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Forest Service Handbook 2409.11a – National Forest Cubic Scaling Handbook
Chapter 60 - Appendixes

Amendment: 2409.11a-2002-5

Effective date: August 06, 2002

Duration: This amendment is effective until superseded or removed.

Approved by: Gloria Manning, Associate Deputy Chief, NFS

Date approved: July 25, 2002

Responsible Staff:

Last Change: 2409.11a-2002-4 to 2409.11a_60_part01.

Superseded Document(s):

Digest: Following is an explanation of the changes throughout the directive by section.

60: Changes the caption of the chapter to Appendixes (formerly, Appendix) and reorganizes the tables and exhibits into separately numbered Appendixes 1 through 14. Makes formatting and editorial changes throughout the chapter.

Appendix 7: Revises and incorporates data in the perimeter defect factor table (formerly numbered Table VII).

Appendix 8: Revises and incorporates data in the shake and pitch ring correction table (formerly numbered Table VIII).

Appendix 9: Incorporates the rectangular area table (formerly numbered Table IX).

Appendix 10: Incorporates the table for solid wood content of miscellaneous products (formerly numbered Table X).

Appendix 11: Incorporates the descriptions of common rots and fungi in sawlogs (formerly numbered Table XI). Corrects typographical errors in the descriptions; revises the section on common names; revises the section on host; and adds sections on distribution and damage, based on information from Agricultural Handbook 521 (Robert F. Scharpf, 1993, Diseases of

Pacific Coast Conifers. Agric. Handb. 521. Washington; DC; U.S. Department of Agriculture, Forest Service.)

Appendix 12: Adds a new table displaying national cubic test log data. Moves to section 14, exhibit 01, the log scale sheet previously set out at the end of this Handbook.

Appendix 13: Revises and incorporates the guide on the use of cull factor algorithms for cubic scaling prepared by Bill Hay of the Pacific Southwest Region (R-5), which was previously issued as a R-5 supplement.

Appendix 14: Revises and incorporates the guide on the use of length cut algorithms for cubic scaling prepared by Bill Hay of the Pacific Southwest Region (R-5), which was previously issued as a R-5 supplement.

Table of Contents

Appendix 7 -- Perimeter Defect Factor Table

Small End Dia.	Vol./Ft. 16' Log (bd. ft.)	Sap Rot and Weather Checks (Diameter reduction in inches)									
		1	2	3	4	5	6	7	8	9	10
4	.063										
5	.125	8.00	8.00								
6	.125		8.00	8.00							
7	.188	5.33	5.33	10.67	10.67						
8	.188		5.33	5.33	10.67	10.67					
9	.250	4.00	4.00	8.00	8.00	12.00	12.00				
10	.375	5.33	8.00	8.00	10.67	10.67					
11	.438	2.29	6.86	9.14	9.14	11.43	11.43				
12	.500	2.00	4.00	8.00	10.00	10.00	12.00	12.00			
13	.625	3.20	4.80	6.40	9.60	11.20	11.20				
14	.688	1.45	4.36	5.82	7.27	10.18	11.64	11.64			
15	.875	3.43	4.57	6.86	8.00	9.14	11.43				
16	1.000	2.00	5.00	6.00	8.00	9.00	10.00	12.00			
17	1.125	1.78	3.56	6.22	7.11	8.89	9.78	10.67			
18	1.313	2.29	3.81	5.33	7.62	8.38	9.90	10.67	11.43		
19	1.500	2.00	4.00	5.33	6.67	8.67	9.33	10.67	11.33	12.00	
20	1.750	2.29	4.00	5.71	6.86	8.00	9.71	10.29	11.43	12.00	
21	1.875	1.07	3.20	4.80	6.40	7.47	8.53	10.13	10.67	11.73	
22	2.063	1.45	2.42	4.36	5.82	7.27	8.24	9.21	10.67	11.15	
23	2.375	2.11	3.37	4.21	5.89	7.16	8.42	9.26	10.11	11.37	11.79
24	2.500	.80	2.80	4.00	4.80	6.40	7.60	8.80	9.60	10.40	11.60
25	2.875	2.09	2.78	4.52	5.57	6.26	7.65	8.70	9.74	10.43	11.13
26	3.125	1.28	3.20	3.84	5.44	6.40	7.04	8.32	9.28	10.24	10.88
27	3.438	1.45	2.62	4.36	4.95	6.40	7.27	7.85	9.02	9.89	10.76
28	3.625	.83	2.21	3.31	4.97	5.52	6.90	7.72	8.28	9.38	10.21
29	3.813	.79	1.57	2.89	3.93	5.51	6.03	7.34	8.13	8.66	9.70
30	4.125	1.21	1.94	2.67	3.88	4.85	6.30	6.79	8.00	8.73	9.21
31	4.438	1.13	2.25	2.93	3.61	4.73	5.63	6.99	7.44	8.56	9.24
32	4.625	.65	1.73	2.81	3.46	4.11	5.19	6.05	7.35	7.78	8.86
33	4.875	.82	1.44	2.46	3.49	4.10	4.72	5.74	6.56	7.79	8.21
34	5.000	.40	1.20	1.80	2.80	3.80	4.40	5.00	6.00	6.80	8.00
35	5.500	1.45	1.82	2.55	3.09	4.00	4.91	5.45	6.00	6.91	7.64

Appendix 7 -- (Continued)

