection Bureau.

Sapwood - The wood of pale color near the outside of the log. Sapwood is more susceptible to decay than heartwood.

Shake - A separation along the grain, the greater part of which occurs between the rings of annual growth. Usually considered to have occurred in the standing tree or during felling.

Sheeting - Members which line the sides of a trench and contain the soil.

Slope of Grain - The angle formed by the fiber direction (grain or orientation of the wood cell) with the longitudinal (long) axis of the member; usually stated as a ratio of rise to run (e.g., 1:20 or 1 in 20)

Split - A separation of the wood parallel to the fiber direction due to the tearing apart of the wood cells.

Spot Bracing (skeleton bracing or spaced sheeting) - Spaced (non-adjacent) vertical sheeting members bearing against the sides of a trench - see fig. 1.

Solid Sheeting - Sheeting in which the members are placed continuously with no spacing between them - see fig. 1.

Softwood - The botanical group of trees that in most cases have needle-like or scalelike leaves. The term has no reference to the actual hardness of the wood.

Stickering - Special stacking arrangement using strips or boards to separate the layers of lumber in a pile and to improve air circulation; thus drying is improved and moist conditions which can cause decay are reduced.

Strength Ratio (SR) - Hypothetical ratio of the strength of a member to the strength it would have if no weakening defects (e.g., knots) were present.

Strength Ratio Grade (G) - An assigned grade used for analysis purposes only within this report which disregarded the effects of wane, damage, and decay.

Strut - Compression bracing member which spans across the trench.

Trench - A short term excavation in which the bottom length exceeds the bottom width, the bottom width is less than 15 feet and the depth is less than 20 feet.

Trimming - Cross cutting a member to remove the low grade, decayed, or damaged material at one or both ends; the remaining material generally will be improved or upgraded in quality.

Ungraded - No grade is assigned to lumber.

Use Recommendations - Refers to recommendations relating to duration of load, damage, bark, decay, insect attack, inspectability, exposure, and storage for trenching lumber.

Wale - Longitudinal bracing member which is used in bending and which transmits the load from the sheeting to the struts - see fig. 1.

Wane - Missing cross-sectional area caused by bark or lack of wood from any cause on edges or corners of a piece of lumber.

White Speck - Small pockets of decay in Western softwood caused by the fungus Fomes pini.

Table 1. Trenching lumber sampled

Sample Number	Metropolitan Area	Member Size	Full-length grading		Regraded ^c in 10 ft. lengths	
			Member ^a Use	Number ^b of Pieces	Member ^a Use	Number ^b of Pieces
1	Wash., D.C.	8 x 8 x 20	W	16	W,S	32
2	Wash., D.C.	12 x 12 x 20	W	14	W,S	28
3	Wash., D.C.	6 x 6 x 10	W,S	21		
4	Wash., D.C.	3 x 12 x 12-16	SH	27		
5	Wash., D.C.	8 x 8 x 10	W,S	15		
6 ^d	Wash., D.C.	12 x 12 x 24	W	8	W,S	12
7	Wash., D.C.	12 x 12 x 10	W,S	19		
8	Wash., D.C.	8 x 8 x 12	W,S	15		
9	Houston, TX	8 x 8 x 12-21	W,S	21		
10	Houston, TX	4 x 6 x 10	W	12		
11	Houston, TX	4 x 6 x 16	W	24		
12	Houston, TX	2 x 8 x 10	SH	10		
13	Houston, TX	8 x 8 x 16-23	W	17	W,S	29
14	Houston, TX	4 x 6 x 12	W	31		
15	Houston, TX	3 x 12 x 12	SH	24		
16	Houston, TX	8 x 8 x 18-20	W	15	W,S	15
17	Houston, TX	4 x 6 x 9-14	W	28		
18	Houston, TX	2 x 8 x 10	SH	30		
19	Southern Calif.	4 x 12 x 7-10	SH	30		
20	Southern Calif.	8 x 8 x 20	W	16	W,S	32
21	Southern Calif.	6 x 6 x 20	W	21	W,S	42
22	Southern Calif.	3 x 12 x 16	SH	35		
23	Southern Calif.	4 x 10-12 x 6-18	SH	20		
24	Southern Calif.	8 x 8 x 5-8	S	11		
		8 x 8 x 12-14	W,S	14		
25	Southern Calif.	3 x 12 x 12	SH	30		
26	Southern Calif.	8 x 8 x 9-12	S	8		

^a W = Wale; S = Strut; SH = Sheeting. Where W and S appear in the same entry (W,S), members were graded both as struts and as wales.

^b Figures here varied somewhat from those used in the analyses (see tables 2 and 3 and app. C) due to missing data for a small number of pieces.

^c Where possible, long wales were regraded in one or two 10 ft. lengths.

^d A trenching jobsite rather than a supply yard.

Table 2. Summary of Findings for the Strength Ratio Grades^a (G)
for Full Length Wales and Sheeting

		Sample Size N	Percent of Pieces With a No. 2 Grade or Higher	Percent of Pieces With a No. 1 Grade or Higher	Average Strength Ratio, SR ^b , Based on No. 2 or Higher Grades	Coefficient of Variation of Strength Ratio
		(1)	(2)	(3)	(4)	(5)
Eastern Species	Wales ^c	241	80	62	57	19%
	Sheeting ^d	83	85	60	56	16%
Douglas- fir New	Wales ^e	37	100	86	58	19%
	Sheeting ^f	65	74	52	55	16%

^a Graded visually for strength but ignoring presence of wane, damage, and decay.

^b The strength ratio, SR, is defined in ASTM as the hypothetical ratio of the strength of a member to the strength it would have if no weakening defects were present. For example, a member with an SR of 45 would be expected to have at least 45 percent of the strength of an equally sized member which is free of any defects. The grades and corresponding SR values are given below in Table 2a. Note that only grades of No. 2 and higher could be assigned SR values for large trenching members; thus average SR values are based only on grades of No. 2 and higher. Grades shown were based on SPIB Grading Rules, 1977 edition.

^c Sizes were 4 x 6, 6 x 6, 8 x 8, and 12 x 12.

^d Thicknesses were 2 and 3 inches.

^e Sizes were 6 x 6 and 8 x 8.

^f Thicknesses were 3 and 4 inches.

Table 2a. Strength ratio (SR) values in terms of grade*

Minimum Strength Ratio	Grade
86	Industrial 86
72	Industrial 72
65	Industrial 65
65	Select Structural
55	No. 1
45	No. 2
Not assigned	No. 3
Not assigned	None

* The strength ratios that correspond to each stress grade are specified under the ALS for lumber 2 to 4 inches thick only. For purposes of simplicity in this trenching study, the ALS strength ratios for dimension lumber were adapted to timber sizes. The practical consequence of this decision is to make the field survey SR data conservative since No. 1 SR and No. 2 SR for timbers under SPIB actually are somewhat higher than for lumber 2 to 4 inches thick.

Table 3. Summary of frequency and economic impact of wane on full length wales

		Frequency (f) of Wales Downgraded Due to Wane		Economic Impact - Frequency (f_e) and Number(N_w) of Wales Downgraded Due to Wane From a No. 2 or Higher to a Grade Lower Than No. 2	
		(1)	(2)	(3)	(4)
		N^a	$f(\%)$	$f_e^b(\%)$	N_w
Eastern Species	Washington, D.C.	106	53	37	39
	Houston	142	25	18	25
	Wash., D.C. and Houston Combined	248	37	26	64
Douglas- fir, New	Southern California	37	3	--	--

^a N = sample size.

^b $f_e = (N_w/N) \times 100$.

Table 4. Allowable Unit Stresses^a for Hardwood Wale and Strut
Trenching Lumber^b

Hardwood group ^c	F _b	F _t	F _c	F _v	F _{c⊥}	E
2 to 4 in. thick, 2 to 14 in. wide						
White oak ^d	875	575	550	105	355	800,000
Mixed oak ^e	850	550	500	80	355	800,000
Mixed hardwoods I ^f	725	475	375	65	165	800,000
Mixed hardwoods II ^g	600	400	350	50	115	800,000
5 in. and thicker, 5 to 20 in wide						
White oak ^d	975	650	525	120	355	800,000
Mixed oak ^e	925	625	475	90	355	800,000
Mixed hardwoods I ^f	800	550	350	75	165	800,000
Mixed hardwoods II ^g	675	450	325	60	115	800,000

^a Allowable unit stresses in psi are symbolized by the notation F_b for bending, F_t for tension, F_c for compression parallel, F_v for shear, F_{c⊥} for compression perpendicular, and E for modulus of elasticity.

^b Ref. Southern Pine Inspection Bureau Grading Rules, 1977 edition, for general grade description as follows:

Grade	Paragraph	Size
No. 2	313	2 to 4 in. thick, 2 to 4 in. wide
No. 2	343	2 to 4 in. thick, 5 to 14 in. wide
No. 2 SR	406	5 in. and thicker, 5 to 20 in. wide

Assumes 10-yr. load duration basis. For new (first use) lumber, adjustments for load duration may be made: for 1-yr. duration multiply by 1.1; for 1 wk., multiply by 1.25; for 2 days, multiply by 1.30. Load duration adjustments for used trenching lumber are not recommended. For hardwood trenching lumber, requirements are waived for manufacture, compression wood, firm knots, skips, stain, and warp. Holes limited as knots; wane limited as given for No. 2 grade in SPIB, 1977 edition.

^c Hardwood species defined per ASTM D 1165.

^d White oak: The following white oaks--bur, chestnut, live, overcup, post, swamp chestnut, swamp white, white.

^e Mixed oak: Red oak (black, cherry bark, laurel, northern red, pin, scarlet, southern red, water, willow); white oak (footnote d).

^f Mixed hardwoods I: Ash (black, blue, green, Oregon); beech; birch (sweet, yellow); cherry; elm (American, rock, slippery); hackberry; hickory (mockernut, pignut, shagbark, shellbark); locust (black, honeylocust); magnolia (cucumber, southern, sweetbay); maple (bigleaf, black, red, silver, sugar); mixed oak (footnote e); pecan (bitternut hickory, nutmeg hickory, pecan, water hickory); red alder; sassafras; sugarberry; sweetgum; sycamore; tanoak; tupelo (black, water); yellow poplar. Excludes all cottonwood, all aspen, basswood, and balsam poplar.

^g Mixed hardwoods II: All hardwoods in Mixed hardwoods I (footnote f) plus black and eastern cottonwood; quaking and bigtooth aspen; basswood. Excludes balsam poplar.

Table 5. Grouping of some domestic woods according to heartwood decay
(taken from [2])

Resistant or very resistant	Moderately resistant	Slightly or nonresistant
Baldcypress (old growth) ^a	Baldcypress (young growth) ^a	Alder
Catalpa	Douglas-fir	Ashes
Cedars	Honeylocust	Aspens
Cherry, black	Larch, western	Basswood
Chestnut	Oak, swamp	Beech
Cypress, Arizona	chestnut	Birches
Junipers	Pine, eastern	Buckeye
Locust, black ^b	white ^a	Butternut
Mulberry, red ^b	Southern pine:	Cottonwood
Oak:	Longleaf ^a	Elms
Bur	Slash ^a	Hackberry
Chestnut	Tamarack	Hemlocks
Gambel		Hickories
Oregon white		Magnolia
Post		Maples
White		Oak (red and black species)
Osage orange ^b		Pines (other than longleaf, slash and eastern white)
Redwood		Poplars
Sassafras		Spruces
Walnut, black		Sweetgum
Yew, Pacific ^b		True firs (western and eastern)
		Willows
		Yellow-poplar

^a The southern and eastern pines and baldcypress are now largely second growth with a large proportion of sapwood. Consequently, substantial quantities of heartwood lumber of these species are not available.

^b These woods have exceptionally high decay resistance.

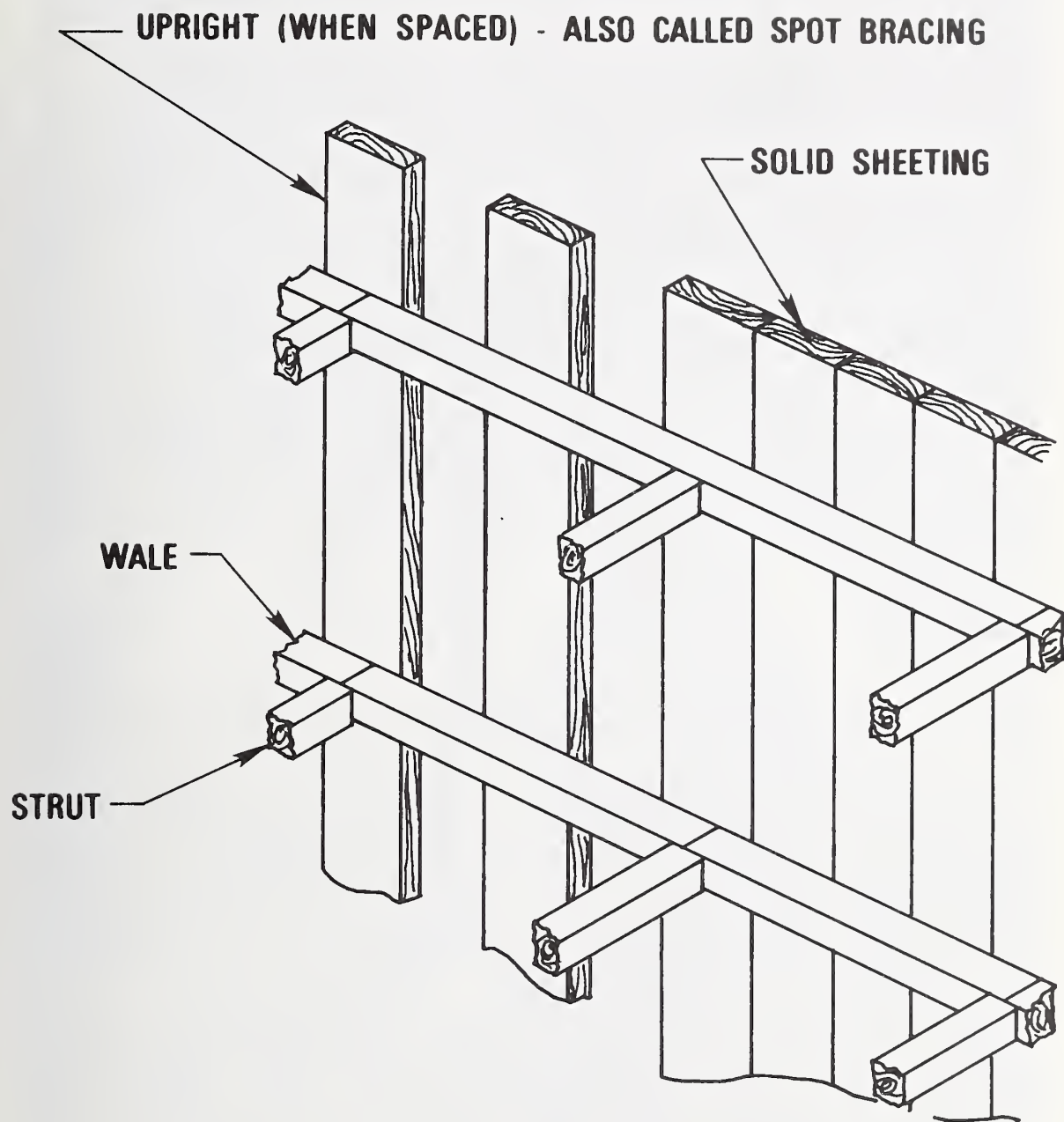


Figure 1. Components of a shoring system



Figure 2. Wane in 12 x 12's.



Figure 3. Lumber storage showing typical close-piled material with heavy weed growth and conditions conducive to lumber deterioration.



Figure 4. Sheeting lumber with a very heavy surface coat of mold.

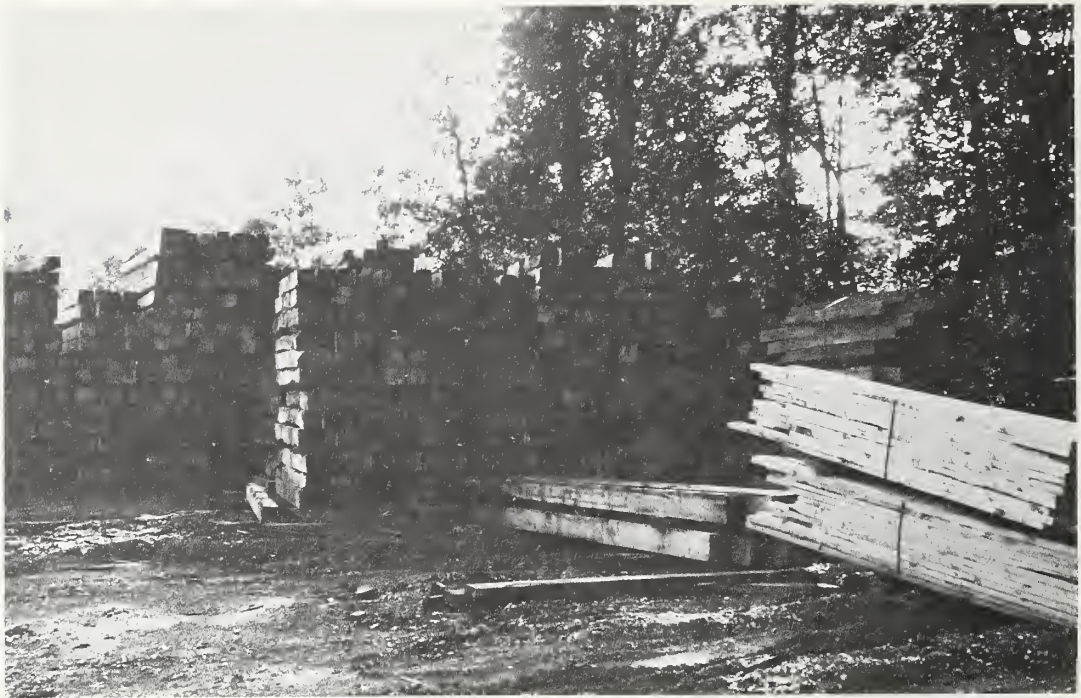


Figure 5. Lumber storage.



Figure 6. A clean, asphalt-surfaced, and well organized yard.



Figure 7. Reused wale material showing checks which result as the stock dries while in yard storage (also see fig. 10).



Figure 8. Yard in California, showing 4 x 12 sheeting. This material had been reused many times.



Figure 9. Lumber defects. Hardwood wale with a high slope of grain and end decay.



Figure 10. Slope of Grain--The appearance of slope of grain, evidenced by drying checks, in this Douglas-fir 12 x 12 may be deceptive. The actual slope of grain over any relatively long length was approximately 1 in 20, which qualifies the piece for higher stress grades.



Figure 11. Lumber defects. Close-piled 8 x 8's showing wane, end checks and rot.



Figure 12. Lumber defects. Rot around a knot.

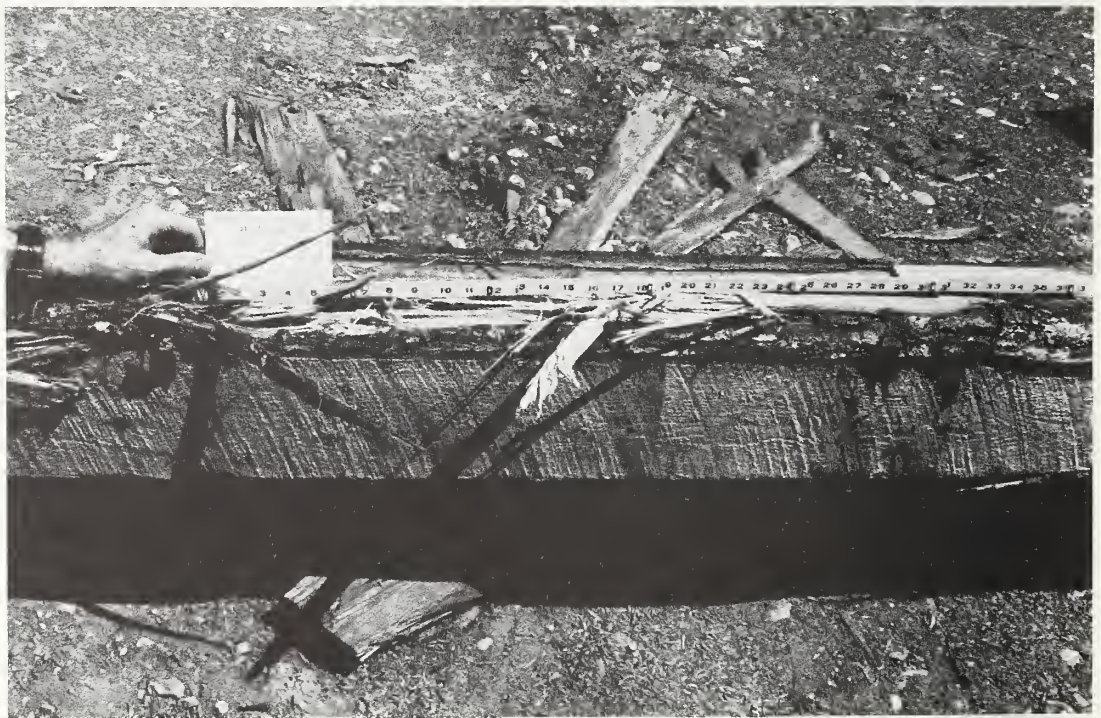


Figure 13. Lumber defects. Forklift damage.



Figure 14. Timbers that appear to have potential for resawing and structural reuse. Resawing could remove the apparent bending failures near the end (top) or the brooming failures (bottom).

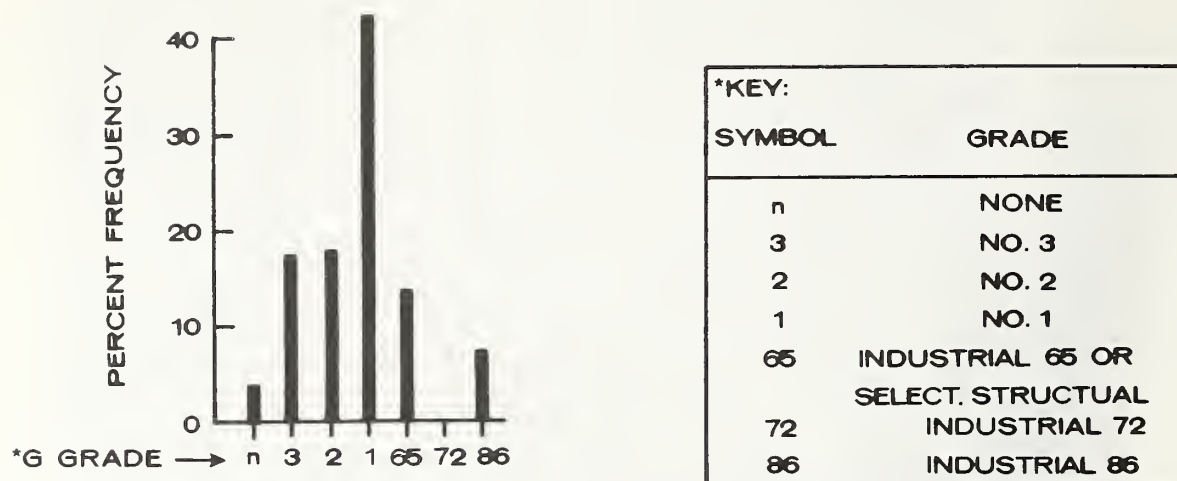


Figure 15. Relative frequency of strength ratio grade (G) of eastern species full length wales in Wash., D.C. and Houston, Texas. Note that the grades of No. 3 and None are not strength grades for wales.



Figure 16. An example of wane in trenching timber that may need to be treated as a structural defect or downgraded to a smaller size.

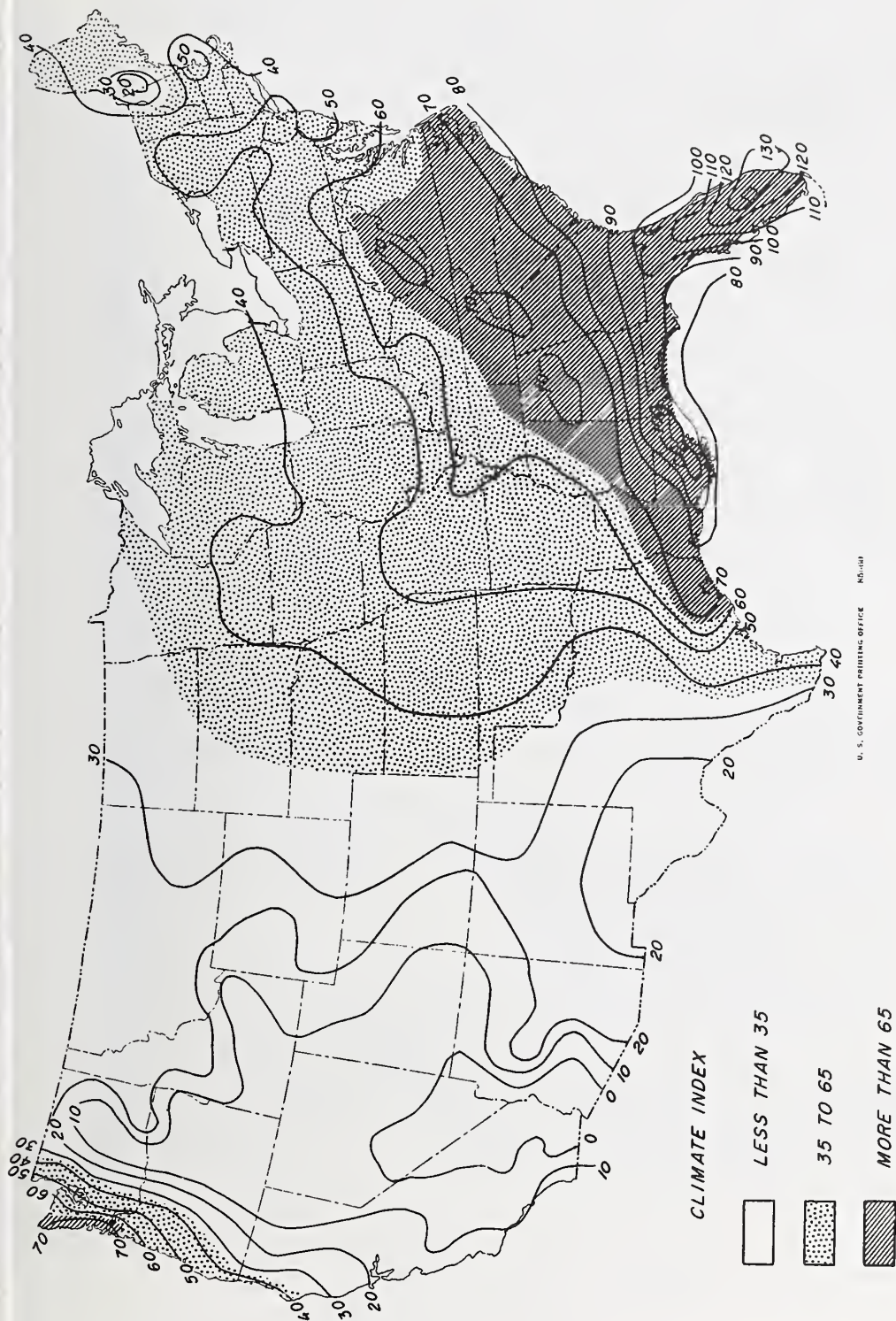


Figure 17.

Levels of decay potential for wood exposed to the weather in aboveground service based on a climate index derived from standard temperature and rainfall data: Darkest areas, wettest climates, most suitable for decay; index greater than 65. Lightest areas, driest climates, least suitable for decay; index less than 35. Gray areas, moderately wet climates, moderately suitable for decay organisms; index 35 to 65 (taken from [7]).

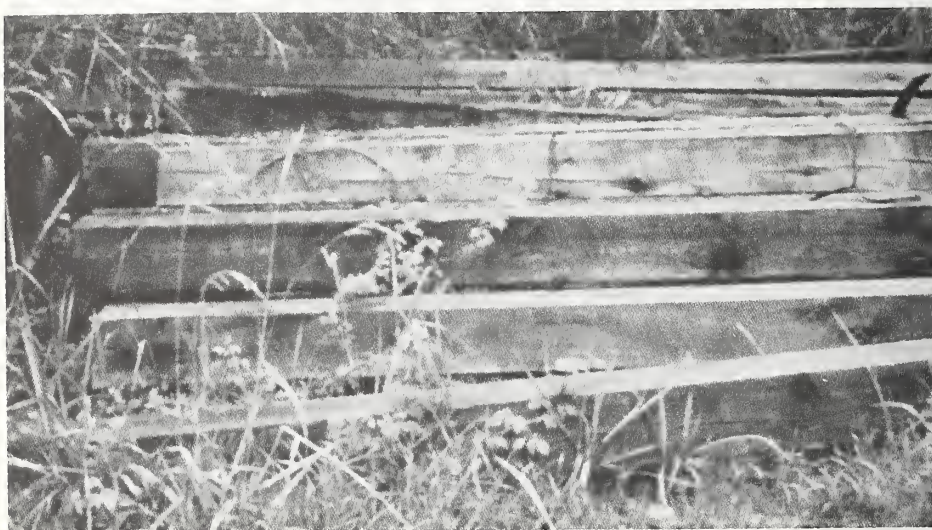


Figure 18. Examples of how poor storage leads to problems. Top: solid stacking of green timbers prevents drying and promotes decay infestation. Bottom: poor housekeeping and piling practices in a holding yard.

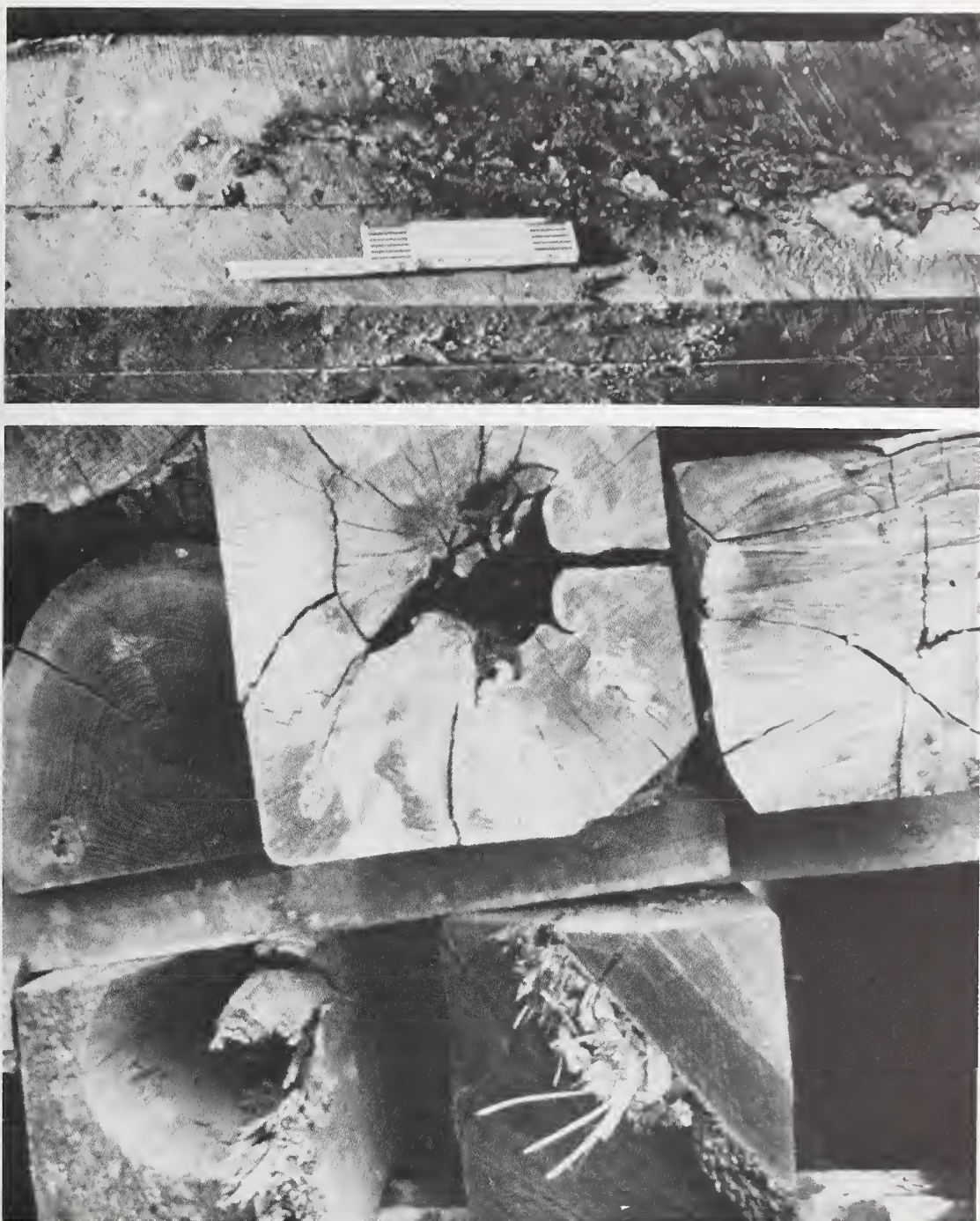


Figure 19. Examples of decay in trenching lumber. Top: decay probably occurred because of close piling. Bottom: decay has occurred in large green timbers before they seasoned.



Figure 20. Trenching timber containing insect infestation.
Piles of borings emphasize hole locations.

APPENDIX A - SAMPLING PROCEDURES AND DESCRIPTION OF DATA ENTRIES AND CODING

This appendix contains descriptions of the sampling procedures, data entries and coding used. Detailed descriptions of the grading methods, and data collection for wane and slope of grain are given. Chapter 3 presents a summary of this appendix.

SAMPLING PROCEDURES

A similar sampling procedure was followed at each geographical area visited. The visits to each area were of one week duration. The first day was spent locating each yard to be visited, contacting the yard personnel, obtaining general usage and inventory information, and choosing what stock was to be sampled. If time permitted, data was taken on the first sample at the first yard. (In Washington, D.C. only one supply yard was visited.) The next three days were spent obtaining data. The last day of the week was usually spent in concluding sampling, interviewing yard personnel, and/or visiting trenching sites in the area.

Within a yard, trenching lumber samples were chosen using the following rationale:

1. Where possible, at least two sizes of wales and/or struts were chosen for study, a relatively large size and a relatively small size. The actual sizes chosen depended on the number of pieces of each size in stock at the time of the visit and the general usage factor for the sizes in stock. For example, in the Washington area, 12 x 12's and 8 x 8's are the most commonly used sizes. Consequently, these two sizes were emphasized in the sampling. In the Houston area 8 x 8's and 4 x 6's were chosen predominantly because they were the more common sizes in that area.
2. Where time permitted, a sample of sheeting material was chosen from each yard. Sheeting, however, had secondary importance in the project. As with wales and struts, a commonly-used size of sheeting was chosen for study.
3. If time permitted, large wale stock was given third priority. That is, in some yards a relatively large stock of a particular size and length was sampled which did not necessarily coincide with the size chosen in 1 above. Stock for which only a small number of pieces was available was avoided.

4. Where possible, preference was given to 20-foot stock for wales or struts to permit two ten-foot lengths for regrading (see table 1). In 20-foot 12 x 12 pieces, for example, the piece was graded as a full-length 12 x 12 wale, as two 10-foot wales, and as two 10-foot struts. A 20-foot 12 x 12 could conceivably be used as an unsupported beam or as a beam supported on 10-foot intervals or cut into 10-foot pieces and used as struts. This procedure derived a maximum amount of information from each member.
5. An attempt was made to sample trenching lumber while keeping yard disruption at a minimum. Yard operators were most cooperative and helpful. Competent yard personnel and equipment were made available in all cases and a spirit of mutual cooperation was maintained. However, it was not possible to sample stock as desired due to yard lay-out and activity. Occasionally, too much movement of large, strapped bundles of lumber was required. Other stock was unavailable because it was being banded for sale or cut to length.

Once a sample size and length had been chosen, several (usually 10-20) pieces were transported by forklift to an out-of-the-way area in the yard where they could be studied. The forklift was used to place the pieces of large stock in a row; individual pieces were turned or moved by use of a cant hook.

EXPLANATION OF DATA ENTRIES AND CODES

Figure A1 shows the sheet used to record data for the field study. The data was coded for two reasons: (1) it was not practical to publish the raw data sheets (about 750), and (2) the coding was needed to perform the computer analysis. Information on lumber sampled is summarized in table 1.

The following is a description of the data sheet entries and the coding used. (Entries deserving additional detail, including grading methods, wane, and slope of grain, are treated later in this appendix.) The coding was done by using 48 separate data entry groups. Each group was then assigned a numerical code which covered the data entries for that group. In the information which follows, the group code number (column number in table A1) and group title are given first; then a description of the group is given; and the numerical code for the entries of that group is given last. A code of "0" or "-1" was used when no information was recorded.

Group Number and Title	Description of Group - Remarks	Numerical Code
		Code Location
1. Lumber Yard	Lumber was evaluated at 7 supply yards and 1 job site.	1 = Wash., D.C. 2 = Wash., D.C. (job site) 3 = Houston, TX 4 = Houston, TX 5 = Houston, TX 6 = Southern CA 7 = Southern CA 8 = Southern CA
2. Sample Number	There were 26 samples taken at the 7 supply yards and 1 job site. With one exception (No. 23) each sample contained only one size (width, thickness) of lumber.	Codes used were the sample numbers given in table 1
3. Specimen Number	There was an assigned specimen number for each full length piece evaluated.	
4. Length Classification	Each piece was graded as full length or one or two 10 ft. sections of the full length piece.	1 = Graded full length 2 = Graded for the first 10 ft. section 3 = Graded for the second 10 ft. section
5. Member Use	Each piece was evaluated according to its intended use of wale (beams and stringers, bending) strut (post and timber, column) or sheeting (beam-plank and joist, bending). A code of 1 was used for full length pieces or 10 ft. partial length pieces of 16 to 24 ft. full length pieces; the full length pieces were first graded	1 = Wale or strut 2 = Strut alone 3 = Sheeting

<u>Group Number and Title</u>	<u>Description of Group - Remarks</u>	<u>Numerical Code</u>
5. Member Use (Cont.).	as wales and then, in certain cases, as struts (see table 1); the 10 ft. partial length pieces were first graded as wales and then as struts. In almost every case, the wale and strut grades were the same (only 3 exceptions were noted). Also see details of grading methods, given later in this appendix.	
6. Species	The species of each specimen was determined through hand lens examination of a smoothed cross-sectional area. Accuracy was checked by sending small pieces from numerous specimens to the Forest Products Laboratory for verification. Field identification seemed to be relatively accurate; errors were generally restricted to mis-naming species within a genus (red oak vs. white oak for example).	1 = red oak (<i>Quercus</i> sp.) 2 = white oak (<i>Quercus</i> sp.) 3 = Black gum, tupelo (<i>Nyssa sylvatica</i>) 4 = Sweet gum, red gum (<i>Liquidambar styraciflua</i>) 5 = White ash (<i>Fraxinus</i> sp.) 6 = Yellow poplar (<i>Liriodendron tulipifera</i>) 7 = Southern yellow pine (<i>Pinus</i> sp.) 8 = Sycamore (<i>Platanus occidentalis</i>) 9 = Hickory (<i>Carya</i> sp.) 10 = Elm (<i>Ulmus</i> sp.) 11 = American elm (<i>Ulmus Americana</i>) 12 = Slippery elm (<i>Ulmus rubra</i>) 13 = Cherry (<i>Prunus serotina</i>) 14 = Sassafras (<i>Sassafras albidum</i>) 15 = River birch (<i>Betula nigra</i>) 16 = Beech (<i>Fagus grandifolia</i>) 17 = Birch (<i>Betula</i> sp.)

<u>Group Number an Title</u>	<u>Description of Group - Remarks</u>	<u>Numerical Code</u>
6. Species (Cont.)		18 = Pecan (<i>Carya illinoensis</i>) 19 = Hackberry (<i>Celtis occidentalis</i>) 20 = Maple (<i>Acer</i> sp.) 21 = Magnolia (<i>Magnolia grandiflora</i>) 22 = Sugarberry (<i>Celtis laevigata</i>) 23 = Honey locust (<i>Gleditsia triacanthos</i>) 24 = Douglas-Fir (<i>Pseudotsuga menziesii</i>)
7. Sold as	Species name or grade by which lumber sold.	1 = Mill Run or Mixed (applies to all eastern species - i.e., no species segregation for eastern species) 2 = No. 1 or better (applied to some Douglas-fir)
8. Nominal Thickness	Thickness for which wood sold as (given in "Member Size" in table 1).	Nominal thickness coded in inches
9. Nominal Width	Width for which wood sold as (given in "Member Size" in table 1).	Nominal width coded in inches
10. Length	Actual length measured to nearest 1/8 in.	Actual length coded in feet (rounded to nearest hundredth of ft.)

<u>Group Number and Title</u>	<u>Description of Group - Remarks</u>	<u>Numerical Code</u>
11. Width ^a at End 1	Actual width at end 1 measured to nearest 1/16 in.	Actual width coded in inches (rounded to nearest thousandth of an in.)
12. Width ^a at End 2	Actual width at end 2 measured to nearest 1/16 in.	Code same as for 11.
13. Thickness ^a at End 1	Actual thickness at end 1 measured to nearest 1/16 in.	Actual thickness coded in inches (rounded to nearest thousandth of an in.)
14. Thickness ^a at End 2	Actual thickness at end 2 measured to nearest 1/16 in.	Code same as for 13.
15. Moisture Content ^b - First Reading	Moisture content at one quarter point taken by an electric moisture meter.	99 = green (greater than or equal to 30% was assumed green). If moisture content less than 30%, actual content coded in percent and rounded to nearest 1 percent.
16. Moisture content ^b - Second Reading	Moisture content at the other quarter point taken by an electric moisture meter.	Code same as for 15.

^a When wane at the end was present, measurements for width and thickness were taken at a location containing no wane, but as close to the end of the member as possible. Width and thickness measurements did not include bark.

^b With only rare exceptions the eastern species were all green. For eastern species, moisture contents on the very outer surfaces were often dry (12-20%), but the wood was usually above fiber saturation point within one-half inch or less of the surface.

<u>Group Number and Title</u>	<u>Description of Group - Remarks</u>	<u>Numerical Code</u>
17. Wane on Face ^c	Wane was recorded for the worst face. Face refers to width. For example, 1/4 means wane was on 1/4 of the width.	1 = <1/4 2 = 1/4 3 = 1/3 4 = 1/2 5 = 3/4 6 = Full 7 = 2/3
18. Wane on Length ^c	Wane was recorded for length.	Code same as for 17.
19. Wane on Thickness ^c	Wane was recorded for thickness.	Code same as for 17.
20. Rings per Inch	For purposes of this study, "density" was implied by measurement of the number of growth rings per inch measured along a line from the pith outward, and the average percent summerwood within a growth ring. The purpose of density measurements was to be able to assign "dense" grades as per SPIB grade rules later, if needed. Density was measured for the Douglas-fir and Southern Yellow Pine members only; no density data were taken for hardwoods. Ring count was taken on one end of a member only, but consistently at one end of a stack for all members within a sample. The rings/in. and percent summerwood information was estimated by the grader. Rings/in. was	Rings per inch rounded to nearest ring were coded.

^c See section describing wane at the end of this appendix.

<u>Group Number and Title</u>	<u>Description of Group -Remarks</u>	<u>Numerical Code</u>
20. Rings per Inch (Cont.).	measured by a scale when the wood had only a few rings per inch (3-6); it was estimated when the number of rings per inch was large (12-20+).	
21. Percent Summerwood	Average percent summerwood recorded (see remarks for 20).	Percent summerwood, rounded to nearest whole percent, coded.
22. Bow	Recorded per SPIB grade book.	1 = Very light 2 = Light 3 = Medium 4 = Heavy
23. Crook	Recorded per SPIB grade book.	Code same as for 22.
24. Cup	Recorded per SPIB grade book.	Code same as for 22.
25. Twist	Recorded per SPIB grade book	Code same as for 22.
26. Critical Knot Type	Type of knot in critical section, usually recorded only for grades of No. 2 and lower. A cluster was defined as more than two knots. The two-knot code was used when two knots were judged important; the knots were not necessarily adjoining. Higher grades often contained numerous, widely scattered knots in sizes permitted in the grade. A "critical" knot was often difficult to pick.	1 = Edge 2 = Center 3 = Spike 4 = Cluster 5 = Two Knots
27. Knot Length (larger dimension) of Critical Knot in 26.	With the two-knot code, measurements for the largest of the two knots, (as determined by the product of the knot length times the width) were coded	Actual dimension coded in inches (decimal).

Group Number and Title	Description of Group -Remarks	Numerical Code
27. Knot Length (larger dimension) of Critical Knot in 26 (Cont.).	except when the critical knot was identified (e.g., spike or rot around knot)- then the critical knot dimensions were coded, even though the critical knot may have been the smaller of the two. For cluster knots, the dimensions of the cluster were coded, and included all knots in the cluster. Knot size was recorded only for the lower grade pieces (No. 2 and No. 3). Determining the knot sizes posed some problems. Knots should be measured counting only growth rings within the branch cross-section forming the knot. However, not all knots are cut perpendicular to the branch axis and, hence, the wood on the periphery of a knot tends to blend into the wood of the tree surrounding the knot. This is particularly true of live knots and in rough-sawn wood.	
28. Knot Width of Critical Knot in 26.	(See description under 27.)	Actual dimension coded in inches (decimal).
29. Slope of Grain - Face 1	Recorded as a rise to run ratio in the form 1:X. For additional detail see slope of grain description later in this chapter.	99 when $X \geq 20$; otherwise, when $X < 20$ actual value of X was coded (e.g., a 1:12 slope of grain was coded as 12 and a 1:20 value coded as 99).
30. Slope of Grain - Face 2	Recorded as a rise to run ratio in the form of 1:X.	Code same as for 29.

<u>Group Number and Title</u>	<u>Description of Group - Remarks</u>	<u>Numerical Code</u>
31. Type of Checks		1 = End or Pith 2 = Surface or Seasoning 3 = End and Surface
32. Size of Checks		1 = Light 2 = Medium 3 = Large or Heavy or Long 4 = Checks present but neither type nor size given
33. Size of Splits	Pitch pockets included, shakes excluded (see 34, 35).	1 = Very short 2 = Short 3 = Medium 4 = Long, Very Long, or Full Length 5 = Split present but size not recorded
34. Size of Shake		1 = Very Short 2 = Short 3 = Medium 4 = Long 5 = Very Long 6 = Full Length
35. Type of Shake		1 = Ring 2 = Heart or Pith 3 = Through 4 = Shake present but type not recorded 5 = Burl
36. Grade Disregarding Wane, Damage, and Decay	Called G grade. SPIB grade recorded for almost all pieces evaluated (i.e., length classifications of 1, 2, and 3 - group No. 4). This grade includes <u>limited</u> decay around the periphery of knots, knotholes, wormholes, and holes (see group No. 37 -	1 = Industrial 86 2 = Industrial 72 3 = Industrial 65 4 = Select Structural 5 = No. 1 Strength Ratio 6 = No. 2 Strength Ratio 7 = No. 3 8 = None or Economy

<u>Group Number and Title</u>	<u>Description of Group - Remarks</u>	<u>Numerical Code</u>
36. Grade Disregarding Wane, Damage, and Decay (Cont.).	code numbers 4, 6, 22, 27, 28). When limited decay was included, it was not recorded under the Decay Grade (group 40) or Decay Type (group 41 and 42). This grade (G) does include, for No. 3 joist and plank grade, unsound wood in spots or streaks limited to 1/3 the cross-section at any point along the length. For additional detail, see the descrip- tion of grading methods later in this appendix.	
37. Critical Defect for Grade in 36. (Not always recorded.)		1 = Knot (one knot or no information given about num- ber of knots) 2 = Knot cluster or clusters (fig. A2) 3 = Knot hole or knot holes 4 = Knot with limited decay (fig. 12, fig. A3) 5 = Wormhole or wormholes 6 = Wormhole(s) with limited rot 7 = Bark pocket (fig. A4) 8 = Shake (fig. A5) 9 = Split (fig. A5) 10 = Checks (fig. 7) 11 = Hole or Holes 12 = Slope of Grain (fig. 9) 13 = Bow 14 = Crook 15 = Cup 16 = Twist 18 = Two knots 19 = Burl

<u>Group Number and Title</u>	<u>Description of Group - Remarks</u>	<u>Numerical Code</u>
37. Critical Defect Grade in 36. (Not always recorded) (Cont.)		20 = Too thin (Scant thickness - fig. A6) 21 = Compression Failure 22 = Knothole with limited decay 23 = Size too small (scantness) (fig. A6) 24 = Too narrow (scant width - fig. A6) 25 = Knots with termites 26 = Pitch Pocket 27 = Hole with limited decay (fig. A7) 28 = White speck (fig. A8)
38. Additional Critical Defect for Grade in 36 (when recorded).		Code same as for 37.
39. Grade for wane dis- regarding damage or decay (when recorded).	Called GW. For members which were graded as struts only (see samples 24 and 26 in table 1), the amount of wane was recorded but a wane grade was omitted.	Code same as for 36.
40. Grade for decay disregarding wane or damage	Called GDE. Limited decay around knots, knotholes, wormholes, and holes was included in group 36 but not in groups 40, 41, and 42.	Code same as for 36.
41. Decay type for grade in 40.	Decay type may be given even though there was no decay grade given (i.e., the decay present did not cause a grade reduc- tion).	1 = Surface (fig. 4) 2 = Pith (fig. 11) 3 = Streak 4 = Decay at knot (fig. 12)

<u>Group Number and Title</u>	<u>Description of Group -Remarks-</u>	<u>Numerical Code</u>
41. Decay type for grade in 40. (Cont.)		5 = Decay at wormhole 6 = Pocket 7 = White Speck (fig. A8) Same as Code 10. 8 = Dry rot 9 = Sapwood 10 = White speck, same as code 7 11 = Decay present but type not recorded 12 = Rot at hole (figs. A7, A9) 14 = Multiple decay types (fig. 4) 15 = Patch (fig. 4) 16 = Butt Rot (fig. 11) 17 = Edge 18 = End (fig. 9) 19 = Heart (fig. 11, fig. A8) 20 = Soft Rot 21 = Rot at bark pocket (fig. A4)
42. Additional Decay Type for Grade in 40.		Code same as for 41.
43. Grade for Damage, Disregarding Wane or Decay	Called GDA	Code same as for 36.
44. Type of Damage for Grade in 43.	Damage type may be present even though no damage grade was given (i.e., the damage present did not cause a grade reduction).	1 = Gouge (fig. A10) 2 = Puncture (fig. A11) 3 = Saw cut, (fig. A12) saw mark, saw kerf 4 = Brooming (fig. 14) 5 = Tear Out (fig. A11) 6 = Split Out

<u>Group Number and Title</u>	<u>Description of Group -Remarks</u>	<u>Numerical Code</u>
44. Type of Damage (Cont.)		<p>7 = Dog mark (a "dog" refers to the steel device which holds the log in position on a saw carriage during the sawing operation)</p> <p>8 = Caused by fork lift or lift truck (fig. 13)</p> <p>9 = Shattered End (fig. 14, fig. A13)</p>
45. Grade on Middle 1/3 Length, Disregarding Wane, Damage, and Decay	Called GM3. All wales (full and 10' - group 4, code 1, 2, and 3) were attempted to be regraded on their middle 1/3 length relative to their G grade (group 36).	Code same as for 36.
46. Length of Trim	Amount of end trimming required to increase grade. If trimming was required at both ends, the total trim length for both ends was coded. Up to 20 percent of the length of a piece was assumed trimmable.	Actual length of trim was coded in feet and rounded to nearest whole foot.
47. Trimmed Grade	Called GT. Grade resulting from trimming.	Code same as for 36.
48. Trimmed Grade Statement	Statement recorded concerning trimmed grade in 47.	<p>1 = Grade "with wane"</p> <p>2 = Grade "without wane"</p> <p>3 = Nothing said about grade</p> <p>4 = Grade "for" everything except wane (e.g., knot, shake, etc.)</p>

<u>Group Number and Title</u>	<u>Description of Group - Remarks</u>	<u>Numerical Code</u>
48. Trimmed Grade Statement (Cont.)		5 = Grade "for wane" 6 = Grade "with wane" and some other defect (e.g., knot). 7 = Grade "without wane" and for some defect (e.g., knot) other than wane.