Perimeter Defect Factor Table

Small End Dia.	Vol./Ft. 16' Log (bd. ft.)	Sap Rot and Weather Checks (Diameter reduction in inches)									
		1	2	3	4	5	6	7	8	9	10
36	5.750	.70	2.09	2.43	3.13	3.65	4.52	5.39	5.91	6.43	7.30
37	6.438	1.71	2.33	3.57	3.88	4.50	4.97	5.75	6.52	6.99	7.46
38	6.688	.60	2.24	2.84	4.04	4.34	4.93	5.38	6.13	6.88	7.33
39	7.000	.71	1.29	2.86	3.43	4.57	4.86	5.43	5.86	6.57	7.29
40	7.500	1.07	1.73	2.27	3.73	4.27	5.33	5.60	6.13	6.53	7.20
41	7.938	.88	1.89	2.52	3.02	4.41	4.91	5.92	6.17	6.68	7.06
42	8.375	.84	1.67	2.63	3.22	3.70	5.01	5.49	6.45	6.69	7.16
43	8.750	.69	1.49	2.29	3.20	3.77	4.23	5.49	5.94	6.86	7.09
44	9.250	.86	1.51	2.27	3.03	3.89	4.43	4.86	6.05	6.49	7.35
45	9.500	.42	1.26	1.89	2.63	3.37	4.21	4.74	5.16	6.32	6.74
46	9.938	.70	1.11	1.91	2.52	3.22	3.92	4.73	5.23	5.64	6.74
47	10.375	.67	1.35	1.73	2.51	3.08	3.76	4.43	5.20	5.69	6.07
48	10.813	.65	1.29	1.94	2.31	3.05	3.61	4.25	4.90	5.64	6.10
49	11.250	.62	1.24	1.87	2.49	2.84	3.56	4.09	4.71	5.33	6.04
50	11.688	.60	1.20	1.80	2.40	2.99	3.34	4.02	4.53	5.13	5.73

Appendix 7 -- (Continued)

Perimeter Defect Factor Table

Small End Dia.	Vol./Ft. 16' Log (bd. ft.)	Sap Rot and Weather Checks (Diameter reduction in inches)									
		11	12	13	14	15	16	17	18	19	20
4	.063										
5	.125										
6	.125										
7	.188										
8	.188										
9	.250										
10	.375										
11	.438										
12	.500										
13	.625										
14	.688										
15	.875										
16	1.000										
17	1.125										
18	1.313										
19	1.500										
20	1.750										
21	1.875										
22	2.063										
23	2.375										
24	2.500	12.00									
25	2.875										
26	3.125	11.52									
27	3.438	11.35	11.93								
28	3.625	11.03	11.59								
29	3.813	10.49	11.28	11.80							
30	4.125	10.18	10.91	11.64							
31	4.438	9.69	10.59	11.27	11.94						
32	4.625	9.51	9.95	10.81	11.46						
33	4.875	9.23	9.85	10.26	11.08	11.69					
34	5.000	8.40	9.40	10.00	10.40	11.20	11.80				
35	5.500	8.73	9.09	10.00	10.55	10.91	11.64				

Appendix 7 -- (Continued)

Perimeter Defect Factor Table

Small End Dia.	Vol./Ft. 16' Log (bd. ft.)	Sap Rot and Weather Checks (Diameter reduction in inches)									
		11	12	13	14	15	16	17	18	19	20
36	5.750	8.00	9.04	9.39	10.26	10.78	11.13	11.83			
37	6.438	8.23	8.85	9.79	10.10	10.87	11.34	11.65			
38	6.688	7.78	8.52	9.12	10.02	10.32	11.07	11.51	11.81		
39	7.000	7.71	8.14	8.86	9.43	10.29	10.57	11.29	11.71	12.00	
40	7.500	7.87	8.27	8.67	9.33	9.87	10.67	10.93	11.60	12.00	
41	7.938	7.69	8.31	8.69	9.07	9.70	10.20	10.96	11.21	11.84	
42	8.375	7.52	8.12	8.72	9.07	9.43	10.03	10.51	11.22	11.46	
43	8.750	7.54	7.89	8.46	9.03	9.37	9.71	10.29	10.74	11.43	11.66
44	9.250	7.57	8.00	8.32	8.86	9.41	9.73	10.05	10.59	11.03	11.68
45	9.500	7.58	7.79	8.21	8.53	9.05	9.58	9.89	10.21	10.74	11.16
46	9.938	7.14	7.95	8.15	8.55	8.86	9.36	9.86	10.16	10.47	10.97
47	10.375	7.13	7.52	8.29	8.48	8.87	9.16	9.64	10.12	10.41	10.70
48	10.813	6.47	7.49	7.86	8.60	8.79	9.16	9.43	9.90	10.36	10.64
49	11.250	6.49	6.84	7.82	8.18	8.89	9.07	9.42	9.69	10.13	10.58
50	11.688	6.42	6.84	7.19	8.13	8.47	9.16	9.33	9.67	9.93	10.35

Appendix 7 -- (Continued)

Perimeter Defect Factor Table

Small End Dia.	Vol./Ft. 16' Log (bd. ft.)	Sap Rot and Weather Checks (Diameter reduction in inches)									
		21	22	23	24	25	26	27	28	29	30
4	.063										
5	.125										
6	.125										
7	.188										
8	.188										
9	.250										
10	.375										
11	.438										
12	.500										
13	.625										
14	.688										
15	.875										
16	1.000										
17	1.125										
18	1.313										
19	1.500										
20	1.750										
21	1.875										
22	2.063										
23	2.375										
24	2.500										
25	2.875										
26	3.125										
27	3.438										
28	3.625										
29	3.813										
30	4.125										
31	4.438										
32	4.625										
33	4.875										
34	5.000										
35	5.500										

Appendix 7 -- (Continued)

Perimeter Defect Factor Table

Small End Dia.	Vol./Ft. 16' Log (bd. ft.)	Sap Rot and Weather Checks (Diameter reduction in inches)									
		21	22	23	24	25	26	27	28	29	30
36	5.750										
37	6.438										
38	6.688										
39	7.000										
40	7.500										
41	7.938										
42	8.375										
43	8.750										
44	9.250	11.89									
45	9.500	11.79	12.00								
46	9.938	11.37	11.97								
47	10.375	11.18	11.57								
48	10.813	10.91	11.38	11.75							
49	11.250	10.84	11.11	11.56	11.91						
50	11.688	10.78	11.04	11.29	11.72						

Appendix 8 -- Shake and Pitch Ring Correction Table

Ring Diameter Inches	Inches of Taper						
	0	1 - 2	3 - 4	5 - 6	7 - 8	9 - 10	11 - 12
6	.60	.71	.78	.82	.85	.87	.89
7	.57	.67	.73	.77	.80	.83	.86
8	.67	.73	.77	.80	.83	.86	.88
9	.64	.69	.73	.78	.81	.83	.85
10	.54	.60	.67	.71	.75	.78	.81
11	.53	.61	.67	.71	.74	.77	.80
12	.56	.62	.67	.70	.74	.77	.79
13	.52	.58	.63	.68	.71	.74	.77
14	.54	.59	.65	.69	.72	.74	.77
15	.48	.55	.60	.64	.67	.70	.73
16	.48	.54	.59	.63	.66	.69	.71
17	.49	.54	.58	.62	.65	.68	.70
18	.46	.51	.55	.60	.63	.66	.69
19	.44	.49	.54	.57	.61	.64	.67
20	.40	.46	.50	.54	.58	.61	.64
21	.42	.46	.51	.55	.58	.62	.64
22	.41	.46	.51	.54	.58	.61	.63
23	.38	.43	.47	.51	.55	.58	.60
24	.40	.44	.49	.52	.56	.58	.61
25	.36	.41	.45	.49	.52	.55	.58
26	.36	.40	.44	.48	.51	.54	.57
27	.35	.39	.43	.47	.50	.53	.55
28	.36	.40	.44	.47	.50	.53	.56
29	.36	.41	.44	.47	.50	.53	.56
30	.36	.39	.43	.46	.50	.52	.55
31	.35	.39	.42	.46	.49	.51	.54
32	.36	.40	.44	.46	.49	.52	.54
33	.37	.40	.43	.47	.49	.52	.54
34	.39	.42	.45	.48	.51	.53	.55
35	.36	.40	.43	.46	.49	.51	.53
36	.37	.40	.43	.46	.49	.51	.53
37	.33	.36	.40	.42	.45	.48	.50
38	.34	.37	.40	.43	.46	.48	.50
39	.35	.37	.40	.43	.46	.48	.50
40	.33	.36	.39	.42	.44	.47	.49

Appendix 8 -- (Continued)

Shake and Pitch Ring Correction Table

Ring Diameter Inches	Inches of Taper						
	0	1 - 2	3 - 4	5 - 6	7 - 8	9 - 10	11 - 12
41	.32	.36	.39	.41	.44	.46	.48
42	.32	.35	.38	.41	.43	.46	.48
43	.32	.35	.38	.41	.43	.45	.48
44	.31	.35	.37	.40	.42	.45	.47
45	.33	.36	.38	.41	.43	.45	.47
46	.33	.35	.38	.40	.43	.45	.47
47	.33	.35	.38	.40	.42	.45	.47
48	.32	.35	.38	.40	.42	.44	.46
49	.33	.35	.38	.40	.42	.44	.46
50	.32	.35	.38	.40	.42	.44	.46
51	.32	.35	.37	.40	.42	.44	.46
52	.33	.35	.37	.40	.42	.44	.46
53	.32	.35	.37	.39	.42	.43	.45
54	.33	.35	.37	.39	.41	.43	.45
55	.32	.35	.37	.39	.41	.43	.45
56	.32	.35	.37	.39	.41	.43	.44
57	.32	.34	.36	.39	.40	.42	.44
58	.32	.34	.37	.39	.40	.42	.44
59	.32	.34	.36	.38	.40	.42	.44
60	.32	.34	.36	.38	.40	.42	.44
61	.32	.34	.36	.38	.40	.42	.43
62	.32	.34	.36	.38	.40	.41	.43
63	.32	.34	.36	.38	.39	.41	.43
64	.31	.34	.35	.37	.39	.41	.43
65	.31	.33	.35	.37	.39	.41	.42

Appendix 9 -- Rectangular Area Table

Use the following table used to determine the equivalent size of squares (length of a side in inch classes) from rectangular areas.

Use this table in conjunction with the table in Appendix 6. The areas listed are for a square having a side equal to the lower limit of each 1-inch size class. The area for the 6-inch class for example, is the area of a 5.6-inch square or 31 square inches (approximately).

To determine the applicable size of a square, the given area must be equal to or greater than the tabular area for the applicable 1-inch size class, but less than the tabular area for the next 1-inch class.