COMPUTER CODING

The 48 groups and their corresponding numerical codes were used to code the data for each of the 726 pieces investigated (467 eastern species and 259 Douglas-fir). Two computer cards were required to record all 48 group entries for each piece. The coded data for groups 1-23 were recorded on the first card, denoted as "a"; the remaining coded data for groups 24-48 were entered on the second card, called "b". The 28 pages of Table A1 present the coded data in the following format. Group numbers appear at the top line of each page. Coding on the first or "a" card (for group 1-23) for the 467 eastern species pieces is shown on the first nine pages and is denoted by H-a1 through H-a9 at the upper right hand corner. The next nine pages, labeled H-b1 through H-b9, show the coded data for groups 24-48 for the 467 eastern species pieces. Similarly the next five pages, labeled S-a1 through S-a5, present the coding for the 259 Douglas-fir pieces for groups 1-23. The final five pages, marked S-b1 through S-b5, show the Douglas-fir coding for groups 24-48. In order to identify each piece, the coding for groups 1-5 was repeated on the second (b) card.

GRADING METHODS

The lumber grader had, until recently (1977), been a grading supervisor for the West Coast Lumber Inspection Bureau (WCLIB). He had many years of softwood lumber grading experience. The grade rules used in this study were, however, those of the Southern Pine Inspection Bureau (SPIB); this was because there were more structural grades available for assignment, particularly in the large timber sizes. In general this did not pose any problems for the grader. Frequent reference was made to the grade rule book during the grading operation. The grader made an attempt to assign each piece to a recognized grade so that lumber strength characteristics of the trenching lumber sampled would be assessed as accurately as possible.

The grader also interpreted the defects in any particular piece in relation to their effect upon member strength. For example, a knot covering

a rather large area on one face and not appearing on the opposite face (or being very small on the opposite face) was considered for its wood displacement rather than its absolute surface area. This was in keeping with normal grading practice. In other cases, a piece was graded lower than its knot size would perhaps indicate; this was due to the presence of other nearby defects or to an accumulation of strength-reducing characteristics. Again, the piece was placed into a grade according to recognized grading practice.

In order to study the effect of wane, damage and decay on grade, the following considerations were emphasized by the grader:

- a) A strength ratio grade, called G, was assigned to each specimen without regard to wane, damage and decay. However, a description of these defects when present was recorded. One exception to this was in the case of rot in or around the periphery of a knot, knothole, or wormhole. Refer to paragraph 413.5 in the SPIB grade rules. Although ASTM standards pertaining to lumber grading make no allowance for decay, Number 2 grade in the SPIB rules permits decay "in knots only." In Number 3 Joist and Plank grade (assigned in this study to pieces which graded lower than Number 2 SR but were within the limits of Number 3 J and P grade) the grading rules permit "unsound wood in spots or streaks limited to 1/3 the cross section at any point along the length." There was no SPIB stress grade for wales and struts less than No. 2. Thus for wales and struts, any grade assignment less than No. 2, was approximated by the field team for illustration only.
- b) Where applicable, a grade was assigned taking wane into account, without regard to damage or decay. One exception was that for members which were graded as struts only (see samples 24 and 26, table 1), the amount of wane was recorded but a wane grade was omitted.
- c) Where applicable, a grade was assigned taking damage into account, without regard to wane or decay.
- d) Where applicable, a grade was assigned taking decay into account, without regard to damage or wane.
- e) Where applicable, a G grade was assigned to the middle 1/3 length if it was of higher grade than the G grade for the entire specimen.

All pieces were assigned a full length G grade as prescribed in SPIB rules which require full length grading. However, for all wales the middle 1/3 was given special consideration. If it was a higher G grade than that assigned to the full-length piece, the G grade of the middle 1/3 was recorded. That information was recorded because the maximum bending stress

in wales is commonly within the middle 1/3 of the member. Thus, if a limiting defect fell outside the middle 1/3 (graded full length or as a 10' piece of a longer member--see f, next paragraph), the middle 1/3 was assigned a higher G grade than that assigned to the entire specimen. Wane, damage and decay were ignored in the middle 1/3 of the length for this purpose. For struts, the loading mode is compression and middle 1/3 grading does not apply.

- f) In addition, selected members were assigned a G grade (G10) in 10' intervals both as a wale and as a strut. This was done for wales to reflect that wales are sometimes loaded as continuous beams (10' support intervals assumed) and to reflect the grade potential of the wales if resawed to shorter lengths. The 10' interval was also chosen to represent strut length, even though the actual strut length used in trenching is often less than 10'. Thus a member was given as many as five grade assignments: a full length wale, two 10' wales, and two 10' struts. With only limited exceptions, the 10' pieces had the same G10 grade as a wale or as a strut. (This statement also applies to members which were 10 feet full length and graded as wales and struts - see table 1.) As given in the EXPLANATION OF DATA ENTRIES AND CODES, these 10' wales and struts were coded as "wale or strut" for a member use (code of 1, group 5) and as a 10' piece of a longer member for length classification (code of 2 or 3, group 4).
- g) Where a critical defect occurred close to an end, members were upgraded by hypothetical end-trimming to estimate the effect of elimination or reduction of the defect. This hypothetical end-trimming could occur on one or both ends and was limited to 20 percent of the member length. The amount of end-trimming and the resulting increase in grade were recorded. Quite often end-trimming removed extensive wane, although the extent of wane removed was not documented.
- h) The structural grades used, with pertinent descriptive comments, ranked from highest to lowest grade, were as follows:
1. Industrial 86 (IND 86) paragraph 441 in SPIB grade rules book. B & B finish on face requirements omitted; no density measurement requirements applied. Permissible slope of grain is 1 in 18. No rot permitted.
 2. Industrial 72 (IND 72) paragraph 442 in SPIB grade rules book. C finish on face requirements omitted; no density measurement or rings per inch requirements applied. Permissible slope of grain is 1 in 14. No rot permitted.

3. Industrial 65 (IND 65) paragraph 443 in SPIB grade rules book. D finish on face requirements omitted; no density measurement or rings per inch requirements applied. Permissible slope of grain is 1 in 12. No rot permitted. This grade is very similar to the grade of Select Structural in joist and plank sizes. In some instances the distinction between the two grades was made, dis-regarding size classification. Select Structural rules are found in paragraph 341 in the SPIB grade rules book. Select Structural has a strength ratio of 65%, as does IND 65. However, there are some small differences in permissible defects between the two grades. Rot is not permitted in either grade.
4. No. 1 SR Timbers (No. 1) paragraph 405 in SPIB grade rules book. Decay permitted in knots only. Permissible slope of grain is 1 in 11. (Here "SR" means stress rated.)
5. No. 2 SR Timbers (No. 2) paragraph 406 in SPIB grade rules book. Decay permitted in knots only. Permissible slope of grain is 1 in 8.
6. No. 3 paragraph 344 in SPIB grade rules book. This is a joist and plank grade and does not actually apply to large members (that is, members greater than 4 inches thick). However, the knot sizes and other defects applicable to the wide face of this joist and plank grade were applied to larger members in this study in an attempt to delineate defects (primarily knots) for a grade lower than Number 2 SR. (In other words, if the poorest face on a wale did not meet Number 2 SR requirements, the face was graded as a two-inch thick joist.) It should be understood that this was for estimation only; no corresponding SPIB grade existed. Limited unsound wood is permitted in this grade.
7. None. This grade designates any piece below No. 3. Pieces assigned this grade most often did not meet wane restrictions of higher grades.

For lower grades of lumber (Number 3 and None, and occasionally for Number 2) a plot of the knots (or at least of the "critical" knot) was made as part of the data sheet* set for a member. Many pieces had a large number of knots on several faces. To aid in grading, a knot plot was made for several locations along the length of a member. In many instances, the visually chosen weakest spot occurred where two to several knots or other defects were close together, often on adjoining faces. The largest, single knot was not necessarily the critical defect.

* Knot plots are not included in this report.

There is no "Post and Timber" designation in the SPIB grading rules; consequently, for consideration of columns versus bending members the Post and Timber grades of the WCLIB grade rules (paragraph 131) were applied by the grader. These considerations primarily involved knot size restrictions. There were about 3 pieces for which the strut grade differed from that assigned to the wales.

Sheeting was graded under joist and plank grading rules. Sheeting thicknesses were nominal 2", 3" or 4". It is noted that both SPIB and WCLIB grade rules permit limited unsound wood only in 2" thicknesses in the No. 2 grade. Unsound wood is also permitted in the No. 3 grade for all thicknesses.

The Douglas-fir sampled in southern California had been graded according to WCLIB or Western Wood Products Association (WWPA) rules, which are quite similar for the data collected in this study. The grade most usually purchased would have been Number 1 and higher, Beam and Stringer grade. There are several small differences, including slope of grain and knot requirements, between the SPIB (used in this study) and WCLIB grading rules.

WANE

Since wane was a serious problem for eastern species wales and struts, a description of the type of wane encountered, the procedure for recording wane data, and the interpretation of the data is given in the following paragraphs. Wane was not always recorded for sheeting.

A piece's worse wide* face (with respect to wane) was turned up for grading purposes and the recording of wane data. The piece was graded for wane on the worse corner of the two exposed (on the wide face turned up). The procedure for recording the wane data follows. If bark was continuous across the wide surface of the piece anywhere along its length, it was recorded as FULL wane. The length of wane was not recorded but could range from a few inches to full length (grading rules interpret wane in the same manner). The same criteria for FULL wane was applied to the thickness dimension. For all practical purposes, however, FULL wane rarely, if ever, extended more than 1/4 of the length of a piece.

Wane was recorded as a fraction of the face width, i.e.: 1/2 face, 1/3 face, etc. (or thickness). A recording of, say, 1/2 face could represent two situations: wane was limited to one side of a member and extended approximately half of the distance toward the other side (fig. A14-a), or, wane existed on both exposed edges and, combined, covered 1/2 the face (fig. A14-b).

* For a non-square member, the "face" (when used in this wane discussion) refers to the worse wide dimension, the "thickness" refers to the worse narrow dimension. For a square member the face and thickness were arbitrarily assigned.

Again, wane could extend from one or two inches to the entire length of the member. Note that these wane designations cover an extremely wide range of "missing wood." Nothing is said about the depth of the wane; i.e., how deep into the piece one must go to reach sound wood. The implication of this situation on member cross-section may be illustrated with two extremes shown in fig. A14-c and d; in each, the wane would have been listed as FULL face and 1/2 thickness.

Note that the same rating could apply to even more severe wane if wane also had appeared on one or both of the bottom edges as was quite often the case.

The same fractional system was used to record the length of wane. If wane was discontinuous, the fraction recorded represented a summation of the separate waness. No distinction was made between continuous and discontinuous wane.

Wane was generally estimated by eye; although it was measured by tape in questionable cases.

It is evident, therefore, that some ambiguity existed in the methods for recording wane. It is noted, however, that in all cases a considerable amount of wood was exposed on any given member. For example, a piece recorded as FULL face (or thickness) rarely, if ever, had bark over the full face for more than 25 percent of the length of the piece. Figure A14-e and f show the extremes in wane represented by the same FULL length-FULL face rating. Thus, wane listed as FULL thickness would add obvious complications in interpreting the data. However, even though a large majority of pieces graded in the larger sizes, particularly in the Washington, D.C. area, had extensive wane, nearly all of the pieces could be classed as serviceable. Pieces rated FULL length-FULL face for wane frequently had 80 percent or more of the cross-section intact as solid wood. From the point of view of mechanics, however, the wood which was missing was very detrimental to the moment of inertia of the member.

SLOPE OF GRAIN

The slope of grain was assigned by the grader. Grain angle was easily observed by surface check orientation for a vast majority of the pieces sampled; at times a scribe was used to follow the grain. Slope of grain was recorded as a rise-to-run ratio (1:14, etc.). Ratios less than 1:20 were recorded as straight grained. Slope of grain is commonly measured over a distance of two to several feet ignoring local grain deviations around knots, for example. If slope of grain was evident on adjacent faces, the worse slope of grain was recorded. It appeared that in quite a few pieces localized, steep grain deviations could be the limiting defect rather than general slope of grain or other defects. Refer to fig. 9.

Table A1. All Coded* Data for Eastern Species and Douglas-fir

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1--1	1	1	1	1	1	1	1	1	A	8	70.33	A.000	A.125	7.875	8.000	99.99	0.4	4.4	0	0	0	0	0
2--1	1	1	2	1	1	1	1	1	A	8	10.00	8.000	A.125	7.875	8.000	0	0	0	0	0	0	0	0
3--1	1	1	3	1	1	1	1	1	A	8	10.00	A.000	A.125	7.875	8.000	0	0	0	0	0	0	0	0
4--1	1	1	4	1	1	1	1	1	A	8	20.17	A.063	7.625	7.875	99.99	0.4	4.4	0	0	0	0	0	
5--1	1	2	1	1	1	1	1	1	A	8	10.00	A.063	7.750	7.625	7.875	0	0	0	0	0	0	0	
6--1	1	2	2	1	1	1	1	1	A	8	10.00	A.043	7.750	7.625	7.875	0	0	0	0	0	0	0	
7--1	1	3	1	1	2	1	1	1	A	8	20.58	A.000	A.000	8.000	8.125	99.99	0.2	4.2	0	0	0	0	
8--1	1	3	2	1	1	2	1	1	A	8	10.00	A.000	A.000	8.000	8.125	0	0	0	0	0	0	0	
9--1	1	3	1	1	2	1	1	1	A	8	10.00	A.000	8.000	8.000	8.125	0	0	0	0	0	0	0	
10--1	1	4	1	1	1	1	1	1	A	8	20.13	7.875	A.063	7.938	8.000	99.99	0.4	4.4	0	0	0	0	
11--1	1	4	2	1	1	1	1	1	A	8	10.00	7.875	A.063	7.938	8.000	0	0	0	0	0	0	0	
12--1	1	4	3	1	1	1	1	1	A	8	10.00	7.875	A.063	7.938	8.000	0	0	0	0	0	0	0	
13--1	1	5	1	1	1	1	1	1	A	8	20.17	A.000	8.000	8.000	7.875	99.99	0.4	6.3	0	0	0	0	
14--1	1	5	2	1	1	1	1	1	A	8	10.00	A.000	A.000	8.000	7.875	0	0	0	0	0	0	0	
15--1	1	5	3	1	1	1	1	1	A	8	10.00	A.000	A.000	8.000	7.875	0	0	0	0	0	0	0	
16--1	1	6	1	1	1	1	1	1	A	8	20.15	7.938	8.188	7.875	7.938	99.99	0.3	4.1	0	0	0	0	
17--1	1	6	2	1	1	1	1	1	A	8	10.00	7.938	8.188	7.875	7.938	0	0	0	0	0	0	0	
18--1	1	6	3	1	1	1	1	1	A	8	10.00	7.938	8.188	7.875	7.938	0	0	0	0	0	0	0	
19--1	1	7	1	1	1	1	1	1	A	8	20.21	A.000	7.938	8.000	7.750	99.99	0.4	3.6	0	0	0	0	
20--1	1	7	2	1	1	1	1	1	A	8	10.00	A.000	7.938	A.000	7.750	0	0	0	0	0	0	0	
21--1	1	7	3	1	1	1	1	1	A	8	10.00	A.000	7.938	A.000	7.750	0	0	0	0	0	0	0	
22--1	1	8	1	1	1	1	1	1	A	8	20.52	A.125	A.000	A.250	8.313	99.99	0.4	6.3	0	0	0	0	
23--1	1	8	2	1	1	1	1	1	A	8	10.00	A.125	A.000	A.250	8.313	0	0	0	0	0	0	0	
24--1	1	8	3	1	1	1	1	1	A	8	10.00	A.125	A.000	A.250	8.313	0	0	0	0	0	0	0	
25--1	1	9	1	1	1	1	1	1	A	8	20.44	7.875	7.938	7.875	7.875	99.99	0.6	6.6	0	0	0	0	
26--1	1	9	2	1	1	1	1	1	A	8	10.00	7.875	7.938	7.875	7.875	0	0	0	0	0	0	0	
27--1	1	9	3	1	1	1	1	1	A	8	10.00	7.875	7.938	7.875	7.875	0	0	0	0	0	0	0	
28--1	1	10	1	1	1	1	1	1	A	8	20.40	7.875	7.875	A.063	8.063	99.99	0.6	4.6	0	0	0	0	
29--1	1	10	2	1	1	1	1	1	A	8	10.00	7.875	7.875	A.063	8.063	0	0	0	0	0	0	0	
30--1	1	10	3	1	1	1	1	1	A	8	10.00	7.875	7.875	A.063	8.063	0	0	0	0	0	0	0	
31--1	1	11	1	1	1	1	1	1	A	8	20.25	A.063	7.875	A.000	8.063	99.99	0.6	6.6	0	0	0	0	
32--1	1	11	2	1	1	1	1	1	A	8	10.00	A.063	7.875	A.000	8.063	0	0	0	0	0	0	0	
33--1	1	11	3	1	1	1	1	1	A	8	10.00	A.063	7.875	A.000	8.063	0	0	0	0	0	0	0	
34--1	1	12	1	1	1	1	1	1	A	8	20.40	7.875	7.938	A.188	8.188	99.99	0.6	6.6	0	0	0	0	
35--1	1	12	2	1	1	1	1	1	A	8	10.00	7.875	7.938	A.188	8.188	0	0	0	0	0	0	0	
36--1	1	12	3	1	1	1	1	1	A	8	10.00	7.875	7.938	A.188	8.188	0	0	0	0	0	0	0	
37--1	1	13	1	1	1	1	1	1	A	8	20.13	7.938	A.188	8.063	7.875	99.99	0.6	2.2	0	0	0	0	
38--1	1	13	2	1	1	1	1	1	A	8	10.00	7.938	A.188	A.063	7.875	0	0	0	0	0	0	0	
39--1	1	13	3	1	1	1	1	1	A	8	10.00	7.938	A.188	A.063	7.875	0	0	0	0	0	0	0	
40--1	1	14	1	1	1	1	1	1	A	8	20.40	7.938	7.875	A.000	7.813	99.99	0.4	6.7	0	0	0	0	
41--1	1	14	2	1	1	1	1	1	A	8	10.00	7.938	7.875	A.000	7.813	0	0	0	0	0	0	0	
42--1	1	14	3	1	1	1	1	1	A	8	10.00	7.938	7.875	A.000	7.813	0	0	0	0	0	0	0	
43--1	1	15	1	1	1	1	1	1	A	8	20.20	A.125	A.175	7.813	8.250	99.99	0.6	5.4	0	0	0	0	
44--1	1	15	2	1	1	1	1	1	A	8	10.00	A.125	A.175	7.813	8.250	0	0	0	0	0	0	0	
45--1	1	15	3	1	1	1	1	1	A	8	10.00	A.125	8.125	7.813	8.250	0	0	0	0	0	0	0	
46--1	1	16	1	1	1	1	1	1	A	8	20.15	A.063	A.063	8.188	8.438	99.99	0.7	6.4	0	0	0	0	

* See computer coding section in appendix A.

Table A1 (Cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
47--1	1.	16.	2.	1.	2.	1.	2.	1.	8.	10.00	8.063	8.063	8.188	8.438	0.	0.	0.	0.	0.	0.	0.	0.	0.	
48--1	1.	16.	3.	1.	2.	1.	2.	1.	8.	10.00	8.063	8.063	8.188	8.438	0.	0.	0.	0.	0.	0.	0.	0.	0.	
49--1	2.	17.	1.	1.	1.	1.	1.	12.	12.	20.79	11.313	11.000	12.000	11.500	99.	99.	0.	0.	0.	0.	0.	0.	0.	
50--1	2.	17.	2.	1.	1.	1.	1.	12.	12.	10.00	11.313	11.000	12.000	11.500	0.	0.	0.	0.	0.	0.	0.	0.	0.	
51--1	2.	17.	3.	1.	1.	1.	1.	12.	12.	10.00	11.313	11.000	12.000	11.500	0.	0.	0.	0.	0.	0.	0.	0.	0.	
52--1	2.	18.	1.	1.	2.	1.	1.	12.	12.	20.26	11.313	11.750	11.750	11.500	99.	99.	0.	0.	0.	0.	0.	0.	0.	
53--1	2.	18.	2.	1.	2.	1.	1.	12.	12.	10.00	11.750	11.750	11.750	11.500	0.	0.	0.	0.	0.	0.	0.	0.	0.	
54--1	2.	18.	3.	1.	2.	1.	1.	12.	12.	10.00	11.750	11.750	11.750	11.500	0.	0.	0.	0.	0.	0.	0.	0.	0.	
55--1	2.	19.	1.	1.	2.	1.	1.	12.	12.	19.54	11.750	11.500	11.750	11.750	99.	99.	0.	0.	0.	0.	0.	0.	0.	
56--1	2.	19.	2.	1.	2.	1.	1.	12.	12.	10.00	11.750	11.500	11.750	11.750	0.	0.	0.	0.	0.	0.	0.	0.	0.	
57--1	2.	19.	3.	1.	2.	1.	1.	12.	12.	10.00	11.750	11.500	11.750	11.750	0.	0.	0.	0.	0.	0.	0.	0.	0.	
58--1	2.	20.	1.	1.	2.	1.	1.	12.	12.	21.07	11.500	12.125	10.000	12.000	99.	99.	0.	0.	0.	0.	0.	0.	0.	
59--1	2.	20.	2.	1.	2.	1.	1.	12.	12.	10.00	11.500	12.125	10.000	12.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	
60--1	2.	20.	3.	1.	2.	1.	1.	12.	12.	10.00	11.500	12.125	10.000	12.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	
61--1	2.	21.	1.	1.	2.	1.	1.	12.	12.	20.81	11.000	12.000	11.000	10.000	99.	99.	0.	0.	0.	0.	0.	0.	0.	
62--1	2.	21.	2.	1.	2.	1.	1.	12.	12.	10.00	11.000	12.000	11.000	10.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	
63--1	2.	21.	3.	1.	2.	1.	1.	12.	12.	10.00	11.000	12.000	11.000	10.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	
64--1	2.	22.	1.	1.	2.	1.	1.	12.	12.	20.51	12.250	12.250	12.000	12.500	99.	99.	0.	0.	0.	0.	0.	0.	0.	
65--1	2.	22.	2.	1.	2.	1.	1.	12.	12.	10.00	12.250	12.250	12.000	12.500	0.	0.	0.	0.	0.	0.	0.	0.	0.	
66--1	2.	22.	3.	1.	2.	1.	1.	12.	12.	10.00	12.250	12.250	12.000	12.500	0.	0.	0.	0.	0.	0.	0.	0.	0.	
67--1	2.	23.	1.	1.	2.	1.	1.	12.	12.	19.32	12.250	11.500	11.875	12.000	99.	99.	0.	0.	0.	0.	0.	0.	0.	
68--1	2.	23.	2.	1.	2.	1.	1.	12.	12.	10.00	12.250	11.500	11.875	12.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	
69--1	2.	24.	1.	1.	2.	1.	1.	12.	12.	21.46	11.875	11.750	12.125	11.750	99.	99.	0.	0.	0.	0.	0.	0.	0.	
70--1	2.	24.	2.	1.	2.	1.	1.	12.	12.	10.00	11.875	11.750	12.125	11.750	0.	0.	0.	0.	0.	0.	0.	0.	0.	
71--1	2.	24.	3.	1.	2.	1.	1.	12.	12.	10.00	11.875	11.750	12.125	11.750	0.	0.	0.	0.	0.	0.	0.	0.	0.	
72--1	2.	25.	1.	1.	1.	1.	1.	12.	12.	20.42	11.625	11.500	12.250	11.875	99.	99.	0.	0.	0.	0.	0.	0.	0.	
73--1	2.	25.	2.	1.	1.	1.	1.	12.	12.	10.00	11.625	11.500	12.250	11.875	0.	0.	0.	0.	0.	0.	0.	0.	0.	
74--1	2.	25.	3.	1.	1.	1.	1.	12.	12.	10.00	11.625	11.500	12.250	11.875	0.	0.	0.	0.	0.	0.	0.	0.	0.	
75--1	2.	26.	1.	1.	1.	1.	1.	12.	12.	20.18	12.000	12.250	12.000	12.500	99.	99.	0.	0.	0.	0.	0.	0.	0.	
76--1	2.	26.	2.	1.	1.	1.	1.	12.	12.	10.00	12.000	12.250	12.000	12.500	0.	0.	0.	0.	0.	0.	0.	0.	0.	
77--1	2.	26.	3.	1.	1.	1.	1.	12.	12.	10.00	12.000	12.250	12.000	12.500	0.	0.	0.	0.	0.	0.	0.	0.	0.	
78--1	2.	27.	1.	1.	4.	1.	1.	12.	12.	20.39	11.313	12.125	11.500	12.125	99.	99.	0.	0.	0.	0.	0.	0.	0.	
79--1	2.	27.	2.	1.	4.	1.	1.	12.	12.	10.00	11.313	12.125	11.500	12.125	0.	0.	0.	0.	0.	0.	0.	0.	0.	
80--1	2.	27.	3.	1.	4.	1.	1.	12.	12.	10.00	11.313	12.125	11.500	12.125	0.	0.	0.	0.	0.	0.	0.	0.	0.	
81--1	2.	28.	1.	1.	1.	1.	1.	12.	12.	20.32	12.000	11.500	11.875	11.500	99.	99.	0.	0.	0.	0.	0.	0.	0.	
82--1	2.	28.	2.	1.	1.	1.	1.	12.	12.	10.00	11.500	11.500	11.875	11.500	0.	0.	0.	0.	0.	0.	0.	0.	0.	
83--1	2.	28.	3.	1.	1.	1.	1.	12.	12.	10.00	11.500	11.500	11.875	11.500	0.	0.	0.	0.	0.	0.	0.	0.	0.	
84--1	2.	29.	1.	1.	1.	1.	1.	12.	12.	20.50	12.000	12.125	11.500	12.250	99.	99.	0.	0.	0.	0.	0.	0.	0.	
85--1	2.	29.	2.	1.	1.	1.	1.	12.	12.	10.00	12.000	12.125	11.500	12.250	0.	0.	0.	0.	0.	0.	0.	0.	0.	
86--1	2.	29.	3.	1.	1.	1.	1.	12.	12.	10.00	12.000	12.125	11.500	12.250	0.	0.	0.	0.	0.	0.	0.	0.	0.	
87--1	2.	30.	1.	1.	2.	1.	1.	12.	12.	20.22	12.000	12.000	11.875	11.875	99.	99.	0.	0.	0.	0.	0.	0.	0.	
88--1	2.	30.	2.	1.	2.	1.	1.	12.	12.	10.00	12.000	12.000	11.875	11.875	0.	0.	0.	0.	0.	0.	0.	0.	0.	
89--1	2.	30.	3.	1.	2.	1.	1.	12.	12.	10.00	12.000	12.000	11.875	11.875	0.	0.	0.	0.	0.	0.	0.	0.	0.	
90--1	3.	31.	1.	1.	7.	1.	1.	6.	6.	10.56	5.675	6.000	5.750	5.938	17.	16.	0.	0.	0.	0.	0.	0.	0.	
91--1	3.	32.	1.	1.	7.	1.	1.	6.	6.	9.94	5.125	5.000	5.000	4.875	99.	25.	0.	2.	1.	2.	6.	33.	0.	
92--1	3.	33.	1.	1.	7.	1.	1.	6.	6.	9.89	5.625	6.125	6.125	6.125	26.	21.	0.	0.	0.	0.	4.	25.	0.	
93--1	3.	34.	1.	1.	7.	1.	1.	6.	6.	11.58	6.125	6.375	6.000	6.375	22.	14.	0.	0.	0.	0.	6.	33.	0.	
94--1	3.	35.	1.	1.	6.	1.	1.	6.	6.	10.90	6.375	6.250	6.125	6.250	99.	23.	0.	0.	0.	0.	0.	0.	0.	
95--1	3.	36.	1.	1.	7.	1.	1.	6.	6.	10.70	6.250	6.375	6.063	6.125	26.	18.	0.	0.	0.	0.	4.	33.	0.	
96--1	3.	37.	1.	1.	7.	1.	1.	6.	6.	10.41	6.125	6.313	6.250	6.313	28.	18.	0.	1.	1.	4.	20.	0.	0.	
97--1	3.	38.	1.	1.	7.	1.	1.	6.	6.	10.54	6.063	6.125	4.875	6.438	24.	22.	0.	6.	2.	4.	4.	20.	0.	
98--1	3.	39.	1.	1.	7.	1.	1.	6.	6.	10.38	6.375	6.375	6.188	6.375	20.	17.	0.	3.	1.	6.	33.	0.	0.	
99--1	3.	40.	1.	1.	7.	1.	1.	6.	6.	10.82	6.000	6.063	5.938	6.063	26.	19.	0.	2.	4.	2.	6.	33.	0.	
100--1	3.	41.	1.	1.	7.	1.	1.	6.	6.	9.69	5.875	6.000	5.750	6.000	22.	16.	0.	0.	0.	4.	2.	6.	33.	0.
101--1	3.	42.	1.	1.	7.	1.	1.	6.	6.	10.40	5.675	5.250	5.750	5.938	27.	19.	0.	0.	1.	4.	6.	41.	0.	
102--1	3.	43.	1.	1.	7.	1.	1.	6.	6.	10.80	6.125	5.938	5.875	5.750	25.	24.	0.	5.	2.	6.	33.	0.	0.	
103--1	3.	44.	1.	1.	7.	1.	1.	6.	6.	9.85	6.000	6.000	6.000	6.000	21.	19.	0.	6.	5.	3.	6.	33.	0.	
104--1	3.	45.	1.	1.	7.	1.	1.	6.	6.	10.90	6.188	5.563	6.125	5.813	24.	22.	0.	0.	0.	0.	6.	33.	0.	

Table A1 (Cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
105--1	3	48	1	1	1	7	1	6	6	9,88	6,000	6,063	5,875	5,750	24,19	0	6	6	3	6	33	0	0
106--1	3	47	1	1	1	9	1	6	6	10,35	6,000	6,000	6,250	5,875	99	99	0	1	2	1	0	0	0
107--1	3	48	1	1	1	7	1	6	6	11,07	6,175	6,000	6,250	6,000	22	20	0	3	4	1	6	33	0
108--1	3	49	1	1	1	7	1	6	6	9,54	6,000	6,000	5,625	5,875	19	17	0	6	1	6	6	33	0
109--1	3	50	1	1	1	7	1	6	6	9,36	6,000	5,375	6,000	6,000	27	22	0	6	4	1	4	20	0
110--1	3	51	1	1	1	8	1	6	6	8,96	5,625	5,625	5,625	5,375	99	99	0	0	0	0	0	0	0
111--1	4	1	3	2	1	3	12	16	54	12,375	12,375	12,375	3,188	2,875	99	99	0	0	0	0	0	0	0
112--1	4	2	1	3	2	1	3	12	16	40	12,375	12,375	2,875	2,875	99	99	0	0	0	0	0	0	0
113--1	4	3	1	3	2	1	3	12	16	66	12,375	12,375	3,375	3,375	99	99	0	0	0	0	0	0	0
114--1	4	4	1	3	2	1	3	12	16	45	12,438	12,375	3,000	2,875	99	99	0	0	0	0	0	0	0
115--1	4	5	1	3	2	1	3	12	16	65	11,000	11,000	-1,000	-1,000	99	99	0	0	0	0	0	0	0
116--1	4	6	1	3	2	1	3	12	16	66	12,125	12,063	3,125	2,875	99	99	0	0	0	0	0	0	0
117--1	4	7	1	3	2	1	3	12	16	66	12,000	12,188	3,000	2,875	99	99	0	0	0	0	0	0	0
118--1	4	8	1	3	2	1	3	12	16	74	12,000	12,063	3,000	2,875	99	99	0	0	0	0	0	0	0
119--1	4	9	1	3	2	1	3	12	16	73	12,125	12,000	3,000	2,938	99	99	0	0	0	0	0	0	0
120--1	4	10	1	3	2	1	3	12	12	00	11,938	12,250	2,938	3,250	99	99	0	0	0	0	0	0	0
121--1	4	11	1	3	2	1	3	12	12	30	12,125	12,250	3,000	3,375	99	99	0	0	0	0	0	0	0
122--1	4	12	1	3	2	1	3	12	11	92	11,875	12,063	3,000	3,000	99	99	0	2	4	0	0	0	0
123--1	4	13	1	3	2	1	3	12	12	46	12,168	12,000	2,750	3,125	99	99	0	1	4	4	0	0	0
124--1	4	14	1	3	2	1	3	12	12	28	12,063	11,750	2,875	2,750	99	99	0	3	6	6	0	0	0
125--1	4	15	1	3	2	1	3	12	12	26	11,813	12,125	2,938	3,400	99	99	0	1	4	4	0	0	0
126--1	4	16	1	3	2	1	3	12	12	79	12,125	12,000	3,063	2,750	99	99	0	0	0	0	0	0	0
127--1	4	17	1	3	2	1	3	12	12	46	12,813	12,125	3,250	2,875	99	99	0	0	0	0	0	0	0
128--1	4	18	1	3	2	1	3	12	13	78	12,313	11,938	3,063	2,875	99	99	0	0	0	0	0	0	0
129--1	4	19	1	3	2	1	3	12	12	00	12,188	12,125	3,000	3,250	99	99	0	0	0	0	0	0	0
130--1	4	20	1	3	2	1	3	12	12	47	12,188	12,250	2,938	3,400	99	99	0	0	0	0	0	0	0
131--1	4	21	1	3	2	1	3	12	13	79	12,313	12,000	3,000	2,875	99	99	0	0	0	0	0	0	0
132--1	4	22	1	3	2	1	3	12	12	26	11,813	12,063	3,188	3,063	99	99	0	0	0	0	0	0	0
133--1	4	23	1	3	2	1	3	12	12	49	12,188	12,188	2,875	3,000	99	99	0	0	0	0	0	0	0
134--1	4	24	1	3	2	1	3	12	13	83	12,125	12,250	3,000	2,875	99	99	0	0	0	0	0	0	0
135--1	4	25	1	3	2	1	3	12	13	04	12,250	12,250	3,063	3,400	99	99	0	0	0	0	0	0	0
136--1	4	26	1	3	2	1	3	12	12	54	12,250	12,375	3,375	3,125	99	99	0	0	0	0	0	0	0
137--1	4	27	1	3	2	1	3	12	13	75	12,000	12,313	3,000	2,938	99	99	0	2	2	2	0	0	0
138--1	5	1	1	1	1	3	1	8	8	10	20	8,250	8,250	8,188	99	99	0	3	3	3	0	0	0
139--1	5	2	1	1	1	3	1	8	8	10	31	7,563	7,563	7,625	8,063	99	99	0	4	4	0	0	0
140--1	5	3	1	1	1	3	1	8	8	10	73	8,500	8,500	7,813	99	99	0	6	3	2	0	0	0
141--1	5	4	1	1	1	3	1	8	8	10	27	7,625	7,625	8,000	8,000	99	99	0	1	3	1	0	0
142--1	5	5	1	1	1	3	1	8	8	10	36	8,250	8,250	8,000	8,000	99	99	0	2	2	0	0	0
143--1	5	6	1	1	1	3	1	8	8	10	35	8,125	7,750	7,750	7,750	99	99	0	4	4	3	0	0
144--1	5	7	1	1	1	3	1	8	8	10	25	8,000	8,000	7,750	8,188	99	99	0	4	4	1	0	0
145--1	5	8	1	1	1	3	1	8	8	10	74	8,000	7,875	7,750	7,750	99	99	0	0	0	0	0	0
146--1	5	9	1	1	1	3	1	8	8	10	89	8,000	7,625	8,250	8,250	99	99	0	0	0	0	0	0
147--1	5	10	1	1	1	3	1	8	8	10	40	8,000	7,875	7,750	8,000	99	99	0	6	2	4	0	0
148--1	5	11	1	1	1	3	1	8	8	10	96	8,000	8,250	7,750	8,063	99	99	0	6	4	2	0	0
149--1	5	12	1	1	1	3	1	8	8	10	47	7,875	7,875	7,875	8,375	99	99	0	0	0	0	0	0
150--1	5	13	1	1	1	3	1	8	8	10	80	8,000	8,250	8,500	8,500	99	99	0	0	0	0	0	0
151--1	5	14	1	1	1	3	1	8	8	10	96	7,875	7,625	8,000	8,000	99	99	0	0	0	0	0	0
152--1	5	15	1	1	1	3	1	8	8	10	52	8,063	7,625	7,625	7,625	99	99	0	0	0	0	0	0
153--2	6	1	2	1	1	3	1	12	12	24	00	11,875	12,250	12,000	12,000	99	99	0	2	4	2	0	0
154--2	6	2	1	1	1	3	1	12	12	24	00	11,875	12,250	12,000	12,000	0	0	0	0	0	0	0	0
155--2	6	3	1	1	1	3	1	12	12	24	00	11,875	12,250	12,000	12,000	0	0	2	4	2	0	0	0
156--2	6	4	1	1	1	3	1	12	12	24	1	11,688	12,000	11,000	99	99	0	6	6	6	0	0	0
157--2	6	5	1	1	1	3	1	12	12	24	00	11,688	11,250	12,000	11,000	0	0	0	0	0	0	0	0
158--2	6	6	1	1	1	3	1	12	12	24	00	11,688	11,250	12,000	11,000	0	0	0	0	0	0	0	0
159--2	6	7	1	1	1	3	1	12	12	24	13	11,950	12,250	12,000	12,000	99	99	0	2	5	2	0	0
160--2	6	8	1	1	1	3	1	12	12	24	00	11,250	12,000	12,250	12,000	0	0	2	4	2	0	0	0
161--2	6	9	1	1	1	3	1	12	12	24	00	11,250	12,000	12,250	12,000	0	0	0	0	0	0	0	0
162--2	6	10	1	1	1	3	1	12	12	24	13	9,625	11,750	12,250	11,500	99	99	0	0	0	0	0	0

Table A1 (Cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
163--2	6	4	2	1	2	1	1	12	12	10.00	9.625	11.750	12.250	11.500	0	0	0	0	0	0	0	0	0	
164--2	6	4	3	1	2	1	1	12	12	10.00	9.625	11.750	12.250	11.500	0	0	0	0	0	0	0	0	0	
165--2	6	5	1	1	2	1	1	12	12	24.17	11.750	12.000	11.625	11.875	99	99	0	6	6	4	0	0	0	
166--2	6	5	2	1	2	1	1	12	12	10.00	11.750	12.000	11.625	11.875	0	0	0	0	0	0	0	0	0	
167--2	6	5	3	1	2	1	1	12	12	10.00	11.750	12.000	11.625	11.875	0	0	0	0	0	0	0	0	0	
168--2	6	6	1	1	2	1	1	12	12	24.27	11.875	11.938	12.375	12.250	99	99	0	4	6	4	0	0	0	
169--2	6	6	2	1	2	1	1	12	12	10.00	11.875	11.938	12.375	12.250	0	0	0	0	0	0	0	0	0	
170--2	6	6	3	1	2	1	1	12	12	10.00	11.875	11.938	12.375	12.250	0	0	0	0	0	0	0	0	0	
171--2	6	7	1	1	9	1	1	12	12	24.44	10.250	12.313	11.875	12.625	99	99	0	0	0	0	0	0	0	
172--2	6	8	1	1	10	1	1	12	12	24.34	12.438	12.000	11.000	11.000	99	99	0	0	0	0	0	0	0	
173--1	7	1	1	1	6	1	1	12	12	9.90	12.125	12.125	12.125	11.875	99	99	0	4	6	3	0	0	0	
174--1	7	2	1	1	9	1	1	12	12	10.00	11.500	11.938	11.500	11.500	99	99	0	4	6	3	0	0	0	
175--1	7	3	1	1	3	1	1	12	12	10.63	11.500	11.875	11.500	11.875	99	99	0	0	0	0	0	0	0	
176--1	7	4	1	1	11	1	1	12	12	10.15	11.750	12.063	11.938	11.750	99	99	0	0	0	0	0	0	0	
177--1	7	5	1	1	10	1	1	12	12	10.83	11.938	11.813	11.875	11.875	99	99	0	0	0	0	0	0	0	
178--1	7	6	1	1	1	1	1	12	12	9.94	12.250	11.875	12.250	11.750	99	99	0	0	0	0	0	0	0	
179--1	7	7	1	1	13	1	1	12	12	10.75	11.938	11.875	11.875	11.938	99	99	0	0	0	0	0	0	0	
180--1	7	8	1	1	11	1	1	12	12	10.34	11.875	12.000	11.750	11.875	99	99	0	0	0	0	0	0	0	
181--1	7	9	1	1	2	1	1	12	12	10.04	11.875	12.125	13.000	11.875	99	99	0	0	0	0	0	0	0	
182--1	7	10	1	1	11	1	1	12	12	10.70	11.875	11.750	11.875	11.750	99	99	0	0	0	0	0	0	0	
183--1	7	11	1	1	2	1	1	12	12	9.84	11.813	11.875	11.688	11.750	99	99	0	2	0	2	0	0	0	
184--1	7	12	1	1	1	1	1	12	12	10.61	11.875	11.813	12.000	12.000	99	99	0	0	0	0	0	0	0	
185--1	7	13	1	1	1	1	1	12	12	10.67	11.625	11.625	11.813	11.750	99	99	0	0	0	0	0	0	0	
186--1	7	14	1	1	2	1	1	12	12	10.60	12.000	11.938	11.875	11.750	99	99	0	0	0	0	0	0	0	
187--1	7	15	1	1	14	1	1	12	12	9.79	12.175	11.688	12.125	11.500	99	99	0	5	1	1	0	0	0	
188--1	7	16	1	1	15	1	1	12	12	10.23	12.175	11.813	11.750	12.000	99	99	0	3	1	2	0	0	0	
189--1	7	17	1	1	2	1	1	12	12	9.63	12.000	12.000	12.063	11.750	99	99	0	4	1	2	0	0	0	
190--1	7	18	1	1	3	1	1	12	12	10.35	11.750	11.500	12.125	11.500	99	99	0	3	4	3	0	0	0	
191--1	7	19	1	1	3	1	1	12	12	10.35	12.250	11.750	12.000	11.813	99	99	0	1	6	1	0	0	0	
192--1	8	1	1	1	2	1	1	8	8	12.94	7.813	7.813	7.813	7.813	1.000	7.875	99	0	2	2	0	0	0	
193--1	8	2	1	1	6	1	1	8	8	12.94	1.000	7.750	7.750	7.563	99	99	0	3	3	3	0	0	0	
194--1	8	3	1	1	16	1	1	8	8	12.54	1.000	7.438	7.438	7.875	99	99	0	2	4	2	0	0	0	
195--1	8	4	1	1	1	1	1	8	8	12.04	1.000	8.000	8.000	7.875	99	99	0	6	5	3	0	0	0	
196--1	8	5	1	1	1	1	1	8	8	12.51	1.000	8.000	8.000	7.875	99	99	0	4	5	3	0	0	0	
197--1	8	6	1	1	3	1	1	8	8	13.35	7.938	7.875	7.875	7.688	7.500	99	99	0	6	4	4	0	0	0
198--1	8	7	1	1	1	1	1	8	8	12.67	8.063	7.875	7.875	7.688	7.500	99	99	0	2	3	2	0	0	0
199--1	8	8	1	1	1	1	1	8	8	12.67	7.688	7.625	7.625	7.750	7.625	99	99	0	6	4	2	0	0	0
200--1	8	9	1	1	6	1	1	8	8	12.42	7.625	7.750	7.750	7.313	7.500	99	99	0	0	0	0	0	0	0
201--1	8	10	1	1	16	1	1	8	8	12.04	7.813	7.563	7.563	7.875	7.500	99	99	0	6	7	0	0	0	0
202--1	8	11	1	1	2	1	1	8	8	12.75	7.500	7.688	7.688	7.563	99	99	0	2	4	2	0	0	0	0
203--1	8	12	1	1	6	1	1	8	8	12.50	8.000	7.750	8.500	8.313	99	99	0	6	1	1	0	0	0	0
204--1	8	13	1	1	7	1	1	8	8	12.15	7.938	7.625	7.625	7.750	7.625	99	99	0	4	4	2	0	0	0
205--1	8	14	1	1	2	1	1	8	8	12.33	7.875	7.750	8.125	7.813	99	99	0	1	4	1	0	0	0	0
206--1	8	15	1	1	2	1	1	8	8	12.54	7.813	7.750	7.813	7.750	99	99	0	2	1	2	0	0	0	0
207--1	8	16	1	1	3	1	1	8	8	13.88	8.125	8.438	8.063	7.938	99	99	0	0	0	0	0	0	0	0
208--1	8	17	1	1	2	1	1	8	8	15.02	7.750	7.563	7.563	7.875	8.000	99	99	0	4	1	4	0	0	0
209--1	8	18	1	1	1	1	1	8	8	15.02	7.675	7.625	7.625	7.875	7.875	99	99	0	0	0	0	0	0	0
210--1	8	19	1	1	2	1	1	8	8	12.23	8.250	7.813	8.063	8.125	99	99	0	0	0	0	0	0	0	0
211--1	8	20	1	1	16	1	1	8	8	15.65	8.375	8.250	8.375	8.250	8.438	99	99	0	0	0	0	0	0	0
212--1	8	21	1	1	3	1	1	8	8	13.25	7.500	7.938	7.750	7.938	7.938	99	99	0	3	1	3	0	0	0
213--1	8	22	1	1	6	1	1	8	8	20.85	8.063	8.188	8.500	7.938	99	99	0	2	2	2	0	0	0	0
214--1	8	23	1	1	2	1	1	8	8	14.70	8.000	8.000	8.250	8.125	99	99	0	0	0	0	0	0	0	0
215--1	8	24	1	1	2	1	1	8	8	14.70	8.000	8.000	8.250	8.125	99	99	0	0	0	0	0	0	0	0
216--1	8	25	1	1	2	1	1	8	8	14.50	7.500	7.750	7.875	8.000	99	99	0	0	0	0	0	0	0	0
217--1	8	26	1	1	2	1	1	8	8	15.29	7.938	7.938	7.938	7.625	8.188	99	99	0	0	0	0	0	0	0
218--1	8	27	1	1	1	1	1	8	8	15.42	8.000	8.250	7.750	7.500	99	99	0	1	4	1	0	0	0	0
219--1	8	28	1	1	4	1	1	8	8	15.17	8.000	7.188	8.000	7.625	99	99	0	0	0	0	0	0	0	0
220--1	8	29	1	1	1	1	1	8	8	14.77	7.875	8.000	8.250	8.250	99	99	0	3	4	1	0	0	0	0