Example: The rectangular area of a heart check measuring 3 inches by 16 inches is 48 square inches (3 x 16 = 48). In the table, search for the first area listing greater than 48. Find 58. The preceding tabular area is 44. The given area of 48 is greater than or equal to 44, but less than 58, so the applicable size of the square is 7 inches.

Rectangular Area (square inches)	Size of Square of Equal Area (inches)
2	2
7	3
13	4
21	5
31	6
44	7
58	8
74	9
92	10
112	11
135	12
159	13
185	14
213	15
243	16
276	17
310	18
346	19
384	20

Rectangular Area (square inches)	Size of Square of Equal Area (inches)
424	21
467	22
511	23
557	24
605	25
655	26
708	27
762	28
818	29
876	30
936	31
999	32
1063	33
1129	34
1197	35
1267	36
1340	37
1414	38
1490	39
1568	40

Rectangular Area (square inches)	Size of Square of Equal Area (inches)
1648	41
1731	42
1815	43
1901	44
1989	45
2079	46
2172	47
2266	48
2362	49
2460	50

Appendix 10 -- Solid Wood Content of Miscellaneous Products

Product	Assumed Dimensions	Ft^3	m^3*
Cord, standard 4' x 4' x 8'	4' x 4' x 8'		
Pulpwood, peeled, conifer		95	2.69
Pulpwood, rough, conifer		85	2.41
Pulpwood, rough, hardwood		83	2.35
Fuelwood, hardwood and conifer		75	2.12
Tie, standard	7" x 9" x 8'	3.50	.099
	7" x 8" x 8'	3.11	.088
	6" x 6" x 8'	2.00	.057
Tie, narrow gauge	7" x 8" x 6.5'	2.53	.072
	6" x 7" x 6.5'	1.90	.054
	6" x 6" x 6.5'	1.63	.046
Post, fence (1" taper)	6" x 7'	1.62	.046
Post, fence (1" taper)	5" x 7'	1.16	.033
Post, split	4.5" x 7'	1.41	.040
Brace, fence	4" x 6'	.52	.015
Stake, fence	3" x 6'	.29	.008
Stay, fence	2" x 6'	.13	.004
Rail, fence	5" x 16'	2.53	.072
Pole, fence (1" taper)	4" x 20'	2.24	.063
Pole, converter (1" taper)	4" x 20'	2.24	.063
Prop (1" taper)	6" x 10'	1.96	.056

* m^3 = cubic meters

Appendix 11 -- Common Rots and Fungi in Saw Logs

This Appendix contains descriptions of common rots and fungi in sawlogs.

1. Phellinus pini (Fomes pini).

Common names - Conk rot, white pocket rot, white speck, red ring rot (sometimes called honeycomb rot), particularly in pine and larch.

Hosts - Douglas-fir, pines, true firs, larch, spruce, hemlock, western redcedar, and, rarely, incense cedar.

Distribution and damage - Occurs throughout the coniferous forests of the world, and in western North America considered to be the single most damaging heart rot organism. Coastal Douglas-fir most commonly infected.

General form - Trunk rot, rarely acting as butt rot. Generally patchy. Enters through dead branch stubs, rarely through wounds. Rot column roughly conical in both directions from area of greatest decay in trunk; often occurs as patchy ring or crescent-shaped areas not uniformly attacking the heartwood, except in very advanced stages; may extend from a few feet to entire tree length.

Characteristics - Heart rot in resinous trees; heart rot or sap rot in trees with little or no resin. Rot in early stages, reddish color in split section with small white patches mingled with pitted areas, and in advanced stages, ring-scaled. Delignifying rot, converting wood to cellulose; white pocket rot.

External signs - Typical fruiting bodies or conks of fungus on log. Indications at old branch whorls, either by swells or by brownish punky substance, that fruiting bodies have dropped off. Soundings made on trunk to detect punkiness indicating decay. Punk knots or blind conks.

Fruiting body - Sometimes called ring-scale fungus, brown shell fungus. Fruiting body hoof or shell shape, perennial, hard, woody, upper surface dark brown, rough, hairy when young, with concentric raised zones, substance brown, pores usually large and round, pore layer stratified.

2. Phaeolus schweinitzii (polyporus schweinitzii).

Common names - Velvet top fungus, red-brown butt rot, Schweinitzii butt rot, brown cubical butt rot, stump or ground rot.

Common Rots and Fungi in Saw Logs

Hosts - Douglas-fir, pines, true firs, larch, spruce, incense cedar, western redcedar, and, rarely, hemlock.

Distribution and damage - Occurs throughout the world where conifers are native or introduced. Hardwoods seldom attacked. Most common on Douglas-fir along the Pacific Coast.

General form - A uniform circular butt rot, a wound fungus. Rot column generally conical from base of tree upward; uniform, usually not advancing beyond first log; may extend from roots to 8 to 12 feet up into first log, but usually not more than 5 or 6 feet upward.

Characteristics - Uniform heart rot of butt of tree; also enters roots. Rot in the early stages light reddish brown; typical stage, reddish brown, pronounced cubical, crumbly, brittle when dry; occasionally with thin resinous crusts of white felt-like material (mycelium), odor of turpentine. Carbonizing rot.

External signs - Typical fruiting bodies of the fungus on the ground near the tree (often partly covered by debris); sometimes found as bracket fungus issuing from injuries at base of the tree (never high up on the trunk). Typical rot indications may be present.