Table A1 (Cont.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
221--3	9	15	1	1	8	1	8	8	14.98	4.500	4.063	4.063	7.750	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
222--3	9	16	1	1	3	1	8	8	14.98	7.563	7.625	7.563	7.250	99.99	0.0	0.3	1.2	0.0	0.0	0.0	0.0	0.0
223--3	9	17	1	1	1	1	8	8	19.23	7.625	7.500	8.250	7.375	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
224--3	9	18	1	1	1	1	8	8	19.31	7.563	7.500	7.500	7.500	99.99	0.0	0.6	1.1	0.0	0.0	0.0	0.0	0.0
225--3	9	19	1	1	1	1	8	8	21.42	7.625	7.875	7.875	7.938	99.99	0.0	2.1	2.0	0.0	0.0	0.0	0.0	0.0
226--3	9	20	1	1	1	1	8	8	15.04	7.688	7.438	7.875	8.188	99.99	0.0	2.1	1.0	0.0	0.0	0.0	0.0	0.0
227--3	9	21	1	1	1	1	8	8	20.21	7.813	8.063	7.375	8.125	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
228--3	10	1	1	1	1	1	8	8	10.07	6.875	5.750	3.875	3.750	99.99	0.0	3.3	5.0	0.0	0.0	0.0	0.0	0.0
229--3	10	2	1	1	1	1	8	8	10.07	5.750	5.625	3.938	4.125	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
230--3	10	3	1	1	1	1	8	8	10.05	5.625	5.625	4.000	4.125	99.99	0.0	2.1	3.0	0.0	0.0	0.0	0.0	0.0
231--3	10	4	1	1	1	1	8	8	10.04	5.875	5.750	4.000	3.313	99.99	0.0	6.4	6.0	0.0	0.0	0.0	0.0	0.0
232--3	10	5	1	1	1	1	8	8	10.04	5.750	5.625	4.000	3.625	99.99	0.0	1.1	1.0	0.0	0.0	0.0	0.0	0.0
233--3	10	6	1	1	1	1	8	8	10.06	5.875	5.438	3.813	4.188	99.99	0.0	6.4	6.0	0.0	0.0	0.0	0.0	0.0
234--3	10	7	1	1	1	1	8	8	10.05	5.750	5.313	3.000	4.375	99.99	0.0	6.4	4.0	0.0	0.0	0.0	0.0	0.0
235--3	10	8	1	1	1	1	8	8	10.04	5.500	5.563	3.750	4.063	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
236--3	10	9	1	1	1	1	8	8	10.07	5.750	5.688	4.000	4.125	99.99	0.0	6.4	4.0	0.0	0.0	0.0	0.0	0.0
237--3	10	10	1	1	1	1	8	8	10.07	5.625	5.750	4.188	4.375	99.99	0.0	6.6	2.0	0.0	0.0	0.0	0.0	0.0
238--3	10	11	1	1	1	1	8	8	10.09	5.875	5.750	4.500	4.750	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
239--3	10	12	1	1	1	1	8	8	10.10	5.875	5.875	3.938	3.875	99.99	0.0	4.2	2.0	0.0	0.0	0.0	0.0	0.0
240--3	11	1	1	1	1	1	8	8	16.03	6.625	6.250	3.563	4.000	99.99	0.0	3.3	4.0	0.0	0.0	0.0	0.0	0.0
241--3	11	2	1	1	1	1	8	8	16.10	6.313	6.688	3.625	3.938	99.99	0.0	5.1	4.0	0.0	0.0	0.0	0.0	0.0
242--3	11	3	1	1	1	1	8	8	16.05	6.375	5.750	3.438	3.938	99.99	0.0	4.3	6.0	0.0	0.0	0.0	0.0	0.0
243--3	11	4	1	1	1	1	8	8	16.04	6.500	6.125	3.750	4.313	99.99	0.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0
244--3	11	5	1	1	1	1	8	8	16.06	6.675	5.813	3.688	4.250	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
245--3	11	6	1	1	1	1	8	8	16.10	4.125	6.063	3.625	4.125	99.99	0.0	2.3	2.0	0.0	0.0	0.0	0.0	0.0
246--3	11	7	1	1	1	1	8	8	16.10	6.750	5.688	3.938	4.250	99.99	0.0	6.6	5.4	0.0	0.0	0.0	0.0	0.0
247--3	11	8	1	1	1	1	8	8	16.04	5.938	6.438	3.875	4.125	99.99	0.0	4.2	6.0	0.0	0.0	0.0	0.0	0.0
248--3	11	9	1	1	1	1	8	8	16.05	6.250	5.813	3.625	3.625	99.99	0.0	3.4	5.0	0.0	0.0	0.0	0.0	0.0
249--3	11	10	1	1	1	1	8	8	16.04	6.375	6.125	3.500	4.000	99.99	0.0	3.2	6.0	0.0	0.0	0.0	0.0	0.0
250--3	11	11	1	1	1	1	8	8	16.04	6.313	5.938	4.063	4.500	99.99	0.0	4.3	6.0	0.0	0.0	0.0	0.0	0.0
251--3	11	12	1	1	1	1	8	8	15.92	6.500	5.750	3.500	4.125	99.99	0.0	2.1	6.0	0.0	0.0	0.0	0.0	0.0
252--3	11	13	1	1	1	1	8	8	16.04	6.375	5.813	3.625	4.125	99.99	0.0	6.1	1.0	0.0	0.0	0.0	0.0	0.0
253--3	11	14	1	1	1	1	8	8	16.14	6.563	5.875	3.188	4.063	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
254--3	11	15	1	1	1	1	8	8	16.04	6.063	6.313	4.000	4.675	99.99	0.0	2.2	2.0	0.0	0.0	0.0	0.0	0.0
255--3	11	16	1	1	1	1	8	8	16.04	5.675	6.188	3.813	4.313	99.99	0.0	5.4	5.0	0.0	0.0	0.0	0.0	0.0
256--3	11	17	1	1	1	1	8	8	16.04	6.250	5.688	3.750	4.188	99.99	0.0	3.1	1.0	0.0	0.0	0.0	0.0	0.0
257--3	11	18	1	1	1	1	8	8	16.14	6.313	5.750	3.500	4.438	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
258--3	11	19	1	1	1	1	8	8	16.06	6.500	5.875	3.500	4.125	99.99	0.0	6.1	1.0	0.0	0.0	0.0	0.0	0.0
259--3	11	20	1	1	1	1	8	8	15.96	6.625	6.125	3.500	4.000	99.99	0.0	2.3	6.0	0.0	0.0	0.0	0.0	0.0
260--3	11	21	1	1	1	1	8	8	16.66	6.125	5.625	3.188	4.250	99.99	0.0	2.1	2.0	0.0	0.0	0.0	0.0	0.0
261--3	11	22	1	1	1	1	8	8	16.10	6.500	6.063	3.750	4.063	99.99	0.0	6.3	6.0	0.0	0.0	0.0	0.0	0.0
262--3	11	23	1	1	1	1	8	8	16.04	6.250	6.000	3.500	4.000	99.99	0.0	4.4	6.0	0.0	0.0	0.0	0.0	0.0
263--3	11	24	1	1	1	1	8	8	16.14	6.250	5.625	3.875	4.250	99.99	0.0	4.1	6.0	0.0	0.0	0.0	0.0	0.0
264--3	12	1	1	1	1	1	8	8	10.04	6.750	6.875	1.875	1.875	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
265--3	12	2	1	1	1	1	8	8	9.94	6.750	6.750	2.500	4.000	99.99	0.0	2.6	6.0	0.0	0.0	0.0	0.0	0.0
266--3	12	3	1	1	1	1	8	8	10.04	6.750	6.875	1.938	1.938	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
267--3	12	4	1	1	1	1	8	8	10.04	6.500	6.500	2.000	4.000	99.99	0.0	6.6	6.0	0.0	0.0	0.0	0.0	0.0
268--3	12	5	1	1	1	1	8	8	10.15	6.750	6.875	1.938	1.875	99.99	0.0	2.6	4.0	0.0	0.0	0.0	0.0	0.0
269--3	12	6	1	1	1	1	8	8	10.07	6.813	6.875	2.000	1.875	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
270--3	12	7	1	1	1	1	8	8	10.07	6.875	6.750	1.938	2.000	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
271--3	12	8	1	1	1	1	8	8	10.04	6.000	6.188	2.000	1.875	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
272--3	12	9	1	1	1	1	8	8	9.91	6.500	6.875	1.500	2.125	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
273--3	12	10	1	1	1	1	8	8	11.13	7.000	6.813	1.938	1.938	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
274--3	12	11	1	1	1	1	8	8	10.04	7.000	7.188	1.875	1.875	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
275--3	12	12	1	1	1	1	8	8	10.08	7.000	7.875	2.000	2.000	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
276--3	12	13	1	1	1	1	8	8	10.05	6.750	6.625	1.938	1.938	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
277--3	12	14	1	1	1	1	8	8	10.05	6.875	7.438	1.938	1.875	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
278--3	12	15	1	1	1	1	8	8	10.04	7.250	6.875	1.938	1.938	99.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table A1 (Cont.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
279--4	13	1	1	1	18	1	8	8	23.06	7.813	8.250	7.938	8.250	99.99	99.99	0	0	0	0	0	0	0
280--4	13	1	2	1	18	1	8	8	10.00	7.813	8.250	7.938	8.250	0	0	0	0	0	0	0	0	0
281--4	13	1	3	1	18	1	8	8	10.00	7.813	8.250	7.938	8.250	0	0	0	0	0	0	0	0	0
282--4	13	2	1	1	1	1	8	8	21.17	8.250	8.250	7.625	8.125	99.99	99.99	0	1	2	1	0	0	0
283--4	13	2	2	1	1	1	8	8	10.00	8.250	8.500	7.625	8.125	0	0	0	0	0	0	0	0	0
284--4	13	2	3	1	1	1	8	8	10.00	8.250	8.500	7.625	8.125	0	0	0	0	0	0	0	0	0
285--4	13	3	1	1	2	1	8	8	20.00	7.813	8.000	8.063	8.375	99.99	99.99	0	0	0	0	0	0	0
286--4	13	3	2	1	2	1	8	8	10.00	7.813	8.000	8.063	8.375	0	0	0	0	0	0	0	0	0
287--4	13	3	3	1	2	1	8	8	10.00	7.813	8.000	8.063	8.375	0	0	0	0	0	0	0	0	0
288--4	13	4	1	1	2	1	8	8	20.54	7.750	7.875	7.500	8.000	99.99	99.99	0	0	0	0	0	0	0
289--4	13	4	2	1	2	1	8	8	10.00	7.750	7.875	7.500	8.000	0	0	0	0	0	0	0	0	0
290--4	13	4	3	1	2	1	8	8	10.00	7.750	7.875	7.500	8.000	0	0	0	0	0	0	0	0	0
291--4	13	5	1	1	2	1	8	8	21.07	7.688	8.250	8.125	8.500	99.99	99.99	0	0	0	0	0	0	0
292--4	13	5	2	1	2	1	8	8	10.00	7.688	8.250	8.125	8.500	0	0	0	0	0	0	0	0	0
293--4	13	5	3	1	2	1	8	8	10.00	7.688	8.250	8.125	8.500	0	0	0	0	0	0	0	0	0
294--4	13	6	1	1	2	1	8	8	20.79	8.063	8.250	7.688	8.250	99.99	99.99	0	2	1	2	0	0	0
295--4	13	6	2	1	2	1	8	8	10.00	8.063	8.250	7.688	8.250	0	0	0	0	0	0	0	0	0
296--4	13	6	3	1	2	1	8	8	10.00	8.063	8.250	7.688	8.250	0	0	0	0	0	0	0	0	0
297--4	13	7	1	1	2	1	8	8	21.96	8.063	8.500	8.000	8.625	99.99	99.99	0	0	0	0	0	0	0
298--4	13	7	2	1	2	1	8	8	10.00	8.063	8.500	8.000	8.625	0	0	0	0	0	0	0	0	0
299--4	13	7	3	1	2	1	8	8	10.00	8.063	8.500	8.000	8.625	0	0	0	0	0	0	0	0	0
300--4	13	8	1	1	1	1	8	8	21.04	8.188	8.438	8.000	8.750	99.99	99.99	0	0	0	0	0	0	0
301--4	13	8	2	1	1	1	8	8	10.00	8.188	8.438	8.000	8.750	0	0	0	0	0	0	0	0	0
302--4	13	8	3	1	1	1	8	8	10.00	8.188	8.438	8.000	8.750	0	0	0	0	0	0	0	0	0
303--4	13	9	1	1	1	1	8	8	23.13	7.813	8.125	7.750	8.375	99.99	99.99	0	1	1	1	0	0	0
304--4	13	9	2	1	1	1	8	8	10.00	7.813	8.125	7.750	8.375	0	0	0	0	0	0	0	0	0
305--4	13	9	3	1	1	1	8	8	10.00	7.813	8.125	7.750	8.375	0	0	0	0	0	0	0	0	0
306--4	13	10	1	1	1	1	8	8	20.90	8.063	8.563	7.875	8.250	99.99	99.99	0	0	0	0	0	0	0
307--4	13	10	2	1	1	1	8	8	10.00	8.063	8.563	7.875	8.250	0	0	0	0	0	0	0	0	0
308--4	13	10	3	1	1	1	8	8	10.00	8.063	8.563	7.875	8.250	0	0	0	0	0	0	0	0	0
309--4	13	11	1	1	2	1	8	8	20.88	7.875	8.063	7.750	8.375	0	0	0	0	0	0	0	0	0
310--4	13	11	2	1	2	1	8	8	10.00	7.875	8.063	7.750	8.375	0	0	0	0	0	0	0	0	0
311--4	13	11	3	1	2	1	8	8	10.00	7.875	8.063	7.750	8.375	0	0	0	0	0	0	0	0	0
312--4	13	12	1	1	2	1	8	8	22.46	6.750	8.000	8.500	8.125	99.99	99.99	0	6	3	4	0	0	0
313--4	13	12	2	1	2	1	8	8	10.00	6.750	8.000	8.500	8.125	0	0	0	0	0	0	0	0	0
314--4	13	12	3	1	2	1	8	8	10.00	6.750	8.000	8.500	8.125	0	0	0	0	0	0	0	0	0
315--4	13	13	1	1	2	1	8	8	16.43	7.813	7.750	7.875	7.750	99.99	99.99	0	0	0	0	0	0	0
316--4	13	13	2	1	2	1	8	8	10.00	7.813	7.750	7.875	7.750	0	0	0	0	0	0	0	0	0
317--4	13	14	1	1	3	1	8	8	17.35	7.750	7.625	7.625	7.875	99.99	99.99	0	0	0	0	0	0	0
318--4	13	14	2	1	3	1	8	8	10.00	7.750	7.625	7.625	7.875	0	0	0	0	0	0	0	0	0
319--4	13	15	1	1	3	1	8	8	17.23	8.000	8.000	7.938	7.875	99.99	99.99	0	0	0	0	0	0	0
320--4	13	15	2	1	3	1	8	8	10.00	8.000	8.000	7.938	7.875	0	0	0	0	0	0	0	0	0
321--4	13	16	1	1	2	1	8	8	16.47	8.125	7.375	8.250	7.813	99.99	99.99	0	0	0	0	0	0	0
322--4	13	16	2	1	2	1	8	8	10.00	8.125	7.375	8.250	7.813	0	0	0	0	0	0	0	0	0
323--4	13	17	1	1	2	1	8	8	17.19	8.188	8.000	8.500	8.375	99.99	99.99	0	5	3	0	0	0	0
324--4	13	17	2	1	2	1	8	8	10.00	8.188	8.000	8.500	8.375	0	0	0	0	0	0	0	0	0
325--4	14	1	1	1	18	1	4	6	12.21	5.500	5.625	3.750	3.813	99.99	99.99	0	4	2	2	0	0	0
326--4	14	2	1	1	1	1	4	6	11.69	5.875	5.750	3.625	3.875	99.99	99.99	0	0	0	0	0	0	0
327--4	14	3	1	1	2	1	4	6	11.98	5.872	5.688	3.750	3.500	99.99	99.99	0	0	0	0	0	0	0
328--4	14	4	1	1	1	1	4	6	12.15	6.250	6.250	3.875	3.875	99.99	99.99	0	2	1	6	0	0	0
329--4	14	5	1	1	1	1	4	6	12.08	6.000	6.125	4.125	4.000	99.99	99.99	0	3	1	4	0	0	0
330--4	14	6	1	1	2	1	4	6	12.00	6.000	6.125	4.000	3.875	99.99	99.99	0	0	0	0	0	0	0
331--4	14	7	1	1	2	1	4	6	11.92	5.938	6.063	3.625	3.750	99.99	99.99	0	0	0	0	0	0	0
332--4	14	8	1	1	18	1	4	6	12.23	5.438	5.750	3.563	4.000	99.99	99.99	0	0	0	0	0	0	0
333--4	14	9	1	1	18	1	4	6	12.25	5.375	5.750	3.750	3.375	99.99	99.99	0	0	0	0	0	0	0
334--4	14	10	1	1	18	1	4	6	12.21	4.125	5.625	3.625	3.750	99.99	99.99	0	6	6	6	0	0	0
335--4	14	11	1	1	18	1	4	6	12.10	5.750	5.875	3.750	3.875	99.99	99.99	0	0	0	0	0	0	0
336--4	14	12	1	1	18	1	4	6	12.07	5.750	5.875	3.750	3.875	99.99	99.99	0	1	1	1	0	0	0

Table A1 (Cont.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
337--4	14	13	14	13	14	13	14	6	12.08	5.675	5.675	3.750	4.000	99	99	0	1	0	0	0	0	0
338--4	14	14	14	14	14	14	4	6	11.96	5.750	5.625	4.875	4.125	99	99	0	0	0	0	0	0	0
339--4	14	15	14	14	14	14	4	6	11.96	5.875	6.000	3.625	4.000	99	99	0	2	2	0	0	0	0
340--4	14	16	14	14	14	14	4	6	12.13	5.875	5.875	3.500	3.500	99	99	0	0	0	0	0	0	0
341--4	14	17	14	14	14	14	4	6	12.13	5.750	5.625	3.625	3.750	99	99	0	0	0	0	0	0	0
342--4	14	18	14	14	14	14	4	6	12.23	6.000	6.250	3.625	3.750	99	99	0	0	0	0	0	0	0
343--4	14	19	14	14	14	14	4	6	12.24	5.750	5.750	3.750	3.750	99	99	0	0	0	0	0	0	0
344--4	14	20	14	14	14	14	4	6	12.33	6.375	5.875	3.563	3.875	99	99	0	0	0	0	0	0	0
345--4	14	21	14	14	14	14	4	6	11.89	6.250	5.875	3.813	3.750	99	99	0	0	0	0	0	0	0
346--4	14	22	14	14	14	14	4	6	11.91	5.750	5.750	3.813	3.750	99	99	0	0	0	0	0	0	0
347--4	14	23	14	14	14	14	4	6	11.92	6.125	5.750	4.125	4.000	99	99	0	3	3	1	0	0	0
348--4	14	24	14	14	14	14	4	6	12.04	5.675	5.750	3.813	4.000	99	99	0	0	0	0	0	0	0
349--4	14	25	14	14	14	14	4	6	11.69	5.750	5.375	3.875	3.375	99	99	0	0	0	0	0	0	0
350--4	14	26	14	14	14	14	4	6	12.11	6.250	6.250	4.000	3.750	99	99	0	6	1	4	0	0	0
351--4	14	27	14	14	14	14	4	6	12.16	6.250	6.000	3.750	3.625	99	99	0	0	0	0	0	0	0
352--4	14	28	14	14	14	14	4	6	12.15	6.250	5.875	4.125	3.875	99	99	0	4	2	3	0	0	0
353--4	14	29	14	14	14	14	4	6	11.95	6.313	6.313	3.625	3.125	99	99	0	0	0	0	0	0	0
354--4	14	30	14	14	14	14	4	6	12.00	6.313	5.750	3.875	3.250	99	99	0	0	0	0	0	0	0
355--4	14	31	14	14	14	14	4	6	12.03	6.000	5.875	4.125	4.063	99	99	0	3	4	3	0	0	0
356--4	15	14	14	14	14	14	3	12	12.54	11.750	11.563	2.875	3.000	99	99	0	0	0	0	0	0	0
357--4	15	2	1	3	2	1	3	12	12.55	11.938	11.500	2.563	3.125	99	99	0	0	0	0	0	0	0
358--4	15	3	1	3	2	1	3	12	12.59	12.813	11.500	2.938	2.750	99	99	0	0	0	0	0	0	0
359--4	15	4	1	3	2	1	3	12	12.57	12.250	12.188	3.125	2.750	99	99	0	0	0	0	0	0	0
360--4	15	5	1	3	1	3	12	12.56	12.250	12.125	3.338	3.750	99	99	0	1	6	0	0	0	0	0
361--4	15	6	1	3	1	3	12	12.49	12.813	11.875	3.188	3.000	99	99	0	2	1	6	0	0	0	0
362--4	15	7	1	3	2	1	3	12	12.48	12.625	12.313	3.500	3.313	99	99	0	1	2	4	0	0	0
363--4	15	8	1	3	2	1	3	12	12.58	12.125	12.000	3.000	2.750	99	99	0	1	1	4	0	0	0
364--4	15	9	1	3	2	1	3	12	12.54	12.125	12.125	2.938	2.938	99	99	0	0	0	0	0	0	0
365--4	15	10	1	3	2	1	3	12	12.53	12.625	12.313	2.938	2.875	99	99	0	0	0	0	0	0	0
366--4	15	11	1	3	2	1	3	12	12.52	12.625	11.872	3.000	2.875	99	99	0	0	0	0	0	0	0
367--4	15	12	1	3	2	1	3	12	12.51	11.500	11.938	3.500	3.500	99	99	0	1	6	4	0	0	0
368--4	15	13	1	3	2	1	3	12	12.56	12.063	12.063	3.500	3.375	99	99	0	1	1	6	0	0	0
369--4	15	14	1	3	2	1	3	12	12.35	12.813	12.250	3.000	3.375	99	99	0	0	0	0	0	0	0
370--4	15	15	1	3	2	1	3	12	12.65	12.063	12.063	2.938	2.875	99	99	0	0	0	0	0	0	0
371--4	15	16	1	3	2	1	3	12	12.42	12.125	11.875	3.125	3.250	99	99	0	0	0	0	0	0	0
372--4	15	17	1	3	1	3	12	12.44	12.250	11.875	3.250	3.188	99	99	0	1	1	1	0	0	0	0
373--4	15	18	1	3	2	1	3	12	12.56	12.250	12.000	3.000	2.938	99	99	0	0	0	0	0	0	0
374--4	15	19	1	3	2	1	3	12	12.40	12.750	12.313	3.063	2.625	99	99	0	0	0	0	0	0	0
375--4	15	20	1	3	2	1	3	12	12.43	12.188	12.125	2.750	2.750	99	99	0	1	3	6	0	0	0
376--4	15	21	1	3	2	1	3	12	12.45	12.250	11.872	2.875	2.750	99	99	0	0	0	0	0	0	0
377--4	15	22	1	3	2	1	3	12	12.42	12.563	12.125	3.000	3.000	99	99	0	0	0	0	0	0	0
378--4	15	23	1	3	2	1	3	12	12.44	12.625	12.250	3.625	3.375	99	99	0	0	0	0	0	0	0
379--4	15	24	1	3	2	1	3	12	12.35	12.625	12.188	3.000	3.125	99	99	0	0	0	0	0	0	0
380--5	16	1	1	3	1	3	8	18	18.66	8.375	8.250	8.375	8.375	99	99	0	0	0	0	0	0	0
381--5	16	1	2	1	3	1	8	10	10.00	8.375	8.250	8.375	8.375	0	0	0	0	0	0	0	0	0
382--5	16	2	1	1	16	1	8	19	19.09	8.563	9.000	8.125	8.750	99	99	0	0	0	0	0	0	0
383--5	16	2	2	1	16	1	8	10	10.09	8.563	9.000	8.125	8.750	0	0	0	0	0	0	0	0	0
384--5	16	3	1	1	3	1	8	18	18.52	8.250	8.313	8.250	8.313	99	99	0	0	0	0	0	0	0
385--5	16	3	2	1	3	1	8	10	10.00	8.250	8.313	8.250	8.313	0	0	0	0	0	0	0	0	0
386--5	16	4	1	1	1	1	8	18	18.50	8.375	8.250	8.313	8.063	99	99	0	6	1	1	0	0	0
387--5	16	4	2	1	1	1	8	10	10.00	8.375	8.250	8.313	8.063	0	0	0	0	0	0	0	0	0
388--5	16	5	1	1	1	1	8	18	18.63	8.688	8.500	8.688	8.250	99	99	0	0	0	0	0	0	0
389--5	16	5	2	1	1	1	8	10	10.00	8.688	8.500	8.688	8.250	0	0	0	0	0	0	0	0	0
390--5	16	6	1	1	1	1	8	18	18.88	8.750	8.500	8.750	8.125	99	99	0	0	0	0	0	0	0
391--5	16	6	2	1	1	1	8	10	10.00	8.750	8.500	8.750	8.125	0	0	0	0	0	0	0	0	0
392--5	16	7	1	1	1	1	8	20	20.00	8.750	8.750	8.500	8.500	99	99	0	0	0	0	0	0	0
393--5	16	7	2	1	1	1	8	10	10.00	8.750	8.750	8.500	8.500	0	0	0	0	0	0	0	0	0
394--5	16	8	1	1	1	1	8	18	18.50	8.563	8.750	8.688	8.750	99	99	0	2	2	0	0	0	0

Table A1 (Cont.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
395--5	16	8	2	1	1	1	1	8	8	10.00	8.563	8.750	8.688	8.750	0	0	0	0	0	0	0	0
396--5	16	9	1	1	1	1	1	8	8	18.46	8.250	8.000	7.875	8.188	99	99	0	0	0	0	0	0
397--5	16	9	2	1	1	1	1	8	8	10.00	8.250	8.000	7.875	8.188	0	0	0	0	0	0	0	0
398--5	16	10	1	1	1	1	1	8	8	18.52	8.188	8.250	7.813	8.000	99	99	0	0	0	0	0	0
399--5	16	10	2	1	1	1	1	8	8	10.00	8.250	8.000	7.813	8.000	0	0	0	0	0	0	0	0
400--5	16	11	1	1	1	1	1	8	8	18.42	8.250	8.500	8.250	8.500	99	99	0	0	0	0	0	0
401--5	16	11	2	1	1	1	1	8	8	10.00	8.250	8.500	8.250	8.500	0	0	0	0	0	0	0	0
402--5	16	12	1	1	1	1	1	8	8	18.73	8.938	8.500	9.000	8.500	99	99	0	0	0	0	0	0
403--5	16	12	2	1	1	1	1	8	8	10.00	8.938	8.500	9.000	8.500	0	0	0	0	0	0	0	0
404--5	16	13	1	1	1	1	1	8	8	18.29	8.175	8.500	8.500	8.500	99	99	0	1	1	0	0	0
405--5	16	13	2	1	1	1	1	8	8	10.00	8.175	8.500	8.500	8.500	0	0	0	0	0	0	0	0
406--5	16	14	1	1	1	1	1	8	8	18.50	8.188	8.000	8.250	8.500	99	99	0	2	2	0	0	0
407--5	16	14	2	1	1	1	1	8	8	10.00	8.188	8.000	8.250	8.500	0	0	0	2	2	0	0	0
408--5	16	15	1	1	1	1	1	8	8	19.52	8.750	8.500	8.938	8.125	99	99	0	4	2	0	0	0
409--5	16	15	2	1	1	1	1	8	8	10.00	8.750	8.500	8.938	8.125	0	0	0	0	0	0	0	0
410--5	17	1	1	1	1	1	1	4	6	12.15	6.125	5.500	3.125	3.250	99	99	0	6	1	6	0	0
411--5	17	2	1	1	1	1	1	4	6	9.24	5.625	6.125	4.000	4.250	99	99	0	2	2	0	0	0
412--5	17	3	1	1	1	1	1	4	6	10.06	5.500	5.750	3.875	3.750	99	99	0	1	1	1	0	0
413--5	17	4	1	1	1	1	1	4	6	9.30	5.938	5.375	3.500	3.000	99	99	0	4	3	6	0	0
414--5	17	5	1	1	1	1	1	4	6	10.35	5.938	5.750	3.625	3.750	99	99	0	0	0	0	0	0
415--5	17	6	1	1	1	1	1	4	6	10.54	5.188	5.188	3.625	4.000	99	99	0	0	0	0	0	0
416--5	17	7	1	1	1	1	1	4	6	10.51	5.750	5.750	3.250	3.500	99	99	0	3	1	6	0	0
417--5	17	8	1	1	1	1	1	4	6	10.24	5.500	6.000	3.750	4.000	99	99	0	6	5	4	0	0
418--5	17	9	1	1	1	1	1	4	6	10.21	5.375	6.250	3.875	3.750	99	99	0	0	0	0	0	0
419--5	17	10	1	1	1	1	1	4	6	10.66	5.750	5.375	3.500	3.750	99	99	0	0	0	0	0	0
420--5	17	11	1	1	1	1	1	4	6	11.62	5.875	5.500	3.683	3.750	99	99	0	6	1	4	0	0
421--5	17	12	1	1	1	1	1	4	6	11.76	5.813	5.750	3.750	3.750	99	99	0	4	2	6	0	0
422--5	17	13	1	1	1	1	1	4	6	10.58	6.125	5.750	3.750	4.000	99	99	0	0	0	0	0	0
423--5	17	14	1	1	1	1	1	4	6	10.82	5.625	5.750	3.625	3.750	99	99	0	6	4	5	0	0
424--5	17	15	1	1	1	1	1	4	6	12.18	6.063	5.750	4.375	3.750	99	99	0	2	2	2	0	0
425--5	17	16	1	1	1	1	1	4	6	12.69	6.250	5.500	4.125	3.500	99	99	0	6	5	4	0	0
426--5	17	17	1	1	1	1	1	4	6	12.04	6.000	5.500	3.750	4.125	99	99	0	0	0	0	0	0
427--5	17	18	1	1	1	1	1	4	6	12.15	6.063	5.750	3.688	3.500	99	99	0	0	0	0	0	0
428--5	17	19	1	1	1	1	1	4	6	12.20	5.750	6.000	3.750	3.500	99	99	0	0	0	0	0	0
429--5	17	20	1	1	1	1	1	4	6	10.10	6.250	5.750	4.063	4.000	99	99	0	0	0	0	0	0
430--5	17	21	1	1	1	1	1	4	6	14.31	6.125	6.250	4.063	3.750	99	99	0	0	0	0	0	0
431--5	17	22	1	1	1	1	1	4	6	14.29	6.000	6.250	4.250	4.063	99	99	0	0	0	0	0	0
432--5	17	23	1	1	1	1	1	4	6	11.98	5.875	5.750	4.250	4.250	99	99	0	0	0	0	0	0
433--5	17	24	1	1	1	1	1	4	6	12.15	6.313	6.250	4.250	4.250	99	99	0	0	0	0	0	0
434--5	17	25	1	1	1	1	1	4	6	10.92	5.875	5.500	3.750	3.750	99	99	0	3	5	6	0	0
435--5	17	26	1	1	1	1	1	4	6	10.46	5.250	5.500	3.500	3.750	99	99	0	0	0	0	0	0
436--5	17	27	1	1	1	1	1	4	6	10.46	5.125	5.250	3.188	3.750	99	99	0	0	0	0	0	0
437--5	17	28	1	1	1	1	1	4	6	10.09	5.750	5.500	3.688	3.500	99	99	0	0	0	0	0	0
438--5	18	1	1	3	1	1	1	2	8	10.83	7.250	7.250	1.750	1.750	99	99	0	1	4	4	0	0
439--5	18	2	1	3	1	1	1	2	8	10.42	8.250	8.250	1.875	1.750	99	99	0	0	0	0	0	0
440--5	18	3	1	3	1	1	1	2	8	10.42	8.250	8.500	1.750	1.750	99	99	0	0	0	0	0	0
441--5	18	4	1	3	1	1	1	2	8	10.42	8.188	8.500	1.875	2.000	99	99	0	0	0	0	0	0
442--5	18	5	1	3	1	1	1	2	8	10.46	8.125	8.250	1.625	1.750	99	99	0	0	0	0	0	0
443--5	18	6	1	3	1	1	1	2	8	10.42	8.375	8.750	1.750	1.750	99	99	0	0	0	0	0	0
444--5	18	7	1	3	1	1	1	2	8	9.97	8.750	8.250	1.875	1.500	99	99	0	3	5	6	0	0
445--5	18	8	1	3	1	1	1	2	8	10.96	8.500	7.500	1.875	1.500	99	99	0	5	3	4	0	0
446--5	18	9	1	3	1	1	1	2	8	10.23	8.313	8.500	1.875	1.750	99	99	0	0	0	0	0	0
447--5	18	10	1	3	1	1	1	2	8	10.69	8.938	8.750	1.813	2.000	99	99	0	0	0	0	0	0
448--5	18	11	1	3	1	1	1	2	8	10.83	8.250	8.500	1.750	1.500	99	99	0	0	0	0	0	0
449--5	18	12	1	3	1	1	1	2	8	8.81	8.688	8.500	1.625	1.625	99	99	0	0	0	0	0	0
450--5	18	13	1	3	1	1	1	2	8	10.04	8.938	8.750	1.875	1.563	99	99	0	0	0	0	0	0
451--5	18	14	1	3	1	1	1	2	8	10.25	8.563	8.500	1.750	1.750	99	99	0	0	0	0	0	0
452--5	18	15	1	3	1	1	1	2	8	10.31	8.625	8.500	1.813	1.750	99	99	0	1	4	4	0	0

Table A1 (Cont.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
453--5.	18.	16.	1.	3.	1.	1.	2.	8.	10.73	8.125	8.500	1.563	1.750	99.99	0.	3.	5.	4.	0.	0.	0.	0.
454--5.	18.	17.	1.	3.	1.	1.	2.	8.	10.81	8.313	8.250	1.625	1.500	99.99	0.	3.	2.	6.	0.	0.	0.	0.
455--5.	18.	18.	1.	3.	1.	1.	2.	8.	10.67	8.375	7.500	1.375	1.750	99.99	0.	2.	1.	6.	0.	0.	0.	0.
456--5.	18.	19.	1.	3.	1.	1.	2.	8.	10.58	8.438	8.750	1.875	1.750	99.99	0.	0.	0.	0.	0.	0.	0.	0.
457--5.	18.	20.	1.	3.	22.	1.	2.	8.	10.35	8.813	7.750	1.938	1.750	99.99	0.	1.	4.	2.	0.	0.	0.	0.
458--5.	18.	21.	1.	3.	12.	1.	2.	8.	10.46	8.250	8.500	1.875	1.750	99.99	0.	0.	0.	0.	0.	0.	0.	0.
459--5.	18.	22.	1.	3.	1.	1.	2.	8.	10.44	7.813	8.000	2.000	1.750	99.99	0.	6.	3.	6.	0.	0.	0.	0.
460--5.	18.	23.	1.	3.	1.	1.	2.	8.	10.48	8.500	8.875	1.875	2.000	99.99	0.	0.	0.	0.	0.	0.	0.	0.
461--5.	18.	24.	1.	3.	1.	1.	2.	8.	10.16	8.625	7.500	1.563	1.500	99.99	0.	0.	0.	0.	0.	0.	0.	0.
462--5.	18.	25.	1.	3.	5.	1.	2.	8.	10.74	8.250	8.750	1.688	1.750	99.99	0.	2.	1.	6.	0.	0.	0.	0.
463--5.	18.	26.	1.	3.	2.	1.	2.	8.	10.83	8.500	8.750	1.750	1.750	99.99	0.	0.	0.	0.	0.	0.	0.	0.
464--5.	18.	27.	1.	3.	2.	1.	2.	8.	10.60	8.500	8.750	1.750	1.750	99.99	0.	0.	0.	0.	0.	0.	0.	0.
465--5.	18.	28.	1.	3.	2.	1.	2.	8.	10.78	8.500	8.500	1.875	2.250	99.99	0.	3.	4.	7.	0.	0.	0.	0.
466--5.	18.	29.	1.	3.	5.	1.	2.	8.	10.51	8.313	8.750	1.813	2.000	99.99	0.	0.	0.	0.	0.	0.	0.	0.
467--5.	18.	30.	1.	3.	5.	1.	2.	8.	10.50	9.438	9.625	1.875	2.000	99.99	0.	1.	5.	6.	0.	0.	0.	0.

Table A1 (Cont.)

1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1--1	1	1	1	1	1	0	0	-1,000	-1,000	99	99	2	1	0	0	0	1	0	0	6	0	0	0	6	7	0	0	0	0
2--1	1	1	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	6	0	0	0	6	7	0	0	0	0
3--1	1	1	3	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	6	0	0	0	6	7	0	0	0	0
4--1	1	2	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	1	0	0	6	0	0	0	6	7	0	0	0	0
5--1	1	2	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	8	0	0	0	8	0	0	0	0	0
6--1	1	2	3	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	7	0	0	0	7	0	0	0	0	0
7--1	1	3	1	1	0	0	2	3,500	2,500	99	99	2	1	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
8--1	1	3	2	1	0	0	2	3,500	2,500	99	99	0	1	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
9--1	1	3	3	1	0	0	0	-1,000	-1,000	99	99	0	1	0	0	0	5	1	0	8	0	0	0	8	0	0	0	0	0
10--1	1	4	1	1	0	0	2	2,000	2,000	99	99	11	0	0	0	0	5	0	0	8	0	0	0	8	0	0	0	0	0
11--1	1	4	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	0	0	8	0	0	0	8	0	0	0	0	0
12--1	1	4	3	1	0	0	1	2,250	1,500	99	99	0	0	0	0	0	5	0	0	5	0	0	0	5	0	0	0	0	0
13--1	1	5	1	1	0	0	2	500	500	99	99	2	1	0	0	1	0	0	8	0	0	0	8	0	0	0	0	0	0
14--1	1	5	2	1	0	0	2	500	500	99	99	0	0	0	0	0	1	0	0	8	0	0	0	8	0	0	0	0	0
15--1	1	5	3	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	8	0	0	0	8	0	0	0	0	0
16--1	1	6	1	1	0	0	0	-1,000	-1,000	99	99	0	2	1	1	0	0	1	0	0	8	0	0	0	8	0	0	0	0
17--1	1	6	2	1	0	0	2	500	500	99	99	0	0	0	0	0	1	0	0	3	0	0	0	3	0	0	0	0	0
18--1	1	6	3	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	8	0	0	0	8	0	0	0	0	0
19--1	1	7	1	1	0	0	2	500	500	99	99	0	0	0	0	4	0	6	8	0	8	9	0	0	0	0	0	0	0
20--1	1	7	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	3	0	0	0	8	0	0	0	8	0	0	0	0	0
21--1	1	7	3	1	0	0	0	-1,000	-1,000	99	99	0	3	0	0	4	0	6	8	0	8	9	0	0	0	0	0	0	0
22--1	1	8	1	1	0	0	2	1,500	1,000	99	99	99	0	0	0	0	5	4	0	8	0	0	0	8	0	0	0	0	0
23--1	1	8	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	6	0	0	0	6	0	0	0	0	0
24--1	1	8	3	1	0	0	0	1,500	1,000	99	99	0	0	0	0	0	5	4	0	8	0	0	0	8	0	0	0	0	0
25--1	1	9	1	1	0	0	1	3,000	2,000	99	99	2	1	0	0	0	6	0	0	8	0	0	0	8	0	0	0	0	0
26--1	1	9	2	1	0	0	2	1,250	750	99	99	99	0	0	0	0	3	0	0	7	0	0	0	7	0	0	0	0	0
27--1	1	9	3	1	0	0	7	2,000	1,000	99	99	99	0	0	0	0	3	0	0	8	0	0	0	8	0	0	0	0	0
28--1	1	10	1	1	0	0	2	2,000	2,000	99	99	99	0	2	0	0	5	1	0	8	0	0	0	8	0	0	0	0	0
29--1	1	10	2	1	0	0	1	1,000	1,000	99	99	0	0	0	0	0	3	0	0	8	0	0	0	8	0	0	0	0	0
30--1	1	10	3	1	0	0	2	2,000	2,000	99	99	0	0	0	0	0	5	1	0	8	0	0	0	8	0	0	0	0	0
31--1	1	11	1	1	0	0	1	1,500	1,500	99	99	2	1	2	0	0	3	0	0	8	0	0	0	8	0	0	0	0	0
32--1	1	11	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	6	0	0	0	6	0	0	0	0	0
33--1	1	11	3	1	0	0	1	1,000	1,000	99	99	0	0	0	0	0	3	0	0	8	0	0	0	8	0	0	0	0	0
34--1	1	12	1	1	0	0	1	3,000	2,000	99	99	2	1	0	0	0	6	4	0	8	0	0	0	8	0	0	0	0	0
35--1	1	12	2	1	0	0	2	1,750	1,500	99	99	0	0	0	0	0	3	0	0	8	0	0	0	8	0	0	0	0	0
36--1	1	12	3	1	0	0	1	3,000	2,000	99	99	0	0	0	0	0	6	0	0	8	0	0	0	8	0	0	0	0	0
37--1	1	13	1	1	0	0	1	3,000	2,000	12	99	2	2	2	0	0	5	0	0	7	0	0	0	7	0	0	0	0	0
38--1	1	13	2	1	0	0	2	1,000	1,000	99	99	99	0	0	0	0	3	0	0	8	0	0	0	8	0	0	0	0	0
39--1	1	13	3	1	0	0	2	2,000	1,500	99	99	99	0	0	0	0	5	0	0	8	0	0	0	8	0	0	0	0	0
40--1	1	14	1	1	0	0	2	3,000	1,500	99	99	10	2	3	0	0	6	12	0	7	0	0	0	7	0	0	0	0	0
41--1	1	14	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	6	12	0	0	0	0	0	6	12	0	0	0	0
42--1	1	14	3	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	6	12	0	0	0	0	0	6	12	0	0	0	0
43--1	1	15	1	1	0	0	0	1,250	1,250	99	99	2	1	0	0	0	3	0	0	8	0	0	0	8	0	0	0	0	0
44--1	1	15	2	1	0	0	0	1,500	1,000	99	99	99	0	0	0	0	3	0	0	8	0	0	0	8	0	0	0	0	0
45--1	1	15	3	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	6	0	0	0	6	0	0	0	0	0
46--1	1	16	1	1	0	0	2	500	500	99	99	2	1	0	0	0	5	0	0	7	0	0	0	7	0	0	0	0	0
47--1	1	16	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
48--1	1	16	3	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	7	0	0	0	7	0	0	0	0	0
49--1	2	17	1	1	0	0	1	3,000	2,250	99	99	99	3	2	0	0	5	1	0	8	0	0	0	8	0	0	0	0	0
50--1	2	17	2	1	0	0	0	1,750	1,750	99	99	99	3	2	0	0	5	1	0	0	0	0	0	5	1	0	0	0	0
51--1	2	17	3	1	0	0	2	500	500	99	99	99	99	2	1	0	4	7	1	8	0	8	1	4	0	0	0	0	0
52--1	2	18	1	1	0	0	1	3,000	3,000	99	99	99	99	2	1	0	4	7	1	8	0	8	1	4	0	0	0	0	0
53--1	2	18	2	1	0	0	0	-1,000	-1,000	99	99	99	99	0	0	0	0	7	6	0	0	0	0	7	6	0	0	0	0
54--1	2	18	3	1	0	0	0	-1,000	-1,000	99	99	99	99	0	0	0	0	7	6	0	0	0	0	7	6	0	0	0	0
55--1	2	19	1	1	0	0	2	1,250	1,250	99	99	99	99	2	1	0	0	7	6	0	0	0	0	7	6	0	0	0	0
56--1	2	19	2	1	0	0	0	-1,000	-1,000	99	99	99	99	0	0	0	0	7	6	0	0	0	0	7	6	0	0	0	0
57--1	2	19	3	1	0	0	0	-1,000	-1,000	99	99	99	99	0	0	0	0	7	6	0	0	0	0	7	6	0	0	0	0
58--1	2	20	1	1	0	0	1	3,500	3,000	99	99	99	99	8	7	0	0	0	0	7	12	0	0	7	12	0	0	0	0

Table A1 (Cont.)

1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
59--1	2	20	2	1	0	0	1	3,500	3,000	0	0	0	0	0	0	0	0	7,12	0	7	0	0	0	0	0	0	0	0	0
60--1	2	20	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	0	7,12	0	7	0	0	0	0	0	0	0	0	0
61--1	2	21	1	1	0	0	2	2,000	2,000	99	99	3	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
62--1	2	21	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
63--1	2	21	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
64--1	2	22	1	1	0	0	2	2,000	2,000	99	99	2	1	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
65--1	2	22	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
66--1	2	22	3	1	0	0	2	2,000	2,000	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
67--1	2	23	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	8,11	0	0	0	0	0	0	0	0	0	0	0	0
68--1	2	23	2	1	0	0	1	4,000	3,000	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
69--1	2	24	1	1	0	0	2	3,250	2,750	99	99	2	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
70--1	2	24	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
71--1	2	24	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
72--1	2	25	1	1	0	0	2	1,500	1,500	99	99	2	1	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
73--1	2	25	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
74--1	2	25	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
75--1	2	26	1	1	0	0	2	7,000	3,750	99	99	2	1	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0
76--1	2	26	2	1	0	0	0	-1,000	-1,000	99	99	0	1	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0
77--1	2	26	3	1	0	0	0	-1,000	-1,000	99	99	0	1	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0
78--1	2	27	1	1	0	0	5	4,000	3,000	99	99	2	1	0	0	0	7,18	0	7	0	0	0	0	0	0	0	0	0	0
79--1	2	27	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
80--1	2	27	3	1	0	0	5	6,000	3,000	0	0	0	0	0	0	0	7,18	0	0	0	0	0	0	0	0	0	0	0	0
81--1	2	28	1	1	0	0	5	3,000	1,750	99	99	2	1	0	0	0	3,18	0	0	0	0	0	0	0	0	0	0	0	0
82--1	2	28	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
83--1	2	28	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
84--1	2	29	1	1	0	0	2	1,500	1,500	99	99	0	1	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
85--1	2	29	2	1	0	0	0	-1,500	-1,000	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
86--1	2	29	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
87--1	2	30	1	1	0	0	5	4,000	2,500	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
88--1	2	30	2	1	0	0	2	4,000	2,500	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
89--1	2	30	3	1	0	0	2	4,000	2,000	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
90--1	3	31	1	1	0	0	0	-1,000	-2,000	99	99	2	2	0	0	0	5	0	6	0	0	0	0	0	0	0	0	0	0
91--1	3	32	1	1	0	0	2	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
92--1	3	33	1	1	0	0	2	1,500	1,250	99	99	2	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
93--1	3	34	1	1	0	0	2	2,000	1,500	18	18	0	2	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
94--1	3	35	1	1	0	0	0	-1,000	-1,000	99	99	1	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
95--1	3	36	1	1	0	0	5	1,500	1,000	99	99	0	1	0	0	0	6,18	0	0	0	0	0	0	0	0	0	0	0	0
96--1	3	37	1	1	0	0	2	3,000	2,000	8	8	1	1	0	0	0	6	1	12	0	0	0	0	0	0	0	0	0	0
97--1	3	38	1	1	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
98--1	3	39	1	1	0	0	2	1,500	1,000	10	10	2	1	0	0	0	5	1	12	6	0	0	0	0	0	0	0	0	0
99--1	3	40	1	1	0	0	1	2,000	2,000	10	10	2	1	0	0	0	5	1	12	6	0	0	0	0	0	0	0	0	0
100--1	3	41	1	1	0	0	1	2,750	2,000	0	0	1	1	0	0	0	5	1	0	6	0	0	0	0	0	0	0	0	0
101--1	3	42	1	1	0	0	5	6,500	1,500	99	99	0	1	0	0	0	6,18	0	8	0	0	0	0	0	0	0	0	0	0
102--1	3	43	1	1	0	0	5	2,500	1,500	99	99	2	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
103--1	3	44	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
104--1	3	45	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	7	8	0	0	0	0	0	0	0	0	0	0
105--1	3	46	1	1	0	0	1	2,000	2,000	99	99	2	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
106--1	3	47	1	1	0	0	5	1,500	1,500	99	99	3	2	0	0	0	7	9	0	0	0	0	0	0	0	0	0	0	0
107--1	3	48	1	1	0	0	5	6,000	2,500	99	99	2	1	0	0	0	7	18	0	0	0	0	0	0	0	0	0	0	0
108--1	3	49	1	1	0	0	2	2,000	2,000	99	99	2	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
109--1	3	50	1	1	0	0	1	2,250	2,000	99	99	2	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
110--1	3	51	1	1	0	0	5	1,500	1,250	99	99	2	2	0	0	0	5	4	0	0	0	0	0	0	0	0	0	0	0
111--1	4	1	3	0	0	2	6,000	2,500	99	99	18	3	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
112--1	4	2	1	3	0	0	3	9,000	3,000	99	99	2	2	0	0	0	3	4	6	7	1	0	0	0	0	0	0	0	0
113--1	4	3	1	3	0	0	2	2,500	1,250	99	99	0	1	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
114--1	4	4	1	3	0	0	3	8,000	3,750	99	99	1	2	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0
115--1	4	5	1	3	0	0	3	5,500	2,000	99	99	3	1	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
116--1	4	6	1	3	0	0	2	2,000	2,000	99	99	2	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0

Table A1 (Cont.)

1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
117--1	4	7	1	3	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
118--1	4	8	1	3	0	0	0	-1.000	-1.000	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
119--1	4	9	1	3	0	0	0	-1.000	-1.000	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120--1	4	10	1	3	0	0	0	-1.000	-1.000	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121--1	4	11	1	3	0	0	0	-1.000	-1.000	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
122--1	4	12	1	3	0	0	0	-1.000	-1.000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
123--1	4	13	1	3	0	0	0	-1.000	-1.000	99	99	1	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
124--1	4	14	1	3	0	0	0	7.000	4.000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125--1	4	15	1	3	0	0	0	-1.000	-1.000	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126--1	4	16	1	3	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
127--1	4	17	1	3	0	0	0	-1.000	-1.000	0	0	3	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
128--1	4	18	1	3	0	0	0	3.000	2.000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
129--1	4	19	1	3	0	0	0	6.500	2.000	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130--1	4	20	1	3	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
131--1	4	21	1	3	0	0	0	2.000	2.000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
132--1	4	22	1	3	0	0	0	6.000	1.750	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133--1	4	23	1	3	0	0	0	-1.000	-1.000	0	0	2	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
134--1	4	24	1	3	0	0	0	5.000	3.750	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135--1	4	25	1	3	0	0	0	-1.000	-1.000	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136--1	4	26	1	3	0	0	0	-1.000	-1.000	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
137--1	4	27	1	3	0	0	0	3.500	2.750	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
138--1	5	1	1	1	0	0	0	-1.000	-1.000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139--1	5	2	1	1	0	0	0	3.500	2.500	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140--1	5	3	1	1	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141--1	5	4	1	1	0	0	0	4.250	2.250	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
142--1	5	5	1	1	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
143--1	5	6	1	1	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144--1	5	7	1	1	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145--1	5	8	1	1	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
146--1	5	9	1	1	0	0	0	4.750	2.250	12	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
147--1	5	10	1	1	0	0	0	3.500	2.500	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148--1	5	11	1	1	0	0	0	-1.000	-1.000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
149--1	5	12	1	1	0	0	0	-1.000	-1.000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150--1	5	13	1	1	0	0	0	2.000	1.375	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151--1	5	14	1	1	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
152--1	5	15	1	1	0	0	0	5.500	3.625	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153--2	6	1	1	1	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
154--2	6	1	2	1	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155--2	6	1	3	1	0	0	0	1.500	1.500	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156--2	6	2	1	1	0	0	0	3.000	2.500	99	99	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157--2	6	2	2	1	0	0	0	-1.000	-1.000	99	99	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
158--2	6	2	3	1	0	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
159--2	6	3	1	1	0	0	0	2.250	2.250	99	99	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160--2	6	3	2	1	0	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
161--2	6	3	3	1	0	0	0	2.000	2.000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162--2	6	4	1	1	0	0	0	-1.000	-1.000	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
163--2	6	4	2	1	0	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
164--2	6	4	3	1	0	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165--2	6	5	1	1	0	0	0	-1.000	-1.000	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166--2	6	5	2	1	0	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
167--2	6	5	3	1	0	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
168--2	6	6	1	1	0	0	0	-1.000	-1.000	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
169--2	6	6	2	1	0	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170--2	6	6	3	1	0	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171--2	6	7	1	1	0	0	0	5.000	3.000	99	99	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
172--2	6	8	1	1	0	0	0	-1.000	-1.000	12	12	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
173--1	7	1	1	1	0	0	0	-1.000	-1.000	99	99	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
174--1	7	2	1	1	0	0	0	-1.000	-1.000	99	99	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A1 (Cont.)

1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
175--1	7	3	1	1	0	0	0	-1,000	-1,000	8	12	3	2	0	4	1	7	8	0	0	0	0	0	0	0	0	0	0	0
176--1	7	4	1	1	0	0	2	5,750	3,000	99	99	1	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
177--1	7	5	1	1	0	0	2	4,000	3,250	99	99	1	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
178--1	7	6	1	1	0	0	5	4,500	2,000	99	99	3	2	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
179--1	7	7	1	1	0	0	0	-1,000	-1,000	99	99	1	2	0	0	5	1	7	8	0	0	0	0	0	0	0	0	0	0
180--1	7	8	1	1	0	0	0	-1,000	-1,000	99	99	2	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
181--1	7	9	1	1	0	0	0	-1,000	-1,000	12	99	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
182--1	7	10	1	1	0	0	1	1,500	-1,000	99	99	0	0	0	0	0	0	5	3	0	0	0	0	0	0	0	0	0	0
183--1	7	11	1	1	0	0	0	-1,000	-1,000	99	99	3	2	0	0	3	1	5	0	0	0	0	0	0	0	0	0	0	0
184--1	7	12	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
185--1	7	13	1	1	0	0	0	-1,000	-1,000	99	0	3	1	0	3	5	6	8	7	0	0	0	0	0	0	0	0	0	0
186--1	7	14	1	1	0	0	2	5,000	3,000	99	99	2	2	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
187--1	7	15	1	1	0	0	0	-1,000	-1,000	99	99	1	2	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
188--1	7	16	1	1	0	0	0	-1,000	-1,000	99	99	1	3	0	0	0	0	6	7	0	0	0	0	0	0	0	0	0	0
189--1	7	17	1	1	0	0	2	4,000	4,000	99	99	1	2	3	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
190--1	7	18	1	1	0	0	2	3,000	2,500	8	99	1	3	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
191--1	7	19	1	1	0	0	1	3,000	2,250	0	0	1	3	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
192--1	8	1	1	0	0	0	0	-1,000	-1,000	99	99	3	2	0	0	0	0	5	1	5	0	0	0	0	0	0	0	0	0
193--1	8	2	1	1	0	0	2	1,000	1,000	99	99	0	0	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0
194--1	8	3	1	1	0	0	5	4,500	1,250	99	99	2	2	0	0	0	0	6	4	0	0	0	0	0	0	0	0	0	0
195--1	8	4	1	1	0	0	2	2,000	2,000	99	99	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0
196--1	8	5	1	1	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
197--1	8	6	1	1	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
198--1	8	7	1	1	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
199--1	8	8	1	1	0	0	0	-1,000	-1,000	8	99	1	3	0	0	0	6	5	12	8	0	0	0	0	0	0	0	0	0
200--1	8	9	1	1	0	0	4	7,000	4,000	99	99	1	1	0	0	0	7	2	0	0	0	0	0	0	0	0	0	0	0
201--1	8	10	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
202--1	8	11	1	1	0	0	5	2,000	1,000	99	99	2	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
203--1	8	12	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
204--1	8	13	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	0	5	7	0	0	0	0	0	0	0	0	0	0
205--1	8	14	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0
206--1	8	15	1	1	0	0	2	1,250	1,000	99	99	3	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
207--1	9	1	1	0	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
208--1	9	2	1	1	0	0	0	-1,000	-1,000	0	0	3	3	0	0	0	0	5	11	0	0	0	0	0	0	0	0	0	0
209--1	9	3	1	1	0	0	0	-1,000	-1,000	99	99	2	3	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0
210--1	9	4	1	1	0	0	1	6,000	4,500	99	99	2	3	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0
211--1	9	5	1	1	0	0	2	3,000	2,750	99	99	2	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
212--1	9	6	1	1	0	0	0	-1,000	-1,000	0	0	2	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
213--1	9	7	1	1	0	0	1	2,000	3,000	18	99	2	2	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
214--1	9	8	1	1	0	0	0	-1,000	-1,000	99	99	2	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
215--1	9	9	1	1	0	0	0	-1,000	-1,000	99	99	2	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
216--1	9	10	1	1	0	0	0	-1,000	-1,000	99	99	0	3	0	0	0	4	0	7	8	0	0	0	0	0	0	0	0	0
217--1	9	11	1	1	0	0	0	-1,000	-1,000	99	99	2	2	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
218--1	9	12	1	1	0	0	2	3,000	2,000	99	99	3	3	0	0	0	0	5	11	0	0	0	0	0	0	0	0	0	0
219--1	9	13	1	1	0	0	0	-1,000	-1,000	99	99	0	3	0	0	0	4	0	6	10	8	0	0	0	0	0	0	0	0
220--1	9	14	1	1	0	0	0	-1,000	-1,000	99	99	0	1	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
221--1	9	15	1	1	0	0	0	-1,000	-1,000	99	99	2	2	0	0	0	0	5	11	0	0	0	0	0	0	0	0	0	0
222--1	9	16	1	1	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
223--1	9	17	1	1	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	7	6	0	0	0	0	0	0	0	0	0	0
224--1	9	18	1	1	0	0	0	-1,000	-1,000	99	99	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
225--1	9	19	1	1	0	0	0	-1,000	-1,000	99	99	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
226--1	9	20	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0
227--1	9	21	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	4	0	7	8	0	0	0	0	0	0	0	0	0
228--1	10	1	1	0	0	0	2	2,750	2,250	99	99	0	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0
229--1	10	2	1	1	0	0	1	2,500	2,000	99	99	2	1	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0
230--1	10	3	1	1	0	0	1	3,000	2,500	5	5	1	1	0	0	0	0	7	12	1	0	0	0	0	0	0	0	0	0
231--1	10	4	1	1	0	0	2	1,500	1,500	99	99	0	0	0	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0
232--1	10	5	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	7	14	0	0	0	0	0	0	0	0	0	0

Table A1 (Cont.)

	1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48		
233--3	10.	6.	1.	0.	0.	0.	0.	0.	-1,000	-1,000	4.	99.	1.	2.	0.	0.	0.	0.	7.12.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
234--3	10.	7.	1.	1.	0.	0.	1.	2,000	-1,875	99.	99.	99.	99.	3.	3.	0.	0.	0.	6.11.	10.	0.	0.	0.	0.	0.	0.	0.	5.	0.	0.	0.	
235--3	10.	8.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	3.	3.	0.	0.	0.	6.11.	10.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
236--3	10.	9.	1.	1.	0.	0.	1.	3,000	3,000	99.	99.	99.	99.	2.	1.	0.	0.	0.	7.	1.	0.	8.	0.	0.	0.	0.	0.	0.	4.	2.	0.	
237--3	10.	10.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	3.	3.	0.	0.	0.	6.	0.	0.	0.	7.	12.	0.	0.	0.	4.	2.	6.	7.	
238--3	10.	11.	1.	1.	0.	0.	1.	-1,000	-1,000	3.	99.	0.	0.	0.	0.	0.	0.	0.	7.12.	0.	0.	0.	7.	3.	4.	0.	0.	0.	0.	0.	0.	
239--3	10.	12.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	4.	0.	0.	0.	7.	0.	0.	0.	0.	0.	2.	4.	3.	
240--3	11.	1.	1.	1.	0.	0.	1.	3,250	2,000	99.	99.	99.	99.	2.	1.	0.	0.	0.	6.	1.	0.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
241--3	11.	2.	1.	1.	0.	0.	2.	2,000	1,500	99.	99.	99.	99.	2.	1.	0.	0.	0.	5.	1.	0.	7.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
242--3	11.	3.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	2.	2.	0.	0.	0.	4.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
243--3	11.	4.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	2.	2.	0.	0.	0.	5.	0.	0.	5.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
244--3	11.	5.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	2.	2.	0.	0.	0.	4.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
245--3	11.	6.	1.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
246--3	11.	7.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	2.	1.	0.	0.	0.	5.19.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
247--3	11.	8.	1.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	3.	4.	0.	0.	0.	8.19.	12.	0.	0.	6.	0.	0.	0.	0.	0.	0.	2.	5.	3.	
248--3	11.	9.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	1.	3.	0.	0.	7.13.	0.	7.	1.	3.	0.	0.	0.	0.	0.	0.	0.	0.	
249--3	11.	10.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	1.	1.	0.	0.	0.	5.11.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
250--3	11.	11.	1.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	1.	1.	0.	0.	0.	4.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
251--3	11.	12.	1.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	3.	1.	0.	0.	0.	0.	4.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
252--3	11.	13.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	4.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	2.	4.	
253--3	11.	14.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	8.20.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.	5.	3.	
254--3	11.	15.	1.	1.	0.	0.	2.	5,000	3,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.	1.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
255--3	11.	16.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	2.	1.	0.	0.	0.	4.	0.	7.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
256--3	11.	17.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	5.	1.	0.	0.	0.	0.	0.	0.	0.	0.	4.	0.	0.	
257--3	11.	18.	1.	1.	0.	0.	3.	5,000	2,000	0.	0.	0.	0.	0.	0.	0.	0.	7.	3.	0.	0.	0.	0.	0.	0.	0.	0.	6.	0.	0.	0.	
258--3	11.	19.	1.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	2.	2.	0.	0.	0.	0.	5.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
259--3	11.	20.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	2.	2.	0.	0.	0.	4.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
260--3	11.	21.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	2.	2.	0.	0.	0.	4.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
261--3	11.	22.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	7.	1.	0.	8.	7.	0.	0.	0.	0.	0.	0.	0.	0.	
262--3	11.	23.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	4.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
263--3	11.	24.	1.	1.	0.	0.	0.	-1,000	-1,000	12.	99.	2.	1.	0.	0.	0.	0.	4.	0.	0.	7.	0.	0.	0.	0.	0.	0.	0.	3.	4.	3.	
264--3	12.	1.	3.	0.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	2.	2.	0.	0.	0.	5.11.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
265--3	12.	2.	3.	0.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	2.	1.	0.	0.	0.	4.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
266--3	12.	3.	1.	3.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	2.	1.	0.	0.	0.	4.	0.	0.	8.	0.	0.	0.	0.	0.	0.	1.	4.	3.	
267--3	12.	4.	1.	3.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	6.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
268--3	12.	5.	1.	3.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	4.	0.	0.	7.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
269--3	12.	6.	1.	3.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
270--3	12.	7.	1.	3.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
271--3	12.	8.	1.	3.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
272--3	12.	9.	1.	3.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	5.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	2.	5.	3.
273--3	12.	10.	1.	3.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	0.	0.	0.	0.	0.	4.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	2.	7.	3.
274--3	12.	11.	1.	3.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
275--3	12.	12.	1.	3.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
276--3	12.	13.	1.	3.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
277--3	12.	14.	1.	3.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
278--3	12.	15.	1.	3.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
279--4	13.	1.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	3.	2.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
280--4	13.	1.	2.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
281--4	13.	1.	3.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
282--4	13.	2.	1.	1.	0.	0.	2.	1,500	999	99.	99.	99.	99.	2.	1.	0.	0.	0.	5.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
283--4	13.	2.	2.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
284--4	13.	2.	3.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
285--4	13.	3.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	2.	2.	0.	0.	0.	5.	0.	0.	5.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
286--4	13.	3.	2.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	0.	0.	5.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
287--4	13.	3.	3.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	0.	0.	5.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
288--4	13.	4.	1.	1.	0.	0.	0.	-1,000	-1,000	99.	99.	99.	99.	3.	3.	0.	0.	0.	7.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
289--4	13.	4.	2.	1.	0.	0.	0.	-1,000	-1,000	0.	0.	0.	0.																			

Table A1 (Cont.)

1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
291--4	13	5	1	1	0	0	2	5,000	3,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
292--4	13	5	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
293--4	13	5	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
294--4	13	6	1	1	0	0	0	-1,000	-1,000	99	3	2	0	4	0	6	8	0	6	0	0	0	0	0	0	0	0	0	0
295--4	13	6	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	6	8	0	0	0	0	0	0	0	0	0	0	0
296--4	13	6	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	6	8	0	0	0	0	0	0	0	0	0	0	0
297--4	13	7	1	1	0	0	4	8,000	3,500	0	3	2	0	0	0	6	2	0	0	0	0	0	0	0	0	0	0	0	0
298--4	13	7	2	1	0	0	2	3,500	2,500	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	0	0	0
299--4	13	7	3	1	0	0	4	-1,000	-1,000	0	0	0	0	0	0	0	5	1	4	0	0	0	0	0	0	0	0	0	0
300--4	13	8	1	1	0	0	2	3,500	3,000	0	0	0	0	0	0	0	5	1	4	0	0	0	0	0	0	0	0	0	0
301--4	13	8	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
302--4	13	8	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
303--4	13	9	1	1	0	0	2	3,000	2,000	99	3	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
304--4	13	9	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
305--4	13	9	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
306--4	13	10	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
307--4	13	10	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
308--4	13	10	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	5	0	0	0	0	0	0	0	0	0	0
309--4	13	11	1	1	0	0	0	-1,000	-1,000	99	3	3	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
310--4	13	11	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
311--4	13	11	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
312--4	13	12	1	1	0	0	0	-1,000	-1,000	99	2	3	0	0	0	5	0	0	8	0	0	0	0	0	0	0	0	0	0
313--4	13	12	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
314--4	13	12	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	5	0	0	8	0	0	0	0	0	0	0	0	0	0
315--4	13	13	1	1	0	0	2	1,500	1,500	99	0	3	2	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
316--4	13	13	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
317--4	13	14	1	1	0	0	0	-1,000	-1,000	99	3	3	4	0	0	7	10	8	0	7	1	18	0	0	0	0	0	0	0
318--4	13	14	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	7	10	8	0	7	1	18	0	0	0	0	0	0	0
319--4	13	15	1	1	0	0	0	-1,000	-1,000	99	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
320--4	13	15	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	10	0	0	5	0	0	0	0	0	0	0	0
321--4	13	16	1	1	0	0	1	2,000	2,000	99	3	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
322--4	13	16	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
323--4	13	17	1	1	0	0	2	7,000	2,750	99	2	2	0	0	0	7	1	0	7	0	0	0	0	0	0	0	0	0	0
324--4	13	17	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0	0
325--4	14	1	1	1	0	0	0	-1,000	-1,000	99	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
326--4	14	2	1	1	0	0	2	1,500	1,500	99	2	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
327--4	14	3	1	1	0	0	0	-1,000	-1,000	99	2	1	0	0	0	7	21	0	0	7	6	18	0	0	0	0	0	0	0
328--4	14	4	1	1	0	0	0	-1,500	-1,500	99	2	2	0	0	0	5	1	0	8	0	0	0	0	0	0	0	0	0	0
329--4	14	5	1	1	0	0	0	-1,000	-1,000	99	0	0	0	0	0	4	0	0	4	0	0	0	0	0	0	0	0	0	0
330--4	14	6	1	1	0	0	1	6,000	3,000	99	2	1	0	0	0	7	19	1	0	0	0	0	0	0	0	0	0	0	0
331--4	14	7	1	1	0	0	5	4,000	3,000	99	3	2	0	0	0	4	7	6	1	0	0	0	0	0	0	0	0	0	0
332--4	14	8	1	1	0	0	1	-1,000	-1,000	99	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
333--4	14	9	1	1	0	0	0	-1,000	-1,000	99	2	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
334--4	14	10	1	1	0	0	0	-1,000	-1,000	99	0	0	0	0	0	7	1	0	8	0	0	0	0	0	0	0	0	0	0
335--4	14	11	1	1	0	0	0	-1,000	-1,000	99	2	2	0	0	0	5	11	7	0	0	0	0	0	0	0	0	0	0	0
336--4	14	12	1	1	0	0	0	-1,000	-1,000	99	0	0	0	0	0	5	1	5	0	0	0	0	0	0	0	0	0	0	0
337--4	14	13	1	1	0	0	0	-1,000	-1,000	99	2	2	0	0	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0
338--4	14	14	1	1	0	0	0	-1,000	-1,000	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
339--4	14	15	1	1	0	0	0	-1,000	-1,000	99	0	0	0	0	0	4	6	8	0	0	0	0	0	0	0	0	0	0	0
340--4	14	16	1	1	0	0	0	-1,000	-1,000	99	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0
341--4	14	17	1	1	0	0	0	-1,000	-1,000	99	1	1	0	0	0	4	0	0	8	18	0	0	0	0	0	0	0	0	0
342--4	14	18	1	1	0	0	0	-1,000	-1,000	99	1	1	0	0	0	5	4	5	0	0	0	0	0	0	0	0	0	0	0
343--4	14	19	1	1	0	0	0	-1,000	-1,000	0	2	2	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
344--4	14	20	1	1	0	0	0	-1,000	-1,000	99	0	0	0	0	0	3	6	8	0	0	0	0	0	0	0	0	0	0	0
345--4	14	21	1	1	0	0	0	-1,000	-1,000	99	0	0	0	0	0	3	6	8	4	0	0	0	0	0	0	0	0	0	0
346--4	14	22	1	1	0	0	0	-1,000	-1,000	99	1	1	0	0	0	7	14	0	0	7	6	18	0	0	0	0	0	0	0
347--4	14	23	1	1	0	0	0	-1,000	-1,000	99	1	1	0	0	0	6	14	27	0	0	0	0	0	0	0	0	0	0	0
348--4	14	24	1	1	0	0	0	-1,000	-1,000	0	1	1	0	0	0	0	0	0	0	7	6	18	0	0	0	0	0	0	0

Table A1 (Cont.)

1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	
349--4	14	25	1	1	0	0	0	-1,000	-1,000	99	99	2	2	0	0	0	0	0	0	0	0	7	6	18	7	1	0	0	0	0
350--4	14	26	1	1	0	0	0	-1,000	-1,000	99	99	3	1	0	0	0	0	0	0	0	0	4	0	8	0	0	0	0	0	0
351--4	14	27	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0
352--4	14	28	1	1	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	0	0	0	0	4	0	4	0	0	0	0	0	0
353--4	14	29	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	0	0	0	0	0	5	0	5	0	0	0	0	0	0
354--4	14	30	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	5	0	5	0	0	0	0	0	0
355--4	14	31	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
356--4	15	1	1	3	0	0	0	-1,000	-1,000	99	99	1	3	0	4	3	7	5	8	0	0	0	0	0	0	0	0	0	0	0
357--4	15	2	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	5	1	1	0	0	0	0	0	0	0	0	0	0	0
358--4	15	3	1	3	0	0	0	-1,000	-1,000	99	99	1	2	0	0	0	3	7	8	0	0	0	0	0	0	0	0	0	0	0
359--4	15	4	1	3	0	0	3	8,000	2,000	99	99	1	1	0	0	0	3	6	5	0	0	0	0	0	0	0	0	0	0	0
360--4	15	5	1	3	0	0	1	5,000	3,500	99	99	1	1	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0
361--4	15	6	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
362--4	15	7	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	4	6	5	8	0	0	0	0	0	0	0	0	0	0
363--4	15	8	1	3	0	0	2	4,500	3,000	99	99	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
364--4	15	9	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	3	6	1	0	0	0	0	0	0	0	0	0	0	0
365--4	15	10	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	4	2	6	8	5	0	0	0	0	0	0	0	0	0	0	0
366--4	15	11	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
367--4	15	12	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
368--4	15	13	1	3	0	0	0	-1,000	-1,000	99	99	1	2	0	0	0	4	1	9	5	0	0	0	0	0	0	0	0	0	0
369--4	15	14	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	7	2	0	0	0	0	0	0	0	0	0	0	0	0
370--4	15	15	1	3	0	0	0	-1,000	-1,000	99	99	0	0	1	0	4	3	6	8	0	0	0	0	0	0	0	0	0	0	0
371--4	15	16	1	3	0	0	1	4,000	3,000	99	99	2	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
372--4	15	17	1	3	0	0	1	3,000	2,000	99	99	1	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
373--4	15	18	1	3	0	0	2	3,000	3,000	99	99	1	1	0	2	4	5	1	0	8	0	0	0	0	0	0	0	0	1	5
374--4	15	19	1	3	0	0	0	-1,000	-1,000	99	99	1	1	2	0	0	4	6	0	0	0	0	0	0	0	0	0	0	0	0
375--4	15	20	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
376--4	15	21	1	3	0	0	0	-1,000	-1,000	99	99	3	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
377--4	15	22	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	6	5	0	0	0	0	0	0	0	0	0	0	0	0
378--4	15	23	1	3	0	0	2	2,750	2,500	99	99	1	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
379--4	15	24	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	4	6	0	0	0	0	0	0	0	0	0	0	0	0
380--5	16	1	1	1	0	0	0	-1,000	-1,000	99	99	3	2	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0
381--5	16	1	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0
382--5	16	2	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
383--5	16	2	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
384--5	16	3	1	1	0	0	0	-1,000	-1,000	10	99	2	1	0	0	0	5	12	0	0	0	0	0	0	0	0	0	0	0	0
385--5	16	3	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	12	0	0	0	0	0	0	0	0	0	0	0	0
386--5	16	4	1	1	0	0	2	4,000	3,000	99	99	1	1	0	0	0	6	4	0	0	0	0	0	0	0	0	0	0	0	0
387--5	16	4	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
388--5	16	5	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
389--5	16	5	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
390--5	16	6	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	5	1	1	0	0	0	0	0	0	0	0	0	0	0
391--5	16	6	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	1	1	0	0	0	0	0	0	0	0	0	0	0
392--5	16	7	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
393--5	16	7	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
394--5	16	8	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
395--5	16	8	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
396--5	16	9	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	5	22	5	0	0	0	0	0	0	0	0	0	0	0
397--5	16	9	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	22	5	0	0	0	0	0	0	0	0	0	0	0
398--5	16	10	1	1	0	0	0	-1,000	-1,000	99	99	1	3	0	0	0	6	10	5	0	0	0	0	0	0	0	0	0	0	0
399--5	16	10	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	6	10	5	0	0	0	0	0	0	0	0	0	0	0
400--5	16	11	1	1	0	0	0	-1,000	-1,000	99	99	2	3	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
401--5	16	11	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
402--5	16	12	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
403--5	16	12	2	1	0	0	0	-1,000	-1,000	99	99	3	2	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
404--5	16	13	1	1	0	0	2	3,000	2,000	99	99	2	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
405--5	16	13	2	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
406--5	16	14	1	1	0	0	0	-1,000	-1,000	10	99	2	2	4	0	0	5	12	9	0	0	0	0	0	0	0	0	0	0	0

Table A1 (Cont.)

1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
407--5	16	14	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
408--5	16	15	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
409--5	16	15	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
410--5	17	1	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
411--5	17	2	1	1	0	0	2	7,500	2,500	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
412--5	17	3	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
413--5	17	4	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
414--5	17	5	1	1	0	0	0	1,500	1,500	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
415--5	17	6	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
416--5	17	7	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
417--5	17	8	1	1	0	0	0	-1,000	-1,000	99	99	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
418--5	17	9	1	1	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
419--5	17	10	1	1	0	0	0	-1,000	-1,000	99	99	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
420--5	17	11	1	1	0	0	0	-1,000	-1,000	99	99	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
421--5	17	12	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
422--5	17	13	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
423--5	17	14	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
424--5	17	15	1	1	0	0	0	-1,000	-1,000	99	99	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
425--5	17	16	1	1	0	0	2	1,500	1,500	99	99	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
426--5	17	17	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
427--5	17	18	1	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
428--5	17	19	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
429--5	17	20	1	1	0	0	0	-1,000	-1,000	99	99	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
430--5	17	21	1	1	0	0	0	-1,000	-1,000	99	99	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
431--5	17	22	1	1	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
432--5	17	23	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
433--5	17	24	1	1	0	0	0	-1,000	-1,000	99	99	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
434--5	17	25	1	1	0	0	0	-1,000	-1,000	99	99	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
435--5	17	26	1	1	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
436--5	17	27	1	1	0	0	5	2,500	2,000	99	99	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
437--5	17	28	1	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
438--5	18	1	3	0	0	0	0	-1,000	-1,000	5	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
439--5	18	2	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
440--5	18	3	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
441--5	18	4	1	3	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
442--5	18	5	1	3	0	0	0	-1,000	-1,000	99	99	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
443--5	18	6	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
444--5	18	7	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
445--5	18	8	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
446--5	18	9	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
447--5	18	10	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
448--5	18	11	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
449--5	18	12	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
450--5	18	13	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
451--5	18	14	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
452--5	18	15	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
453--5	18	16	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
454--5	18	17	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
455--5	18	18	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
456--5	18	19	1	3	0	0	2	2,000	2,000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
457--5	18	20	1	3	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
458--5	18	21	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
459--5	18	22	1	3	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
460--5	18	23	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
461--5	18	24	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
462--5	18	25	1	3	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
463--5	18	26	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
464--5	18	27	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A1 (Cont.)

	1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	
465--5.	18.	28.	1.	3.	0.	0.	0.	0.	-1.000	-1.000	99.	99.	0.	0.	0.	0.	0.	4.	0.	0.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
466--5.	18.	29.	1.	3.	0.	0.	0.	0.	-1.000	-1.000	99.	99.	0.	0.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
467--5.	18.	30.	1.	3.	0.	0.	0.	0.	-1.000	-1.000	0.	0.	0.	0.	0.	0.	0.	4.	0.	0.	7.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Table A1 (Cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
1--6	19.	1.	1.	1.	3.	24.	0.	4.	12.	5.48	11.125	11.063	3.938	3.750	12.	11.	0.	0.	0.	0.	11.	33.	0.	0.
2--6	15.	2.	1.	2.	2.	24.	0.	4.	12.	9.44	11.375	11.438	3.313	3.500	11.	11.	0.	4.	3.	4.	11.	33.	0.	0.
3--6	19.	3.	1.	2.	2.	24.	0.	4.	12.	9.46	11.439	11.375	3.500	3.500	15.	11.	0.	6.	4.	3.	11.	33.	0.	0.
4--6	15.	4.	1.	2.	2.	24.	0.	4.	12.	9.44	11.250	11.250	3.625	3.625	14.	15.	0.	0.	0.	0.	11.	33.	0.	0.
5--6	19.	5.	1.	3.	24.	0.	4.	12.	5.27	11.375	11.500	3.500	3.500	3.625	15.	15.	0.	0.	0.	0.	11.	33.	0.	0.
6--6	15.	6.	1.	3.	24.	0.	4.	12.	10.79	11.928	12.000	3.938	3.938	3.750	10.	14.	0.	0.	0.	0.	4.	33.	0.	0.
7--6	19.	7.	1.	3.	24.	0.	4.	12.	9.48	11.813	11.750	3.875	3.875	3.875	14.	15.	0.	0.	0.	0.	4.	33.	0.	0.
8--6	15.	8.	1.	3.	24.	0.	4.	12.	7.42	11.375	11.500	3.375	3.375	3.500	16.	19.	0.	3.	4.	5.	9.	33.	0.	0.
9--6	19.	9.	1.	3.	24.	0.	4.	12.	7.41	11.500	11.563	3.750	3.750	3.750	16.	15.	0.	0.	0.	0.	12.	33.	0.	0.
10--6	15.	10.	1.	3.	24.	0.	4.	12.	10.64	11.750	11.688	3.813	3.813	3.750	28.	25.	0.	0.	0.	0.	6.	33.	0.	0.
11--6	15.	11.	1.	3.	24.	0.	4.	12.	9.44	11.625	11.438	3.500	3.500	3.688	99.	27.	0.	0.	0.	0.	12.	50.	0.	0.
12--6	19.	12.	1.	3.	24.	0.	4.	12.	9.43	11.563	11.563	3.563	3.563	3.750	99.	27.	0.	0.	0.	0.	5.	40.	0.	0.
13--6	15.	13.	1.	3.	24.	0.	4.	12.	9.47	11.563	11.563	3.625	3.625	3.813	99.	99.	0.	0.	0.	0.	0.	0.	0.	0.
14--6	15.	14.	1.	3.	24.	0.	4.	12.	9.44	11.813	12.000	3.813	3.813	3.750	59.	99.	0.	0.	0.	0.	0.	0.	0.	0.
15--6	15.	15.	1.	3.	24.	0.	4.	12.	9.43	11.500	11.688	3.625	3.625	3.625	59.	99.	0.	0.	0.	0.	15.	33.	0.	0.
16--6	19.	16.	1.	3.	24.	0.	4.	12.	9.48	12.000	11.875	3.375	3.375	3.750	59.	99.	0.	0.	0.	0.	8.	33.	0.	0.
17--6	15.	17.	1.	3.	24.	0.	4.	12.	7.46	11.688	11.625	3.750	3.750	3.625	59.	99.	0.	0.	0.	0.	12.	33.	0.	0.
18--6	15.	18.	1.	3.	24.	0.	4.	12.	9.45	11.688	11.375	3.625	3.625	3.813	99.	99.	0.	0.	0.	0.	0.	0.	0.	0.
19--6	15.	19.	1.	3.	24.	0.	4.	12.	9.47	12.125	11.813	3.750	3.750	3.625	99.	99.	0.	0.	0.	0.	12.	33.	0.	0.
20--6	15.	20.	1.	3.	24.	0.	4.	12.	7.71	11.875	11.688	3.688	3.688	3.625	55.	99.	0.	1.	2.	1.	16.	50.	0.	0.
21--6	19.	21.	1.	3.	24.	0.	4.	12.	7.44	11.625	11.625	3.625	3.625	3.563	99.	99.	0.	0.	0.	0.	12.	50.	0.	0.
22--6	15.	22.	1.	3.	24.	0.	4.	12.	10.13	11.375	11.750	3.375	3.375	3.500	16.	99.	0.	0.	0.	0.	12.	33.	0.	0.
23--6	19.	23.	1.	3.	24.	0.	4.	12.	9.42	11.875	12.063	3.625	3.625	3.625	17.	99.	0.	0.	0.	0.	14.	50.	0.	0.
24--6	15.	24.	1.	3.	24.	0.	4.	12.	7.42	11.500	11.750	3.688	3.688	3.563	99.	99.	0.	0.	0.	0.	12.	50.	0.	0.
25--6	15.	25.	1.	3.	24.	0.	4.	12.	8.13	11.688	11.563	3.625	3.625	3.625	59.	99.	0.	0.	0.	0.	9.	25.	0.	0.
26--6	15.	26.	1.	3.	24.	0.	4.	12.	9.46	11.750	11.563	3.750	3.750	3.625	55.	99.	0.	0.	0.	0.	12.	33.	0.	0.
27--6	19.	27.	1.	3.	24.	0.	4.	12.	7.42	11.563	11.375	3.625	3.625	3.563	99.	99.	0.	0.	0.	0.	10.	50.	0.	0.
28--6	15.	28.	1.	3.	24.	0.	4.	12.	7.42	11.813	11.825	3.063	3.063	3.500	59.	99.	0.	0.	0.	0.	16.	50.	0.	0.
29--6	15.	29.	1.	3.	24.	0.	4.	12.	7.42	11.688	11.625	3.625	3.625	3.375	95.	20.	0.	0.	0.	0.	15.	33.	0.	0.
30--6	15.	30.	1.	3.	24.	0.	4.	12.	9.42	11.313	11.063	3.563	3.563	3.625	20.	14.	0.	0.	0.	0.	8.	25.	0.	0.
31--6	20.	1.	1.	1.	24.	2.	8.	8.	20.35	7.875	7.875	7.875	8.000	7.813	55.	99.	5.	0.	0.	0.	4.	33.	0.	0.
32--6	20.	1.	2.	1.	24.	2.	8.	8.	10.00	7.875	7.875	7.875	8.000	7.813	0.	0.	0.	0.	0.	0.	4.	33.	0.	0.
33--6	20.	1.	3.	1.	24.	2.	8.	8.	10.00	7.875	7.875	7.875	8.000	7.813	0.	0.	0.	0.	0.	0.	4.	33.	0.	0.
34--6	20.	2.	1.	24.	2.	8.	8.	20.27	8.000	8.000	8.000	7.875	8.125	30.	29.	5.	0.	0.	0.	0.	8.	33.	0.	0.
35--6	20.	2.	2.	1.	24.	2.	8.	8.	10.00	8.000	8.000	7.875	8.125	0.	0.	0.	0.	0.	0.	0.	8.	33.	0.	0.
36--6	20.	2.	3.	1.	24.	2.	8.	8.	10.00	9.000	8.000	7.875	8.125	0.	0.	0.	0.	0.	0.	0.	8.	33.	0.	0.
37--6	20.	3.	1.	1.	24.	2.	8.	8.	20.29	7.875	7.875	7.875	7.938	7.813	59.	99.	3.	0.	0.	0.	8.	33.	0.	0.
38--6	20.	3.	2.	1.	24.	2.	8.	8.	10.00	7.875	7.875	7.875	7.938	7.813	0.	0.	0.	0.	0.	0.	8.	33.	0.	0.
39--6	20.	3.	3.	1.	24.	2.	8.	8.	10.00	7.875	7.875	7.875	7.938	7.813	0.	0.	0.	0.	0.	0.	8.	33.	0.	0.
40--6	20.	4.	1.	1.	24.	2.	8.	8.	20.35	7.875	7.875	7.875	7.875	7.875	28.	30.	3.	0.	0.	0.	20.	50.	0.	0.
41--6	20.	4.	2.	1.	24.	2.	8.	8.	10.00	7.875	7.875	7.875	7.875	7.875	0.	0.	0.	0.	0.	0.	20.	50.	0.	0.
42--6	20.	4.	3.	1.	24.	2.	8.	8.	10.00	7.875	7.875	7.875	7.875	7.875	0.	0.	0.	0.	0.	0.	20.	50.	0.	0.
43--6	20.	5.	1.	1.	24.	2.	8.	8.	20.31	7.875	7.875	7.750	7.875	7.625	99.	99.	5.	0.	0.	0.	4.	66.	0.	0.
44--6	20.	5.	2.	1.	24.	2.	8.	8.	10.00	7.875	7.875	7.750	7.875	7.625	0.	0.	0.	0.	0.	0.	4.	66.	0.	0.
45--6	20.	5.	3.	1.	24.	2.	8.	8.	10.00	7.875	7.875	7.750	7.875	7.625	0.	0.	0.	0.	0.	0.	4.	66.	0.	0.

Table A1 (Cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
46--6	20	6	1	1	24	0	8	20	25	7	8	8	7	9	9	5	0	0	0	20	50	0	0	
47--6	20	6	2	1	24	0	8	10	00	7	8	8	7	9	9	5	0	0	0	20	50	0	0	
48--6	20	6	3	1	24	0	8	10	00	7	8	8	7	9	9	5	0	0	0	20	50	0	0	
49--6	20	7	1	1	24	2	8	10	00	7	7	50	7	8	7	25	5	0	0	20	50	0	0	
50--6	20	7	2	1	24	2	8	10	00	7	7	50	7	8	7	25	5	0	0	20	50	0	0	
51--6	20	7	3	1	24	2	8	10	00	7	7	50	7	8	7	25	5	0	0	20	50	0	0	
52--6	20	8	1	1	24	2	8	20	38	7	8	7	7	8	8	99	5	0	0	20	50	0	0	
53--6	20	8	2	1	24	2	8	10	00	7	8	7	7	8	8	0	0	0	0	8	33	0	0	
54--6	20	8	3	1	24	2	8	10	00	7	8	7	7	8	8	0	0	0	0	8	33	0	0	
55--6	20	9	1	1	24	2	8	20	29	7	8	8	7	9	9	3	0	0	0	20	50	0	0	
56--6	20	5	2	1	24	2	8	10	00	7	9	3	8	0	0	0	0	0	0	20	50	0	0	
57--6	20	9	3	1	24	2	8	10	00	7	9	3	8	0	0	0	0	0	0	20	50	0	0	
58--6	20	10	1	1	24	2	8	20	40	7	9	3	8	0	0	0	0	0	0	12	66	0	0	
59--6	20	10	2	1	24	2	8	10	00	7	9	3	8	0	0	0	0	0	0	12	66	0	0	
60--6	20	10	3	1	24	2	8	10	00	7	9	3	8	0	0	0	0	0	0	12	66	0	0	
61--6	20	11	1	1	24	2	8	20	38	7	8	7	8	8	0	0	0	0	0	12	33	0	0	
62--6	20	11	2	1	24	2	8	10	00	7	8	7	8	8	0	0	0	0	0	12	33	0	0	
63--6	20	11	3	1	24	2	8	10	00	7	8	7	8	8	0	0	0	0	0	12	33	0	0	
64--6	20	12	1	1	24	2	8	20	29	8	0	0	0	0	0	0	0	0	0	16	50	0	0	
65--6	20	12	2	1	24	2	8	10	00	8	0	0	0	0	0	0	0	0	0	16	50	0	0	
66--6	20	12	3	1	24	2	8	10	00	8	0	0	0	0	0	0	0	0	0	16	50	0	0	
67--6	20	13	1	1	24	2	8	20	38	7	9	3	8	0	0	0	0	0	0	12	50	0	0	
68--6	20	13	2	1	24	2	8	10	00	7	9	3	8	0	0	0	0	0	0	12	50	0	0	
69--6	20	13	3	1	24	2	8	10	00	7	9	3	8	0	0	0	0	0	0	12	50	0	0	
70--6	20	14	1	1	24	2	8	20	38	7	8	7	8	8	0	0	0	0	0	16	50	0	0	
71--6	20	14	2	1	24	2	8	10	00	7	8	7	8	8	0	0	0	0	0	16	50	0	0	
72--6	20	14	3	1	24	2	8	10	00	7	8	7	8	8	0	0	0	0	0	16	50	0	0	
73--6	20	15	1	1	24	2	8	20	29	7	8	7	8	8	0	0	0	0	0	6	33	0	0	
74--6	20	15	2	1	24	2	8	10	00	7	8	7	8	8	0	0	0	0	0	6	33	0	0	
75--6	20	15	3	1	24	2	8	10	00	7	8	7	8	8	0	0	0	0	0	6	33	0	0	
76--6	20	16	1	1	24	2	8	20	29	7	8	7	8	8	0	0	0	0	0	4	33	0	0	
77--6	20	16	2	1	24	2	8	10	00	7	9	3	8	0	0	0	0	0	0	4	33	0	0	
78--6	20	16	3	1	24	2	8	10	00	7	9	3	8	0	0	0	0	0	0	4	33	0	0	
79--6	20	1	1	1	24	2	6	6	20	35	6	0	6	0	0	0	0	0	0	1	20	33	0	0
80--6	20	1	2	1	24	2	6	6	10	00	6	0	6	0	0	0	0	0	0	20	33	0	0	
81--6	20	1	3	1	24	2	6	6	10	00	6	0	6	0	0	0	0	0	0	20	33	0	0	
82--6	20	2	1	1	24	2	6	6	20	38	5	9	5	8	7	25	1	0	0	0	20	50	0	0
83--6	20	2	2	1	24	2	6	6	10	00	5	9	5	8	7	25	1	0	0	0	20	50	0	0
84--6	20	2	3	1	24	2	6	6	10	00	5	9	5	8	7	25	1	0	0	0	20	50	0	0
85--6	20	3	1	1	24	2	6	6	20	34	5	9	5	8	7	99	5	0	0	0	20	50	0	0
86--6	20	3	2	1	24	2	6	6	10	00	5	9	5	8	7	99	5	0	0	0	20	50	0	0
87--6	20	3	3	1	24	2	6	6	10	00	5	9	5	8	7	99	5	0	0	0	20	50	0	0
88--6	20	4	1	1	24	2	6	6	20	35	5	9	5	8	7	99	28	0	0	0	15	50	0	0
89--6	20	4	2	1	24	2	6	6	10	00	5	9	5	8	7	99	28	0	0	0	15	50	0	0
90--6	20	4	3	1	24	2	6	6	10	00	5	9	5	8	7	99	28	0	0	0	15	50	0	0
91--6	20	5	1	1	24	2	6	6	20	38	5	9	5	8	7	99	5	0	0	0	9	33	0	0
92--6	20	5	2	1	24	2	6	6	10	00	5	9	5	8	7	99	5	0	0	0	9	33	0	0
93--6	20	5	3	1	24	2	6	6	10	00	5	9	5	8	7	99	5	0	0	0	9	33	0	0
94--6	20	6	1	1	24	2	6	6	20	38	5	8	6	0	0	0	0	0	0	0	9	33	0	0
95--6	20	6	2	1	24	2	6	6	10	00	5	8	6	0	0	0	0	0	0	0	9	33	0	0
96--6	20	6	3	1	24	2	6	6	10	00	5	8	6	0	0	0	0	0	0	0	9	33	0	0
97--6	20	7	1	1	24	2	6	6	20	40	6	0	0	0	0	0	0	0	0	0	20	50	0	0
98--6	20	7	2	1	24	2	6	6	10	00	6	0	0	0	0	0	0	0	0	0	20	50	0	0
99--6	20	7	3	1	24	2	6	6	10	00	6	0	0	0	0	0	0	0	0	0	20	50	0	0
100--6	20	8	1	1	24	2	6	6	20	38	6	0	0	0	0	0	0	0	0	0	18	33	0	0
101--6	20	8	2	1	24	2	6	6	10	00	6	0	0	0	0	0	0	0	0	0	18	33	0	0
102--6	20	8	3	1	24	2	6	6	10	00	6	0	0	0	0	0	0	0	0	0	18	33	0	0
103--6	20	9	1	1	24	2	6	6	20	39	6	0	0	0	0	0	0	0	0	0	12	33	0	0

Table A1 (Cont.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
104--6	21	9	2	1	24	2	6	6	10.00	6.000	6.000	5.875	6.000	6.000	0	0	0	0	12.33	0	0	0
105--6	21	9	3	1	24	2	6	6	10.00	6.000	6.000	5.875	6.000	6.000	0	0	0	0	12.33	0	0	0
106--6	21	10	1	1	24	2	6	6	20.35	6.000	5.938	6.000	5.875	99	99	0	0	0	0	12.33	0	0
107--6	21	10	2	1	24	2	6	6	10.00	6.000	5.938	6.000	5.875	0	0	0	0	0	0	12.33	0	0
108--6	21	10	3	1	24	2	6	6	10.00	6.000	5.938	6.000	5.875	0	0	0	0	0	0	12.33	0	0
109--6	21	11	1	1	24	2	6	6	20.36	6.000	6.000	5.875	5.813	99	99	4	0	0	0	12.33	0	0
110--6	21	11	2	1	24	2	6	6	10.00	6.000	6.000	5.875	5.813	0	0	0	0	0	0	12.33	0	0
111--6	21	11	3	1	24	2	6	6	10.00	6.000	6.000	5.875	5.813	0	0	0	0	0	0	12.33	0	0
112--6	21	12	1	1	24	2	6	6	20.33	6.063	5.813	6.000	5.875	99	99	0	3	1	5	33	0	0
113--6	21	12	2	1	24	2	6	6	10.00	6.063	5.813	6.000	5.875	0	0	0	0	0	0	5.33	0	0
114--6	21	12	3	1	24	2	6	6	10.00	6.063	5.813	6.000	5.875	0	0	0	0	0	0	5.30	0	0
115--6	21	13	1	1	24	2	6	6	20.36	6.000	6.000	5.875	5.875	99	99	4	1	1	12	50	0	0
116--6	21	13	2	1	24	2	6	6	10.00	6.000	6.000	5.875	5.875	0	0	0	0	0	0	12.50	0	0
117--6	21	13	3	1	24	2	6	6	10.00	6.000	6.000	5.875	5.875	0	0	0	0	0	0	12.50	0	0
118--6	21	14	1	1	24	2	6	6	20.36	6.000	5.938	6.000	5.875	99	99	5	0	0	0	8.33	0	0
119--6	21	14	2	1	24	2	6	6	10.00	6.000	5.938	6.000	5.875	0	0	0	0	0	0	8.33	0	0
120--6	21	14	3	1	24	2	6	6	10.00	6.000	5.938	6.000	5.875	0	0	0	0	0	0	8.33	0	0
121--6	21	15	1	1	24	2	6	6	20.35	5.938	5.813	5.938	5.875	99	99	0	0	0	0	10.33	0	0
122--6	21	15	2	1	24	2	6	6	10.00	5.938	5.813	5.938	5.875	0	0	0	0	0	0	10.33	0	0
123--6	21	15	3	1	24	2	6	6	10.00	5.938	5.813	5.938	5.875	0	0	0	0	0	0	10.33	0	0
124--6	21	16	1	1	24	2	6	6	20.34	5.813	5.875	5.938	5.875	29	99	4	0	0	0	18.33	0	0
125--6	21	16	2	1	24	2	6	6	10.00	5.813	5.875	5.938	5.875	0	0	0	0	0	0	18.33	0	0
126--6	21	16	3	1	24	2	6	6	10.00	5.813	5.875	5.938	5.875	0	0	0	0	0	0	18.33	0	0
127--6	21	17	1	1	24	2	6	6	20.33	6.000	5.938	5.938	6.063	99	99	4	0	0	0	12.50	0	0
128--6	21	17	2	1	24	2	6	6	10.00	6.000	5.938	5.938	6.063	0	0	0	0	0	0	12.50	0	0
129--6	21	17	3	1	24	2	6	6	10.00	6.000	5.938	5.938	6.063	0	0	0	0	0	0	12.50	0	0
130--6	21	18	1	1	24	2	6	6	20.34	6.000	6.000	5.938	6.063	99	99	5	0	0	0	10.33	0	0
131--6	21	18	2	1	24	2	6	6	10.00	6.000	6.000	5.938	6.063	0	0	0	0	0	0	10.33	0	0
132--6	21	18	3	1	24	2	6	6	10.00	6.000	6.000	5.938	6.063	0	0	0	0	0	0	10.33	0	0
133--6	21	19	1	1	24	2	6	6	20.34	5.875	5.750	5.750	5.750	24	25	4	0	0	0	20.33	0	0
134--6	21	19	2	1	24	2	6	6	10.00	5.875	6.000	5.750	5.750	0	0	0	0	0	0	20.33	0	0
135--6	21	19	3	1	24	2	6	6	10.00	5.875	6.000	5.750	5.750	0	0	0	0	0	0	20.33	0	0
136--6	21	20	1	1	24	2	6	6	20.38	5.750	6.125	5.125	5.813	24	28	5	0	0	0	20.33	0	0
137--6	21	20	2	1	24	2	6	6	10.00	5.750	6.125	5.125	5.813	0	0	0	0	0	0	20.33	0	0
138--6	21	20	3	1	24	2	6	6	10.00	5.750	6.125	5.125	5.813	0	0	0	0	0	0	20.33	0	0
139--6	21	21	1	1	24	2	6	6	20.38	5.875	5.938	5.875	5.875	22	22	4	0	0	0	20.33	0	0
140--6	21	21	2	1	24	2	6	6	10.00	5.875	5.938	5.875	5.875	0	0	0	0	0	0	20.33	0	0
141--6	21	21	3	1	24	2	6	6	10.00	5.875	5.938	5.875	5.875	0	0	0	0	0	0	20.33	0	0
142--7	22	1	1	3	24	2	3	12	16.00	11.750	11.688	2.500	2.500	19	17	7	0	0	0	4.20	0	0
143--7	22	2	1	3	24	2	3	12	16.21	11.688	11.813	2.625	2.750	20	20	0	0	0	0	4.33	0	0
144--7	22	3	1	3	24	2	3	12	16.03	11.563	11.563	2.875	2.875	18	18	0	0	0	0	15.33	0	0
145--7	22	4	1	3	24	2	3	12	16.01	11.688	11.438	2.438	2.438	18	21	7	0	0	0	11.25	0	0
146--7	22	5	1	3	24	2	3	12	16.17	11.750	11.875	2.563	2.438	21	21	7	1	4	4	20.33	0	0
147--7	22	6	1	3	24	2	3	12	16.00	11.625	11.750	2.875	3.000	16	23	7	0	0	0	15.33	0	0
148--7	22	7	1	3	24	2	3	12	16.03	11.563	11.563	2.875	2.875	18	18	0	0	0	0	15.33	0	0
149--7	22	8	1	3	24	2	3	12	16.11	11.688	11.750	2.875	2.875	23	26	0	0	0	0	15.33	0	0
150--7	22	9	1	3	24	2	3	12	16.00	11.625	11.750	2.625	2.625	18	22	7	0	0	0	4.33	0	0
151--7	22	10	1	3	24	2	3	12	16.00	11.688	11.875	2.875	2.875	21	22	7	0	0	0	15.33	0	0
152--7	22	11	1	3	24	2	3	12	16.00	11.875	11.875	3.000	3.000	27	28	7	0	0	0	6.25	0	0
153--7	22	12	1	3	24	2	3	12	16.00	11.875	11.875	2.813	2.813	25	28	7	0	0	0	9.25	0	0
154--7	22	13	1	3	24	2	3	12	16.11	11.688	11.750	2.875	2.875	21	20	0	1	2	15	33	0	0
155--7	22	14	1	3	24	2	3	12	16.06	11.938	11.813	2.875	2.875	22	22	7	0	0	0	6.25	0	0
156--7	22	15	1	3	24	2	3	12	16.00	11.750	11.813	2.625	2.625	28	28	7	0	0	0	8.50	0	0
157--7	22	16	1	3	24	2	3	12	16.00	11.875	11.875	2.813	2.813	24	28	7	0	0	0	9.33	0	0
158--7	22	17	1	3	24	2	3	12	16.00	11.813	11.875	2.875	2.875	21	22	7	1	2	20	33	0	0
159--7	22	18	1	3	24	2	3	12	16.32	11.750	11.875	2.813	2.813	26	21	24	0	0	0	12.33	0	0
160--7	22	19	1	3	24	2	3	12	16.17	11.875	11.875	3.000	3.125	21	28	7	0	0	0	15.25	0	0
161--7	22	20	1	3	24	2	3	12	16.01	11.875	11.813	2.500	2.125	28	25	7	0	0	0	10.33	0	0

Table A1 (Cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
162--7	22	21	1	3	24	2	3	12	16	00	11.750	11.750	2.750	2.813	24	24	7	0	0	0	14	33	0	0
163--7	22	22	1	3	24	2	3	12	15.98	11.875	12.000	3.000	3.063	21	21	0	1	3	3	10	33	0	0	
164--7	22	23	1	3	24	2	3	12	16.00	11.875	11.938	2.813	3.000	27	24	7	0	0	0	12	33	0	0	
165--7	22	24	1	3	24	2	3	12	16.00	11.750	11.938	3.125	3.125	25	25	9	0	0	0	10	33	0	0	
166--7	22	25	1	3	24	2	3	12	16.00	11.875	12.125	2.625	2.625	26	23	9	0	0	0	12	33	0	0	
167--7	22	26	1	3	24	2	3	12	16.00	11.625	11.750	2.625	2.625	30	26	23	9	0	0	0	20	33	0	0
168--7	22	27	1	3	24	2	3	12	16.17	11.750	11.875	2.875	2.875	28	28	8	0	0	0	18	33	0	0	
169--7	22	28	1	3	24	2	3	12	16.00	11.875	11.938	2.648	2.648	26	30	9	0	0	0	9	33	0	0	
170--7	22	29	1	3	24	2	3	12	16.25	11.813	12.000	2.875	2.875	30	28	30	8	0	0	0	18	33	0	0
171--7	22	30	1	3	24	2	3	12	16.00	11.875	12.000	2.625	2.625	27	30	8	0	0	0	20	33	0	0	
172--7	22	31	1	3	24	2	3	12	16.19	11.938	12.000	2.625	2.625	27	27	9	0	0	0	12	33	0	0	
173--7	22	32	1	3	24	2	3	12	16.31	11.813	11.750	2.625	2.625	27	27	9	0	0	0	15	33	0	0	
174--7	22	33	1	3	24	2	3	12	15.99	11.938	12.000	3.000	3.000	30	30	9	0	0	0	18	33	0	0	
175--7	22	34	1	3	24	2	3	12	16.02	11.688	11.875	2.500	2.500	25	27	9	0	0	0	20	33	0	0	
176--7	22	35	1	3	24	2	3	12	16.02	11.875	11.938	2.875	2.875	25	27	9	1	1	2	18	33	0	0	
177--8	23	1	1	3	24	2	4	12	8.00	11.875	11.750	3.375	3.813	12	12	0	0	0	0	15	33	0	0	
178--8	23	2	1	3	24	2	4	12	8.42	11.375	11.313	3.438	3.750	25	24	0	0	0	0	15	33	0	0	
179--8	23	3	1	3	24	2	4	10	8.31	9.750	9.875	3.875	3.938	25	26	0	0	0	0	16	33	0	0	
180--8	23	4	1	3	24	2	4	12	6.25	11.938	11.688	3.875	3.750	20	18	0	0	0	0	12	33	0	0	
181--8	23	5	1	3	24	2	4	12	8.00	5.750	9.438	3.938	3.938	19	18	0	0	0	0	15	33	0	0	
182--8	23	6	1	3	24	2	4	10	7.04	5.750	9.688	3.750	3.750	19	22	0	0	0	0	25	33	0	0	
183--8	23	7	1	3	24	2	4	10	8.00	9.750	9.750	4.000	4.000	16	19	0	0	0	0	20	33	0	0	
184--8	23	8	1	3	24	2	4	10	8.02	9.750	9.750	4.063	4.063	20	19	0	0	0	0	20	33	0	0	
185--8	23	9	1	3	24	2	4	10	8.00	5.750	9.750	3.938	3.938	22	24	0	0	0	0	20	33	0	0	
186--8	23	10	1	3	24	2	4	10	12.54	9.938	9.750	3.875	3.938	16	16	0	0	0	0	25	33	0	0	
187--8	23	11	1	3	24	2	4	10	12.13	9.625	9.625	4.000	4.125	14	13	0	0	0	0	20	33	0	0	
188--8	23	12	1	3	24	2	4	10	18.13	9.750	9.750	3.875	3.875	18	21	0	0	0	0	15	33	0	0	
189--8	23	13	1	3	24	2	4	12	18.25	9.750	9.875	3.938	3.938	13	17	0	0	0	0	16	33	0	0	
190--8	23	14	1	3	24	2	4	10	18.23	9.875	10.000	4.000	4.000	24	23	0	0	0	0	20	33	0	0	
191--8	23	15	1	3	24	2	4	10	18.25	9.813	9.750	3.938	4.000	21	23	0	0	0	0	18	33	0	0	
192--8	23	16	1	3	24	2	4	10	18.17	5.750	9.938	3.750	3.813	26	16	0	0	0	0	16	33	0	0	
193--8	23	17	1	3	24	2	4	10	18.23	9.875	9.875	3.875	3.875	25	18	0	0	0	0	20	33	0	0	
194--8	23	18	1	3	24	2	4	10	16.21	10.000	10.000	3.938	4.000	20	19	0	0	0	0	12	33	0	0	
195--8	23	19	1	3	24	2	4	10	18.25	9.625	9.875	4.000	3.938	20	25	0	0	0	0	18	33	0	0	
196--8	23	20	1	3	24	2	4	10	18.33	9.813	9.750	3.875	3.750	16	28	0	0	0	0	25	33	0	0	
197--8	24	1	1	2	24	2	2	8	6.17	8.000	7.813	8.500	8.063	15	0	0	1	6	1	7	33	0	0	
198--8	24	2	1	2	24	2	2	8	6.42	7.563	7.625	7.625	7.750	13	0	0	0	0	0	12	33	0	0	
199--8	24	3	1	2	24	2	2	8	6.73	8.063	8.000	7.938	7.875	16	0	0	0	0	0	4	33	0	0	
200--8	24	4	1	2	24	2	2	8	5.75	8.125	8.000	8.250	8.438	13	0	0	1	6	1	15	50	0	0	
201--8	24	5	1	2	24	2	2	8	7.81	7.750	7.750	7.938	7.938	12	0	0	0	0	0	8	33	0	0	
202--8	24	6	1	2	24	2	2	8	7.54	8.000	8.000	7.875	8.000	12	0	0	1	2	1	4	20	0	0	
203--8	24	7	1	2	24	2	2	8	5.00	7.563	7.875	8.125	8.000	16	0	0	0	0	0	8	33	0	0	
204--8	24	8	1	2	24	2	2	8	6.55	7.938	8.000	7.563	7.500	17	0	0	0	0	0	14	33	0	0	
205--8	24	9	1	2	24	2	2	8	6.54	8.250	8.125	7.875	8.000	16	0	0	0	0	0	4	20	0	0	
206--8	24	10	1	2	24	2	2	8	6.54	8.000	7.625	7.875	7.875	12	0	0	1	4	1	20	33	0	0	
207--8	24	11	1	2	24	2	2	8	8.21	8.000	7.750	7.750	7.625	12	0	0	0	0	0	6	20	0	0	
208--8	24	12	1	1	24	2	2	8	12.33	8.250	8.250	7.875	7.875	14	13	0	0	0	0	7	25	0	0	
209--8	24	13	1	1	24	2	2	8	12.00	8.125	8.063	8.000	7.813	15	13	9	2	2	12	33	0	0		
210--8	24	14	1	1	24	2	2	8	12.58	8.000	7.938	7.875	8.000	17	13	0	0	0	0	4	25	0	0	
211--8	24	15	1	1	24	2	2	8	11.92	7.875	7.813	8.375	8.313	17	17	0	0	0	0	5	33	0	0	
212--8	24	16	1	1	24	2	2	8	12.00	8.125	8.125	7.875	7.875	16	17	0	0	0	0	12	33	0	0	
213--8	24	17	1	1	24	2	2	8	11.96	7.875	7.875	7.750	7.750	14	16	0	0	0	0	6	33	0	0	
214--8	24	18	1	1	24	2	2	8	11.98	7.875	7.750	8.000	7.875	17	16	0	0	0	0	8	33	0	0	
215--8	24	19	1	1	24	2	2	8	12.00	7.875	7.938	8.000	7.875	13	15	0	0	0	0	3	25	0	0	
216--8	24	20	1	1	24	2	2	8	11.56	7.938	7.875	7.875	7.750	11	11	0	0	0	0	4	20	0	0	
217--8	24	21	1	1	24	2	2	8	13.54	7.625	8.000	7.875	7.875	11	11	0	2	2	1	8	33	0	0	
218--8	24	22	1	1	24	2	2	8	14.29	7.875	7.750	8.000	8.125	15	17	0	1	1	1	6	50	0	0	
219--8	24	23	1	1	24	2	2	8	13.60	7.875	8.000	8.000	7.938	16	13	0	0	0	0	9	33	0	0	