Fruiting body - Sometimes called velvet-top or cow-dung (cow-pie) fungus. Fruiting body annual, stem short, dark brown, covered with stiff hairs, flesh brown, soft and spongy when fresh, brittle when dry, pores large when young, becoming torn with age. Attached to the roots near the base of the tree or directly on the base of the tree.

3. Echinodontium tinctorium.

Common names - Indian paint fungus, brown stringy rot, rust-red stringy rot.

Hosts - True firs and hemlock are common hosts; Douglas-fir and spruce rarely infected. Of economic importance only on true firs and hemlocks.

Distribution and damage - Distributed throughout the western United States on true firs and hemlock, and considered to be the most serious heart rot organism on these tree species.

General form - A uniform circular trunk rot, entering through branch stubs and wounds. Rot column roughly conical in both directions from area of greatest decay; very uniform, occupying most or all of the length, depending upon the degree of infection.

Common Rots and Fungi in Saw Logs

Characteristics - Uniform heart rot, confined to given trees almost entirely. Rot in early stages, wood spongy yellow-stained; typical stages, soft stringy, often separating along the annual rings, brownish to rusty red in color; knots showing deep rusty red color. Sawed surface of cross-section pitted, broken, stringy with reddish brown discolorations, often hollow rotted; carbonizing rot; thus, reducing cellulose, producing dark-colored decay.

External signs - Typical fruiting bodies of the fungus on the tree. Indications at branch whorls of either swells or deep rust red punk knots where fruiting bodies have dropped off. Large number of dead branch stubs accompanied by pronounced swells of whorls. A deep rusty red color in old branch stubs. Soundings made on trunk. Many injuries, such as logging scars, fire scars, frost cracks, blazes, and so on are indications of typical rot.

Fruiting body - Sometimes called Indian paint fungus; fruiting body perennial, hard, woody, gray or black above with concentric growth zones; substance brick red, lower surface covered with hard sharp spines when mature.

4. Fomitopsis pinicola (Fomes pinicola).

Common names - Brown crumbly rot, red belt fungus.

Hosts - Most western conifers including pines, true firs, Douglas-fir, western hemlock, western larch, western redcedar, spruce, and in Alaska especially Sitka spruce and western hemlock.

Distribution and damage - One of the most common wood rot organisms in coniferous forests of western North America. Although mainly a decomposer of dead and down timber, it has also been known to cause heart rot in living trees, particularly in Alaska.

General form - A uniform circular trunk rot, a wound fungus. Rot column generally uniform and conical; usually occupies entire heartwood of tree on the portion of the tree infected, rarely extending beyond the first log length.

Characteristics - Uniform heart rot found principally in dead, standing, and down timber, occasionally acting as heart rot in living trees by gaining entrance through injuries. In early stages light brown rot, and in typical stage, reddish brown, cubical, crumbly and brittle when dry, white felt-like layers of mycelium between cubical patches. Felt patches larger, thicker, and nonresinous as compared to those of velvet-top fungus. Carbonizing rot.

Common Rots and Fungi in Saw Logs

External signs - Typical "red belt" fruiting bodies of the fungus on the tree. Typical rot found at old branch stubs. Soundings made on trunk; typical rot indications may be present.

Fruiting body - Sometimes called red-margin fomes or red-belt fomes. Fruiting body, perennial, hard, woody, flat or hoof-shaped, surface smooth, furrowed gray or black with resinous crust, margin white or reddish, substance whitish or wood colored, pores in layers.

5. Laetiporus sulphureus (Polyporus sulphureus).

Common names - Brown cubical rot, reddish-brown heart rot, sulfur fungus.

Hosts - Douglas-fir, true firs, pines, hemlock, spruce, larch, and western redcedar.

Distribution and damage - Common on hardwoods and conifers throughout much of North America. In the western United States, causes considerable rot in conifers, particularly true firs.

General form - Uniform circular butt and trunk rot, a wound fungus. Rot column generally uniform and conical; usually occupies entire heartwood of tree at point of greatest infection. Usually a butt rot, rarely extending beyond the first log.

Characteristics - Uniform heart rot. In early stages light brown rot, and in typical stage a dark reddish brown decay breaking into medium-sized irregular cubes. Cracks of cubes often filled with white mycelial felts plainly evident in cross-section, appearing as a network. Felts do not have resin pockets, like brown trunk rot (quinine fungus), nor resinous crusts like red-brown butt rot (velvet-top fungus). Carbonizing rot.

External signs - Typical fruiting bodies of the fungus on the tree. Soundings made on the trunk; typical rot indications may be present.

Fruiting body - Sometimes called sulfur fungus. Fruiting structure annual, broad, with several parts one above another, smooth, zoned, lemon yellow to orange, white when old, flesh white, crumbly when dry, pores small, sulfur yellow.

6. Fomitopsis officinalis (Fomes officinalis).

Common names - Brown trunk rot, reddish-brown heart rot, quinine fungus.

Common Rots and Fungi in Saw Logs

Hosts - Found most commonly on Douglas-fir and larch, but also attacks pines, spruce, and hemlock; seldom occurs on true firs.

Distribution and damage - Occurs in both Europe and North America. In western North America traditionally considered an important trunk rot of old-growth conifers.

General form - Trunk rot. Wound fungus. Rot column generally uniform and conical; usually occupies entire heartwood of tree in advanced stages. Most commonly occupies upper portion of merchantable timber; rarely a typical butt rot.