Table A1 (Cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
220--8	24	24	24	1	1	24	2	8	8	13.54	7.813	7.938	7.875	7.688	16	15	0	0	0	0	6	50	0	0
221--8	24	25	1	1	24	2	8	8	8	13.81	8.250	8.000	8.000	8.000	20	14	0	0	0	0	4	50	0	0
222--8	25	1	1	3	24	2	3	12	13.08	11.125	11.500	3.000	3.000	2.875	12	12	0	0	0	0	9	33	0	0
223--8	25	2	1	3	24	2	3	12	13.21	11.563	11.750	2.750	2.750	2.563	12	12	0	0	0	0	8	33	0	0
224--8	25	3	1	3	24	2	3	12	12.58	11.500	11.439	2.750	2.750	2.875	11	11	0	0	0	0	6	33	0	0
225--8	25	4	1	3	24	2	3	12	12.75	11.750	11.750	2.750	2.750	2.750	16	18	0	0	0	0	6	33	0	0
226--8	25	5	1	3	24	2	3	12	13.38	11.750	11.750	2.688	2.688	2.750	16	20	0	0	0	0	4	25	0	0
227--8	25	6	1	3	24	2	3	12	12.21	11.750	11.750	3.000	3.000	3.063	19	19	0	0	0	0	6	33	0	0
228--8	25	7	1	3	24	2	3	12	12.51	11.750	11.625	2.875	2.875	3.000	21	22	0	1	1	2	7	33	0	0
229--8	25	8	1	3	24	2	3	12	12.98	11.750	11.750	2.875	2.875	2.875	22	25	0	0	0	0	7	33	0	0
230--8	25	9	1	3	24	2	3	12	13.17	11.750	11.938	2.625	2.625	2.875	19	20	0	0	0	0	20	50	0	0
231--8	25	10	1	3	24	2	3	12	12.56	12.000	12.000	3.000	3.000	3.000	22	22	0	0	0	0	12	33	0	0
232--8	25	11	1	3	24	2	3	12	12.96	11.938	11.938	2.813	2.813	2.875	22	20	0	0	0	0	8	25	0	0
233--8	25	12	1	3	24	2	3	12	12.79	11.750	11.813	2.875	2.875	2.875	17	18	0	1	1	4	5	25	0	0
234--8	25	13	1	3	24	2	3	12	12.63	12.000	12.000	2.750	2.750	3.000	18	19	0	0	0	0	15	33	0	0
235--8	25	14	1	3	24	2	3	12	13.00	11.875	11.875	2.875	2.875	2.750	20	26	0	0	0	0	9	33	0	0
236--8	25	15	1	3	24	2	3	12	11.96	11.563	11.750	2.813	2.813	2.750	18	24	0	0	0	0	5	33	0	0
237--8	25	16	1	3	24	2	3	12	13.13	11.500	11.750	2.688	2.688	2.875	17	25	0	0	0	0	5	50	0	0
238--8	25	17	1	3	24	2	3	12	12.06	11.938	11.875	2.938	2.938	2.875	17	22	0	0	0	0	8	33	0	0
239--8	25	18	1	3	24	2	3	12	11.56	11.563	11.625	2.938	2.938	2.875	19	23	0	0	0	0	25	50	0	0
240--8	25	19	1	3	24	2	3	12	11.94	11.938	11.938	2.750	2.750	2.750	21	24	0	1	1	7	25	0	0	
241--8	25	20	1	3	24	2	3	12	12.13	11.563	11.813	2.750	2.750	2.750	15	22	0	0	0	0	18	33	0	0
242--8	25	21	1	3	24	2	3	12	12.00	11.875	12.000	2.875	2.875	2.875	23	23	0	0	0	0	25	33	0	0
243--8	25	22	1	3	24	2	3	12	12.08	11.625	11.750	2.813	2.813	2.875	18	17	0	0	0	0	8	50	0	0
244--8	25	23	1	3	24	2	3	12	13.42	11.563	11.375	2.875	2.875	2.875	14	25	0	0	0	0	5	25	0	0
245--8	25	24	1	3	24	2	3	12	11.92	11.875	11.813	2.563	2.563	2.813	18	16	0	0	0	0	10	33	0	0
246--8	25	25	1	3	24	2	3	12	11.81	11.500	11.500	2.875	2.875	2.875	19	18	0	0	0	0	9	33	0	0
247--8	25	26	1	3	24	2	3	12	12.17	11.938	12.000	2.875	2.875	2.875	14	16	0	0	0	0	8	33	0	0
248--8	25	27	1	3	24	2	3	12	12.17	11.813	11.938	2.625	2.625	2.750	17	21	0	0	0	0	4	33	0	0
249--8	25	28	1	3	24	2	3	12	13.25	11.875	11.813	2.875	2.875	2.938	15	17	0	0	0	0	4	20	0	0
250--8	25	29	1	3	24	2	3	12	13.54	11.938	12.000	2.938	2.938	2.750	14	17	0	0	0	0	4	33	0	0
251--8	25	30	1	3	24	2	3	12	13.17	12.000	12.000	3.000	3.000	2.688	16	25	0	0	0	0	20	33	0	0
252--8	26	1	1	2	24	2	8	8	12.01	8.000	7.875	7.875	7.875	8.000	21	21	0	0	0	0	10	33	0	0
253--8	26	2	1	2	24	2	8	8	11.98	7.813	7.750	7.750	7.750	7.750	17	16	0	0	0	0	8	33	0	0
254--8	26	3	1	2	24	2	8	8	9.54	8.125	8.125	8.000	7.875	7.875	18	18	0	0	0	0	4	33	0	0
255--8	26	4	1	2	24	2	8	8	10.08	7.250	7.375	8.000	7.750	7.750	19	19	0	0	0	0	8	50	0	0
256--8	26	5	1	2	24	2	8	8	11.96	8.250	8.313	8.000	8.000	7.875	25	19	0	0	0	0	10	33	0	0
257--8	26	6	1	2	24	2	8	8	8.92	8.188	8.000	8.000	7.500	7.500	23	22	0	0	0	0	8	33	0	0
258--8	26	7	1	2	24	2	8	8	11.75	7.438	7.500	7.500	7.438	7.438	23	22	0	0	0	0	20	33	0	0
259--8	26	8	1	2	24	2	8	8	10.17	8.250	8.250	8.000	8.000	8.000	16	16	0	0	0	0	5	33	0	0

Table A1 (Cont.)

1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1-6	10	1	1	3	6	0	1	3,750	3,500	99	99	1	1	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
2-6	15	2	1	3	0	0	1	3,000	1,500	12	99	1	2	0	0	0	7	1	0	7	0	0	0	0	0	0	0	0	0
3-6	15	3	1	3	0	0	4	4,500	3,750	8	99	1	0	0	0	0	7	2	12	8	0	0	0	0	0	0	0	0	0
4-6	15	4	1	3	0	0	2	5,000	4,250	15	99	2	2	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0
5-6	15	5	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
6-6	15	6	1	3	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	0	0	0	0	8	20	1	8	6	0	0	0
7-6	15	7	1	3	0	0	2	5,000	4,500	99	99	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0
8-6	15	8	1	3	0	0	2	5,000	3,750	59	99	0	0	0	0	0	6	1	0	7	0	0	0	0	0	0	0	0	0
9-6	15	9	1	3	0	0	1	2,750	2,750	59	99	2	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
10-6	15	10	1	3	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
11-6	15	11	1	3	0	0	2	4,000	4,000	59	99	1	1	0	0	0	7	1	0	7	0	0	0	0	0	0	0	0	0
12-6	15	12	1	3	0	0	0	-1,000	-1,000	59	99	2	1	0	0	0	4	0	0	0	7	1	0	0	0	0	0	0	0
13-6	15	13	1	3	0	0	1	3,000	2,500	59	99	1	1	0	0	0	5	0	0	6	10	0	0	0	0	0	0	0	0
14-6	15	14	1	3	0	0	2	4,000	4,000	59	99	1	1	0	0	0	4	7	8	1	0	0	11	0	0	0	0	0	0
15-6	15	15	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	5	1	0	0	7	6	0	0	0	0	0	0	0
16-6	15	16	1	3	0	0	2	3,250	3,000	99	99	0	3	2	0	0	5	9	1	0	0	0	0	0	0	0	0	0	0
17-6	15	17	1	3	0	0	2	4,000	3,750	59	99	1	1	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
18-6	15	18	1	3	0	0	0	-1,000	-1,000	10	99	0	0	0	0	0	5	12	0	0	7	1	0	0	1	0	0	0	0
19-6	15	19	1	3	0	0	1	4,500	4,250	59	99	0	0	0	0	0	7	25	0	0	0	0	0	0	0	0	0	0	0
20-6	15	20	1	3	0	0	0	-1,000	-1,000	59	99	1	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
21-6	15	21	1	3	0	0	0	-1,000	-1,000	99	99	0	2	0	0	0	4	0	0	0	6	10	0	0	0	0	0	0	0
22-6	15	22	1	3	0	0	0	-1,000	-1,000	99	99	3	2	0	0	0	4	0	0	0	6	10	0	0	0	0	0	0	0
23-6	15	23	1	3	0	0	2	8,000	6,000	2	99	2	1	0	0	0	8	1	12	0	0	0	0	0	0	0	0	0	0
24-6	15	24	1	3	0	0	0	-1,000	-1,000	0	0	0	3	0	0	0	6	9	0	0	7	10	0	0	0	0	0	0	0
25-6	15	25	1	3	0	0	0	-1,000	-1,000	99	99	1	2	0	0	0	5	28	0	0	0	0	0	0	0	0	0	0	0
26-6	15	26	1	3	0	0	5	-1,000	-1,000	59	99	1	1	0	0	0	5	18	0	0	0	0	0	0	0	0	0	0	0
27-6	15	27	1	3	0	0	0	-1,000	-1,000	13	99	1	1	4	0	0	7	9	0	0	0	0	0	0	0	0	0	0	0
28-6	15	28	1	3	0	0	0	-1,000	-1,000	99	99	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
29-6	15	29	1	3	0	0	0	6,500	3,000	99	99	1	1	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
30-6	15	30	1	3	0	0	0	-1,000	-1,000	59	99	1	1	0	0	0	7	24	0	0	0	0	0	0	0	0	0	0	0
31-6	20	1	1	1	0	0	0	-1,000	-1,000	99	99	1	1	0	0	0	5	1	0	0	0	0	0	0	5	6	0	0	0
32-6	20	1	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
33-6	20	1	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
34-6	20	2	1	1	0	0	2	2,500	2,000	99	99	2	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
35-6	20	2	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
36-6	20	2	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
37-6	20	3	1	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
38-6	20	3	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
39-6	20	3	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
40-6	20	4	1	1	0	0	0	-1,000	-1,000	99	99	2	1	0	0	0	5	3	0	0	0	0	0	0	0	0	0	0	0
41-6	20	4	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0	0	0	0	0	0
42-6	20	4	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0	0	0	0	0	0
43-6	20	5	1	1	0	0	2	2,750	2,500	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
44-6	20	5	2	1	0	0	2	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
45-6	20	5	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
46-6	20	6	1	1	0	0	2	3,000	2,000	59	99	1	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
47-6	20	6	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
48-6	20	6	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
49-6	20	7	1	1	0	0	1	3,750	2,500	59	99	5	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
50-6	20	7	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
51-6	20	7	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0
52-6	20	8	1	1	0	0	0	-1,000	-1,000	99	99	1	2	2	0	0	5	9	0	0	0	0	0	0	0	0	0	0	0
53-6	20	8	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
54-6	20	8	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	9	0	0	0	0	0	0	0	0	0	0	0
55-6	20	9	1	1	0	0	2	2,000	1,500	0	0	1	1	2	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
56-6	20	9	2	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
57-6	20	5	3	1	0	0	0	-1,000	-1,000	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0

Table A1 (Cont.)

[illegible]

Table A1 (Cont.)

1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
116--6	21	13	2	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117--6	21	13	3	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
118--6	21	14	1	1	6	0	0	-1.000	-1.000	99	2	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
119--6	21	14	2	1	6	0	0	-1.000	-1.000	0	0	2	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120--6	21	14	3	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121--6	21	15	1	1	6	0	0	-1.000	-1.000	99	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
122--6	21	15	2	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
123--6	21	15	3	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
124--6	21	16	1	1	6	0	0	-1.000	-1.000	99	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125--6	21	16	2	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126--6	21	16	3	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
127--6	21	17	1	1	6	0	0	-1.000	-1.000	99	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
128--6	21	17	2	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
129--6	21	17	3	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130--6	21	18	1	1	6	0	0	-1.000	-1.000	10	9	2	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
131--6	21	18	2	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
132--6	21	18	3	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133--6	21	19	1	1	6	0	0	-1.000	-1.000	99	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
134--6	21	19	2	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135--6	21	19	3	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136--6	21	20	1	1	6	0	0	-1.000	-1.000	8	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
137--6	21	20	2	1	6	0	0	-1.000	-1.000	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
138--6	21	20	3	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139--6	21	21	1	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140--6	21	21	2	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141--6	21	21	3	1	6	0	0	-1.000	-1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
142--7	22	1	1	3	0	0	1	1.500	1.250	99	9	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
143--7	22	2	1	3	0	0	0	-1.000	-1.000	9	9	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144--7	22	3	1	3	0	0	0	-1.000	-1.000	55	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145--7	22	4	1	3	0	0	0	-1.000	-1.000	99	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
146--7	22	5	1	3	0	0	0	-1.000	-1.000	99	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
147--7	22	6	1	3	0	0	5	3.000	2.750	99	9	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148--7	22	7	1	3	0	0	0	-1.000	-1.000	99	2	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
149--7	22	8	1	3	0	0	5	-1.000	-1.000	99	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150--7	22	9	1	3	0	0	1	3.000	2.500	99	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151--7	22	10	1	3	0	0	5	-1.000	-1.000	99	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
152--7	22	11	1	3	0	0	0	-1.000	-1.000	99	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153--7	22	12	1	3	0	0	3	-1.000	-1.000	99	11	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
154--7	22	13	1	3	0	0	1	2.750	2.000	99	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155--7	22	14	1	3	0	0	0	-1.000	-1.000	99	9	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156--7	22	15	1	3	0	0	5	-1.000	-1.000	99	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157--7	22	16	1	3	0	0	4	-1.000	-1.000	99	9	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
158--7	22	17	1	3	0	0	1	2.750	2.750	99	9	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
159--7	22	18	1	3	0	0	4	-1.000	-1.000	99	9	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160--7	22	19	1	3	0	0	0	-1.000	-1.000	99	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
161--7	22	20	1	3	0	0	0	-1.000	-1.000	99	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162--7	22	21	1	3	0	0	0	-1.000	-1.000	99	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
163--7	22	22	1	3	0	0	0	-1.000	-1.000	99	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
164--7	22	23	1	3	0	0	0	-1.000	-1.000	6	9	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165--7	22	24	1	3	0	0	0	-1.000	-1.000	99	9	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166--7	22	25	1	3	0	0	0	-1.000	-1.000	99	9	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
167--7	22	26	1	3	0	0	0	-1.000	-1.000	99	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
168--7	22	27	1	3	0	0	0	-1.000	-1.000	99	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
169--7	22	28	1	3	0	0	0	-1.000	-1.000	99	9	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170--7	22	29	1	3	0	0	0	-1.000	-1.000	99	9	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171--7	22	30	1	3	0	0	4	8.000	2.500	99	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
172--7	22	31	1	3	0	0	1	3.000	2.500	99	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
173--7	22	32	1	3	0	0	0	-1.000	-1.000	15	9	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A1 (Cont.)

1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
174--7	22	33	1	3	0	0	0	-1.000	-1.000	99	99	1	2	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0
175--7	22	34	1	3	0	0	0	-1.000	-1.000	0	0	0	0	2	0	0	7	20	0	0	0	0	0	0	0	0	0	0	0
176--7	22	35	1	3	0	0	0	-1.000	-1.000	0	0	0	0	2	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0
177--8	23	1	1	3	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
178--8	23	2	1	3	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
179--8	23	3	1	3	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
180--8	23	4	1	3	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
181--8	23	5	1	3	0	3	0	-1.000	-1.000	99	99	2	2	0	0	0	6	10	16	0	0	0	0	0	0	0	0	0	0
182--8	23	6	1	3	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	6	3	0	0	0	0	0	0	0	0	0	0	0
183--8	23	7	1	3	0	0	0	-1.000	-1.000	99	99	0	3	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
184--8	23	8	1	3	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
185--8	23	9	1	3	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
186--8	23	10	1	3	0	0	0	-1.000	-1.000	0	0	3	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
187--8	23	11	1	3	0	0	0	-1.000	-1.000	99	99	2	1	0	0	0	5	0	0	0	0	0	0	0	6	0	0	0	0
188--8	23	12	1	3	0	0	0	-1.000	-1.000	10	99	2	1	0	0	0	5	1	2	0	0	0	0	0	0	0	0	0	0
189--8	23	13	1	3	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
190--8	23	14	1	3	0	0	1	-1.000	-1.000	99	99	2	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
191--8	23	15	1	3	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
192--8	23	16	1	3	0	0	0	-1.000	-1.000	99	99	2	3	0	0	0	5	10	0	0	0	0	0	0	0	0	0	0	0
193--8	23	17	1	3	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
194--8	23	18	1	3	0	0	0	-1.000	-1.000	99	99	2	2	4	0	0	7	9	0	0	0	0	0	0	0	0	2	6	4
195--8	23	19	1	3	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
196--8	23	20	1	3	0	0	0	-1.000	-1.000	99	99	3	3	0	0	0	5	10	0	0	0	0	0	0	0	0	0	0	0
197--8	24	1	1	2	0	0	0	-1.000	-1.000	99	99	3	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
198--8	24	2	1	2	0	0	1	-1.000	-1.000	99	99	1	2	0	0	0	7	1	0	0	0	0	0	0	0	0	5	0	0
199--8	24	3	1	2	0	0	0	-1.000	-1.000	99	99	2	3	0	0	0	5	10	1	0	0	0	0	0	0	0	0	0	0
200--8	24	4	1	2	0	0	0	-1.000	-1.000	99	99	1	2	0	0	0	6	11	0	0	0	0	0	0	0	6	1	0	0
201--8	24	5	1	2	0	0	0	-1.000	-1.000	99	99	2	3	0	0	0	5	10	0	0	0	0	0	0	0	0	0	0	0
202--8	24	6	1	2	0	0	0	-1.000	-1.000	99	99	2	3	0	0	0	6	10	0	0	0	0	0	0	0	0	0	0	0
203--8	24	7	1	2	0	0	0	-1.000	-1.000	99	99	2	3	0	0	0	5	10	0	0	0	0	0	0	0	0	0	0	0
204--8	24	8	1	2	0	2	0	-1.000	-1.000	6	9	0	0	0	0	0	7	12	0	0	0	0	0	0	0	0	0	0	0
205--8	24	9	1	2	0	0	0	-1.000	-1.000	99	99	0	0	4	0	0	7	9	0	0	0	0	0	0	0	0	0	0	0
206--8	24	10	1	2	0	0	0	-1.000	-1.000	99	99	0	0	4	0	0	7	9	0	0	0	0	0	0	0	0	0	0	0
207--8	24	11	1	2	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	5	10	1	0	0	0	0	0	0	0	0	0	0
208--8	24	12	1	1	0	0	0	-1.000	-1.000	99	99	2	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
209--8	24	13	1	1	0	0	0	-1.000	-1.000	99	99	2	3	0	0	0	5	10	0	0	0	0	0	0	0	0	0	0	0
210--8	24	14	1	1	0	0	0	-1.000	-1.000	99	99	2	3	0	0	0	5	10	1	0	0	0	0	0	0	0	0	0	0
211--8	24	15	1	1	0	0	0	-1.000	-1.000	99	99	1	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
212--8	24	16	1	1	0	0	0	-1.000	-1.000	0	0	2	3	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
213--8	24	17	1	1	0	0	0	-1.000	-1.000	0	0	2	3	0	0	0	5	10	1	0	0	0	0	0	0	0	0	0	0
214--8	24	18	1	1	0	3	0	-1.000	-1.000	99	99	0	4	0	0	0	6	16	10	0	0	0	0	0	0	3	0	0	0
215--8	24	19	1	1	0	0	0	-1.000	-1.000	99	99	0	3	4	0	0	6	10	9	0	0	0	0	0	0	0	0	0	0
216--8	24	20	1	1	0	0	0	-1.000	-1.000	99	99	2	3	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
217--8	24	21	1	1	0	0	0	-1.000	-1.000	99	99	0	3	0	0	0	5	10	1	0	0	0	0	0	0	0	0	0	0
218--8	24	22	1	1	0	0	0	-1.000	-1.000	99	99	2	3	0	0	0	5	1	0	0	0	0	0	0	0	0	3	0	0
219--8	24	23	1	1	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
220--8	24	24	1	1	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
221--8	24	25	1	1	0	3	0	-1.000	-1.000	99	99	2	3	0	0	0	6	10	16	0	0	0	0	0	0	0	0	0	0
222--8	25	1	1	3	0	0	0	-1.000	-1.000	15	99	2	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0
223--8	25	2	1	3	0	0	0	-1.000	-1.000	99	99	0	4	0	0	0	6	9	0	0	0	0	0	0	0	0	5	2	3
224--8	25	3	1	3	0	0	0	-1.000	-1.000	99	99	0	3	0	0	0	5	10	0	0	0	0	0	0	0	0	0	0	0
225--8	25	4	1	3	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
226--8	25	5	1	3	0	0	0	-1.000	-1.000	99	99	1	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
227--8	25	6	1	3	0	0	0	-1.000	-1.000	99	99	2	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
228--8	25	7	1	3	0	0	0	-1.000	-1.000	99	99	1	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
229--8	25	8	1	3	0	0	0	-1.000	-1.000	99	99	1	2	3	0	0	6	12	0	0	0	0	0	0	0	0	0	0	0
230--8	25	9	1	3	0	0	0	-1.000	-1.000	99	99	0	3	4	0	0	6	9	0	0	0	0	0	0	0	0	2	4	3
231--8	25	10	1	3	0	0	0	-1.000	-1.000	99	99	0	0	2	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0

Table A1 (Cont.)

	1	2	3	4	5	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	
232--8.	25.	11.	1.	3.	0.	0.	0.	0.	-1.000	-1.000	99.	99.	0.	0.	4.	0.	0.	7.	9.	0.	0.	0.	0.	0.	0.	0.	0.	4.	3.	0.	
233--8.	25.	12.	1.	3.	0.	0.	5.	3.500	3.000	99.	99.	0.	0.	0.	0.	0.	0.	6.10.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
234--8.	25.	13.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	1.	1.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
235--8.	25.	14.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	3.	2.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
236--8.	25.	15.	1.	3.	0.	0.	0.	-1.000	-1.000	9.	99.	0.	0.	0.	0.	0.	6.12.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	0.	0.	0.	0.
237--8.	25.	16.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	0.	0.	5.	0.	0.	7.	9.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	5.	4.
238--8.	25.	17.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	1.	1.	0.	0.	0.	5.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.	0.
239--8.	25.	18.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	0.	0.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	1.	0.	0.
240--8.	25.	19.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	1.	1.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
241--8.	25.	20.	1.	3.	0.	0.	0.	-1.000	-1.000	8.	99.	1.	1.	0.	0.	0.	6.12.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
242--8.	25.	21.	1.	3.	0.	0.	0.	-1.000	-1.000	0.	0.	1.	1.	0.	0.	0.	4.	0.	0.	0.	6.	10.	0.	0.	0.	0.	0.	0.	0.	0.	0.
243--8.	25.	22.	1.	3.	0.	0.	1.	4.000	4.000	99.	99.	2.	2.	0.	0.	0.	6.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.
244--8.	25.	23.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	1.	1.	0.	0.	0.	5.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
245--8.	25.	24.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	1.	1.	0.	0.	0.	5.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
246--8.	25.	25.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	1.	2.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
247--8.	25.	26.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	1.	3.	0.	0.	0.	5.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
248--8.	25.	27.	1.	3.	0.	0.	0.	-1.000	-1.000	0.	0.	0.	0.	4.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.	7.	3.	0.
249--8.	25.	28.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	2.	2.	0.	0.	0.	5.	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.	6.	0.	0.	0.
250--8.	25.	29.	1.	3.	0.	0.	1.	-1.000	-1.000	99.	99.	2.	3.	0.	0.	0.	5.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
251--8.	25.	30.	1.	3.	0.	0.	0.	-1.000	-1.000	99.	99.	1.	2.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
252--8.	26.	1.	2.	0.	0.	0.	0.	-1.000	-1.000	99.	99.	1.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.	6.	0.	2.	5.
253--8.	26.	2.	1.	2.	0.	0.	0.	-1.000	-1.000	99.	99.	2.	3.	0.	0.	0.	5.10.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
254--8.	26.	3.	1.	2.	0.	0.	0.	-1.000	-1.000	99.	99.	3.	2.	4.	0.	0.	7.	9.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
255--8.	26.	4.	1.	2.	0.	0.	0.	-1.000	-1.000	99.	99.	0.	3.	4.	0.	0.	6.10.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
256--8.	26.	5.	1.	2.	0.	0.	0.	-1.000	-1.000	99.	99.	1.	3.	0.	0.	0.	5.10.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
257--8.	26.	6.	1.	2.	0.	0.	0.	-1.000	-1.000	99.	99.	0.	3.	0.	0.	0.	6.10.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
258--8.	26.	7.	1.	2.	0.	0.	0.	-1.000	-1.000	99.	99.	3.	2.	0.	0.	0.	5.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
259--8.	26.	8.	1.	2.	0.	0.	0.	-1.000	-1.000	0.	0.	0.	3.	0.	0.	0.	6.10.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Trenching Lumber. Page ____ of ____ Date: _____

Yard: _____ Spec. No.: _____ Use Class: _____

Species: Actual _____ Sold as: _____

Nom. Dim. ____ x ____ L: _____ W: _____, ____ T: _____, ____

MC at quarter points: _____, _____

Assigned (stamped) grade: _____

ALS stress grade assigned by grader: _____

Trimmed ALS stress grade by grader: _____

Max. wane:	Face	Length	Thickness
(circle)	<1/4 1/4 1/3 1/2 3/4 FULL	<1/4 1/4 1/3 1/2 3/4 FULL	<1/4 1/4 1/3 1/2 3/4 FULL

Density (soft wood only): Rings/in. _____ % summerwood _____

Damage: Type _____ Est. grade reduction _____

Description _____

Warp: Bow _____ Crook _____ Cup _____ Twist _____
(Very lt, Lt, Med, Hvy)

Knot type in critical section: Edge ____ Ctr ____ Spike ____ Cluster ____

Knot Size: Length _____, Width _____

Slope of Grain (degrees): Face 1 (critical spot) _____ Face 2 _____

Decay: Type _____ Est. grade reduction _____

Extent _____

Checks: Type _____ Size: Light ____, Medium ____

Splits: Very short __ Short __ Medium __ Long __

Storage Conditions:

Open _____ Stickered _____ Ground contact _____

Sheltered _____ Non-stick. _____ Elevated _____

Figure A1. Sheet used to record data for the field study.



Figure A2. Lumber defect - knot cluster.

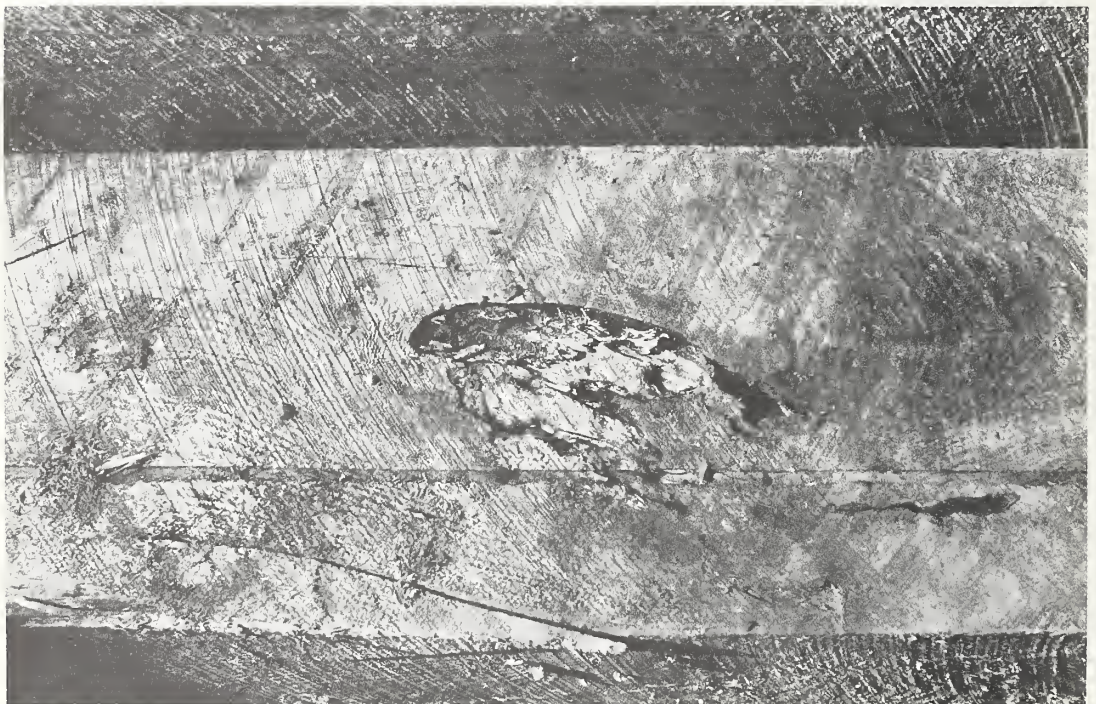


Figure A3. Lumber defect--limited decay at a knot.

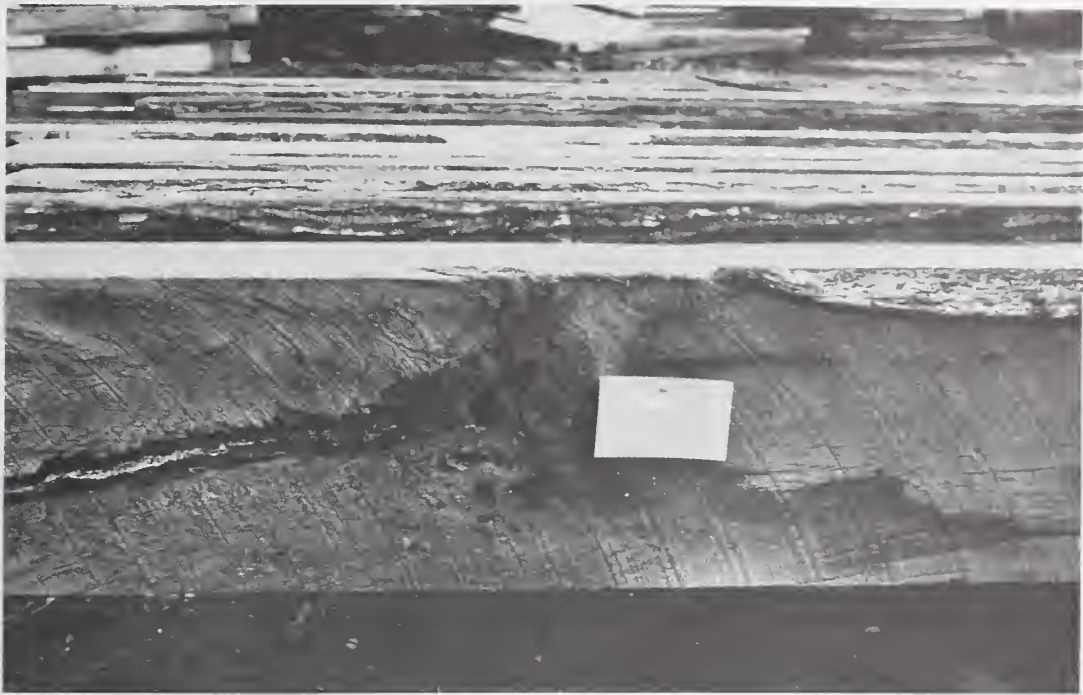


Figure A4. Lumber defects. Decay, rot at bark pocket.



Figure A5. Lumber defects. Sewer planks used as sheeting. Boards are severely end checked; many have included pith and extensive shake and splits.



Figure A6. Lumber defect--scant, too thin and too thick--generally, poorly cut.



Figure A7. Lumber defect--hole, with limited decay.

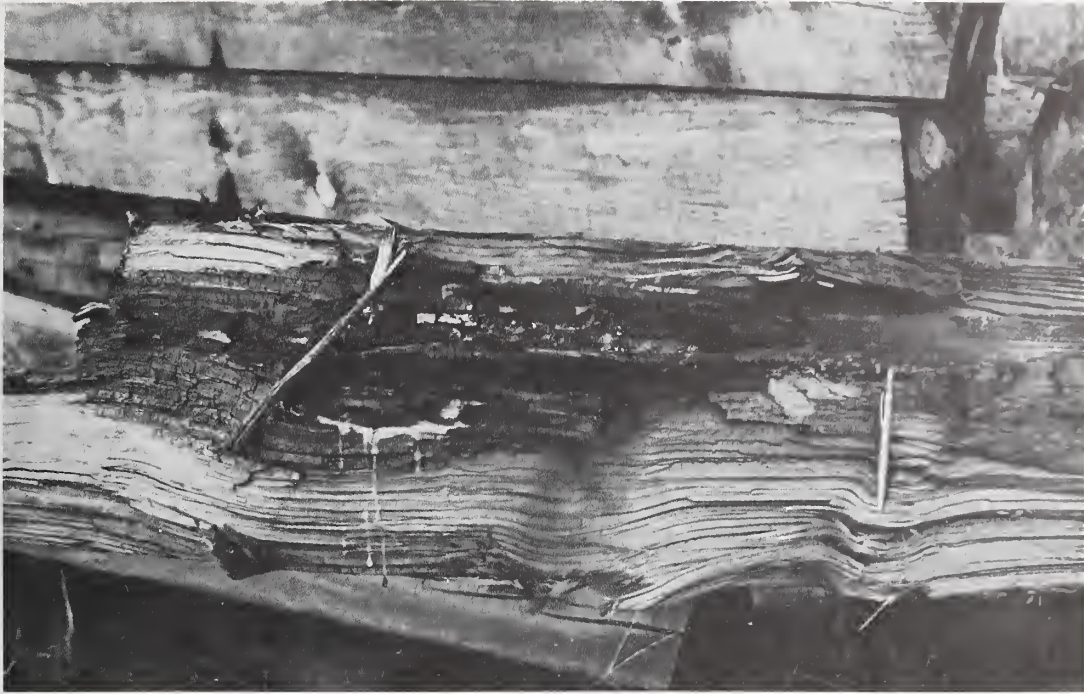


Figure A8. Lumber defect - white speck in Douglas-fir



Figure A9. Lumber defect - rot at a hole.



Figure A10. Lumber defect - gouge.



Figure A11. Use defects in trenching lumber.
Puncture and fiber tear-out.

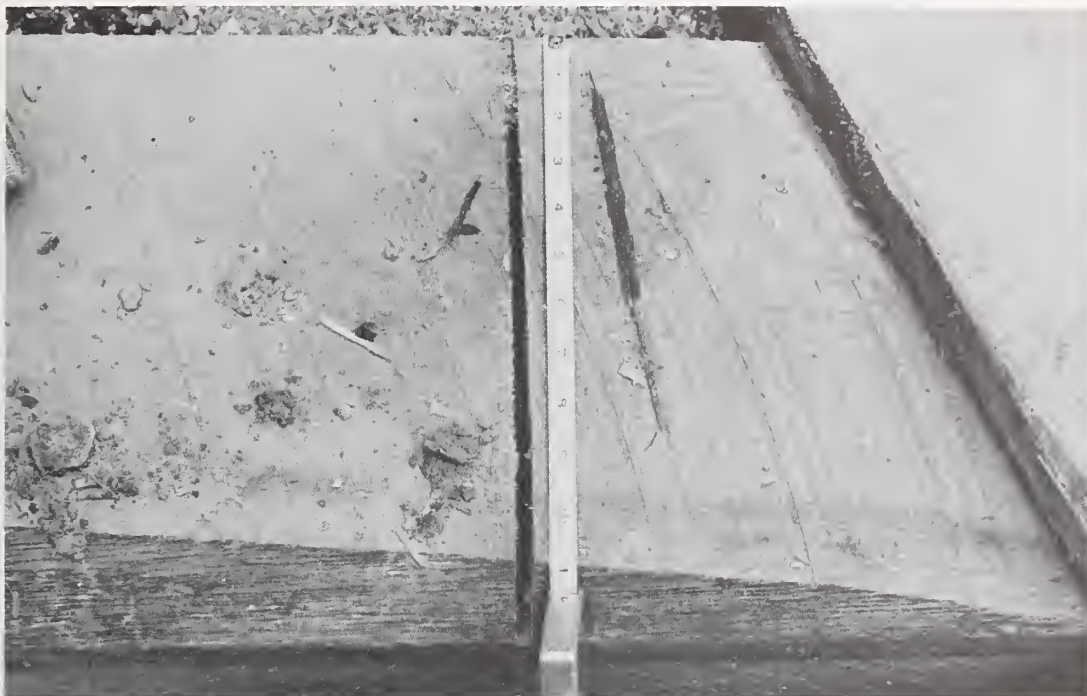


Figure A12. Use defects in trenching lumber. Saw cut, 2 inches deep in 12 x 12.



Figure A13. Lumber defect - shattered ends of 4 x 12's.

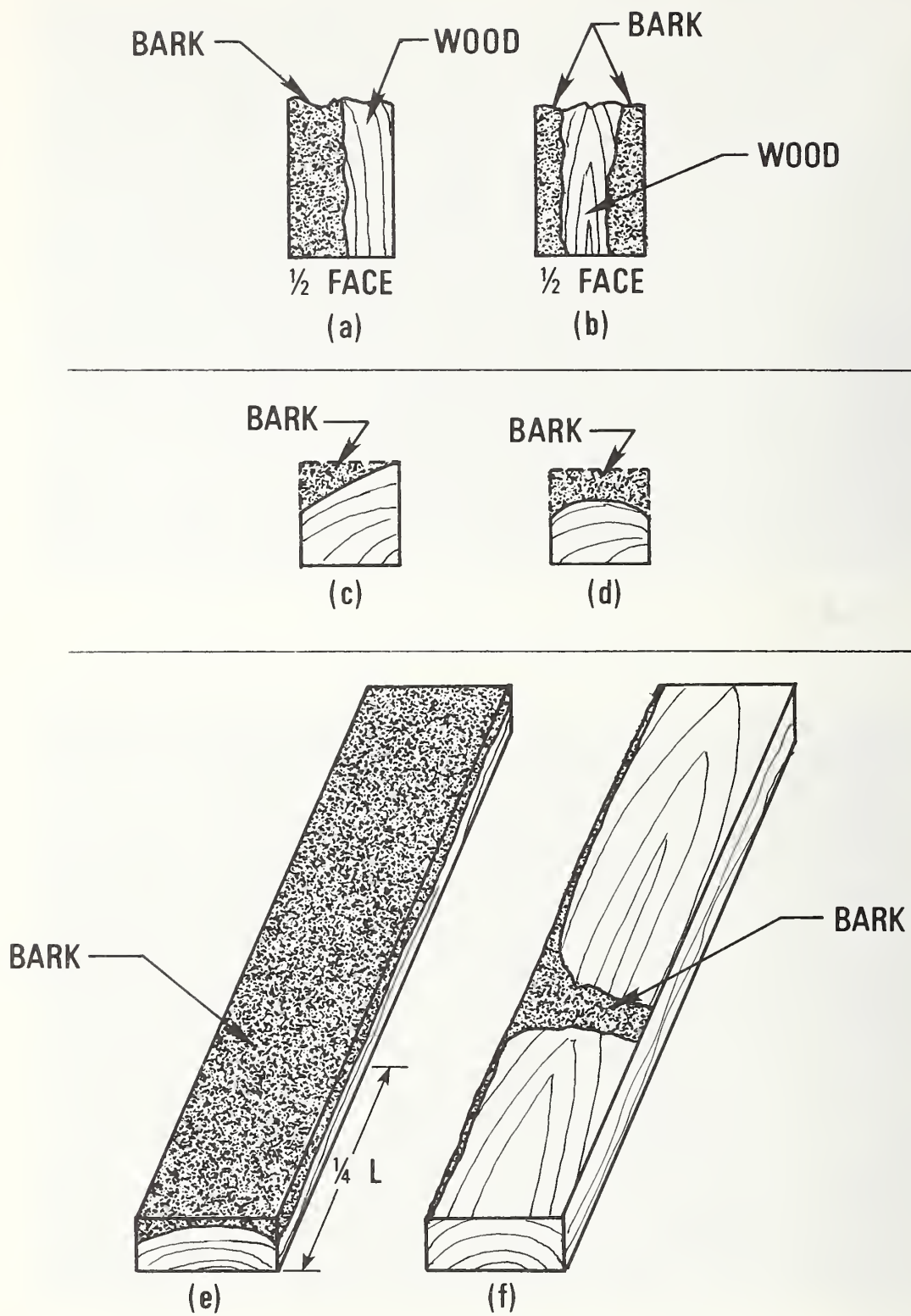


Figure A14. Wane Configurations

APPENDIX B - GENERAL OBSERVATIONS AND DESCRIPTIONS OF YARDS VISITED

This appendix presents the general observations and descriptions of the supply yards investigated. Chapter 3 presents a summary of this appendix. A discussion follows of the yards visited.

WASHINGTON, D.C.

Only one yard was visited in the Washington, D.C. area. The yard carried a large amount of trenching lumber. Most material was purchased from five counties in southern or eastern Maryland. Stock was bought on a Mill Run basis; that is, "as it comes," ungraded, of any species, and green. According to hardwood grade rules this includes 3B and BTR^a grades, with 25 percent sound wood and unlimited wane permitted. Generally, lower grade logs are merely slabbed on the saw to produce a square cant^b and delivered by truck to the lumber yard where the cants were piled by size and length. The stock was generally stored on wood foundations to keep it off the ground and to allow room for a forklift to get under it. Stock was separated every several courses by 4 x 4's for the same purpose.

There were relatively few pieces for which knots had to be mapped. By far the most prevalent defect was wane. There was no material which was reused at this yard.

An estimated species breakdown was: 50 percent red and white oak, 35 percent gum, 15 percent poplar, hickory, sycamore, maple, beech, birch, cherry and pecan. The yard foreman commented that yellow poplar was not used for trenching purposes if possible. However, poplar was not segregated in the piles observed; according to the company personnel, it was just not sought as a species by the company.

Table B1 presents some general information for the Washington, D.C. yard.

A trenching site was visited in the Washington, D.C. area. Although the excavation itself was not seen, several large cribs made of 12 x 12's, 24 feet long, were observed (fig. B1). The 12 x 12 members were measured and graded; however, the members obviously could not be moved by hand to observe all four faces in all cases. The grade was assigned based upon only what could be seen without dismantling or moving the large cribs.

^a 3B and BTR grades include the low grade of 3B and of all higher (Better) grades.

^b A cant is a piece which has been sawn on all four faces; wane may be present.

An interesting insect attack was observed on these cribs. Numerous holes had been drilled into the wood by an insect (fig. 20, ch. 5). The holes were about 3/16 of an inch in diameter and disappeared into the wood. One implication of this is that green hardwoods may be assumed to be quite susceptible to insect infestation during yard storage and even on the job site.

HOUSTON, TEXAS

The trenching lumber in Houston was green, mill run, mixed species hardwoods. The Houston stock is purchased green, and, because of the very high relative humidity, much of the material had surface stain and mold. Outdoor storage in the Houston area appears to lead to very rapid deterioration. It was claimed that much of the stock is kept only 2-3 weeks before sale and, thus, mold is no problem. However, at this time the stockpile was said to be high for winter or bad weather demands.

Popular sizes in the Houston area are 8 x 8, 4 x 4, and 4 x 6 for wales and struts, and 2-inch thick lumber for sheeting.

Contrary to the situation found in the Washington, D.C. area, wane was only a minor problem; off-size was claimed to be a major problem. Wane, however, still resulted in many pieces being graded "None" by SPIB rules.

There were several discussions with mill managers and trenching contractors regarding sheeting material called "board road" and "sewer lumber". Sewer lumber is two-inch material which is satisfactory for use as sheeting. Board road is usually mis-cut, odd-size material which is intended to provide roadway support for heavy oil drilling equipment. It has a one-use lifetime and can be of very poor quality. It appeared to consist primarily of the last board or two cut from a log, usually very close to the pith. However, it is frequently reported that board road is used as sheeting because it is sold cheaply. (On the other hand, an inspector for the city of Houston pointed out that the cost of trenching lumber is small relative to the overall cost of a job. Hence, no one pays much attention to the cost or quality of sheeting lumber in contract bids.) Wane is permissible in board road. Although it is purchased and sold as nominal 3 x 8 material, it comes in various dimensions, ranging from 1-1/4 to 2-1/2 inches thick and 6-1/2 to 7-1/2 inches wide. Most board road was claimed to be about 1-1/2 inches thick and about 6 inches wide. The range, mean, and standard deviation for thickness measurements for a stack of 65 board road members sampled at a yard in Houston were:

Range: 1.25" to 2.50"

Mean: 1.66"

Standard Deviation: 0.275"

Sewer lumber, on the other hand, is said to be 2 x 8 material with relatively uniform thickness and variable width (nominal 2 x 8 is actually 2" x 6", nominal 2 x 6 is actually 2" x 5", according to yard personnel). Sewer lumber is satisfactory for trenching; board road is not, but is used because the "price is right" according to lumber yard and contractor personnel. The National Hardwood Lumber Association grade rules contain rules for "sheet piling, sewer sheathing, and hardwood hearts". There are no products resembling board road, however.

Of interest is that the general foreman at a Houston yard seemed quite familiar with various species. However, what he was sure was an oak was actually white ash. The conclusion is that, once a log is cut into lumber, it is doubtful if accurate species segregation is feasible or even possible by yard personnel. It was also observed at the Washington, D.C. yard that the yard manager was the only one to exhibit an ability to identify red and white oak by the bark characteristics. (It is rather doubtful if bark can be used as a consistently accurate characteristic.)

Two trenching sites were visited in Houston (figs. B2, B3). Neither site utilized very large members. It was the opinion of a trenching contractor and of an inspector that each trenching job is so totally unique that it would be impossible to write standards or grades for trenching lumber use.

Table B2 summarizes the general information for the three Houston yards visited.

SOUTHERN CALIFORNIA

Based on the grader and the few grade stamps that were readable, all trenching material sampled in southern California was Douglas-fir. However, species were not checked on a piece-by-piece basis. All material is purchased green. If it is stored very long, moderate to severe splitting or surface and end checking occur. Downgrading is occasionally the result.

Wales and struts are usually 6 x 6 and 8 x 8 stock. Sheeting stock is 3 x 8 to 3 x 12 and 4 x 10 to 4 x 12. Other sizes are stocked in the yards for use in home-building and general construction, but not as trenching material. One yard uses 3 x 8 to 3 x 12 ECONOMY grade; in service it is cut into 6 to 7 foot lengths (rib sets) for use as "lagging" (horizontal members inserted between the flanges of I-beams and often left behind when the trench is filled).

In Los Angeles all jobs have specifications for trenching lumber (usually No. 1 and higher grades). Thus, most dealers buy No. 1 and higher grades for the job.

The three yards in southern California were clean and two of them had asphalted surfaces (Fig 6). Yard personnel were usually knowledgeable about lumber grades and grading practice.

Wales are specified as to either grade or allowable stress value by the contractor according to local ordinances (city specifications). They are usually No. 1 or No. 2 (often purchased by one yard as No. 2 and higher grade). Grades are checked at the site by city inspectors. Grades lower than No. 2 are used for blocking.

The manager of one yard indicated that it is difficult to regulate lumber used in trenching because each job is "different"; the same opinion was heard in Houston.

White speck, a form of white pocket rot, is common in Douglas-fir trenching lumber; it is caused by the fungus "Fomes pini" and is a problem in trenching because the inspectors react adversely to it.

One yard manager stated that he generally purchased only one or two grades of lumber for use as wales - No. 2 and BETTER (BTR) or No. 1 and BTR; these were as specified by the contractor or city of Los Angeles specifications. The same grades were purchased in 3 x 12 size for use as sheeting. Economy grade 3 x 12's are cut into shorts, which are relatively defect-free pieces two to five feet long that are used as blocking or in pallet manufacture.

In one yard, a small colony of termites was discovered in a close-piled stack of sheeting. The material was relatively green, but had been stored up off the asphalted surface. A portion of two pieces had been attacked, and the infestation appeared to be about six square inches and about 1/4 inch deep.

One set of 3 x 12 sheeting examined was, like nearly all the other Douglas-fir sampled, not grade-stamped. It had been purchased as No. 1 and BTR; however, most pieces had a grader's mark of one or zero on them, indicating that the piece had been graded and marked, but not grade-stamped. Some pieces had a one on one side and a zero on the other, indicating that regrading of some sort had taken place. The source of the lumber was unknown. The grader for this study indicated that most of the material was Number 1 in quality.

At one yard, the trenching lumber, which was purchased new as No. 1 and BTR, green Douglas-fir, was reused many times. The lumber was typically used numerous times on one job site and then stored until needed elsewhere. Material was discarded at the job site if it was deemed unfit for further use, usually as the result of a lengthwise split. Used 4 x 12 sheeting stock was observed and only about a foot or less on the end had been visibly damaged during driving and subsequent withdrawal (fig. 8). Some 4 x 12 sheeting had reportedly been used at least 26 times. This material was never regraded. However, regrading could be readily accomplished because dirt appeared to be only a relatively minor hindrance. The reused material was drier than when originally graded and had a tendency to check and split quite a bit. This downgraded roughly 25 percent of the pieces (fig. 7).

Discussions with the Construction Division of the Los Angeles County Flood Control District were informative. Trenching lumber is closely specified by the state codes and OSHA specifications. For "rib sets" 3 x 8 Utility and Construction grades are often used. In one tunnel site 3 x 10 sheeting was used both horizontally (lagging) and vertically (sheeting). The tunnel was 45 feet beneath the road surface. Although no grade stamps were observed, the sheeting appeared to be of good quality (few knots, but one piece with extensive white speck was observed). Some sheeting failures were observed, but these were isolated instances. Both 3" and 4" thick material were being used. Refer to figs. B4 and B5.

Table B3 shows the general information for the three yards visited in southern California.

Table B1. General Information for the Yard in the Washington D.C. Area

General Yard Descriptions:

Species in stock:* Red Oak, White Oak, Gum, Beech, Poplar, So. Pine, Sycamore, Hickory, Elm, Birch (water or river), Cherry

Source of lumber: 1-5 Local mills usually, occasionally from as many as 10 mills - southern or eastern Maryland

Species and grades normally purchased:
Mill run hardwoods
Some So. Pine sheeting & bigger sizes.

Sizes normally in stock:

6 x 6	8 x 8	12 x 12	2, 3, 4 in. thick by 6 to 12 in. wide
6 x 8	10 x 10		

Storage Conditions: Open, stickered, elevated

Estimated no. of reuses: None

Comments: Large yard, very cooperative

Turn over time - 30 days for some, more for others, usually 6 to 24 mo.

No Reused material

This is "normal" stock period

Mill Differences - Most cut for grade; some veneer high grading
and use lower material for trenching;
some mills cut to better tolerances

* Observed by survey personnel.

Table B2. General Information for Yards in Houston, Texas

General Yard Descriptions: Two yards clean and well organized, one yard not clean or neat.

Species in stock:*

Red & White Oak, one yard manager reported 70-85% Red and White Oak. Elm, Hackberry, Hickory, Pecan, Gum (Tupelo), Red Gum, White Ash, Beech (rarely) Sycamore (rarely), Magnolia (rarely), no Poplar, Cypress (rarely), Pine, and Douglas-fir (12 x 12 x long)

Source of lumber: Local mills -- East Texas, Louisiana, Mississippi

Species and grades normally purchased:

Mill run, green, mixed species, hardwoods, (one yard manager reported 50% Oak; two yards reported no Poplar; one yard reported no Birch; one yard reported So. Pine 4x, 6x and 8x in shorter lengths.)

Sizes normally in stock:

2 x 4	2 x 6	2 x 10	4 x 4	6 x 6	8 x 8	10 x 10	12 x 12
3 x 12	2 x 8	2 x 12	4 x 6	6 x 8	8 x 10		

Storage Conditions: Open; stickered and non-stickered; ground contact and elevated conditions

Time in storage before use: 2-9 weeks

Estimated no. of reuses: None

Comments: Amount of lumber sold for trenching varies widely from year to year, depending on large construction jobs in Houston area.

Major problem is with local mills -- they won't separate species

Material is left on site at trenches

Ninety percent of lumber is left in place

Contractor reuses 4x and large squares; none is returned to the yard, however.

Board road contractors reuse the material (it is rented)

"Big problem -- get size standards for 2", 3", and 4" material!"

"2 x 6's should be outlawed for trenching"

* Observed by survey personnel, unless noted otherwise.

Table B3. General Information for Three Yards in Southern California

General Yard Descriptions: Neat, clean, and orderly (two yards on asphalt surfaces)

Species in stock: Douglas-fir

Source of lumber: California and Oregon

Species and grades normally purchased:
(One yard reported that all lumber bought is green)

No. 1 and BTR

No. 2 and BTR

Sizes normally in stock:

8 x 8	6 x 6	4 x 12 - sheeting
10 x 10	6 x 8	3 x 12 - sheeting
12 x 12		3 x 8 - sheeting

Storage Conditions: Open, stickered, and elevated.

Time in storage before use: 1 week to 6 months

Comments: One yard sometimes buys No. 1 or Select Structural, etc.,
as job specifies rather than buying several grades together.



Figure B1. Trenching site in Washington, D.C. area, showing 24-foot
crib made of 12 x 12 hardwood wales. Box is 8-feet wide,
6-feet high and is to contain 54-inch diameter concrete pipe.



Figure B2. Trenching site in Houston, Texas.



Figure B3. Trenching site in Houston, Texas showing the way in which the trench is braced directly following the back-hoe excavation. On the ground beside the trench may be seen sections of sheeting waiting for placement.

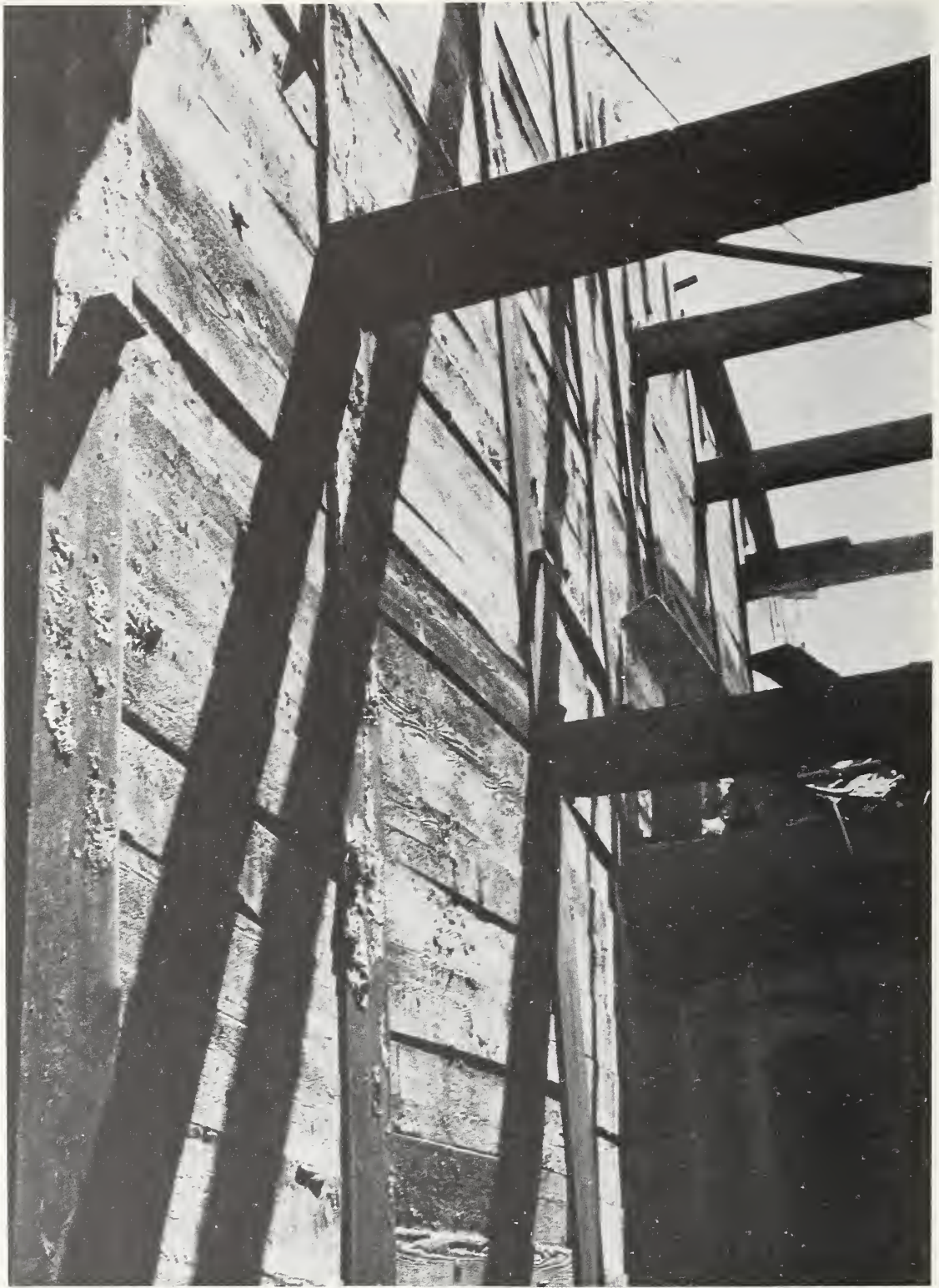


Figure B4. Lagging in place in a 45-foot deep tunneling operation in California.

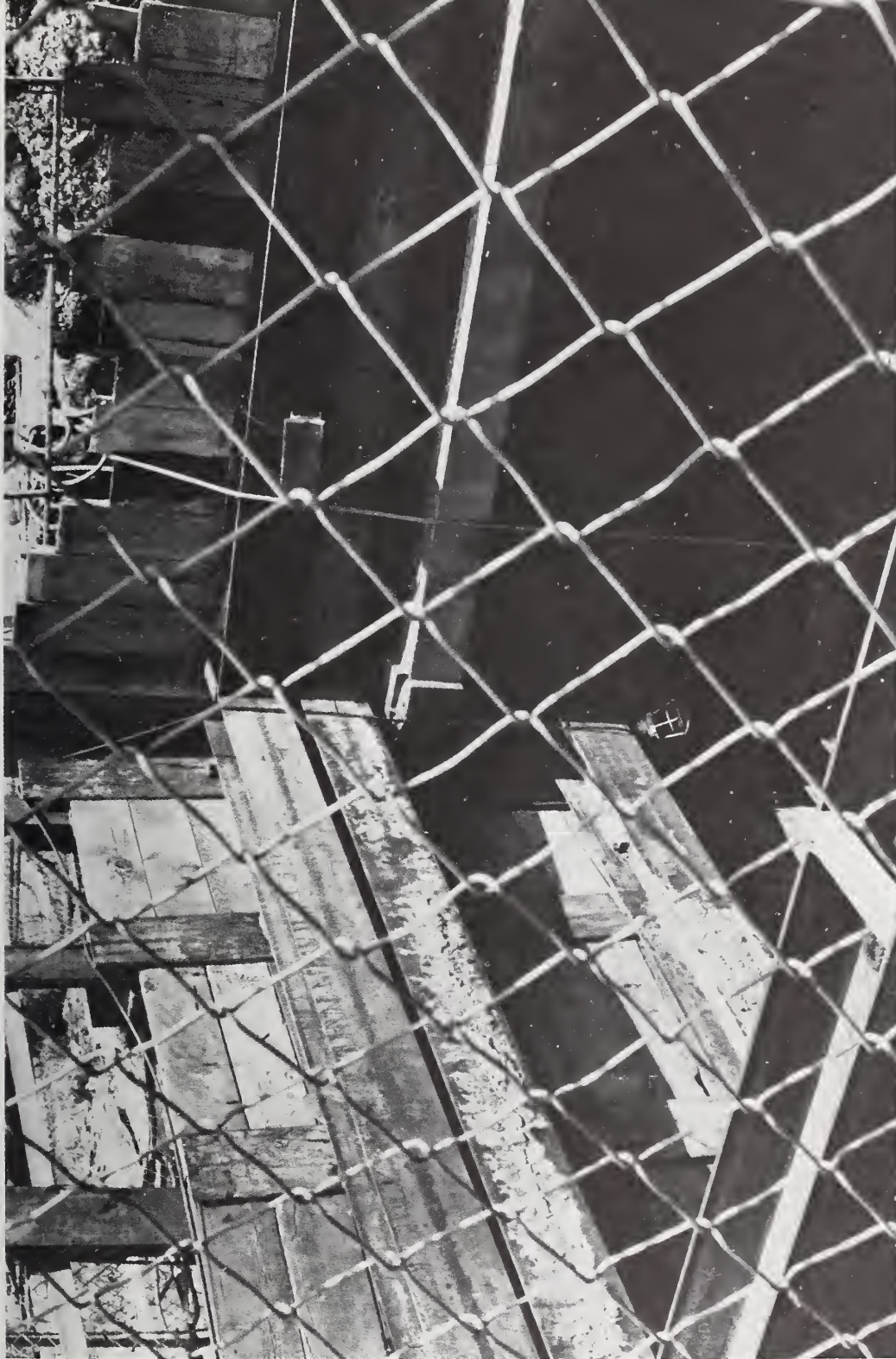


Figure B5. Sheeting in place at a trenching site in California. Some pieces are vertically oriented and some are horizontally oriented (lagging).



APPENDIX C - ANALYSIS OF FIELD INVESTIGATION DATA

This appendix presents the details of the analysis of the data collected in the field investigation. A summary of the results, findings, and conclusions of the analysis is given in chapter 3.

STRENGTH RATIO GRADE (G)

The most important grade taken was a strength ratio grade called G, in which the effects of wane, damage, and decay were disregarded. The G grade provided a basis for evaluating the effects of:

- a) regrading, by partial length grading, or upgrading by hypothetical trimming, and
- b) downgrading, by taking into account wane, damage, or decay.

Figure C1 shows bar charts of the relative frequency of the G grade for full length eastern species wales (D.C. and Houston-primarily hardwood).

A wale graded over its full length is hereafter called a "full" wale whereas a 10' length of a full length wale is called a "10'" wale.

Figure C1 shows both individual and combinations of lumber size and location. Figure C2 shows similar information for eastern species sheeting; figures C3 and C4 present bar charts for Douglas-fir wales and sheeting, respectively. On each bar chart in the four figures, the location, size (width and thickness), and sample size (N) are given.

In order to estimate and compare the average grade and grade variability associated with each bar chart, the strength ratio (SR) was used. The strength ratio is defined in ASTM as the hypothetical ratio of the strength of a member to the strength it would have if no weakening defects (e.g., knots) were present. For example, a member with an SR value of 45 percent would be expected to have at least 45 percent of the strength of the same piece if it were free of defects. Table 2a shows the SR values for grades of No. 2 and higher. The following information is also shown for each bar chart:

- ° percentage, P, of the sample of size N which had G grades of No. 2 or higher
- ° the average value, \overline{SR} , and coefficient of variation, CV_{SR} , of the SR values

Note that \overline{SR} and CV_{SR} are based only on grades of No. 2 and higher, since SR values could not be assigned to grades lower than No. 2 for wales and struts. Also, the SR is not the actual value for each piece but the SR for the grade assigned to that piece. That is, the SR based on the grade represents a lower limit for the SR for each piece. Thus,

the \overline{SR} values presented in this report are lower than the actual \overline{SR} values. Because pieces which were less than No. 2 were excluded from the calculation of CV_{SR} and since the actual SR values greater than 86 were not included, the CV_{SR} values given in this report are less than the actual CV_{SR} values. Further, it should be noted that the larger sizes of No. 1 and 2 in the SPIB grade rules have SR values greater than 45 and 55; yet in this study these ratios were assigned to corresponding grades of timbers and joists and planks. This was done to permit combining all sizes in one grading characterization.

Table C1 summarizes the range of values of \overline{SR} , CV_{SR} , and P (col. 1-3 and 7-9) for the bar charts shown in figures C1 to C4. The range is the minimum and maximum values which occurred when analyzing the lumber sizes separately. That is, the minimum is the smallest value for all sizes; similarly, the maximum is the largest value. Table C1 also shows \overline{SR} , CV_{SR} , and P values (col. 4-6 and 10-12) for various combinations of the bar charts taken collectively; these combined values represent either a geographic area or new versus used lumber.

As seen in table C1, the range of the \overline{SR} values (column 1) did not vary much for both eastern species (D.C. and Houston) and new Douglas-fir wales, ranging from 55-60; the range of the \overline{SR} values of 52-53 for used Douglas-fir wales was even less. The combined (as previously defined) CV_{SR} value (col. 5) of 19 was the same for all eastern species wales as it was for the new Douglas-fir wales. In contrast, the combined CV_{SR} value for all used Douglas-fir wales was only 10.

The combined values of \overline{SR} (col. 10) for sheeting did not vary significantly, and with the exception of used Douglas-fir, agree closely with the corresponding wale values. Comparing combined values of CV_{SR} for sheeting (col. 11) shows that used Douglas-fir sheeting is lowest at 13 percent (this agrees with the trend for wales: 10 percent in col. 5).

The use of the strength ratio to estimate and compare the grade average and variability has the limitation that the No. 3 grades could not be assigned strength ratio values for wales and struts. The strength ratio, however, appears reasonable to use since the percent of the wales for which a strength ratio could be assigned (P) was relatively high. As table C1 (col. 3) shows, P ranged from 71 to 100 percent for all wale cases considered, with the combined values of P ranging from 77 to 100 percent (col. 6). It should be noted that for new Douglas-fir wales, P was 100 percent. Hence, if \overline{SR} values could be assigned to No. 3 and None grades, the eastern species \overline{SR} values for wales would be lowered while the Douglas-fir \overline{SR} values for the new wales would remain the same.

Except for several cases, then, the \overline{SR} values had a rather narrow range, with values from about 55 to 60 for both wales and sheeting and for both eastern species and Douglas-fir. The 55-60 range for \overline{SR} represents a

grade range between No. 1 (SR = 55) and Industrial 65 or Select Structural (SR = 65). The range of CV_{SR} values for all wales and sheeting cases, however, was relatively larger, ranging from 7 to 24 percent.

Wales were graded as beams and stringers while struts were considered as compression members and graded as posts and timbers. As table 1 shows, many pieces were graded first as wales and then as struts. With only limited exceptions, the wale and strut grades were the same. Thus, for the most part, the G grade results for wales in table C1 should apply as well to struts.

ANALYSIS OF REGRADING

Two methods, A and B, were used to assess the quality variability of wales. Both methods involved comparing partial length to full length grading.

In method A, each wale was initially assigned a full length G grade. If a wale was 20' long (Type I) each 10' half was also assigned a G grade (G10). If the G10 grade for either 10' piece exceeded the G grade for the 20' length, the higher G10 grade was recorded. For wales greater than 10' but less than 20' (Type II), a 10' piece measured from one end was assigned a G grade (G10). If the G10 grade exceeded the G grade for the full length wale, it was again recorded.

The 10' length was chosen on the assumption that the basic structural module for wales used with solid sheeting is often 10'--that is, the wale would be supported by struts at 10' intervals.

Method A--Type I addresses the question: What is the grade improvement, if any, of a 10' piece of a wale relative to the grade based on a full length wale? In other words, what is the more correct strength distribution, considering the possibility of load sharing and the probability that the maximum load may not occur on the weaker 10' section.

Table C2, based on 66 full length wales, shows the G10 grade versus the full length grade based on method A, Types I and II, for wales in D.C. and Houston combined.

The partial length used in the method B was the middle 1/3 of each wale. The method was applied to both full and 10' wales, as well as wales whose actual total length was 10' (which would also be termed "full"). If the G grade on the middle 1/3 (GM3) exceeded the G grade on the total wale length, then the GM3 grade was recorded. Middle-1/3 grading was chosen to reflect that the maximum bending stress might often occur in the middle 1/3 of a simply supported wale.

Thus, if a critical defect, such as a knot, occurred outside the middle 1/3 of a wale length (here "wale length" refers to either full length or a 10' piece of a longer wale) the middle 1/3 was recorded as having a GM3 grade higher than the G grade assigned to the entire wale. (Here

the GM3 grade is referred to as a partial length grade and the G grade assigned to the entire wale (whether "full" or "10'") is referred to as a full length grade.) Table C3, based on 362 pieces assigned GM3 grades, presents GM3 grade results for method B for wales in D.C. and Houston combined.

Table C4 presents, for methods A and B, the average strength ratio (\overline{SR}) for partial length (col. 1) and full length (col. 2) grades and the average increase in SR due to partial length grading (col. 3). Both methods clearly show that there was a significant increase in SR (col. 3) in those wales for which the partial length grade exceeded the full length grade.

Table C4 (col. 4) also lists the percentage of wales for which the partial length exceeded the full length grade. These percentages were based on all wales considered for regrading, including wales with full length grades below No. 2. For wales in D.C. and Houston, method A (G10) resulted in considerably larger percentages of wales for which the partial length grade exceeded the full length grade than did method B (GM3). An explanation of one factor which may contribute to the larger percentage for method A is as follows. For a single defect, such as a large knot, which controls the grade, method A - Type I will almost always result in an upgrade on one of the two 10' pieces. Whereas in method B, on the average, only 2/3 of the time will the defect fall outside the middle third (resulting in an upgrade). Hence, based on this crude model, the ratio of the number of pieces having improved quality in Method A-Type I to method B would be $1/(2/3)$ or 1.5. A more thorough study would be necessary to quantify the effect of defect type and location.

In col. 1-3 of table C4, only wales for which SR values could be assigned (i.e., having G grades of No. 2 or higher) were considered. Of the eastern species wales that could be upgraded by partial length grading, 74 to 100 percent had G grades of No. 2 or higher, depending on the geographic area and whether method A or B was used. All of the Douglas-fir wales which could be upgraded by partial length grading had G grades of No. 2 or higher. Thus, the average SR values for partial length grading and their increase due to partial length grading should be a representative indication of a higher structural capability than that indicated by full length grading.

REDUCTION OF CROSS-SECTIONAL AREA AND MOMENT OF INERTIA

Three methods were used to analyze the loss of cross-sectional area and bending resistance (moment of inertia) due to missing cross-sectional area. The first method used average end dimensions; the second method was based on wane data (for example, wane on 1/3 of the thickness and 1/2 the width); the third method was based on the amount of downgrading due to wane, even though the cross-sectional area and moment of inertia reductions could not be determined quantitatively.

End Dimensions Method

A member width was determined as the average of two measurements taken, one at each end. Thickness was determined in the same manner. The cross-sectional area and moment of inertia about the centroidal axis were computed using a rectangular cross-section. For comparison, the ratio of the cross-sectional area based on the average actual end dimensions to the area based on the nominal dimensions ("as sold"--given by "Member Size" in Table 1) was computed and is referred to as the "area ratio, A, based on end dimensions." Similarly a ratio (inertia ratio, I) of the two corresponding moments of inertia was also computed.

Wane Data Method

As explained in appendix A, many wane configurations are possible for a single wane data entry. Thus, due to the limited wane information, an accurate analysis of the loss in cross-section was not possible.

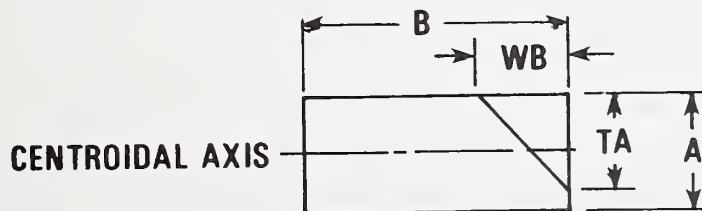
This method was based on using data on the extent of wane occurring at the worst affected corner and assumed that the wane was triangular in shape. The fractional portion of a member's cross-sectional area occupied by wane is given by $1/2 (WT)$, where W and T are wane measurements expressed as a fraction of the nominal ("as sold"-- see table 1) width and thickness. This expression tends to overestimate wane because the wane surface is commonly convex rather than flat as assumed by triangularity (for example, see figs. 11 and 16).

The expressions for the cross-sectional area, a, and moment of inertia, i, about the centroidal axis for a section with wane are:

$$a = AB[1 - (WT/2)] \quad (1)$$

$$i = (A^3B/3) - ((1/12)(A^3BWT^3)) - ((A^3B(0.5 - (WT^2/6))^2)/(1 - (WT/2))) \quad (2)$$

where, as shown below, A and B are the nominal width and thickness of the section.



In a manner similar to the first method, the ratios of the reduced to nominal area (A), and moment of inertia (I) were computed based on Eqns. (1) and (2).

The average and coefficient of variation values for the area (\bar{A}, CV_A) and inertia (\bar{I}, CV_I) ratios based on the end dimensions and wane data methods are given in:

- o Table C5 for full wales and for sheeting used as spot bracing-- spot bracing refers to a single, separate, vertical upright against the soil (fig. 1).
- o Table C6 shows \bar{A} and \bar{I} for sheeting used as solid sheeting-- solid sheeting refers to vertical sheeting which is continuous (see fig. 1).

Both tables C5 and C6 show the range of values (minimum and maximum ratios -- see footnotes d and b, tables C5 and C6) which occurred when several lumber sizes were analyzed separately; also shown is a combined value for those same lumber sizes analyzed collectively.

Discussion of End Dimensions and Wane Data Methods

In interpreting the I and A ratio values there are several important things to note. For the end dimensions method, the width and thickness measurements taken at the ends of the lumber did not include bark. In addition, if wane at the end was present, full section measurements were taken at a location containing no wane, but as close to the end of the member as possible. As a result, the "end measurements" did not represent wane. (For example, see figs. 11 and 16). Also, rectangular cross-sections were assumed, even though they were not always such.

If a piece had no wane, it was assumed that the actual and nominal dimensions were identical. In other words the maximum value each ratio could be was 100. In contrast, the ratios based on the end dimensions reflect sections which had actual cross-sectional areas calculated from dimensions larger and smaller than nominal. Thus ratio values in excess of 100 were possible.

Further, the assumptions involved in the computation of the I and A ratios in the wane data method can greatly influence the ratio values. When interpreting the ratios based on wane, note that in some cases wane was relatively rare. As table C5 shows, the percentage of wales which had wane were much less frequent in Douglas-fir (11%) than in the eastern species (59%) material. Thus, the \bar{A} and \bar{I} ratios based on the wane data would reflect only the low wane frequency; that is, the ratios would not reflect the severity of the wane as measured only on the set of pieces that had wane. Further, note that in the case of sheeting, wane data were not always recorded.

Finally, the end dimensions were recorded for almost all pieces. Thus, the end dimension method is better than the wane method for comparing eastern species with Douglas-fir, since wane was so relatively infrequent in Douglas-fir.

Analysis of Wales

As Table C5 shows, there was a large range in the \bar{A} , CV_A , \bar{I} , and CV_I values for eastern species for wales (D.C. and Houston) for both the end dimensions and wane methods; this is in contrast to the smaller range of values for the new Douglas-fir wales (end dimensions method).

Based on combined values for wales using the end dimensions method:

- o \bar{I} and \bar{A} ratios for eastern species agree closely with the Douglas-fir values
- o CV_A and CV_I values for eastern species are over three times larger than for Douglas-fir

Analysis of Sheeting

Spot bracing which uses single, separate, vertical uprights against the soil and solid sheeting, which uses continuous vertical uprights (see fig. 1), were analyzed separately. This was done because the width of the upright is used in determining the cross-sectional area and inertia for spot bracing. For solid sheeting, however, only the thickness needs to be considered.

As Table C5 shows, for the eastern species material using the end dimensions method, the range of \bar{A} , CV_A , \bar{I} , and CV_I values for spot bracing, as for wales, were also large. The combined (as previously defined) \bar{A} and \bar{I} ratios for eastern species spot bracing considerably exceeded those for Douglas-fir. Note that Douglas-fir sheeting is produced under ALS standards whereas no standards exist for the eastern species sheeting.

The ranges of values for \bar{A} and \bar{I} for eastern species solid sheeting (Table C6) were again large; this is in contrast to the smaller ranges for the Douglas-fir solid sheeting. Like spot bracing, the combined \bar{A} and \bar{I} ratios, for eastern species solid sheeting exceeded those for the Douglas-fir, with the exception of the relatively low \bar{A} and \bar{I} values for the board road material (see appendix B). Again note that the ALS standards were used for Douglas-fir, but not for the eastern species.

Excluding board road, there was very good agreement between the \bar{A} and \bar{I} values for spot bracing (end dimensions--table C5) and solid sheeting (end thickness--table C6) for eastern species as well as for Douglas-fir.

Wane Downgrading Method

The third method involved comparing the amount of downgrading due to wane. If the grade was limited by wane, a grade for wane called GW was assigned (damage and decay were disregarded when assigning the GW grade). Not all full wales which could have been assigned a GW grade were given one--but many were. Often the GW grade was less than the G grade assigned to the wale; at times the G and GW grades were the same. Tables C7, C8 and C9 show the number of occurrences of GW as a function of G for full wales observed in D.C., Houston, and D.C. and Houston combined. When compared with the G grade (the grade without wane, damage, or decay), the GW grade provides a measure of the downgrading caused by wane.

In the wane downgrading method only full wales (graded over their full length) were analyzed. The wales were divided into two groups: those wales with GW grades of No. 2 and higher and wales with GW grades less than No. 2 (No. 3 and None).

Table C10 presents the number and fraction of full wales downgraded due to wane (relative to their G grade--cols. 2 and 3) and a breakdown of those wales into grades of No. 2 and higher (cols. 4 and 5) and, lower than No. 2 (cols. 6 and 7). As shown in col. 3, 53% of the D.C. full wales and 25% of the Houston full wales were downgraded by wane. In contrast, the southern California Douglas-fir had only 3% (col. 3) of the full wales downgraded.

A quantitative analysis of the strength ratio reduction caused by the GW grade was not done because over 75% of the wales assigned a GW grade had GW grades of None or No. 3, for which a strength ratio could not be assigned.

From an economic viewpoint and based on the SPIB grading rules used in this study, if a No. 2 grade was chosen as a minimum grade then the following percentages of the wales were downgraded from a G grade of No. 2 or higher to a GW grade of No. 3 or None:

- o D.C., table C7, 70% (39/56; 39 obtained as: $2 + 8 + 4 + 16 + 5 + 4 = 39$)
- o Houston, table C8, 71% (25/35)
- o D.C. and Houston, table C9, 70% (64/91)

Note that the above percentages are based on the number of wales downgraded due to wane. Lower percentages, based on the total number of wales (including those not downgraded due to wane), are:

- o D.C.: 37% (39/106)
- o Houston: 18% (25/142)

o D.C. and Houston: 26% (64/248)

Thus, there were high percentages of wales which would be downgraded due to wane if a No. 2 wane restriction were required.

DECAY

When the amount of decay exceeded the limited decay around knot holes, wormholes, etc. permitted in the strength ratio (G) grade (see EXPLANATION OF DATA ENTRIES AND CODES, group No. 40, app. A) a decay grade, called GDE, was assigned. For the GDE grade, wane and damage were disregarded. As in the wane downgrading analysis, only full wales were analyzed for decay downgrading. About 7 percent of the eastern species full length wales were downgraded to a non-stress grade status relative to their G grade due to decay. Because decay is not acceptable in significant quantity in high structural grades, the GDE grades generally were either No. 3 or None. No downgrade due to decay was observed for the 37 new Douglas-fir full length wales.

Tables C11, C12, and C13 show the number of occurrences of GDE as a function of G for full wales for D.C., Houston, and D.C. and Houston combined.

DAMAGE

Very little mechanical damage, caused by handling or use, was observed. Only 1 percent of the eastern species full length wales were downgraded relative to their G grade. No hardwood sheeting was downgraded. For new and used Douglas-fir members, only 1 percent of the full length wales and struts and 3 percent of the sheeting were downgraded. The Douglas-fir sheeting percentage did not include brooming that could be eliminated by trimming prior to reuse.

POTENTIAL FOR UPGRADING BY TRIMMING

A trimmed grade called GT, was assigned to a member if its G, GW, or GDE grades could be upgraded by hypothetical trimming. Tables C14, C15, and C16 show the number of occurrences of GT in terms of its minimum untrimmed grade (minimum of G, GW, or GDE) for D.C., Houston, and D.C. and Houston combined. As in the case of wane and decay downgrading, only wales graded over their full length were considered.

The purpose of the trim analysis was to provide preliminary economic information on the potential upgrading due to trimming. The following trimming analysis is based on the choice of No. 2 as the minimum acceptable grade. Of the full length wales graded in D.C. and Houston, approximately 125 wales (about 50%) were less than No. 2 in quality for strength ratio, wane, or decay. Of the 46 wales that could be upgraded by trimming and which were less than No. 2 (Table C16), 38 (83%) of them could be trimmed to a grade of No. 2 or higher. Table C17 shows the analysis of these 38 full wales in terms of the frequency of

the trim length necessary to upgrade them. Table C17 shows that a trim length of 2 feet was, by far, the most prevalent.

With all grades considered, only 11 percent (4 out of 37) of the new Douglas-fir full length wales could be upgraded by trimming; all of these were No. 2 or higher before trimming.

It should be noted that the trimmed grade was a rough estimate made under field conditions. It was not always consistent in definition. For example, at times the effects of wane were ignored when assigning the trimmed grade. Nonetheless, the analysis does at least provide an indication of the effects of trimming in upgrading.

SPECIES

Table C18 shows the relative frequency of species for full hardwood wales and sheeting for D.C., Houston, and D.C. and Houston combined. As seen in table C18, in all cases, at least 50 percent of the pieces sampled were either red or white oak. In addition to the above, information on species, including approximate strength values, is given in appendix B.

Also, in a special study at a trenching jobsite in D.C., 17 out of 36 (47%) wales and struts sampled for species were yellow poplar--a significant increase compared with the 7.5 percent figure for full wales found in D.C. This indicates that although the yard managers and contractors contacted claim to not "like" poplar, it still occurred and, in this case, its occurrence was significant compared to the other species.

SLOPE OF GRAIN

A general slope of grain of 1:20 or straighter as measured in softwood lumber grading was considered straight. As described in appendix A, slope of grain was measured on two adjacent faces--1 and 2. Table C19 shows the relative frequency of the general slope of grain for all eastern species full length wales and sheeting. As evident from table C19, only about 5 percent of the members observed had a general slope of grain of 1 in 10 or steeper (fig. 9). Similar trends are shown in table C20 for Douglas-fir full length wales, struts, and sheeting. Thus, few pieces of No. 1 or 2 level were limited by slope of grain in the grading process.

MOISTURE CONTENT

Almost all of the eastern species sampled were green. The moisture content of the Douglas-fir varied from green to 10 percent.

Table C1. Summary of the Average and Coefficient of Variation Values of the Strength Ratio for the Strength Ratio Grade (G)

Description	Full Wales						Sheeting					
	Range of Values by Size ^a			Combined Value ^b			Range of Values by Size ^a			Combined Value ^b		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	\overline{SR}^c	$CV_{SR}^d(\%)$	$P^e(\%)$	\overline{SR}	$CV_{SR}(\%)$	$P(\%)$	\overline{SR}	$CV_{SR}(\%)$	$P(\%)$	\overline{SR}	$CV_{SR}(\%)$	$P(\%)$
DC	55-60	19-24	72-97	58	22	85	57	20	74	57	20	74
HOUSTON	56-57	13-18	71-86	56	16	77	52-62	7.4-15	87-100	56	15	90
DC, HOUSTON	55-60	13-24	71-97	57	19	80	52-62	7.4-20	74-100	56	16	85
NEW DOUGLAS-FIR	56-60	8.0-23	100	58	19	100	54-57	14-18	67-80	55	16	74
USED DOUGLAS-FIR	52-53	8.1-12	72-100	52 ^f	10 ^f	84 ^f	57-59	12-15	90-95	58	13	92
NEW & USED DOUGLAS-FIR	52-60	8.0-23	72-100	56 ^f	17 ^f	93 ^f	54-59	12-18	67-95	56	15	82

^a Minimum and maximum values which occurred when analyzing the lumber sizes separately (see figs. C1 to C4)-that is, the minimum is the smallest value for all sizes and the maximum is the largest value for all sizes.

^b Value for all lumber sizes taken collectively.

^c \overline{SR} = Average strength ratio.

^d CV_{SR} = Coefficient of variation of strength ratio.

^e P = Percent of pieces for which a strength ratio value could be assigned.

^f Includes struts and wales.

Table C2. Frequency of the G Grade Versus the G10 Grade Based on Method A--Includes Types I and II for Wales in Washington, D.C. and Houston, Texas

G Grade

No Entry	Ind 86	Ind 72	Ind 65	Sel. Struc.	No. 1	No. 2	No. 3	None	Row Totals
No Entry									
Ind 86		3			2	1			6
Ind 72						1			1
Ind 65					6	2			8
Sel. Struc.									
No. 1						4			4
No. 2							1	1	2
No. 3									
NONE									

Column
Totals

3

8

8

1

1

21

Table C3. Frequency of the G Grade Versus the GM3 Grade Based on Method B--Includes All "Full" and "10'" Wales in Washington, D.C. and Houston, Texas

G Grade

	No Entry	Ind 86	Ind 72	Ind 65	Sel. Struc	No. 1	No. 2	No. 3	None	Row Totals
No Entry										
Ind 86		2	4			5	2	2		15
Ind 72			3			2				5
Ind 65						10	1	1		12
Sel. Struc.						7	1	1	2	11
No. 1							5	1		6
No. 2								2		2
No. 3										
NONE										

Column Totals

2 7 24 9 7 2 51

GM3 Grade Method B

Table C4. Summary of Regrading Analysis of Wales

Regrade Method	(1) ^a			(2) ^a			(3)		(4) ^b		
	Avg. SR for Partial Length Grade			Avg. SR for Full Length Grade			Avg. Increase in SR Due to Partial Length Grade (Col. 1 minus Col. 2)		Percentage of Wales for Which Partial Length Grade Exceeded Full Length Grade		
A-Type I and II	Wash. D.C.	Houston	New Douglas-fir	Wash. D.C.	Houston	New Douglas-fir	Wash. D.C.	Houston	Wash. D.C.	Houston	New Douglas-fir
	73 ^c	61	70	63 ^d	53 ^c	51	20 ^c (14) ^e	10(5)	46 ^c	16	32
B-Full and 10'	76	64	71	73	57	53	19(25)	11(17)	16	12	29

^a Based only on wales for which the partial length grade exceeded the full length grade and for which the full length grade was No. 2 or higher.

^b Based on all wales considered for regrading, including those for which the full length grade was less than No. 2.

^c Only 1 piece of Type II occurred.

^d No Type II occurred.

^e Numbers in parentheses are number of wales on which the avg. increase in SR is based.

Table C5. Analysis of Cross-Sectional Area and Moment of Inertia Ratios
for Full Wales and Sheeting (Spot Bracing)

Description	Based on End Dimensions				Based on Wane						
	N ^a	\bar{A} (%)	CV _A (%)	\bar{I} (%)	CV _I (%)	\bar{A} (%)	CV _A (%)	\bar{I} (%)	CV _I (%)	N ^b _w	P(%) ^c
Full Wales											
D.C. and Houston 4x6, 6x6, 8x8, 12x12											
Range ^d of Values	21-94	94-102	4.0-9.3	87-105	8.9-20.1	88-98	4.4-15.8	80-96	9.0-24.6	14-53	36-83
Combined ^e Value	249	97	7.8	95	16.9	92	13.0	87	21.0	150	59
Douglas-fir-New 6x6, 8x8											
Range of Values	16-21	97-98	2.0-2.4	94-96	4.8-5.9					1-3	6-14
Combined Value	37	98	2.2	95	5.5					4	11
Sheeting-Spot Bracing											
D.C. and Houston 2x8, 3x12											
Range of Values	13-30	82-104	4.8-9.6	74-111	9.6-25.9	95-99	3.2-13.6	93-98	3.5-18.4	3-12	16-40
Combined Value	91	97	10.9	91	27.6	97	8.5	96	11.4	27	29
Douglas-fir-New 3x12, 4x12											
Range of Values	30-35	88-92	4.6-6.7	72-81	11.7-18.6					5	14-17
Combined Value	65	90	6.3	77	17.1					10	15

^a N = number in sample; values of N are for end dimensions method; in some instances they differed slightly from N values for wane method.

^b N_w = number of pieces that had wane--any amount.

^c Percent wales with wane: $P = (N_w/N) \times 100$.

^d Minimum and maximum values which occurred when analyzing the lumber sizes separately, that is the minimum is the smallest value for all sizes; similarly, the maximum is the largest. For the eastern species 8 x 8 size, two separate groups were analyzed: one for D.C. and one for Houston. For eastern species sheeting two separate groups (both from Houston) were analyzed for the 2 x 8 size; similarly two separate groups (one from D.C., one from Houston) were analyzed for the 3 x 12 size.

^e Value for all sizes taken collectively.

Table C6. Analysis of Cross-Sectional Area and Moment of Inertia Ratios for Solid Sheeting--Based on End Thickness

Description	N ^a	$\bar{A}(\%)$	$\bar{I}(\%)$
D.C. and Houston 2x8, 3x12			
Range of Values ^b	14-30	88-102	69-107
Combined Value ^c	94	96	91
Board Road			
2x ^d	65	83	57
3x ^d	65	55	17
Douglas-fir-New 3x12, 4x12			
Range of Values	30-35	91-93	75-81
Combined Value	65	92	78

^a N = number in sample.

^b Minimum and maximum values which occurred when analyzing the lumber sizes separately, that is the minimum is the smallest value for all sizes; similarly, the maximum is the largest. For eastern species, two separate groups (both from Houston) were analyzed for the 2 x 8 size; similarly two separate groups (one from D. C., one from Houston) were analyzed for the 3 x 12 size.

^c Value for all sizes taken collectively.

^d 2x and 3x refer to 2" and 3" nominal thicknesses. Board road was reportedly sold as 3" nominally thick material (see appendix B); the 2" nominal thickness is included here for comparison.

Table C7. Frequency of Downgrade by Wane for Full Wales in Washington, D.C.

G Grade, Wane Ignored

	No Entry	Ind 86	Ind 72	Ind 65	Sel. Struc	No. 1	No. 2	No. 3	None	Row Totals
No Entry										
Ind 86										
Ind 72										
Ind 65										
Sel. Struc.										
No. 1	2	2	1	1	7					4
No. 2	3	1	1	2	4	2				12
No. 3							2			6
NONE	4	5	16	8	1					34
Column Totals	9	1	8	27	10	1				56

GW Grade, Wane Considered

Table C8. Frequency of Downgrade by Wane for Full Wales in Houston, Texas

G Grade, Wane Ignored

	No Entry	Ind 86	Ind 72	Ind 65	Sel. Struc	No. 1	No. 2	No. 3	None	Row Totals
No Entry										
Ind 86										
Ind 72										
Ind 65										
Sel. Struc.										
No. 1			1							1
No. 2					3					3
No. 3				3	2	1				6
NONE				8	8	3	6			25

Column Totals

1 11 13 4 6 35

GW Grade, Wane Considered

Table C9. Frequency of Downgrade by Wane for Full Wales in Washington, D.C. and Houston, Texas

G Grade, Wane Ignored

	No Entry	Ind 86	Ind 72	Ind 65	Sel. Struc	No. 1	No. 2	No. 3	None	Row Totals
No Entry										
Ind 86										
Ind 72										
Ind 65										
Sel. Struc.										
No. 1		2		3						5
No. 2		3	1	1		10				15
No. 3					3	6	3			12
NONE		4		5	8	24	11	7		59

Column Totals

9 1 9 11 40 14 7 91

Table C10. Number and Percent of Full Wales Downgraded by Wane

Description	Total Number of Full Length Wales Assigned a G Grade	No. (N) and Percent (P) of Wales Which Were Downgraded Because of Wane		
		All Wales Downgraded by Wane	Wales Downgraded by Wane: No. 2 and Higher	Wales Downgraded by Wane: Lower than No. 2
	N_1 (1)	N_2 (2) $P_2 = N_2 / N_1 \times 100$ (3)	N_3 (4) $P_3 = N_3 / N_1 \times 100$ (5)	$P_4 = N_4 / N_1 \times 100$ (6) (7)
Wash DC	106	56	16	40
Houston	142	35	4	31
DC & Hstn	248	91	20	71
Douglas-Fir New	37	1	1	0

Table C11. Frequency of Downgrade Due to Decay for Full Wales in Washington, D.C.

G Grade, Decay Ignored

	GDE Grade, Decay Considered										Row Totals
	No Entry	Ind 86	Ind 72	Ind 65	Sel. Struc	No. 1	No. 2	No. 3	None		
No Entry											
Ind 86											
Ind 72											
Ind 65											
Sel. Struc.											
No. 1											
No. 2						1					1
No. 3						3	2				5
NONE						1	1	1			3

Column Totals

5

3

1

9

Table C12. Frequency of Downgrade Due to Decay for Full Wales in Houston, Texas

G Grade, Decay Ignored

	No Entry	Ind 86	Ind 72	Ind 65	Sel. Struc	No. 1	No. 2	No. 3	None	Row Totals
No Entry										
Ind 86										
Ind 72										
Ind 65										
Sel. Struc.										
No. 1										
No. 2										
No. 3						5	1			6
NONE						1				1

Column
Totals

11517

Table C13. Frequency of Downgrade Due to Decay for Full Wales in Washington, D.C. and Houston, Texas

G Grade, Decay Ignored

	No Entry	Ind 86	Ind 72	Ind 65	Sel. Struc	No. 1	No. 2	No. 3	None	Row Totals
No Entry										
Ind 86										
Ind 72										
Ind 65										
Sel. Struc.										
No. 1										
No. 2						1				1
No. 3						8	3			11
NONE					1	1	1	1		4

Column Totals

1 10 4 1 16

GDE Grade, Decay Considered

Table C14. Frequency of the Minimum of Grades with Wane, Decay, or Other Grade-Reducing Defects Versus the Grade Achievable with Trimming--for Full Wales in Washington, D.C.

Minimum of the G, GW, and GDE Grades

	No Entry	Ind 86	Ind 72	Ind 65	Sel. Struc	No. 1	No. 2	No. 3	None	Row Totals
No Entry										
Ind 86						1	1	1		3
Ind 72										
Ind 65								1		1
Sel. Struc.										
No. 1							2	3	2	7
No. 2								1	10	11
No. 3									7	7
NONE										

Column Totals

1 3 6 19 29

GT Grade

Table C15. Frequency of the Minimum of Grades With Wane, Decay, or Other Grade-Reducing Defects Versus the Grade Achievable with Trimming--for Full Wales in Houston, Texas

Minimum of the G, GW, and GDE Grades

	No Entry	Ind 86	Ind 72	Ind 65	Sel. Struc	No. 1	No. 2	No. 3	None	Row Totals
No Entry										
Ind 86										
Ind 72										
Ind 65										
Sel. Struc.						3	5			8
No. 1					1	3	7			11
No. 2						1	1			2
No. 3								1		1
NONE										

Column Totals

1 7 14 22

GI Grade

Table C16. Frequency of the Minimum of Grades With Wane, Decay, or Other Grade-Reducing Defects Versus the Grade Achievable With Trimming--for Full Length Wales in Washington, D.C. and Houston, Texas

Minimum of the G, GW, and GDE Grades

	No Entry	Ind 86	Ind 72	Ind 65	Sel. Struc	No. 1	No. 2	No. 3	None	Row Totals
No Entry										
Ind 86						1	1	1		3
Ind 72										
Ind 65								1		1
Sel. Struc.								3	5	8
No. 1							3	6	9	18
No. 2								2	11	13
No. 3									8	8
NONE										

Column Totals

1 4 13 33 51

Table C17. Trim Length Necessary to Upgrade Full Length Wales

Trim* Length (Ft)	Number of Wales (Percent frequency in parentheses)		
	From a None Grade to a No. 2 or Higher	From a No. 3 Grade to a No. 2 or Higher	From Either a None or No. 3 Grade to a No. 2 or Higher
1	3 (12%)	1 (8%)	4 (11%)
2	16 (64%)	9 (69%)	25 (66%)
3	4 (16%)	3 (23%)	7 (18%)
4	2 (8%)	0 (0%)	2 (5%)
Totals	25 (100%)	13 (100%)	38 (100%)

* Includes trimming from both ends, if necessary; up to 20 percent of the length of a piece was trimmable for upgrading purposes.

Table C18. Frequency (Percent) of Eastern Species Full Length Wales and Sheeting by Species

Species	Full Wales			Sheeting		
	DC	Houston	DC & Houston	DC	Houston	DC & Houston
	N [*] =107	N=148	N=255	N=25	N=69	N=94
Red Oak	21.5	33.8	28.6	12	29.0	24.5
White Oak	28.0	29.0	28.6	88	47.8	58.5
Black Gum, Tupelo	9.3	11.5	10.6		1.5	1.1
Red Gum, Sweet Gum	2.8	3.4	3.1		0.0	0.0
White Ash	0.0	4.7	2.7		10.1	7.4
Yellow Poplar	7.5	1.3	3.9		0.0	0.0
So. Yellow Pine	17.8	0.0	7.4		0.0	0.0
Sycamore	1.9	0.7	1.2		0.0	0.0
Hickory	3.7	0.0	1.6		0.0	0.0
Elm	0.0	0.0	0.0		1.5	1.1
American Elm	2.8	0.0	1.2		0.0	0.0
Slippery Elm	0.0	3.4	2.0		1.5	1.1
Cherry	0.9	0.0	0.4		0.0	0.0
Sassafras	0.9	0.0	0.4		0.0	0.0
River Birch	0.9	0.0	0.4		0.0	0.0
Beech	1.9	1.3	1.6		0.0	0.0
Pecan	0.0	9.5	5.5		0.0	0.0
Hackberry	0.0	0.7	0.4		0.0	0.0
Maple	0.0	0.7	0.4		0.0	0.0
Magnolia	0.0	0.0	0.0		1.5	1.1
Sugar Berry	0.0	0.0	0.0		5.8	4.2
Honey Locust	0.0	0.0	0.0		1.5	1.1

* N = Number in sample.