Characteristics - Uniform heart rot. Rot in early stages, light brown, in typical stage, dark reddish brown, brittle dry, crumbly with thin mycelial felt masses in clefts. Carbonizing rot.

External signs - Typical fruiting bodies of the fungus on the tree are the principal means of distinction between rots of this species and of sulfur fungus. Soundings made on the trunk; typical rot indications may be present.

Fruiting body - Also known as *Fomes laricis* (chalky quinine fungus). Perennial hoof-shaped, sometimes cylindrical, snow white, substance white, soft, bitter to the taste, pores small, white, and arranged in layers.

7. Phellinus weirii (Poria weirii).

Common names - Laminated root rot, yellow laminated rot.

Hosts - In Pacific Northwest, Douglas-fir, western hemlock, and western larch species most frequently damaged; in inland western United States, western redcedar often suffers butt decay from this fungus. Several other coniferous species can be hosts, while all hardwoods are immune.

Distribution and damage - Occurs throughout the Pacific Northwest from Northwestern California to British Columbia. Known mainly as a root disease organism, but does decay tree roots and butts. Heavy losses occur not only from tree mortality, but also from blowdown as a result of root decay. Research has shown there are two basic forms of *Phellinus weirii:* one that causes root and butt rot of western redcedar and another that causes root disease of Douglas-fir. Most damaging disease of Douglas-fir in Pacific Northwest.

Common Rots and Fungi in Saw Logs

General form - Butt rot. Uniform circular rot. Wound fungus. Rot column generally uniform and conical; may extend from roots to 5 to 8 feet up into first log, often causing hollow butts. Rarely found throughout entire length in old trees.

Characteristics - Uniform heart rot. Rot yellow color, decaying springwood, separating annual rings. In advanced stages, brown, with mycelium felt between layers. Carbonizing rot.

External signs - Typical fruiting bodies of the fungus on the tree (in root crotches, often cementing forest debris about the roots into a punky mass). Soundings at base of tree and exposed root spurs.

Fruiting body - Sometimes called brown cedar poria. Fruiting structure flat growing, inconspicuous, perennial, stratified, substances brown. Grows in root crotches and underside of down trees and logs.

8. Heterobasidion annosum (Fomes annosus).

Common names - Annosus root disease, annosus root and butt rot, white, spongy rot.

Hosts - Occurs on most conifer species in the western United States, but particularly common on true firs in California, Oregon, and Washington and on hemlock in the Pacific Northwest.

Distribution and damage - Occurs throughout the coniferous forests of northern Europe, southeastern United States, and western North America. Although primarily known as a root disease organism, it also acts as an important butt and trunk rot on some species.

General form - Butt rot. Uniform circular. Pathogenic; can attack the cambium layer. Rot column generally conical and uniform, filling heartwood and part or all of sapwood; may extend from roots to 6 or 8 feet into first log, sometimes much higher in hemlock, soon producing hollow butts.

Characteristics - Uniform sap rot and heart rot of butt. Rot in early stages, ranging from lilac to reddish color; typical stage, whitish areas occasionally with black dots in center of white areas; last stages, annual rings separated; and final stages, wet spongy. Fine mycelium felt masses under bark scales. Delignifying rot.

Common Rots and Fungi in Saw Logs

External signs - Typical fruiting bodies of the fungus in rot crotches, usually covered by litter or duff. Resin flow at base of tree and exposed roots.

Fruiting body - Sometimes called rot fomes. Fruiting body woody, usually thin and irregular, with a smooth brown crust, perennial; substance white or pale yellowish, pores small, stratified, and white. Found in the root crotches or under litter, not easily seen.

9. Pholiota adiposa (Pholiota limonella).

Common names - Brown-mottled white rot, yellow cap fungus, mottled rot, yellow heart rot.

Hosts - True firs, pines, hemlock, and spruce.

Distribution and damage - Found on both hardwoods and conifers in the United States, but in the West, primarily a problem on true firs and hemlock. In California and parts of Oregon, considered a major heart rot organism in old-growth true fir stands.

General form - Trunk rot. Uniform circular. Rot column generally conical in heartwood; may extend from stumps to entire merchantable tree length. Usually confined to the first two log lengths; sometimes localized in a single log.

Characteristics - Uniform heart rot, principally of trees with little or no resin. Rot in early stages, a light yellow stain, in typical stage, yellow or honey color, brownish streaks, yellowish to light tan or white felt-like masses running across grain, breaking up in the last stages and separating annual rings, finally becoming hollow rotted. Carbonizing rot.

External signs - Typical fruiting bodies of the fungus on the tree. Soundings made on the trunk. Typical rot indications may be present.

Fruiting body - Sometimes called scaly pholiota or yellow cap fungus. Fruiting body annual, mushroom type, appearing in clusters, yellow on upper surface, sticky when wet, stem yellow, gills yellowish to brown.

Common Rots and Fungi in Saw Logs

10. Ceratocystis species.

Common name - Blue stain.

Hosts - Pines in particular are affected, but all soft and hardwoods can be affected.

General form - Sap stain. Since bluing fungus does not attack the cell walls, except to a negligible extent, and feeds only upon the cell contents, blued wood is not weakened. This has been determined by comparative mechanical tests on stained and unstained wood. But high moisture content and warm weather, which promote the development of the bluing fungus, are highly favorable to the development of true wood-destroying fungi. Blued wood may soon show evidences of decay when put in service, due to the true wood-destroying fungi and not to the bluing fungus. Although the strength of blued wood is not impaired by the color, the wood may be objectionable in places where color is a factor.