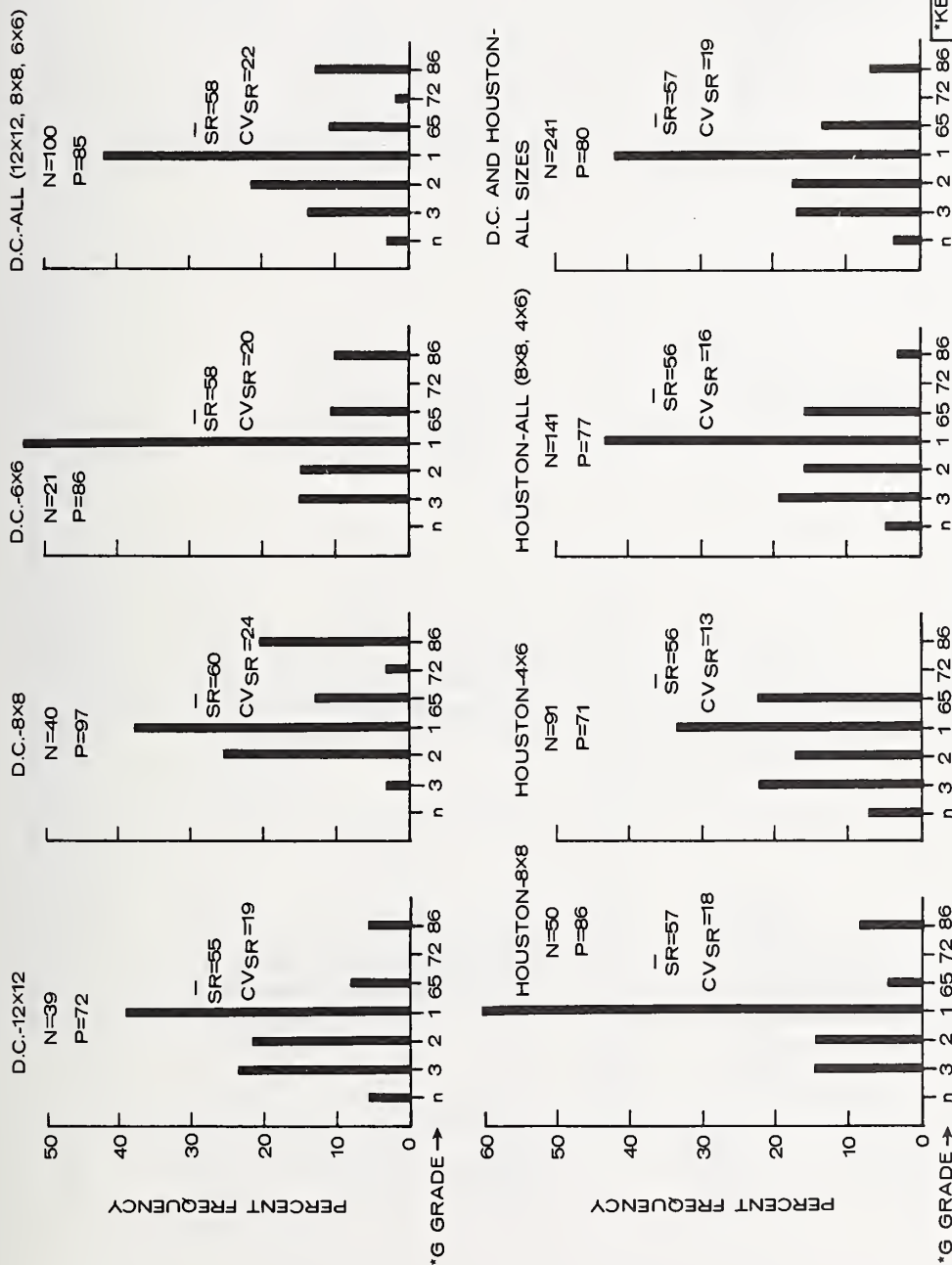
Table C19. Frequency of General Slope of Grain for All
Eastern Species Full Length Wales and Sheeting

Slope of Grain	Frequency (%)	
	Face 1	Face 2
1:3	0.3	0.0
1:4	0.3	0.0
1:5	0.6	0.3
1:7	0.0	0.3
1:8	1.9	0.3
1:10	1.3	1.0
1:11	0.0	0.3
1:12	1.6	0.7
1:18	0.6	0.7
1:20 or straighter	93.3	96.4

Table C20. Frequency of General Slope of Grain* for All
Douglas-fir Full Length Wales, Struts, and Sheeting

Slope of Grain	Frequency (%)	
	Face 1	Face 2
1:2	0.6	0.0
1:6	1.2	0.0
1:8	2.3	0.6
1:9	1.2	0.0
1:10	1.8	0.0
1:11	0.0	0.6
1:12	0.6	0.0
1:13	0.6	0.0
1:15	1.8	0.0
1:20 or straighter	90.0	98.8

* SPIB NO. 2 SR grade permitted slope of grain of 1:8 or less.



*KEY:	SYMBOL	G GRADE
n		NONE
3		NO. 3
2		NO. 2
1		NO. 1
65		INDUSTRIAL 65 OR SELECT STRUCTURAL
72		INDUSTRIAL 72
86		INDUSTRIAL 86

Figure C1. Relative Frequency of the G Grade (Disregarding Wane, Damage, and Decay) for Full Wales for Washington, D.C. and Houston, Texas.

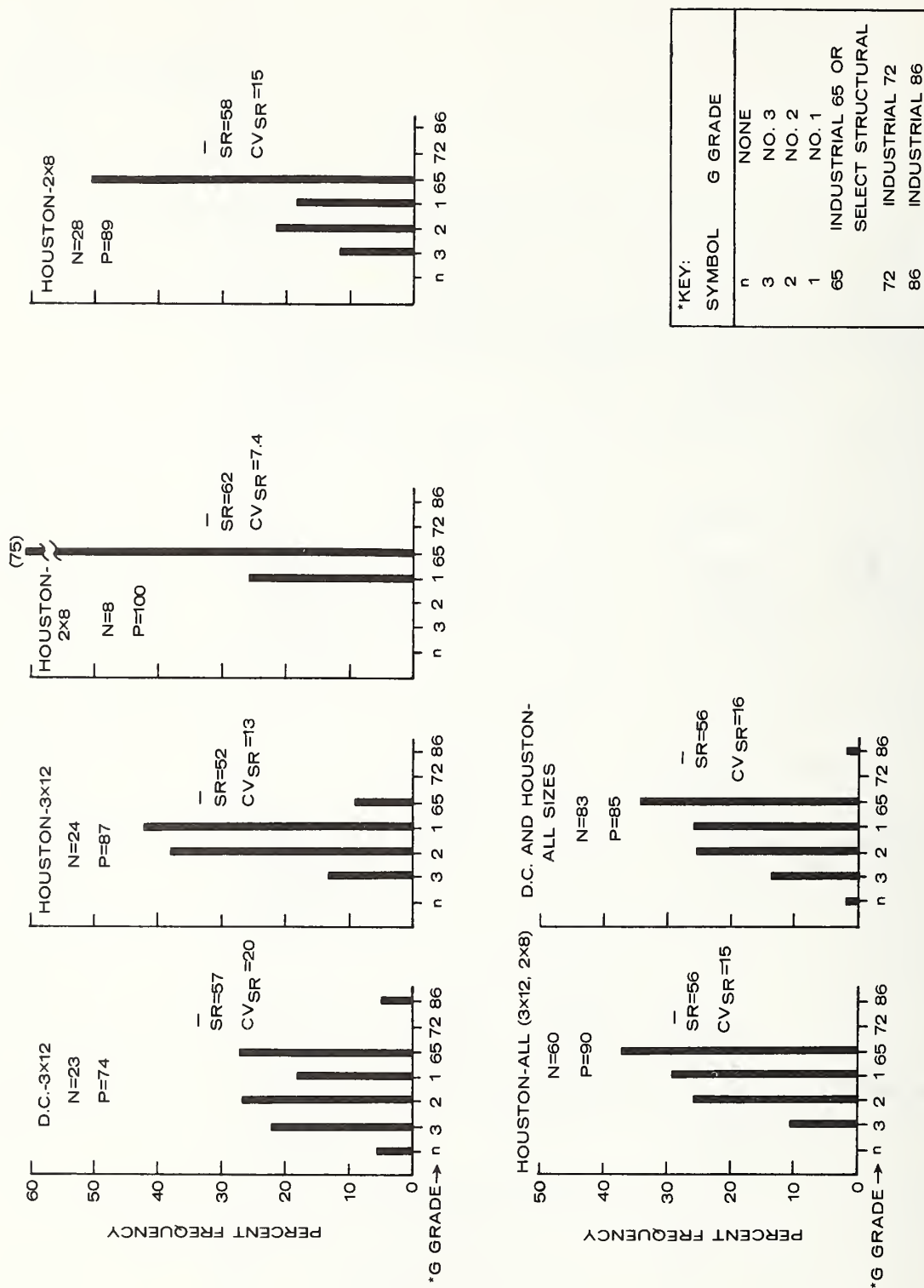


Figure C2. Relative Frequency of the G Grade for Sheet piling for Washington, D.C. and Houston, Texas.

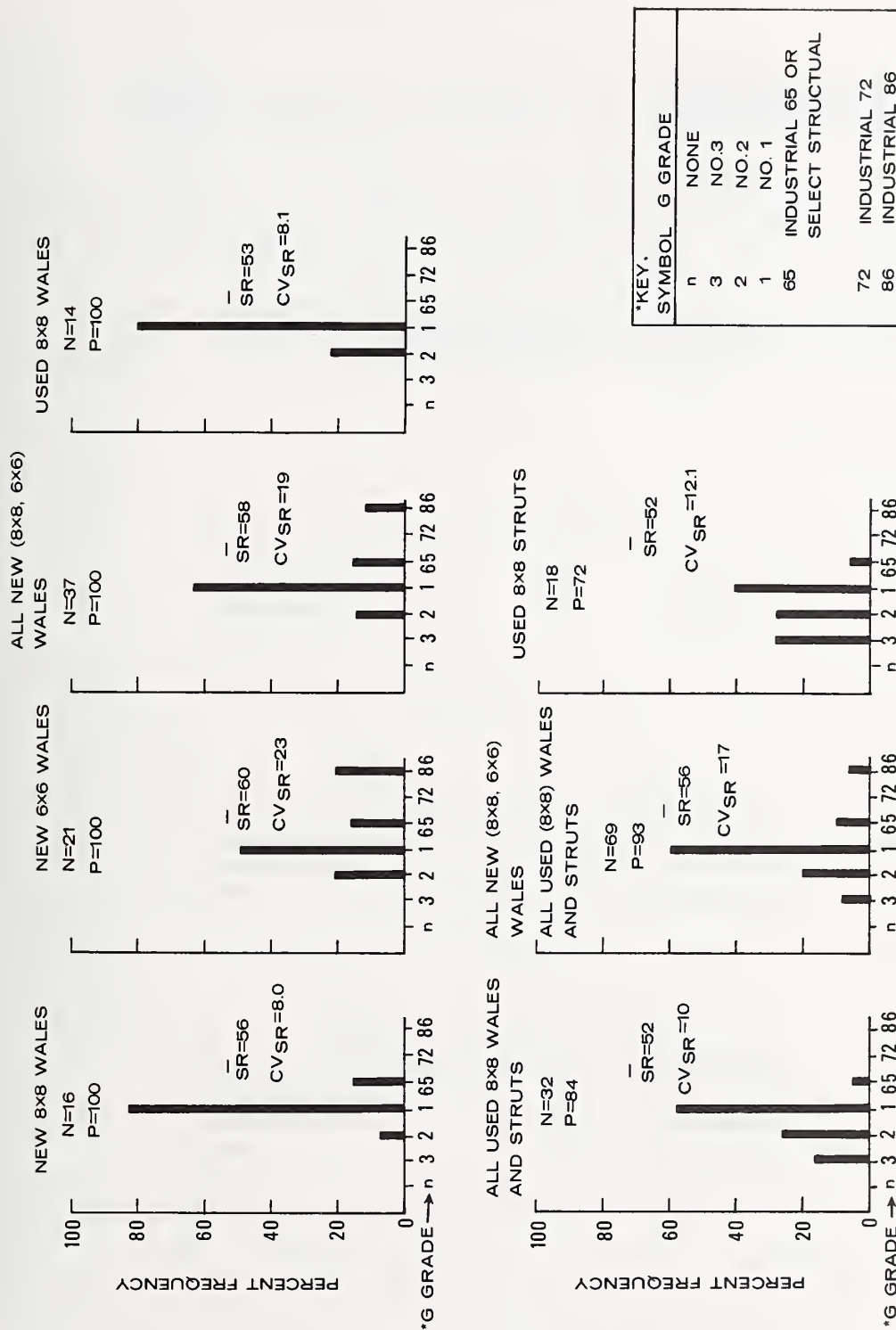


Figure C3. Relative frequency of the G Grade for Douglas-fir Full Wales and Struts in southern California.

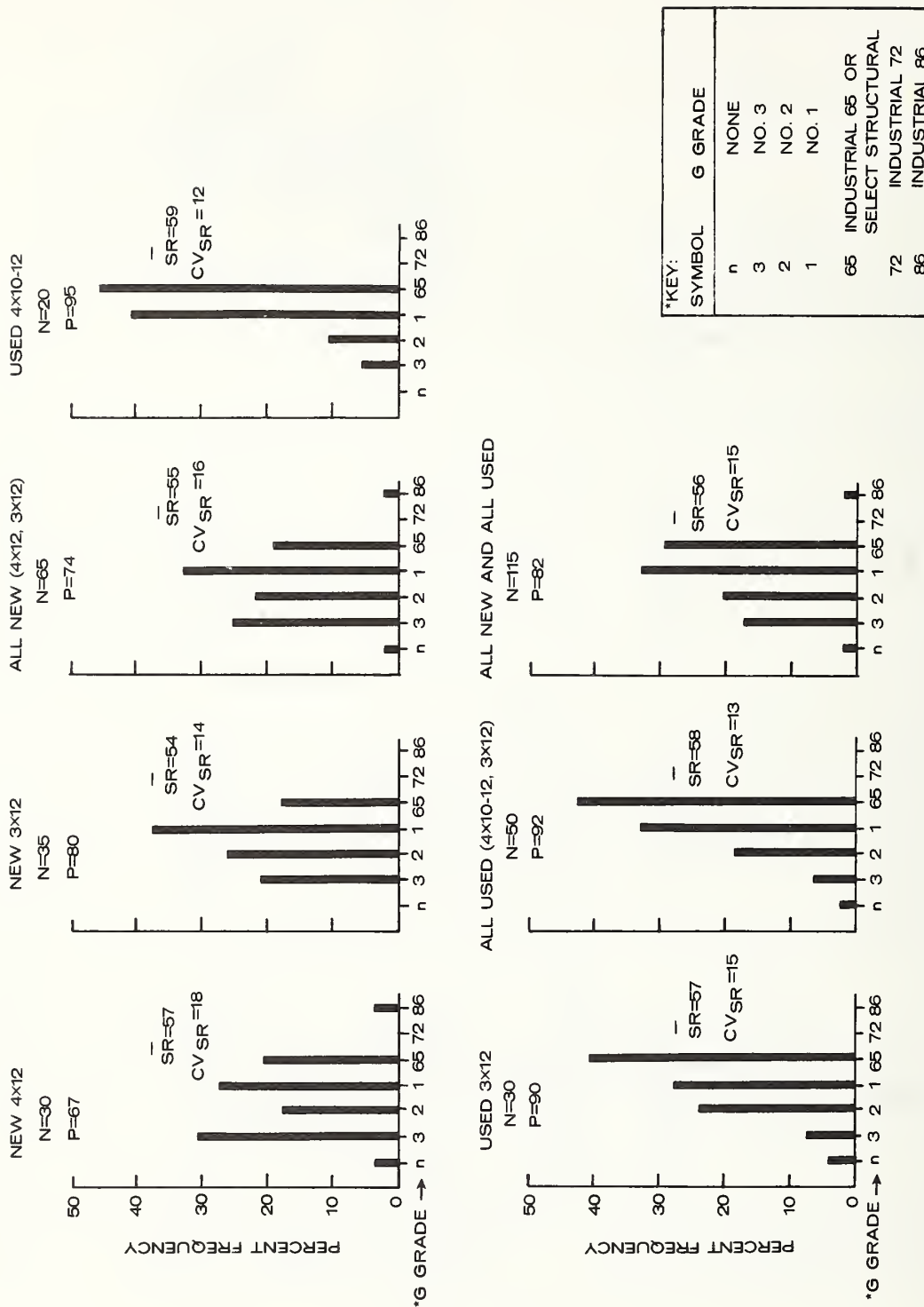


Figure C4. Relative frequency of the G Grade for Douglas-fir sheeting in southern California.

TRENCHING LUMBER: STRESS DERIVATION AND USE RECOMMENDATIONS

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Forest Service
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for the

National Bureau of Standards
U.S. Department of Commerce

ABSTRACT

Hardwood lumber and timber, which traditionally have not been stress-graded, are commonly used in trenching and excavation applications. This paper presents a practical guide to the interpretation of ASTM standards applicable to the derivation of allowable stresses for hardwood lumber.

A commentary on use recommendations that relate to the severe trenching environment provides the basis for assuring structural integrity in trenching when both new and used lumber are utilized.

CONTENTS

	<u>Page</u>
Introduction.	D-1
Part I. Derivation of Allowable Properties--A Practical Guide for Interpretation of ASTM Standards.	D-3
Basic Clear Hardwood Mechanical Property Statistics and Timber Volume Estimates.	D-5
Species Combinations and Weighting Factors.	D-5
Clear Wood or Basic Stresses.	D-5
Clear Wood Property Summary	D-13
Allowable Unit Stresses for Clear, Straight-Grained Lumber.	D-13
Allowable Unit Stresses for Lumber Grades	D-19
Bibliography I.	D-20
Appendix IA--Alternative Design Stresses for Compression Perpendicular to Grain	D-21
Appendix IB--Growing Stock Volume	D-24
Appendix IC--A Computer Program for Calculating the Exclusion Limit for a Combination of Species.	D-27
Part II. Use Recommendations--A Commentary on Application.	D-34
Use Environment and Mechanical Properties	D-34
Exposure.	D-43
Storage	D-46
Bibliography II	D-51



TRENCHING LUMBER: STRESS DERIVATION

AND USE RECOMMENDATIONS

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INTRODUCTION

The National Bureau of Standards (NBS), in cooperation with the Forest Products Laboratory (FPL), is engaged in a study for the Occupational Safety and Health Administration (OSHA) of the engineering and construction practices of excavation and trenching. The study will develop a technical basis for recommending revisions to existing standards where technical weaknesses or ambiguities exist.

Lumber often is the key structural member in trenching, having to withstand soil pressure during excavation and subsequent construction. Thus safe and efficient trenching requires a knowledge of lumber properties. Apparently a high percentage of trenching lumber comes from hardwoods, which traditionally are not stress graded. One FPL responsibility in the cooperative agreement with NBS involves adapting a stress grading system to both new and used trenching lumber, with emphasis on hardwoods.

Two existing ASTM standards provide the analytical basis for deriving design properties of trenching lumber. These standards detail the procedures for determining basic clear wood mechanical properties and subsequently deriving allowable unit stresses using visual grading procedures. These standards are ASTM D 2555-76, "Standard Methods for Establishing Clear Wood Strength Values," and ASTM D 245-74, "Standard Methods for Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber." Hereafter, the standards are referred to as D 2555 and D 245.

Trenching lumber often is large in cross section, green, and marketed locally. In addition, the lumber most commonly is used in contact with soil and exposed to all types of weather. Consequently, the task of FPL includes making use recommendations to reflect the unique circumstances

^{1/} Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

of trenching. These recommendations are assumed to apply to lumber after the visual grading standards have been considered.

Part I of this report covers the derivation of allowable properties; Part II consists of the use recommendations. In combination, they provide the basis for assigning use-oriented properties to trenching lumber and for establishing application rules.

In Part I, the procedures of D 2555 and D 245 are outlined in sequence. Tables I-1 to I-10 capsule the procedures as referenced by the text. The tables begin with a presentation of clear wood mechanical property averages and variability statistics. Also included are estimates of growing stock volumes for individual species or groups of species if individual statistics are not available. Subsequent tables perform successive operations that provide for species marketing combinations and adjustments for variability, safety, duration of load, seasoning, strength ratio, etc., as required for the derivation of design stresses. Some additional comments concerning recent developments in the derivation of allowable properties in compression perpendicular to grain are given in appendix IA.

The text and tables I-1 to I-10 do not cover all possible aspects of the derivation procedures. (In fact, the ASTM standards fail to do that also.) Traditionally, the lumber associations provide much more detail in their derivation workbooks. However, this paper was prepared as a guideline for the NBS cooperative trenching lumber study. If the format of Part I, including tables I-1 to I-10, is used by lumber associations for other purposes, it is assumed that individual agencies will add detail to their workbooks to cover unique circumstances and to satisfy requirements not provided by this paper.

Part II discusses types of lumber defects that can be anticipated in structural trenching lumber, including suggestions for categorizing damage where reuse is of interest. Particular emphasis is placed on decay and insect damage, with recommendations on effective service life under trenching conditions. The recommendations of Part II are specific to trenching and should not be adopted for other uses without careful review of the bases for the recommendations.

PART I. DERIVATION OF ALLOWABLE PROPERTIES--

A PRACTICAL GUIDE FOR INTERPRETATION OF ASTM STANDARDS

Allowable properties for visually graded lumber are based on clear wood properties as cataloged in D 2555 (3).^{2/} Three tables of properties are presented: Table 1 of D 2555 comprises properties derived by double sampling procedures (5). This is designated in D 2555 as method "A." Species sampled and analyzed by D 143 cruciform procedures (1) or by random methods (4) are designated method "B" and are listed in tables 2 and 3 of D 2555. D 2555 also provides rules and procedures for developing clear wood properties of species grouped for marketing purposes. Once the clear wood properties of a species or market group are established, the steps necessary for allowable property derivation are found in D 245.

Several sample property derivations are used in Part I to illustrate procedures. Yellow-poplar demonstrates the derivation of stresses for a single species; the "aspen" group demonstrates a combination (marketing group) where the composite dispersion factor (CDF) for the group is not limiting; the "maple" group illustrates a combination for which the CDF is controlling; and "cottonwood" illustrates a combination involving both a method A and a method B species. The aspen, maple, and cottonwood groupings are not necessarily intended as official marketing groups but were selected arbitrarily to illustrate various possible combination procedures.

For accurate identification of species used in this part both common and botanical names are included here:

Aspen, bigtooth--Populus grandidentata
quaking--P. tremuloides

Cottonwood, black--P. trichocarpa
eastern--P. deltoides

Maple, black--Acer nigrum
red--A. rubrum
silver--A. saccharinum
sugar--A. saccharum

Yellow-poplar--Liriodendron tulipifera

^{2/} Underlined numbers in parentheses refer to Bibliography I on page 20.

Table I-1.--Clear wood mechanical property means and measures of variability and timber volume

Species or region	Modulus of rupture		Modulus of elasticity		Compression parallel		Shear		Compression perpendicular		Volume Million ft ³
	Average	Stand- ard devia- tion	Average	Stand- ard devia- tion	Average	Stand- ard devia- tion	Average	Stand- ard devia- tion	Average	Stand- ard devia- tion	
	Lb/in. ²	Lb/in. ²	1,000 lb/in. ²	1,000 lb/in. ²	Lb/in. ²	Lb/in. ²	Lb/in. ²	Lb/in. ²	Lb/in. ²	Lb/in. ²	
Aspen											
Bigtooth	5,400	864	1,120	246	2,500	450	732	102	206	58	2,970
Quaking	5,130	821	860	189	2,140	385	656	92	181	51	11,093
Maple											
Black	7,920	1,267	1,328	292	3,270	589	1,128	158	601	168	1,801
Red	7,690	1,230	1,386	305	3,280	590	1,151	161	405	113	6,037
Silver	5,820	931	943	207	2,490	448	1,053	147	369	103	5,507
Sugar	9,420	1,507	1,546	340	4,020	724	1,465	205	645	181	8,566
Yellow- poplar	5,950	952	1,222	269	2,660	479	792	111	269	75	6,753
Cottonwood											
Black	4,890	1,000	1,083	197	2,200	1.00	612	1.00	165	46	394
Eastern	5,260	842	1,013	223	2,280	410	682	95	196	55	1/5,000

1/ Timber volume estimates for eastern cottonwood are not available. A fictitious estimate is assumed in order to demonstrate species combinations and property derivation procedures in subsequent tables.

Basic Clear Hardwood Mechanical Property

Statistics and Timber Volume Estimates

Table I-1 lists the average, standard deviation, and variability index, obtained by double sampling, for mechanical properties of black cottonwood. Black cottonwood is the only hardwood that has been evaluated by double sampling. Table 1 of D 2555 is the data source for method A species.

Averages and standard deviations for method B species are also listed in table I-1. Method B species are those for which mechanical property estimates are established in accordance with D 143 or by random sampling procedures. Tables 2 and 3 of D 2555 are the data sources for method B species.

Standing timber volume estimates are also listed in table I-1. Tables 4 and 5 of D 2555 are the primary data sources for volume data. Volume data have been collected for some hardwood species not included in D 2555 and are tabulated in appendix IB.

Species Combinations and Weighting Factors

It is frequently desirable for marketing purposes to combine or group species that have relatively similar properties. ASTM procedures seek equitable treatment for each species in a group or combination by weighting factors based upon standing timber volume. A species weighting factor is the ratio of individual species volume to the combined volume of all species in the combination (D 2555, paragraph 5). Marketing groups, species, and weighting factors are listed in table I-2, in which we have used the aspen, maple, and cottonwood groups for demonstration purposes.

Clear Wood Stresses

This section shows how stresses are assigned for clear unseasoned wood for individual species and for marketing groups. Modulus of rupture (R), compression parallel to grain ($C_{||}$), and shear strength are near-minimum property values (5 pct exclusion limits); compression perpendicular to grain (C_{\perp}) and modulus of elasticity (E) are average values. Tables I-3 to I-6 summarize procedures for assigning clear wood stresses. Further application of procedures for assigning clear wood values to combinations as outlined below and in tables I-3 to I-6 are given in D 2555, 5.5.

Table I-2.--Combinations and combination weighting factor

Combination	Species	Volume	Weighting factor
		<u>Million ft³</u>	
Aspen	Bigtooth	2,970	0.2112
	Quaking	11,093	.7888
Maple	Black	1,801	.0822
	Red	6,037	.2755
	Silver	5,507	.2513
	Sugar	8,566	.3909
Cottonwood	Black	394	.0730
	Eastern	5,000	.9270

Table I-3.--Assigned exclusion limits for modulus of rupture,
compression parallel, and shear (lb/in.²)

Species or combination	Species	\bar{x}	VI	s	Weighted exclusion limit	CDF	CDF check value	Assigned value
MODULUS OF RUPTURE								
Aspen	Bigtooth	5,400		864		1.84		
	Quaking	5,130		821	3,814	1.60	N.A.	3,814
Maple	Black	7,920		1,267		2.33		
	Red	7,690		1,230		2.22		
	Silver	5,820		931	4,963	.92	4,442	4,442
	Sugar	9,420		1,507		2.96		
Yellow-poplar		5,950		952	4,384			4,384
Cottonwood	Black	4,890	1.00	951		1.13		
	Eastern	5,260		842	3,820	1.71	3,768	3,768
COMPRESSION PARALLEL								
Aspen	Bigtooth	2,500		450		2.14		
	Quaking	2,140		385	1,538	1.56	N.A.	1,538
Maple	Black	3,270		589		2.06		
	Red	3,280		590		2.07		
	Silver	2,490		448	2,056	.97	1,827	1,827
	Sugar	4,020		724		2.71		
Yellow-poplar		2,660		479	1,872			1,872
Cottonwood	Black	2,200	1.00	360		1.65		
	Eastern	2,280		410	1,606	1.64	N.A.	1,606
SHEAR								
Aspen	Bigtooth	732		102		2.15		
	Quaking	656		92	512	1.56	N.A.	512
Maple	Black	1,128		158		1.55		
	Red	1,151		161		1.67		
	Silver	1,053		147	883	1.16	835	835
	Sugar	1,465		205		2.84		
Yellow-poplar		792		111	609			609
Cottonwood	Black	612	1.00	92		1.02		
	Eastern	682		95	518	1.73	503	503

Table I-4.--Assigned averages for compression perpendicular (lb/in.²)

Species or combination	Species	\bar{x}	Weighting factor	Weighted \bar{x}	Check value ($\bar{x}_{\min} \cdot 1.10$)	Assigned value
Aspen	Bigtooth	206	0.2112	186.3	199.1	186
	Quaking	181	.7888			
Maple	Black	601	.0822	505.8	405.9	406
	Red	405	.2755			
	Silver	369	.2513			
	Sugar	645	.3909			
Yellow-poplar		269	N.A.	N.A.	N.A.	269
Cottonwood	Black	165	.0730	194	181.5	182
	Eastern	196	.9270			

Table I-5.--Assigned averages for modulus of elasticity (1,000 lb/in.²)

Species or combination	Species	\bar{x}	Weighting factor	Weighted \bar{x}	VI	\bar{x}/VI_{\min}	Method A check ($1.16 \times \bar{x}/VI_{\min}$)	Method B check ($\bar{x}_{\min} \cdot 1.10$)	Assigned value
Aspen	Bigtooth Quaking	1,120 860	0.2112 .7888	914.9				946.0	915
Maple	Black Red Silver Sugar	1,328 1,386 943 1,546	.0822 .2775 .2513 .3909	1,335.1			1,037.3		1,037
Yellow- poplar		1,222							1,222
Cottonwood	Black Eastern	1,083 1,013	.0730 .9270	1,018	1.00	1,083	1,256	1,114	1,018

Table I-6.--A sample property derivation (E) when D 2555 tables A1 and A2 ratios are limiting^{1/}

Species or combination	Green \bar{x}	Seasoning factor ^{2/}	\bar{x}_{19} or \bar{x}_{15}	Weighting factor	Weighted \bar{x}_{19} or \bar{x}_{15}	Method B check	Assigned value	Allowable unit stress for clear lumber ^{3/}
	<u>1,000</u>		<u>1,000</u>		<u>1,000</u>	<u>1,000</u>	<u>1,000</u>	<u>1,000 lb/in.²</u>
	<u>lb/in.²</u>		<u>lb/in.²</u>		<u>lb/in.²</u>	<u>lb/in.²</u>	<u>lb/in.²</u>	
19 PERCENT MC								
Black	1,328	1.14	1,514	0.0822				
Red	1,386	1.133	1,570	.2755	1,508	1,182	1,182	1257
Silver	943	1.14	1,075	.2513				
Sugar	1,546	1.126	1,741	.3909				
15 PERCENT MC								
Black	1,328	1.20	1,594	.0822				
Red	1,386	1.19	1,649	.2755	1,582	1,245	1,245	1324
Silver	943	1.20	1,132	.2513				
Sugar	1,546	1.18	1,824	.3909				

^{1/} This table applies only to modulus of elasticity because it is the lone instance in this paper where D 2555 table A1 or A2 ratios are limiting. The format of the table will vary depending upon whether method A or B species are used or which mechanical property is involved.

^{2/} The factor for 15 pct MC is the dry/green ratio (D 2555, table A-1) limited by the seasoning factor (D 245, table 11); for 19 pct MC the factor is calculated from the 15 pct MC factor according to D 245, 7.1.2 and is also limited by the seasoning factor (D 245, table 11).

^{3/} Assigned value \div 0.94. Enter in table I-8.

Exclusion Limits

Exclusion limits (EL) for individual species are calculated as

$$EL = \bar{x} - 1.645 s \text{ (Note 9, D 2555)}$$

where \bar{x} and s are estimates of species averages and standard deviations from table I-1.

Exclusion limits for combinations are the 5th percentile of the volume-weighted frequency distribution (D 2555, 5.2.2.2 and 5.3.2.2). A computer program for computation of a group exclusion limit (GEL) is given in appendix IC. However, an estimate can be obtained by computing a volume weighted average GEL for all species in the combination (D 2555, Note 8).

Method A species.--(D 245, 5.2.2.3.) GEL is limited by a composite dispersion factor (CDF) value of 1.18. CDF is calculated for each species in the combination as

$$CDF = \frac{(\bar{x}/VI) - GEL}{s} \quad (1)$$

where VI is the variability index from table I-1. If CDF for one or more species in a combination is less than 1.18, the assigned value is the minimum GEL calculated as

$$GEL = (\bar{x}/VI) - 1.18 s \quad (2)$$

for each species having a CDF less than 1.18.

Method B species.--(D 245, 5.3.2.3.) GEL is limited by a CDF value of 1.48. CDF is calculated for each species in the combination as

$$CDF = (\bar{x} - GEL)/s \quad (3)$$

If CDF for one or more species in a combination is less than 1.48, the assigned value is the minimum GEL calculated as

$$\text{GEL} = \bar{x} - 1.48 s \quad (4)$$

for each species having a CDF less than 1.48.

Both A and B species.--CDF limits are applied to method A species as per equations (1) and (2); to method B species as per equations (3) and (4). If CDF limitations are involved, the lowest result of equations (1), (2), (3), and (4) is assumed for GEL (D 2555, 5.4.2.1).

Mean Values

C_{\perp} and E values for combinations are volume-weighted averages calculated as

$$\bar{\bar{x}} = \sum_{i=1}^n R_i \bar{x}_i \quad (5)$$

where

$\bar{\bar{x}}$ = volume-weighted average for a combination,
n = number of species in the combination,
R = ratio of the volume of the ith species to the combined volume
of all species in the combination (D 2555, 5.2.1, 5.3.1,
and 5.4.1), and
 \bar{x} = average C_{\perp} or E value of the ith species.

Method A species.--Assigned E values may not exceed the minimum quantity, 1.16 (\bar{x}/VI), calculated for each species. (D 2555, 5.2.1.1, 5.2.2) C_{\perp} is limited as for method B species.

Method B species.--The assigned C_{\perp} and E values may not exceed the minimum quantity, 1.10 \bar{x} , in the combination. (D 2555, 5.3.1.1)

Both A and B Species.--For combinations containing both method A and method B species, the limitations of method A and method B are applied as appropriate.

Nonvolume Species

A species for which no volume estimates are available may be included in a combination. Assigned values are determined for the combination excluding the "nonvolume" species and for the "nonvolume" species as an individual. If the assigned values for the "nonvolume" species exceed the combination values, the combination values are assumed. If not, the assigned values for the "nonvolume" species are assumed for the combination.

Clear Wood Property Summary

Table I-7 summarizes the clear wood property assignments for individual species and marketing combinations as derived in tables I-3 through I-6. Modulus of rupture values listed in this table are assumed for clear wood tension values.

Allowable Unit Stresses for Clear, Straight-Grained Lumber

Allowable unit stresses for clear straight-grained lumber are derived from the clear wood values in table I-7 by adjustment factors and modifications for seasoning effects and density (in our examples, modification for density is not applicable). The result is shown in table I-8.^{3/} F_b values apply to lumber 2 inches wide only.

Adjustment Factors (D 245, 6.2, 6.2.1, and table 9)

F_b , F_t , F_c , and F_v Adjustment factors include a factor for normal duration of load and a factor of safety.

The factor for E adjusts for span-depth ratio from 14 to 21 and from concentrated centerpoint loading to uniform loading.

The factor for $F_{c\perp}$ includes adjustment for average ring position and a factor of safety.

F_t is derived as $0.55 F_b$. (D 245, 4.2.5)

^{3/} Allowable properties are symbolized by the notation F_b for bending, F_t for tension, F_c for compression parallel, F_v for shear, $F_{c\perp}$ for compression perpendicular, and E for modulus of elasticity.

Table I-7.--Clear wood values summary

Species or Combination	Modulus of rupture	C \parallel	Shear	C \perp	Modulus of elasticity
	<u>Lb/in.²</u>	<u>Lb/in.²</u>	<u>Lb/in.²</u>	<u>Lb/in.²</u>	<u>1,000</u> <u>lb/in.²</u>
Aspen	3,814	1,538	512	186	915
Maple	4,442	1,827	835	406	1,037
Yellow-poplar	4,384	1,872	609	269	1,222
Cottonwood	3,768	1,606	503	182	1,018

Table I-8.--Allowable unit stresses for clear straight-grained lumber^{1/}

Species or combination	$\frac{1}{F_b}$	F_t	F_C	F_v	$F_{C\perp}$	E
	<u>Lb/in.²</u>	<u>Lb/in.²</u>	<u>Lb/in.²</u>	<u>Lb/in.²</u>	<u>Lb/in.²</u>	<u>1,000</u> <u>Lb/in.²</u>
UNSEASONED						
Aspen	1,658	912	732	114	124	973
Maple	1,931	1,062	870	186	271	1,103
Yellow-poplar	1,906	1,048	891	135	179	1,300
Cottonwood	1,638	901	765	112	121	1,083
19 PERCENT MAXIMUM MC						
Aspen	2,072	1,140	1,098	123	186	1,109
Maple	2,414	1,328	1,305	201	406	^{2/} 1,257
Yellow-poplar	2,382	1,310	1,336	146	268	1,482
Cottonwood	2,048	1,126	1,148	121	182	1,235
15 PERCENT MAXIMUM MC						
Aspen	2,238	1,231	1,281	129	186	1,168
Maple	2,607	1,434	1,522	210	406	^{2/} 1,324
Yellow-poplar	2,573	1,415	1,559	152	268	1,560
Cottonwood	2,211	1,216	1,339	127	182	1,300
FOR SEASONED MATERIAL THICKER THAN 4 IN. ^{3/}						
Aspen			805			992
Maple			957			1,125
Yellow-poplar			980			1,326
Cottonwood			842			1,105

^{1/} F_b values apply to 2-inch depth only.

^{2/} Limited by dry-green ratio (table I-6).

^{3/} F_b , F_t , F_v , and $F_{C\perp}$ are the same as for unseasoned.

Table I-9.--Strength ratios, quality factors, and special adjustments

Category	Grade	F _b ^{1/}		F _t		Strength ratio			Quality factor
		Strength ratio	Depth	Strength ratio	Special ^{2/} reduction	F _C F _V F _{CL}			
						F _C	F _V	F _{CL}	
Structural light framing	Select structural	67 x	3/0.9397	67		78	50	100	100
	No. 1	55 x	.9397	55		62	50	100	100
	No. 2	45 x	.9397	45		49	50	100	90
	No. 3	26 x	.9397	26		30	50	100	80
Light framing	Construction	34 x	3/.9397	34		56	50	100	80
	Standard	19 x	.9397	19		46	50	100	80
	Utility	9 x	.9397	9		30	50	100	80
	Studs (2-4 inches wide) Studs (5-6 inches wide)	26 x	3/.9397 .8937	26	0.80	30	50	100	80
Structural joists and planks	Select structural	65 x	3/.8254	65	1.00	69	50	100	100
	No. 1	55 x	.8254	55	1.00	62	50	100	100
	No. 2	45 x	.8254	45	.80	52	50	100	90
	No. 3	26 x	.8254	26	.80	33	50	100	80
Beams and stringers	Strength ratio 86	86 x		86	NA	90	50	100	100
	Strength ratio 72	72 x	4/.8195	72	NA	80	50	100	100
	Select structural	65 x	.7743	65	NA	75	50	100	100
	No. 1	55 x		55	NA	62	50	100	100
Posts and timbers	Strength ratio 86	86 x		86	NA	90	50	100	100
	Strength ratio 72	72 x	4/.8195	72	NA	80	50	100	100
	Select structural	65 x	.7743	65	NA	75	50	100	100
	No. 1	55 x		55	NA	62	50	100	100

1/ For multiple member use, see "Allowable Unit Stresses for Lumber Grades."

2/ No adjustment required for 2- to 4-in. width. Where a factor is given, it applies to 5- and 6-in. nominal widths only. For 8-in. width, the factors are 0.90 for select structural, 0.80 for No. 1 and 0.64 for Nos. 2 and 3. For 10-in. and wider, use 0.80 for select structural, 0.60 for No. 1, and 0.48 for Nos. 2 and 3.

3 These depth adjustments assume dry ALS sizes.

4/ 0.8195 applies to actual widths 12 in. and less; 0.7743 applies to actual widths 12 to 20 in.

Table I-10.--Sample allowable unit stresses: Beams and stringers category; Select Structural grade;
members greater than 12-inch nominal width^{1/}

	F_b		F_t		F_C		F_v		$F_{C\perp}$		E	
	$\frac{\text{Lb}}{\text{in.}^2}$	$\frac{\text{Lb}}{\text{in.}^2}$	$\frac{\text{Lb}}{\text{in.}^2}$	$\frac{\text{Lb}}{\text{in.}^2}$	$\frac{\text{Lb}}{\text{in.}^2}$	$\frac{\text{Lb}}{\text{in.}^2}$	$\frac{\text{Lb}}{\text{in.}^2}$	$\frac{\text{Lb}}{\text{in.}^2}$	$\frac{\text{Lb}}{\text{in.}^2}$	$\frac{\text{Lb}}{\text{in.}^2}$	$\frac{\text{Lb}}{\text{in.}^2}$	
	UNSEASONED											
Aspen	834	825	593	600	549	550	57	55	124	125	973	1,000,000
Maple	972	975	690	700	652	650	93	95	271	270	1,103	1,100,000
Yellow-poplar	959	950	681	675	668	675	68	70	179	180	1,300	1,300,000
Cottonwood	824	825	586	575	574	575	56	55	121	120	1,083	1,100,000
	SEASONED ^{2/}											
Aspen	834	825	593	600	604	600	57	55	124	125	992	1,000,000
Maple	972	975	690	700	718	725	93	95	271	270	1,125	1,100,000
Yellow-poplar	959	950	681	675	735	725	68	70	179	180	1,326	1,300,000
Cottonwood	824	825	586	575	632	625	56	55	121	120	1,105	1,100,000

^{1/} The first column for each property is unrounded. The second is rounded according to D 245, 6.1.1.

^{2/} D 245, 7.1.3 and 7.1.4.

Seasoning Modifications (D 245, table 11)

Table I-8 contains unseasoned values which apply to lumber of all dimensions, except for F_b values which apply to 2-inch depth only. Allowable stresses, reflecting increases for 19 and 15 percent maximum moisture content in use, are also given in table I-8. These increases for seasoning are limited by the Dry/Green clear wood property ratios in tables A1 and A2, D 2555.

Provisions for handling seasoning increases for instances where D 2555 ratios are limiting are given in D 245 (7.1.2) when stresses for a single species are being derived.

D 245 does not provide direction for handling seasoning increases when the D 2555 ratios are limiting for one or more species in a combination. However, the American Lumber Standards Committee (ALSC) Board of Review has approved a procedure that performs seasoning adjustments prior to forming a combination (WWPA Grading Rule, 3rd Edition effective July 1, 1974 (8)). Seasoning adjustments are made to the averages and standard deviations tabulated in table I-1 for all species in the combination. For individual species or properties controlled by D 2555 ratios (tables A1 and A2), the adjustments are as per D 245 (7.1.2); other adjustments are as normal (D 245, table 11), except that the seasoning factor is applied to both the average and standard deviation. Using the adjusted values, combination and derivation procedures are carried out as usual beginning with moisture-adjusted table I-1 values.^{4/}

For lumber sizes thicker than 4 inches, a 10 percent increase over green values is given for compression members and a 2 percent increase is given for modulus of elasticity (D 245, 7.1.3 and 7.1.4). Compression members must be sufficiently seasoned before the increase is applied, and appreciable seasoning of the outer fibers must take place to benefit from an increase in E. Stresses for seasoned lumber thicker than 4 inches are included in table I-8.

Modification for Density

Strength properties may be increased by 17 percent and E by 5 percent for lumber meeting dense requirements (D 245, 5.6 and table 8). All

^{4/} Because unseasoned properties are required in the "unseasoned" part of I-8, a supplemental table (table I-6 is an example) should be prepared showing property derivations for combinations where D 2555 ratios (tables A1 and A2) are limiting. The supplemental table may be limited to a single property if the D 2555 ratios (table A1 or A2) are limiting in one property only. Table I-8 should show by asterisk and footnote those values derived in the supplemental table.

species other than Douglas-fir and southern pine must follow the provisions of paragraph 5.6.2 of D 245. Allowable unit stresses reflecting a density increase can be shown by a second column for each property in table I-8 for the appropriate species or by preparation of a duplicate table showing the dense values.

Allowable Unit Stresses for Lumber Grades

Allowable unit stresses for lumber grades are derived from table I-8 values for clear lumber by application of strength ratios (D 245, section 4 and tables 1-6) to strength properties and a quality factor to E values (D 245, 4.2.4 and table 7). Special factors are applied to F_b values to adjust for depth effect, and an additional factor may be applied where applicable for repetitive loading. Adjustments to F_t values conform to reductions recently recommended by the National Forest Products Association (6) and approved by the ALSC Board of Review.

A strength ratio (D 245, 4) is the ratio of the strength of a piece of lumber containing strength-reducing characteristics such as knots to its expected strength if it were a clear, straight-grained piece. Strength ratios for various lumber categories are given in table I-9. The F_b strength ratios listed for grades of lumber in the Structural Light Framing (SLF), Light Framing (LF), Studs (S), and Structural Joists and Planks (SJ&P) categories are minimum ratios specified for these grades by the National Grading Rule (NGR) as developed under PS 20-70 (7). Strength ratios for other lumber categories are not covered by the NGR. The strength ratios listed for these categories in table I-9 are arbitrarily chosen for demonstration purposes only and do not necessarily correspond to any grade description.

Table I-9 also lists quality factors to be applied to modulus of elasticity values. The quality factors are related to F_b strength ratios (D 245, 4.2.4, table 7). An example of stress-grade development comparable to the derivations outlined in tables I-7 to I-10 is given in D 245, 8.0 and table 13.

Size effect.-- F_b values are adjusted for size effect by a multiplication factor $(2/d)^{1/9}$, where d is the net surfaced depth or width (D 245, 6.3.1). For simplicity, a 11.25-inch depth adjustment factor (0.8254) is commonly applied to members 5 to 12 inches in nominal width and a 3.5-inch depth factor (0.9397) is applied to nominal widths 4 inches and less in SLF and LF categories. In this report (for demonstration only), we have assumed a 20-inch depth factor (0.7743) for grades of Beams and Stringers and Posts and Timbers for actual widths (depth) greater than 12 inches and 12-inch depth factor (0.8195) for nominal widths 12 inches and smaller.

Contiguous members.--An increase in F_b of 15 percent is recommended for design consideration for contiguous members because member interaction provides greater load-carrying capacity than expected from predicted individual member performance (D 245, 7.8.1). This adjustment may be inappropriate for a majority of trenching applications.

Lumber grades.--Allowable unit stresses for lumber grades (table I-10) are obtained by application of strength ratios and other adjustments given in table I-9 to clear lumber values given in table I-8.

Rounding.--For publication, allowable unit stresses are rounded as per D 245, 6.1.1. Rounded values are included in table I-10.

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Appendix IA--Alternative Design Stress Derivation

Compression Perpendicular to Grain

In the evolution of structural lumber grades and associated allowable design stresses, little emphasis was given to compression perpendicular (C_{\perp}) or bearing stresses because they commonly were considered of little or no significance. In fact, current C_{\perp} allowable stresses are derived from average proportional limit values which have no apparent relevance to design.

Recently, however, more efficient engineering design practices are resulting in instances where bearing stresses are limiting in design.

This has prompted research^{5/} at the Forest Products Laboratory directed to developing a more appropriate C_{\perp} design basis.

Research is currently in progress at Forest Products Laboratory to describe the stress-compression behavior in C_{\perp} for a number of species and to develop models for predicting similar behavior in other species. Figure A-1 shows a typical stress-compression result from the current study for the 25 percent tolerance limit (75 pct confidence).

Similar tolerance limits can be estimated for D 2555 species with 75 percent confidence by

$$TL = a + bP - 0.711 \sqrt{c \left[1.111 + \frac{(P - 311.1)^2}{1,020,000} \right]} \quad (A1)$$

where TL = an estimated tolerance limit (lb/in.²),

P = an average proportional limit from D 2555 (lb/in.²), and

a, b, c = constants from table A-1.

To utilize equation (A1), an engineer must first decide how much compression can be tolerated. Then, appropriate constants from table A-1 are substituted in the equations to obtain TL stresses for that design compression level. TL stresses for intermediate compression levels can be obtained by straightline interpolation between stresses obtained for the 0.03-, 0.06-, and 0.10-inch compression levels.

The estimated TL stresses do not make allowances for the effect of the angle of the growth rings. Unpublished research at the Forest Products Laboratory indicates that C_{\perp} strength at 45° to the annual rings may be

5/ Bendtsen, B. A., Haskell, J. H., and Galligan, W. L. Characterizing the Stress-compression Relationship of Wood in Compression Perpendicular to Grain. Wood Science 10(3):111-121. 1978.

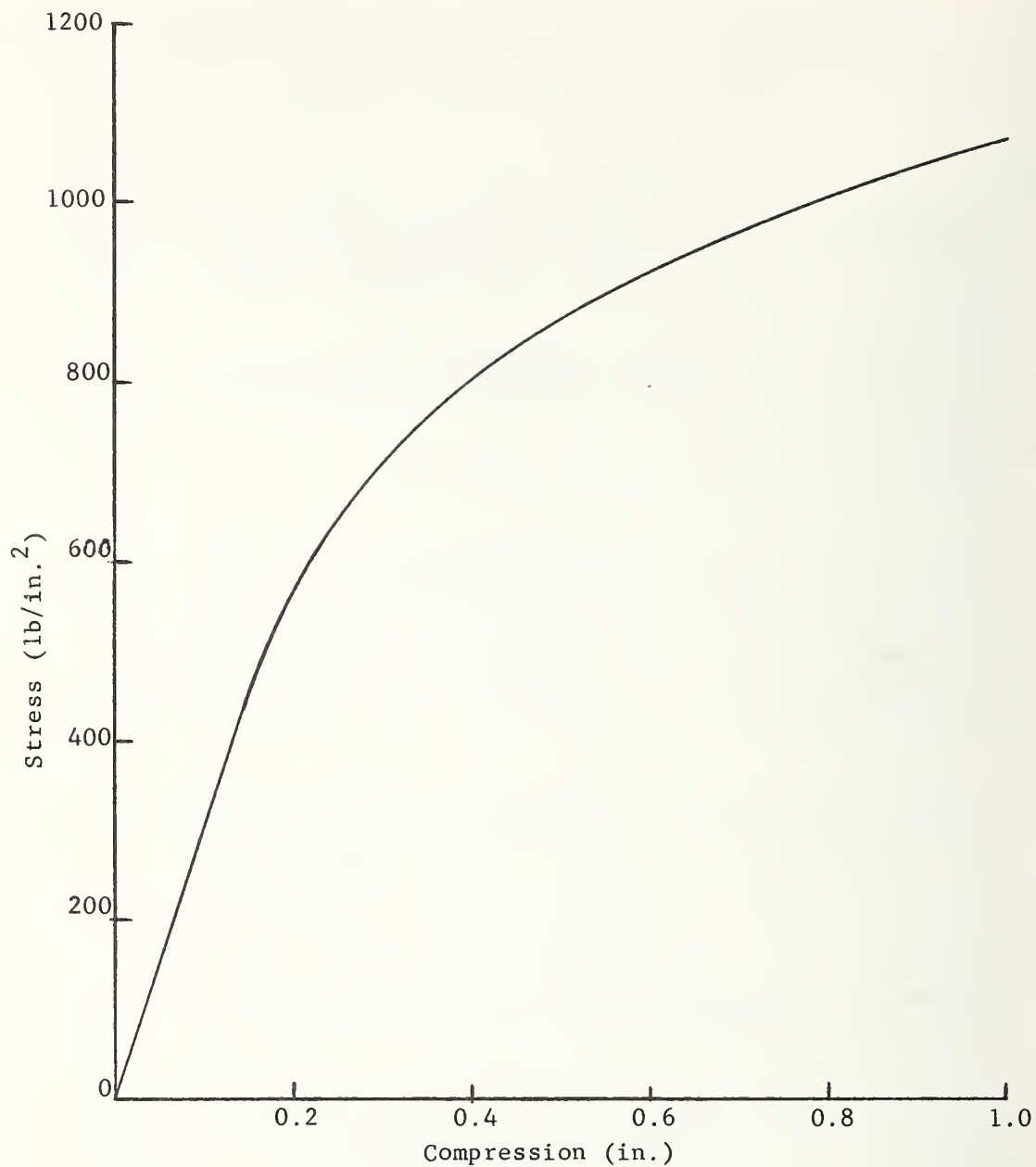


Figure A-1.--A typical 25 percent tolerance limit (75 pct confidence) stress-compression behavior.

about 40 percent lower than the results obtained from standard tests. Thus, we recommend that a reduction factor of 1.67 be applied to the TL stresses.

Also, the TL stresses do not include a safety factor. However, the consequence of exceeding C_l design stresses in wood structures is commonly cosmetic failure only. In trenching and excavation, appearance is not important and design with C_l can be quite liberal. Except for the most critical design circumstances, a safety factor should not be required considering that the C_l values obtained from (A1) are estimated lower tolerance limits with associated confidence.