> **NOTE: Certain other discolorations of sapwood are produced by fungi belonging to the molds, of which the green mold on fruits or in certain cheeses is an example. Such stains are usually superficial and may be planed off. They are difficult to distinguish by visual inspection from the true blue stain.**

Characteristics - Blue, bluish gray or black color of the sapwood, rarely in the heartwood; color is usually most intense in the rays, causing it to appear in streaks in early stages. Due to the character of the wood, conifers are more susceptible than hardwoods. The fruiting body of the bluing fungus is not readily seen. When the color is so dense that it is almost black, small bristles with a bulbous base may be seen with a hand lens. The color, depending upon the weather conditions, usually appears very rapidly in trees killed by bark beetles or fire, or in piled logs cut from green trees. Lumber in yards may blue very rapidly if not properly piled or treated.

Blue color is due to the reflection to the surface of the wood of the colored mycelium in the wood cells. The wood itself is not stained by the true bluing fungus.

External signs - "Blued" sapwood or blued streaks extending from the sap into the heartwood of some logs. Dead and dying trees, killed by bark beetles, fire, or various other agents, are very susceptible to blue stain.

Common Rots and Fungi in Saw Logs

Fruiting body - Sometimes called bluing fungus. Fruiting body small, black, with long appendages, can best be seen with hand lens, appears on surface of boards or on wood of logs beneath bark.

11. Oligoporus amarus (Polyporus amarus, Tyromyces amarus).

Common names - Pecky rot, pocket dry rot, pencil rot, brown pocket rot.

Host - Incense cedar only known host.

Distribution and damage - Causes a common heart rot of incense cedar throughout its natural range, which is California, Oregon, and Nevada near the California border.

General form - Trunk rot. Rot column usually occupies entire heartwood, not common in butt portion.

Characteristics - In early stage, pocket dry rot appears as a faint yellowish-brown discoloration of the heartwood. Later, elongated pockets with pointed ends develop, longer than broad, from one-half inch to 12 inches. Wood broken down into a dark brown friable residue. Pockets confined to the heartwood of the main trunk or bases or large limbs. Pockets seldom form in exposed heartwood, are sparse near large open wounds.

External signs - Typical fruiting bodies rarely occur on living trees. Open borings or shot-hole cups replace conks. Large open fire wounds are indicators of this rot in most locations.

Fruiting body - Half bell-shaped or somewhat hoof-shaped, 4 to 8 inches wide, buff to tan on top, bright sulfur-yellow underneath, darkens in age to chalky tan, soft and moist when fresh, firm and dry when old.

12. Dichomitus squalens (Polyporus anceps).

Common name - Red rot, red ray rot.

Hosts - Ponderosa and Jeffrey pine in particular are affected.

Common Rots and Fungi in Saw Logs

Distribution and damage - Occurs often in ponderosa, Jeffrey, and Coulter pines in southern California; rare elsewhere along the Pacific Coast, but common and damaging on pines in the Southwest and Rocky Mountains. This fungus acts both as a decomposer of dead wood and as a heart rot.

General form - Heart rot. Fungus does not require conspicuous entrance courts such as wounds, fire scars, or dead tops. Enters only through recently dead, bark-covered branches. Requires moisture to sustain attack. Rot column extending to heartwood invaded longitudinally by a localized infection in the form of a decay column from a knot. Radial and tangential spread initially slow; may spread through entire tree length, but affects mostly logs from middle portion.

Characteristics - Wood decayed in irregular streaks or pockets. In early stage of decay, heartwood reddish to dark brown; discolored areas, often fan-shaped, radiate out from the log center, resemble spokes of a wheel or may be isolated anywhere in heartwood. In advanced stage, heartwood whitish or grayish in color; rotted wood consists of soft white strands of cellulose intermixed with less rotted wood particles, often wet and soggy, usually in log center, often surrounded by the fanlike areas of an early stage. In longitudinal section, incipient decay often appears as several separate discolored areas. In advanced stage, appears continuous. Decay entering through knots may be concentrated in the pith cavity.

External signs - Limited. Fruiting bodies rarely formed on trees and then only on dead bark-covered branches. No swollen knots.

Fruiting body - Fruiting bodies found mostly on decaying dead material in contact with the ground.

Appendix 12 -- National Cubic Test Log Data

Segment 1 is the small end segment. Segment 2 is the large end segment.
Volume summary by segment is in italics.
Total log volume summary is in bold.