Table A-1.--Parameters for estimating compression perpendicular to grain tolerance limits

Compression level	a	b	c
<u>In.</u>			
0.03	36.05	1.098	1,905
.06	21.75	1.475	1,435
.10	27.19	1.677	7,263

Appendix IB--Growing Stock Volume

Timber growing stock volume data are used as weighting factors in the derivation of allowable design properties for marketing combinations consisting of two or more species. Volume data for many species are presented in tables 4 and 5 of D 2555. But timber of species other than those in these tables are used in trenching and excavation. Volume data for additional species were obtained from Resources Evaluation Research (RER), U.S. Forest Service, Washington Office, by species and State where available. This information is summarized in table B-1 by four major geographic regions: North Central, Northeast, Southeast, and Midsouth. The States or portions of States in each region are as follows:

North Central.--Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, and Wisconsin.

Northeast.--Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, and West Virginia.

Southeast.--Florida, Georgia, North Carolina, South Carolina, and Virginia.

Midsouth.--Alabama, Arkansas, Louisiana, Mississippi, East Oklahoma, Tennessee, and East Texas.

For many of the species listed in table B-1, volume data have not yet been tabulated by the RER in every region. Thus, for these species, total species volume estimates are not listed. Nevertheless, the data should still be useful for making combinations within a region or between two or more regions. For example, there may be interest in developing design properties for a combination of all red oaks, all white oaks, or all oaks in the Midsouth region, the Southeast region, or the two regions combined.

The volume estimates in table B-1 should not be considered official in the context of National timber inventories normally published by RER of the U.S. Forest Service. Although there may be small discrepancies in the data, we believe they are sufficiently accurate for use as weighting factors for developing species combinations.

These discrepancies exist because the data received from RER contained volume estimates for an "Other Hardwoods" category in each major region. If the volume was not tabulated for a particular species in a region, we could not be certain whether the region contained no volume for that species or whether the species was included in the "Other Hardwoods" category. However, a species included in this category is likely to be of minor importance (low volume) in the region. Also, a volume estimate may contain more than one species; e.g., "basswood" estimates may contain American and white basswood. In this case, however, white basswood most likely does not make a significant contribution to the total basswood volume. A similar conclusion would probably also apply where other species estimates are combined.

Table B-1.--Growing stock volume for certain hardwood species
by major geographic regions (million ft³)

Species	North Central	North- east	Mid- south	South- east	Total
Ash (Fraxinus):					
Green (F. pennsylvanica)	<u>1</u> / -	-	1,282	-	-
White (F. Americana)	-	-	575	-	-
Balsam poplar (Populus balsamifera)	637	-	<u>2</u> / ---	---	-
Basswood (Tilia sp.)	1,606	995	164	202	2,771
Birch (Betula):					
Gray (B. populifolia)	---	10	---	---	10
Paper (B. papyrifera)	2,114	1,658	---	---	3,773
River (B. nigra)	95	21	160	---	275
Boxelder (Acer negundo)	20	-	193	25	-
Cherry (Prunus sp.)	331	2,404	-	118	-
Cottonwood eastern (Populus deltoides)	457	-	472	91	-
Cucumber (Magnolia acuminata)	1	125	49	81	256
Elm (Ulmus)					
American (U. americana)	-	-	884	-	-
Rock (U. thomasii)	-	-	4	-	-
Slippery (U. rubra)	-	-	161	-	-
Holly (Ilex opaca)	---	3	118	68	189
Locust:					
Black locust (Robinia psuedoacacia)	92	365	153	321	931
Honeylocust (Gleditsia triacanthos)	30	---	136	12	178
Magnolia (Magnolia):					
Southern (M. grandiflora)	---	---	142	92	234
Sweetbay (M. virginiana)	---	---	672	606	1,278

(Page 1 of 2)

Table B-1.--Growing stock volume for certain hardwood species
by major geographic regions (million ft³)--Con.

Species	North Central	North- east	Mid- south	South- east	Total
Oak red (<i>Quercus</i> sp.)					
Black (<i>Q. velutina</i>)	-	-	2,109	1,458	-
Cherrybark (<i>Q. falcata</i> var. <i>pagodaefolia</i>)	-	-	1,169	204	-
Laurel (<i>Q. laurifolia</i>)	-	-	481	1,572	-
Northern red (<i>Q. rubra</i>)	-	-	1,164	1,842	-
Pin (<i>Q. palustris</i>)	-	-	50	40	-
Scarlet (<i>Q. Coccinea</i>)	-	-	774	1,932	-
Shumard (<i>Q. shumardii</i>)	-	-	229	38	-
Southern red (<i>Q. falcata</i>)	-	-	3,392	1,400	-
Willow (<i>Q. phellos</i>)	-	-	1,775	511	-
Oak, white (<i>Quercus</i> sp.)					
Bur (<i>Q. macrocarpa</i>)	-	-	11	---	-
Chestnut (<i>Q. prinus</i>)	-	-	1,222	2,677	-
Chinkapin (<i>Q. muehlenburgii</i>)	-	-	---	10	-
Overcup (<i>Q. lyrata</i>)	-	-	975	179	-
Post (<i>Q. stellata</i>)	-	-	4,041	778	-
Swamp chestnut (<i>Q. michauxii</i>)	-	-	333	267	-
Swamp white (<i>Q. bicolor</i>)	-	-	16	15	-
White (<i>Q. alba</i>)	-	-	4,752	4,608	-
Osage-Orange (<i>Maclura pomifera</i>)	1	---	14	---	15
Sassafras (<i>Sassafras albidum</i>)	48	30	114	---	192
Tupelo (<i>Nyssa</i>):					
Black gum (<i>N. sylvatica</i>)	282	442	2,529	5,400	8,653
Water (<i>N. aquatica</i>)	---	---	1,213	652	1,864
Walnut (<i>Juglans nigra</i>)	374	254	-	107	-

1/ - Symbolizes that the volume for the species in the region is unknown.

2/ --- Symbolizes that there is no significant volume for the species in the region.

(Page 2 of 2)

Appendix IC--A Computer Program for Calculating the

Exclusion Limit for a Combination of Species

ASTM D 2555, Section 5.2.2.2 and others, require calculation of a 5 percent exclusion limit for modulus of rupture, maximum crushing strength parallel to grain, and shear by adding the areas under volume-weighted frequency distributions of each species at successively higher levels of strength until a value is obtained below which 5 percent of the area under the combined frequency distribution will fall.

This appendix presents a computer program for calculating the 5 percent exclusion limit for three mechanical properties. The program is written in Fortran V and has been executed on the Univac 1110. It should be easily adaptable to other computers.

Numerical Procedure

The frequency distribution of a mechanical property for a combination of species is, in general, a heterogeneous distribution. The numerical procedure assumes the heterogeneous distribution is made up of two or more component normal distributions, having sample estimates of the property mean and standard deviations as listed in table I-1, with each component distribution weighted according to the volume estimates in that table. These normal distributions overlap one another, and a value of the property is sought such that 95 percent of the wood in the entire combination will exceed it.

The property axis of the combined frequency distribution is subdivided into a set of uniform classes of width (\underline{w}). Each component normal frequency distribution is integrated from $-\infty$ to an upper class limit (\underline{x}_1) selected to be below the exclusion limit of the heterogeneous distribution. Then integration results are weighted to reflect the timber volume of the species represented by each component distribution. Successive classes are then integrated, the results weighted and accumulatively summed until the summation exceeds 0.05. The last class integrated contains the 5 percent exclusion limit, which is then obtained by straight-line interpolation between summations of integrations to the lower and upper limits of the last class.

For successful operation of the program, \underline{x}_1 must be below the 5 percent exclusion limit of the combined distribution. Also, \underline{w} must be small for accurate interpolation of the exclusion limit in the last class. Arbitrarily chosen dimensionless factors are entered as input to calculate \underline{x}_1 and \underline{w} as a proportion of the lowest species property average ($\underline{\bar{x}}$) in the combination. We have found factors of 0.5 and 0.005 appropriate for calculating \underline{x}_1 and \underline{w} , respectively.

Additional details concerning the numerical procedures can be obtained from the Forest Products Laboratory.

Program Input

There are two kinds of card inputs: (1) Species statistics and (2) factors for calculating \bar{x}_i and \bar{w} . Type (1) cards each describe one species and are limited to 50 in number. Figure C-1 is an example of a set of cards for four species and the type (2) card. A species statistics card includes estimates of the mean (\bar{x}) and standard deviation (\bar{s}) for modulus of rupture, maximum crushing strength parallel to grain, and shear; a volume estimate; and any convenient species designation code.

Program Output

The program output shown in table C-1 is self-explanatory.

Figure C-1.--Sample input cards

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

TYPE (1) CARDS

Species designation

Modulus of rupture

Compression parallel

Shear

Volume

x

S

X

S

X

S

[illegible]

TYPE (2) CARD

```
Initial
  integration
    limit
      (x1)
```

Class
width
(w)

A large grid of graph paper, consisting of 20 columns and 15 rows of squares, intended for plotting a graph.

Table C-1.--Program output.

MOR

SPECIES	AVE PROP	STD DEV	EXCL LIM	REL WT	COMBINED EXCL LIMIT
1	7920.	1267.	5836.	.0822	
2	7690.	1230.	5667.	.2755	
3	5820.	931.	4289.	.2513	4963.
4	9420.	1507.	6941.	.3909	

COMP PAR

SPECIES	AVE PROP	STD DEV	EXCL LIM	REL WT	COMBINED EXCL LIMIT
1	3270.	589.	2301.	.0822	
2	3280.	590.	2309.	.2755	
3	2490.	448.	1753.	.2513	2056.
4	4020.	724.	2829.	.3909	

SHEAR

SPECIES	AVE PROP	STD DEV	EXCL LIM	REL WT	COMBINED EXCL LIMIT
1	1128.	158.	868.	.0822	
2	1151.	161.	886.	.2755	
3	1053.	147.	811.	.2513	883.
4	1465.	205.	1128.	.3909	

The Program

```
C
C   A PROGRAM FOR CALCULATING PROPERTIES FOR GROUPS OF SPECIES
C
C   DIMENSION STRAT(3,999),EXC(3),JSQ(51),XBAR(51,3),STD(51,3),AVE(3),
C   .C(3,3),XM(3),VOL(51)
C   DATA ASP/.56418958/A1/.22583684/A2/-.25212866/A3/1.2596951/
C   DATA A4/-1.2878224/A5/.94064607/A6/.3275911/
C
C   READ FACTORS FOR CALCULATING INITIAL X AND CLASS WIDTH VALUES,
C   FACTORS ARE MULTIPLIED BY THE LEAST AVERAGE PROPERTY OF A GROUP
C   TO ARRIVE AT THE ACTUAL VALUES. DATA CARD FORMAT IS
C   2F10., RIGHT JUSTIFIED, INCLUDE DECIMAL POINTS.
C
C   1 READ 2,XFC,WFC
C   2 FORMAT(2F10.0)
C
C   DO 4 J=1,3
C   EXC(J)=0.
C   AVE(J)=0.
C   DO 3 K=1,999
C   3 STRAT(J,K)=0.
C   4 CONTINUE
C
C   READ A GROUP OF 2-50 DATA CARDS FOLLOWED BY A TRAILER CARD
C   THAT HAS 99 PUNCHED IN CC 1-2. DATA IS RIGHT JUSTIFIED,
C   WITHOUT DECIMAL POINTS, AS FOLLOWS
C
C   COL 1-2                ANY NUMERICAL SPECIES DESIGNATION          12
C
C   COL 3-9,16-21,27-32    SPECIES AVERAGE PROPERTIES
C
C   COL 10-15,22-26,33-37  STANDARD DEVIATION OF PROPERTIES
C                           FOR THE SPECIES
C
C   COL 38-44              TIMBER VOLUME
C
C   COL 45-80              MAY BE USED FOR REMARKS.  NOT PROCESSED
C                           BY THE PROGRAM
C
C   DO 7 J=1,52
C   READ 6,JSQ(J),XBAR(J,1),STD(J,1),XBAR(J,2),STD(J,2),XBAR(J,3),
C   .STD(J,3),VOL(J)
C   6 FORMAT(I2,F7.0,F6.0,2(F6.0,F5.0),F7.0)
C   IF(JSQ(J).EQ.99)GO TO 8
C   7 CONTINUE
C
C   8 JN=J-1
C   AVOL=0.
C   DO 12 I=1,3
C   TVOL=AVOL
C   DO 10 J=1,JN
C   AVE(I)=AVE(I)+XBAR(J,I)*VOL(J)
C   10 TVOL=TVOL+VOL(J)
C   12 AVE(I)=AVE(I)/TVOL
```

```

C      DEVELOP C=ARRAY
      DO 13 J=1,3
13     XM(J)=99999999.
      DO 15 J=1,3
      DO 15 K=1,JN
      IF(XBAR(K,J).GE.XM(J))GO TO 15
      XM(J)=XBAR(K,J)
15     CONTINUE
      DO 17 J=1,3
      C(J,1)=XM(J)*XFC
      C(J,3)=XM(J)*WFC
17     C(J,2)=C(J,1)+997.*C(J,3)
      PRINT 99
99     FORMAT(1H1)
      DO 50 JJ=1,3
      IF(AVE(JJ)),50,
      DO 32 II=1,JN
      N=0
      L=0
      Y=C(JJ,1)
20     IF(Y-C(JJ,2)),21,21
      IF(N-998)22,21,22
21     L=L+1
22     N=N+1
      X=(Y-XBAR(II,JJ))/STD(II,JJ)
      XX=X
      IF(X),24,24
      X=-X
24     X=X/1.414214
      E=1./(1.+A6*X)
      X2=-(X*X)
      Q=2.*ASP*EXP(X2)
      ERR=.5*(A1*E+A2*E*E+A3*E*E*E+A4*E*E*E*E+A5*E*E*E*E*E)*Q
      IF(XX),25,25
      AREA2=ERR
      GO TO 26
25     AREA2=1.-ERR
26     IF(Y-C(JJ,1))30,,30
      STRAT(JJ,N)=STRAT(JJ,N)+AREA2*VOL(II)
28     Y=Y+C(JJ,3)
      AREA1=AREA2
      GO TO 20
30     STRAT(JJ,N)=STRAT(JJ,N)+(AREA2-AREA1)*VOL(II)
      IF(L-1)28
      N=N+1
      STRAT(JJ,N)=STRAT(JJ,N)+ERR*VOL(II)
      IF(Y-C(JJ,2)),32,32
      PRINT 33,JJ
33     FORMAT(' EXCLUSION LIMIT NOT REACHED FOR PROP',I2)
32     CONTINUE
      DO 38 I=1,999
38     STRAT(JJ,I)=STRAT(JJ,I)/TVOL
      CUM=0.
      DO 46 I=1,999

```

```

      IF(I-1),,42
      IF(.05-STRAT(JJ,I)),,42
      PRINT 40,JJ
40  FORMAT(/,' LOWEST CLASS CONTAINS EXCLUSION LIMIT FOR PROP',I3)
      GO TO 50
42  IF(STRAT(JJ,I)-.05+CUM),44,44
      CUM=CUM+STRAT(JJ,I)
      GO TO 46
44  STEPS=I-2
      EXC(JJ)=C(JJ,1)+STEPS*C(JJ,3)+C(JJ,3)*(.05-CUM)/STRAT(JJ,I)
      GO TO 50
46  CONTINUE
50  CONTINUE
      PRINT 99
      DO 80 I=1,3
      IF(AVE(I)),80,
      IF(I-2),53,55
      PRINT 52
52  FORMAT(' MOR')
      GO TO 63
53  PRINT 56
56  FORMAT(///// ' COMP PAR')
      GO TO 63
55  PRINT 58
58  FORMAT(///// ' SHEAR')
      GO TO 63
63  PRINT 64
64  FORMAT(/,' SPECIES  AVE PROP  STD DEV  EXCL LIM  REL WT  COMBINED
      .EXCL LIMIT',/)
      JD=JN/2+1
      DO 70 J=1,JN
      FIVEP=XBAR(J,I)-1.645*STD(J,I)
      WT=VOL(J)/TVOL
      K=JSQ(J)
      IF(JD.EQ.J) GO TO 66
      PRINT 68,K,XBAR(J,I),STD(J,I),FIVEP,WT
      GO TO 70
66  PRINT 68,K,XBAR(J,I),STD(J,I),FIVEP,WT,EXC(I)
68  FORMAT(I5,F12.0,2F9.0,F9.4,5X,F8.0)
70  CONTINUE
80  CONTINUE
      PRINT 99
      STOP
      END

```

PART II. USE RECOMMENDATIONS--A COMMENTARY ON APPLICATION

Structural properties of lumber derived in Part I are predicated upon controlled use in which no degradation of properties occurs. Trenching lumber is a somewhat unique application for structural wood since, in most cases, the lumber is in contact with the soil and is subject to an environment more severe than that for which most wood products are specified. The following sections consider various aspects of trenching lumber applications assuming severe environment, some reuse of structural members, and the need for structural integrity related to safety of both life and property, for finite periods of time.

Use Environment and Mechanical Properties

Duration of Load

New lumber.--Increases in allowable stresses for short-term loading conditions are justified as per paragraph 203 NDS (6).^{6/} Otherwise, normal loading is assumed for all use not exceeding 10 years; 90 percent of normal loading stresses are used where the duration exceeds 10 years.

Used lumber.--The uncertainty of actual loadings in trenching applications and the difficulty in accurately accumulating load duration history suggest a conservative approach for used lumber. Thus, it is recommended that normal loading stresses be used in all reuse applications not exceeding 10 years; 90 percent of normal loading where the duration exceeds 10 years.

Damage

All lumber is graded under the assumption that strength-affecting characteristics may be present in a piece if they do not reduce the strength below the level predicted by the defect upon which the grade is based. Mechanical damage may be tolerated without a grade change on this basis. However, if the damage has the equivalent effect of a grade reduction, the piece must be regraded. Thus, it is recommended that used lumber with visible evidence of mechanical damage be regraded before reuse. Further guidelines follow.

Structural damage.--(1) Gouge--Minor scrapes or gouges on flat surfaces will be subjected to the same limitations as "skips"; on corners, they will be limited as wane. Major gouges, or those that exceed skip or wane limitations, will be treated as a knot as per D 245.

(2) Splits--Splits will have the same limitations as splits in new lumber.

^{6/} Underlined numbers in parentheses indicate references in Bibliography II, p. 51

(3) Punctures--Punctures have the same limitations as knots of equivalent size.

Severe structural damage.--Severe structural damage is defined as damage potentially causing a loss in strength in excess of that expected solely because of loss in section as graded under gouges, splits, or punctures. Severe structural damage may not necessarily be visible; i.e., it may be judged that the visible physical damage could not have occurred without having caused more serious but less evident severe damage. An example is a puncture wherein the average size of a hole is moderate but one side is much larger than that on the other. The extent of damage is therefore difficult to accurately assess. A second example is a broomed end on a strut. The actual extent of shear failure beyond the brooming is difficult to assess. If a member is judged to have potentially severe structural damage, it should be (a) designated for resawing to remove damaged portions and then regraded, (b) designated for nonstructural use, or (c) discarded. Figure II-1 shows examples of damage where the timbers could be resawed and used as structural members.

Wane

Successful use of essentially full round timbers in much trenching lumber, particularly wales and struts, suggests that wane may not be critical unless a flat surface is required for fastening other materials. It is desirable that wane restrictions for trenching lumber be related to demonstrable need for cross sectional area as defined by the strength ratio for the grade or by design requirements. Pieces not meeting wane restrictions may be treated as a smaller size. Figure II-2 shows an example of a timber that probably would not meet the wane restriction.

Bark

Traditionally, a substantial amount of trenching lumber is used with the bark remaining on the piece. This practice is not recommended as the bark will prevent the sapwood underneath from drying out, thus encouraging decay and maintaining a haven for insect attack. Further, a removal of bark is essential for adequate grading of the members. It is recommended, therefore, that bark be removed from trenching lumber.

Decay Attack

Wood kept constantly dry does not decay. If kept below approximately 20 percent moisture content, wood will last indefinitely. Further, if it is kept continuously submerged in water (probably comparable to underground, below water table exposure) even for long periods of time, it is not decayed significantly by the common decay fungi regardless of the wood species or the presence of sapwood. Bacteria and certain soft-rot fungi can attack submerged wood, but the resulting deterioration is



Figure II-1.--Timbers that appear to have potential for resawing and structural reuse. Resawing could remove the apparent bending failures near the end (top) or the brooming failures (bottom).

D-36

(M 145 664-1A)

(M 145 667-3)



Figure II-2.--Extensive wane in trenching timber must be treated as a structural defect or downgraded to a smaller size.

(M 145 667-11)

very slow (1,2) and is not a concern in trenching lumber even when reused repeatedly.

The heartwood of some common native species has varying degrees of natural decay resistance. Untreated sapwood of all species has low resistance to decay and usually has a short service life under conditions conducive to decay. Decay resistance of heartwood is greatly affected by differences in preservative qualities of the wood extractives, attacking fungus, and conditions of exposure. Considerable difference in service life may be obtained from pieces of wood cut from the same species or even from the same tree and used under apparently similar conditions. Furthermore, in a few species, such as spruces and the true firs (not Douglas-fir), heartwood and sapwood are so similar in color that they cannot be easily distinguished. Marketable sizes of some species, such as southern pine and baldcypress, are largely second growth and contain a high percentage of sapwood.

Precise ratings of decay resistance of heartwood of different species are not possible because of differences within species and the variety of service conditions to which wood is exposed. However, broad groupings of many of the native species based on service records, laboratory tests, and general experience are helpful in choosing heartwood for use under conditions favorable to decay. Table II-1 shows such groupings for some domestic woods according to their average heartwood decay resistance. The extent of variations in decay resistance of individual trees or wood samples of the species is much greater for most of the more resistant species than for the slightly or nonresistant species.

Both resistant and nonresistant species can be utilized as trenching lumber. However, if decay hazards are present, any sapwood and the heartwood of nonresistant species should only be utilized for service where the potential for decay is low or moderate or where the exposure time is limited. Specific recommendations are given in a later section.

If a trench design defines certain members as not structurally critical, sheeting perhaps, nonresistant material might be used even where decay hazards are severe. Alternatively, nonresistant material can be treated with preservatives for severe exposure conditions.

It is important to note that green lumber will support decay organisms and that heavy timber dries very slowly. Thus, for green timbers, the exposure period must include processing and storage times. Specific recommendations regarding exposure periods for various geographical locations are discussed in a later section ("Exposure").

Table II-1.--Grouping of some domestic woods according to heartwood decay (taken from (8))

Resistant or very resistant	Moderately resistant	Slightly or nonresistant
Baldcypress (old growth) ^{1/}	Baldcypress (young growth) ^{1/}	Alder
Catalpa	Douglas-fir	Ashes
Cedars	Honeylocust	Aspens
Cherry, black	Larch, western	Basswood
Chestnut	Oak, swamp chestnut	Beech
Cypress, Arizona	Pine, eastern ^{1/}	Birches
Junipers ^{2/}	white	Buckeye
Locust, black	Southern pine:	Butternut
Mulberry, red ^{2/}	Longleaf ^{1/}	Cottonwood
Oak:	Slash ^{1/}	Elms
Bur	Tamarack	Hackberry
Chestnut		Hemlocks
Gambel		Hickories
Oregon white		Magnolia
Post		Maples
White		Oak (red and black species)
Osage orange ^{2/}		Pines (other than long- leaf, slash and eastern white)
Redwood		Poplars
Sassafras		Spruces
Walnut, black		Sweetgum
Yew, Pacific ^{2/}		True firs (western and eastern)
		Willows
		Yellow-poplar

1/ The southern and eastern pines and baldcypress are now largely second growth with a large proportion of sapwood. Consequently, substantial quantities of heartwood lumber of these species are not available.

2/ These woods have exceptionally high decay resistance.

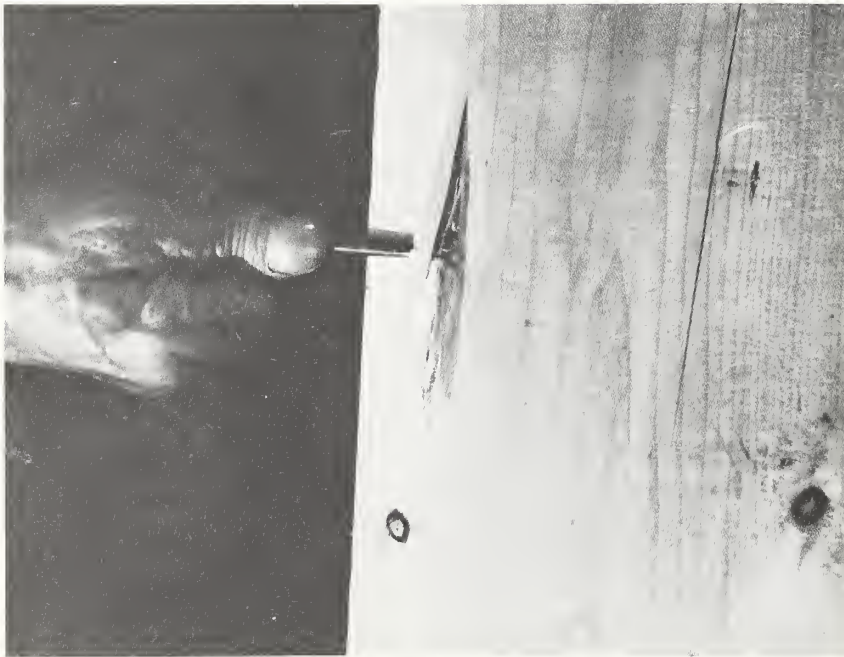


Figure II-3.--The "pick test" for early decay. Watted wood if sound
(left) lifts as a long silver or breaks by splintering; if infected
(right) it tends to lift in short lengths and to break abruptly across
the grain without splintering. (From (7)).

(M 124 721)

Unfortunately, sapwood is present in much trenching lumber, particularly on edges and corners. Where decay resistance is essential, sapwood should be treated as wane to take advantage of the natural decay resistance of durable species (in critical service). If sapwood exceeds the wane limitation of the grade, a piece should be downgraded.

For most severe decay hazards pressure treatments are often required. Even the very decay resistant species may require preservative treatments for important structural uses. A general overview of preservation is available in the Wood Handbook (8).

Decay is prohibited in members for all structural uses if identifiable by visual inspection. An exception may be pieces in which decay occurs in a knot but does not extend into the wood. Decay can usually be recognized by the appearance of brown or white spots or irregular zones and the occurrence of collapsed or abnormally shrunken areas. If decay is suspected but not visually confirmed, the toughness or brashness of fibers should be tested by inserting a sharp probe (pick test) a short distance into the wood in a suspected area and prying downward on the probe to bring out a small section. Interpretation of the pick test is given in figure II-3. Borderline cases should be judged to contain decay, and along with pieces containing decay, should be designated for nonstructural use or should be discarded. A more thorough discussion of the pick test and its interpretation is given in (7).

Surface mold and stain is an indication that conditions are extremely favorable for strength reducing decay to take place, although the extent of the decay is difficult to assess (8). The presence of the mold also suggests the storage procedure is inadequate to prevent decay. Pieces having extensive mold or stain should be examined with the pick test as described in the preceding paragraph.

Insect Attack

Insect damage can occur in seasoned or unseasoned lumber. In trenching operations, the principal concern is where established large colonies of insects are in existence. Where installation may exist for a year or more, control of insects, particularly termites, must be considered. No method is known for estimating from appearance the amount of reduction of strength from insect damage. If damage is evident, critical members should be removed from service and the piece resawn and regraded or placed in a noncritical use. Detailed discussion of insect attack is found in the Wood Handbook.

Grading rules for stress-rated lumber do not permit lumber containing insect attack to be rated for critical structural use. In trenching, a major concern would be attack subsequent to grading, during storage, and during the trenching operation. Insect attack under these conditions can include beetles and termites. Both hardwoods and softwoods are susceptible. Any evidence of attack should not be overlooked, as beetles

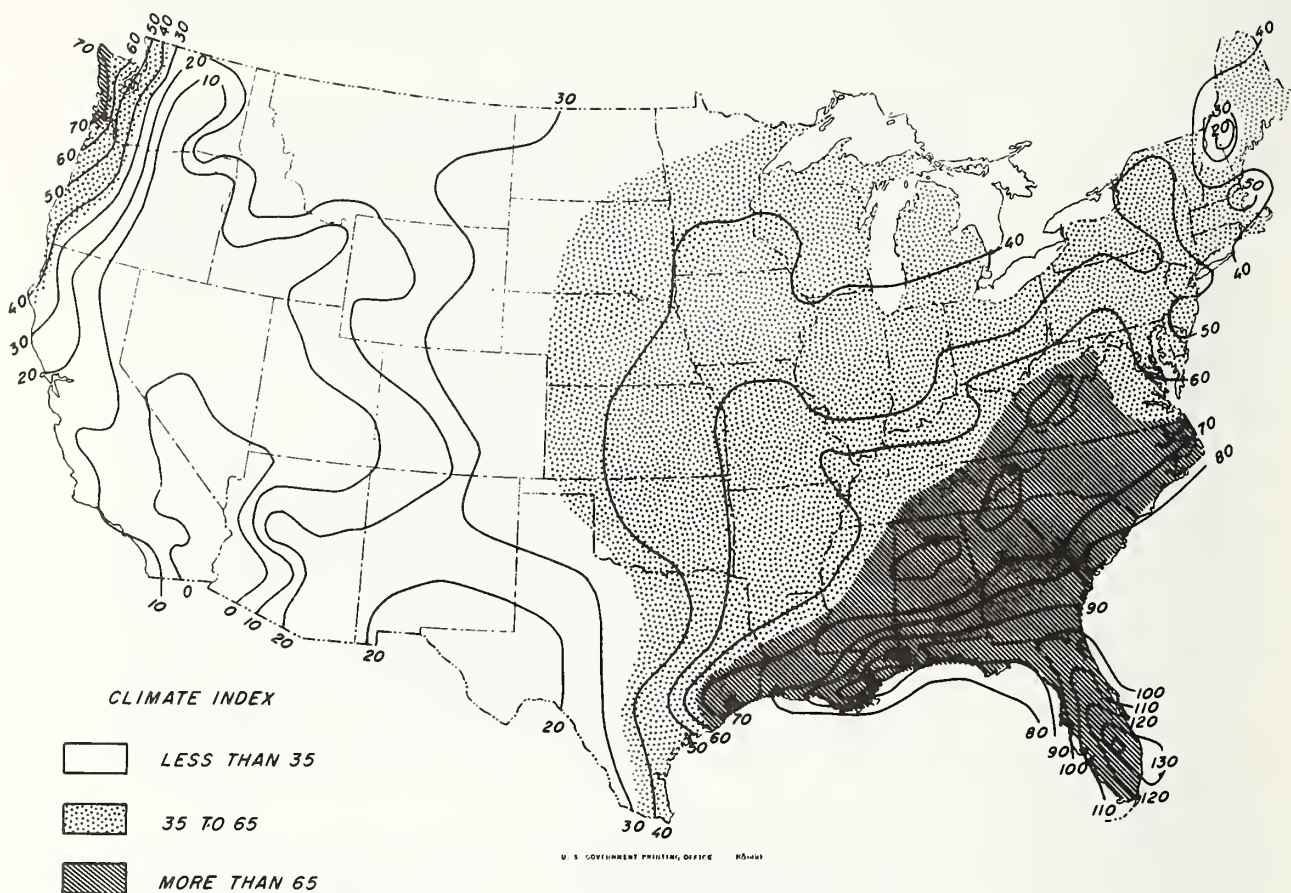


Figure II-4.--Levels of decay potential for wood exposed to the weather in aboveground service based on a climate index derived from standard temperature and rainfall data: Darkest areas, wettest climates, most suitable for decay; index greater than 65. Lightest areas, driest climates, least suitable for decay; index less than 35. Gray areas, moderately wet climates, moderately suitable for decay organisms; index 35 to 65 (taken from (7)).

(M 138 247)

can remain active while the lumber is in use. Timber commonly used for trenching is not resistant to termite or beetle attack.

Inspectability

Members that are encased with mud or dirt or otherwise rendered nongradeable because growth characteristics and other defects are not visible should be downgraded to nonstructural use or discarded. Alternatively they may be hosed clean with water or surfaced clean (planed) if feasible and then graded.

Exposure

Trenching lumber will often be exposed to decay organisms and insects in the use environment. This use exposure determines the useful life of the trenching material if, during the storage period, it was protected from moisture and provided with adequate ventilation. If, on the other hand, the trenching material is close piled and not shielded from rain or splash during storage, this storage period then becomes part of the effective life of the trenching material from a decay and insect exposure perspective. In essence, close piling and lack of moisture and insect control during storage reduces the effective potential life of the trenching lumber at the trenching site. Discussion of this aspect follows:

Decay

Decay in structural members is a function of species, temperature, moisture content, and time. It is difficult, therefore, to make simple quantitative observations on exposure for use guidelines. Generalizations, for example, are that fenceposts of substantially or very resistant species may last 10 to 20 years, while those of nonresistant heartwood may last 5 years or less (3,5,7). Fencepost use demands little bending strength; structural trenching criteria must be more stringent.

Moisture and temperature, which vary greatly with local conditions, are the principal factors affecting rate of decay. When exposed to conditions that favor decay, wood deteriorates more rapidly in warm, humid areas than in cool or dry areas. High altitudes are less favorable to decay than low altitudes because the average temperatures as a rule are lower and the growing seasons for decay fungi are shorter. The relative decay hazard by location is discussed further in later paragraphs.

Climatic and soil conditions at the trenching site provide environments conducive to decay. If long exposure is anticipated in high moisture content-high temperature environment, preservation may be a better option than decay-resistant heartwood. The climate zones of figure II-4 may be

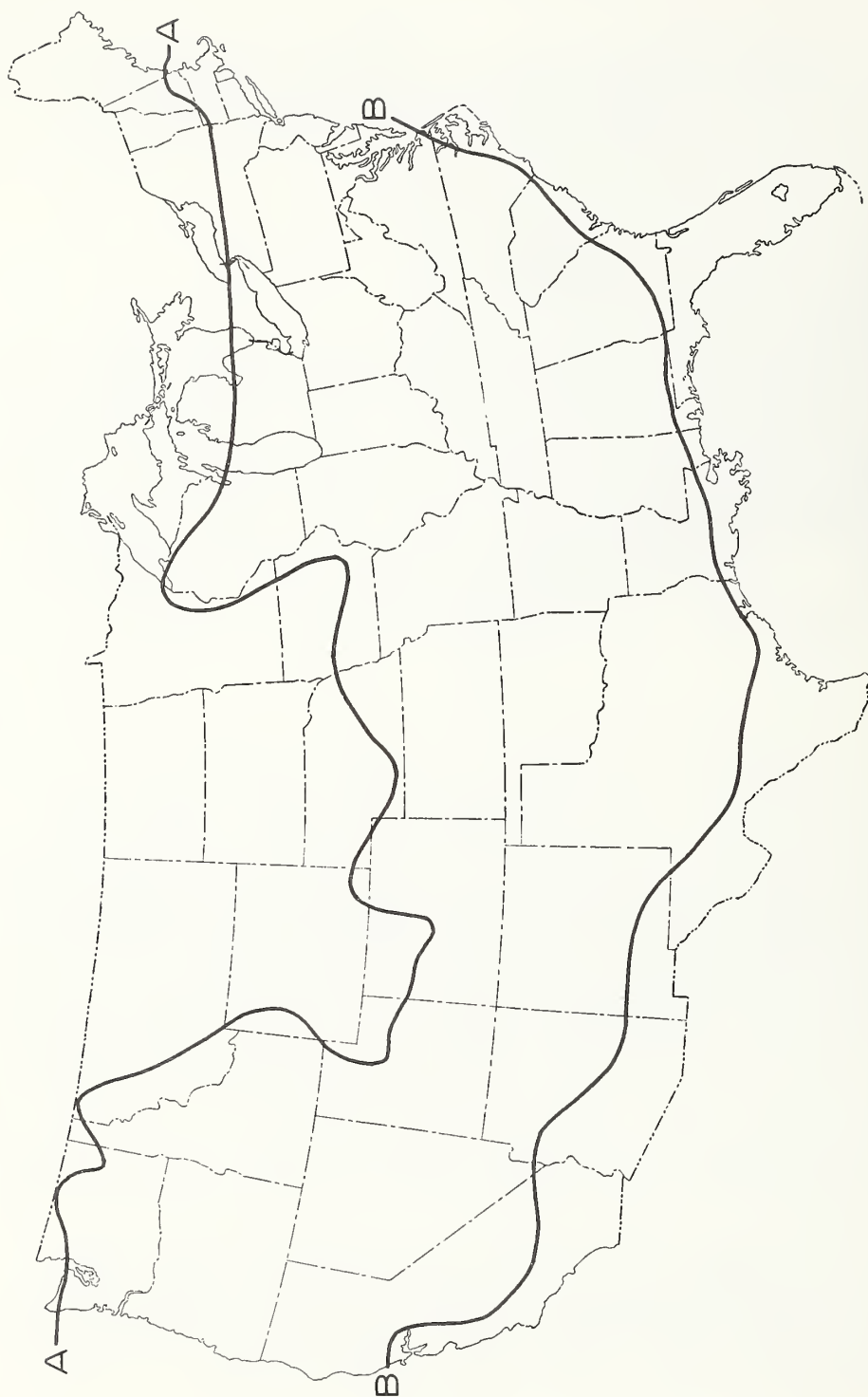


Figure II-5.--A, The northern limit of recorded damage done by subterranean termites in the United States; B, the northern limit of damage done by dry-wood or nonsubterranean termites (taken from (8)).

(M 134 686)

used to estimate the seriousness of decay hazard. The decay potential indicated is derived by a climate index (7):

$$\text{Climate Index: } \frac{\sum_{\text{Jan}}^{\text{Dec}} (T-35) (D-3)}{30},$$

where T is the mean monthly temperature in degrees F and D is the mean number of days in the month with 0.01 inch or more of precipitation. The summation of the products for each month provides a yearly "index." Clearly, there are local regions within figure II-4 in which, because of elevation or other influences, the climate index formula is a more accurate estimation than the map.

Decay is very slow when the index is below 35; moderate at 35 to 65; and rapid above 65.

Temperature alone is an indicator of decay under some conditions. Little or no decay occurs below 32° F or above 100° F; very slow attack occurs below 50° F and above 90° F. The most rapid attack occurs between 75°-90° F.

The choice of species or a requirement for treatment for structural shoring requires judgment about anticipated exposure. Unfortunately, no precise information is available concerning the time involved for decay infestation to occur, to become established, and to progress to the point of causing significant strength degradation. The climate index is useful in identifying relative decay hazard zones in the United States. Lacking, however, is a quantification of "expected useful life" of timbers in the various hazard zones.

Based upon counsel with other Forest Products Laboratory staff (researchers in the Protection of Wood in Use and Biodegradation of Wood research teams), the following recommendations were developed:

<u>Climate index</u>	<u>Maximum exposure</u>
>65	9 mo.
35-65	12 mo.
<35	24 mo.

These recommendations are for nonresistant to moderately resistant species. If the anticipated exposure period (including storage during processing at holding yards and onsite) exceeds the periods listed, resistant or very resistant species (table II-1) or pressure treatment with preservatives is recommended. When trenching completion is delayed, a plan must be developed for onsite inspection to assure that structural integrity is maintained. Storage plans should include provisions for

proper handling of nonresistant or moderately resistant species if the recommended exposure periods will be exceeded.

The exposure periods recommended above should be considered as rule-of-thumb. Additional interpretation may be appropriate for specific onsite conditions, season of the year, and the geographical location within a broad hazard zone.

Insects

Protection from insect attack depends upon inspection procedures, good housekeeping, and onsite treatment. Attack generally is not rapid, but regular inspection for insect attack is recommended in critical regions where exposure will be over 6 months on the job site. In reuse, any evidence of attack should be regarded as damage and requires inspection before use in critical applications.

Termite attack is influenced by climate and by natural habitat. Figure II-5 illustrates the general boundaries of recorded damage. A more specific illustration of the relative hazard of subterranean termite infestation is seen in figure II-6.

Storage

If wood is dried below the fiber saturation point (FSP), it generally is immune from attack by decay fungi. The FSP varies between species and between pieces, and the actual moisture content may be imprecisely known; therefore, 20 percent moisture content is generally considered the maximum "safe" moisture content.

Wood dried to 20 percent moisture content will not regain enough moisture to render it susceptible to decay even in relative humidity conditions approaching 100 percent, provided it is protected from rainwater and other sources of free water. New lumber sold as dry should be checked with a moisture meter to determine actual moisture content. Dry lumber (20 pct moisture content and less) can be safely bulk piled under a roof or cover. Large timbers may require years to season and dry, permitting decay to take place and promoting some insect attack as well. (See our comments earlier under "Exposure" concerning the necessity of including storage time as a part of recommended exposure period.) As a general rule, trenching lumber above the FSP should be stickered to permit adequate ventilation and discourage surface decay and insect degradation. Sticker-ing such as used for railroad ties may be a practical option.

The importance of proper lumber storage cannot be overemphasized. Rapid deterioration of wood strength can be traced to incipient fungus infections originating during poor storage. Figures II-7, II-8, and II-9 show examples of poor storage practices encouraging decay and insect

infestations. Trenching lumber should be protected against wetting from the ground and, as noted, should be stickered to promote drying, particularly after wetting from rain. In permanent or long-term storage, lumber should be placed under a roof for protection or provided with other protection from rain. Lumber at these sites should be above the ground, preferably on foundations of concrete, asphalt, or treated wood. These recommendations apply particularly when reuse is anticipated.

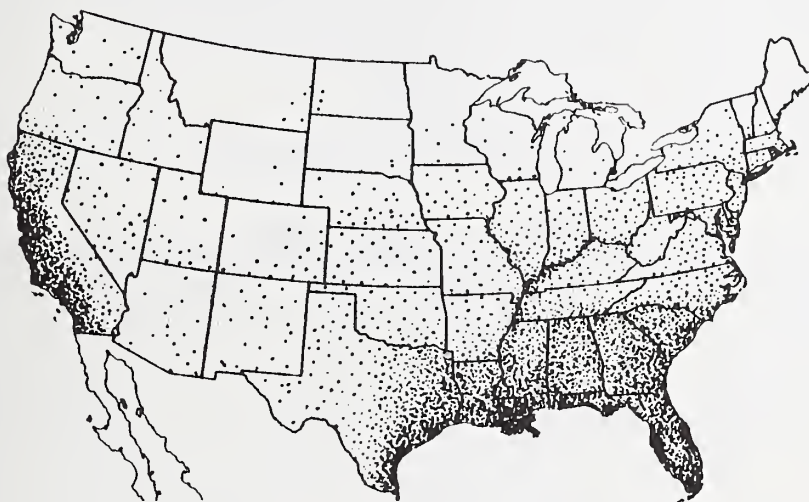


Figure II-6.--Relative hazard of termite infestation in United States is indicated by density of stippling (taken from (4)).

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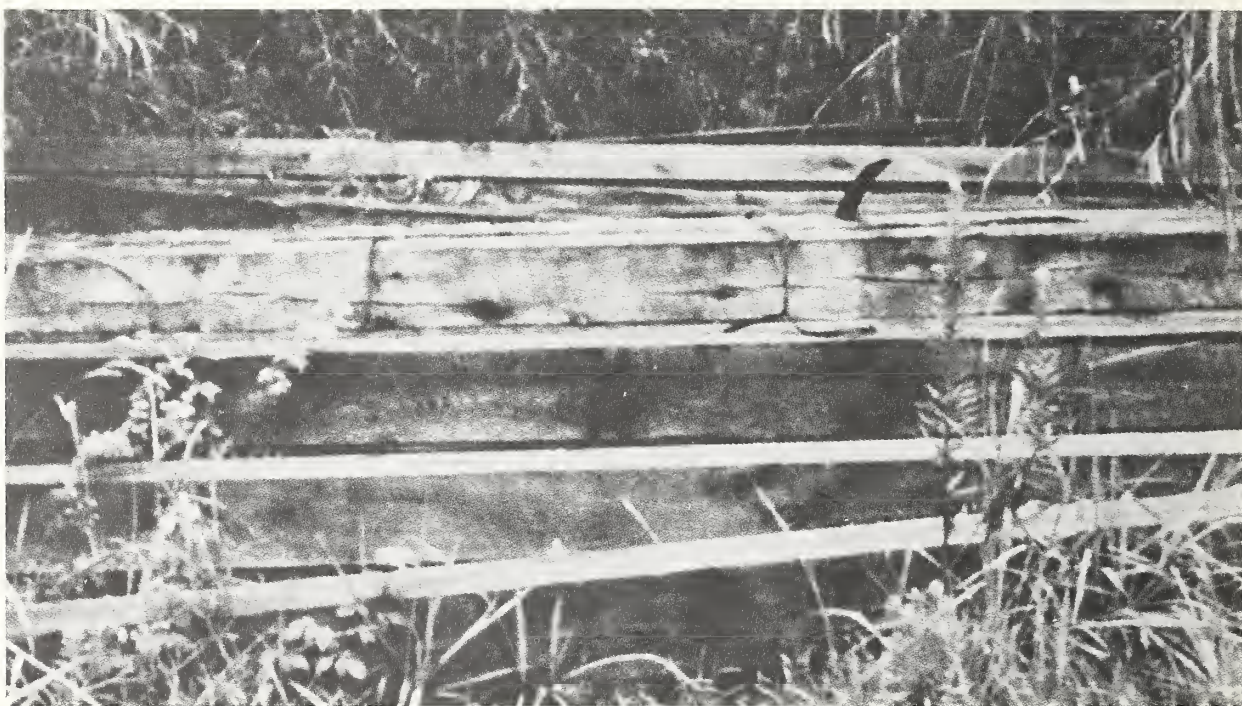


Figure II-7.--Examples of how poor storage leads to problems. Top, solid stacking of green timbers prevents drying and promotes decay infestation. Bottom, poor housekeeping and piling practices in a holding yard.

(M 145 666-11)
(M 145 665-7A)



Figure II-8.--Examples of decay in trenching lumber. Top, decay probably occurred because of close piling. Bottom, decay has occurred in large green timbers before they seasoned.

(M 145 665-19A)
(M 145 667-7)

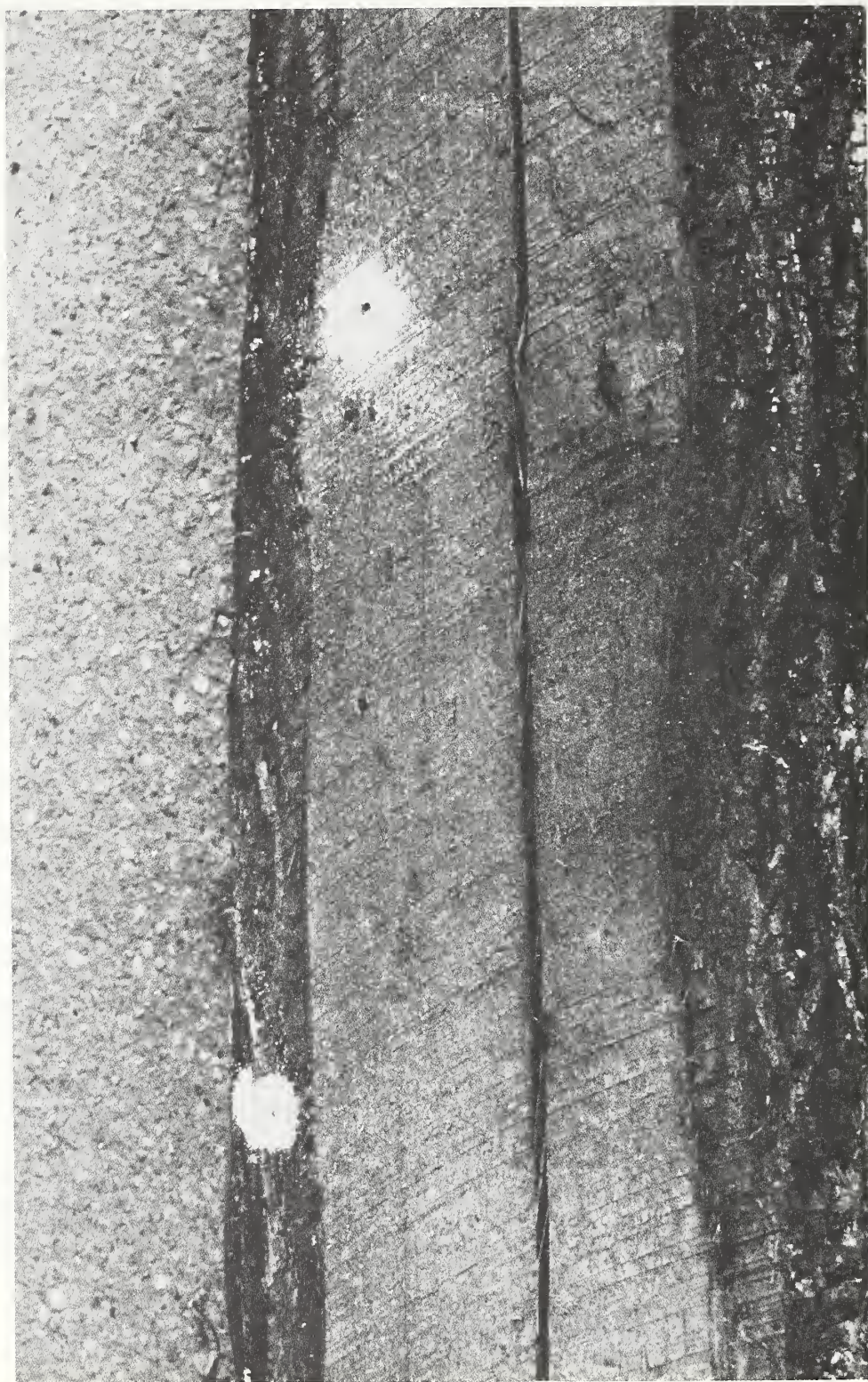


Figure II-9.--Trenching timber containing insect infestation. Piles of borings emphasize hole locations.

(M 145 666-7)

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16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.) In certain areas of the United States, lumber is used extensively to brace trenches against collapse. The life and safety of the workers in these trenches therefore depends on the structural adequacy of the lumber bracing used. This report presents a study of the properties and characteristics of trenching lumber which are critical to its structural performance. Using these properties and characteristics, allowable stresses and use recommendations are proposed. The National Bureau of Standards (NBS) conducted a field study of trenching lumber and found that either ungraded eastern species, primarily hardwood, or graded Douglas-fir is used. For graded Douglas-fir, allowable design stresses and other properties are established by existing standards. The eastern species, however, are ungraded and no accepted guidelines are used to assign allowable design stresses and other properties. The results of the field study indicate that 80 percent of the eastern species trenching lumber, when graded by existing softwood grading rules (Southern Pine Inspection Bureau Grading Rules, 1977 edition) is No. 2 grade or higher; 60 percent is No. 1 grade or higher. These percentages do not reflect the effects of wane (deficiency in cross-sectional area) and decay, which are additional problems. NBS therefore recommends that, for hardwood wales and struts, allowable stresses and other properties be based on a No. 2 minimum grade with appropriate provisions to control wane and decay. (continued)			
17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons) Construction lumber; construction safety; excavation; hardwood; lumber grading; shoring; softwood; timber engineering; trench bracing; trenching.			
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16. ABSTRACT (continued)

Use recommendations were developed, which consider duration of load, mechanical damage to lumber, presence of bark, decay, insect attack, inspectability, exposure, and storage for various aspects of trenching lumber applications. These recommendations reflect a severe trenching environment, possible reuse of structural members, and the need for structural integrity to protect life and property.

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