Gross				Defect Deductions								Volume Summary				
Log	**Len**	**d1**	**D2**	**Seg**	**Defect Type**	**Dia**	**Dia**	**Len**	**% Ded**	**End Dim. W x H**	**Avg W x H**	**Gross**	**Defect**	**Net**	**% Rem**	**Defect Factor**
1	14	18	20		Squared Area			14		2 x 5 - 4 x 7	3 x 6	**27.6**	**1.8**	**25.8**	**93**	**2.29**
2	17	22	25		Squared Area			17		2 x 11 - 4 x 14	3 x 12		4.3			2.42
								17		4 x 3 - 6 x 7	5 x 5		3.0			1.94
												51.4	**7.3**	**44.1**	**86**	**4.36**
3	16	20	22		Squared Area			16		10 x 12 - 10 x 12	10 x 12	**38.6**	**13.3**	**25.3**	**66**	**8.57**
4	40	10	18	1	Squared Area			20		2 x 8	3 x 8	*16.1*	*3.3*	*12.8*	*80*	*10.67*
				2				20		5 x 8	4 x 8	*28.4*	*4.4*	*24.0*	*85*	*7.27*
												44.5	**7.7**	**36.8**		
5	8	29	32		Squared Area			8		14 x 14 - 16 x 16	15 x 15	**40.7**	**12.5**	**28.2**	**69**	**7.08**
6	21	14	19	1	Squared Area			10		7 x 8	8 x 9	*13.2*	*5.0*	*8.2*	*62*	*13.09*
				2				11		11 x 12	10 x 11	*19.5*	*8.4*	*11.1*	*57*	*11.56*
												32.7	**13.4**	**19.3**		
7	34	16	21	1	Squared Area			16		2 x 14			3.1			4.00
								16		4 x 6			2.7			4.00
												26.9	*5.8*	*21.1*	*78*	*8.00*
				2								*39.4*	*0.0*	*39.4*	*100*	*0.00*
												66.3	**5.8**	**60.5**		
8	9	40	41		Sq. Area/Percent			9	80	15 x 20		**80.5**	**15.0**	**65.5**	**81**	**3.74**
9	12	36	36		Sq. Area/Percent			12	95	14 x 16 - 16 x 18	15 x 17		20.2			5.12
								12	75	7 x 7 - 7 x 7	7 x 7		3.1			0.92
												84.8	**23.3**	**61.5**	**73**	**6.04**

Appendix 12 -- (Continued)

National Cubic Test Log Data

Gross				Defect Deductions								Volume Summary				
Log	**Len**	**d1**	**D2**	**Seg**	**Defect Type**	**Dia**	**Dia**	**Len**	**% Ded**	**End Dim. W x H**	**Avg W x H**	**Gross**	**Defect**	**Net**	**% Rem**	**Defect Factor**
10	20	25	28		Sq. Area/Percent			20	80	11 x 15 - 13 x 17	12 x 16		21.3			6.68
					Squared Area			20		1 x 23 - 3 x 27	2 x 25		6.9			2.43
												76.8	**28.2**	**48.6**	**63**	**9.11**
11	14	22	24		Squared Area			8		3 x 16		**40.5**	**2.7**	**37.8**	**93**	**1.94**
12	16	15	16		Squared Area			2		8 x 10			1.1			1.57
								10		2 x 14			1.9			2.86
												21.0	**3.0**	**18.0**	**86**	**4.43**
13	20	10	16		Squared Area			4		7 x 8		**19.4**	**1.6**	**17.8**	**92**	**3.73**
14	8	42	43		Squared Area			8		23 x 27 - 25 x 30	24 x 28	**78.8**	**37.3**	**41.5**	**53**	**9.31**
15	26	19	22	1	Squared Area			6		1 x 17		*26.2*	*0.7*	*25.5*	*97*	*1.00*
				2				8		1 x 15			0.8			0.91
								6		2 x 4			0.3			0.46
								14		10 x 10			9.7			6.93
												35.3	*10.8*	*24.5*	*69*	*8.30*
												61.5	**11.5**	**50.0**		
16	34	19	22	1	Squared Area			16		2 x 14	2 x 14	*35.0*	*3.1*	*31.9*	*91*	*2.67*
				2				18		2 x 14	2 x 14	*45.4*	*3.5*	*41.9*	*92*	*2.13*
												80.4	**6.6**	**73.8**		
17	34	21	24	1	Squared Area			16		1 x 11	1 x 12		1.3			1.07
								4		3 x 11			0.9			0.67
												42.3	*2.2*	*40.1*	*95*	*1.74*
				2	Squared Area			18		1 x 15	1 x 14		1.8			1.26
								8		2 x 11			1.2			0.75
												54.2	*3.0*	*51.2*	*94*	*2.01*
												96.5	**5.2**	**91.3**		
18	34	18	20	1	Squared Area			16		2 x 13	2 x 14		3.1			3.05
								8		3 x 4			0.7			0.76
												29.9	*3.8*	*26.1*	*87*	*3.81*
				2				18		2 x 17	2 x 16	*37.4*	*4.0*	*33.4*	*89*	*3.33*
												67.3	**7.8**	**59.5**		

Appendix 12 -- (Continued)

National Cubic Test Log Data

Gross				Defect Deductions								Volume Summary				
Log	Len	d1	D2	Seg	Defect Type	Dia	Dia	Len	% Ded	End Dim. W x H	Avg W x H	Gross	Defect	Net	% Rem	Defect Factor
19	34	24	30	1	Squared Area			16		2 x 8	2 x 10	*56.9*	*2.2*	*54.7*	*96*	*1.20*
				2				18		2 x 16	2 x 14	*80.0*	*3.5*	*76.5*	*96*	*1.16*
												136.9	**5.7**	**131.2**		
20	43	31	34	1	Squared Area			14		1 x 12	2 x 12	*75.8*	*2.3*	*73.5*	*97*	*0.90*
				2				14			2 x 12	*80.7*	*2.3*	*78.4*	*97*	*0.86*
				3				15		3 x 12	3 x 12	*91.8*	*3.8*	*88.0*	*96*	*1.03*
												248.3	**8.4**	**239.9**		
21	8	14	17		Length			2				**10.6**	**2.7**	**7.9**	**75**	**4.00**
22	13	16	18		Length			4				**20.6**	**6.3**	**14.3**	**69**	**4.92**
23	12	13	14		Length			6				**11.9**	**6.0**	**5.9**	**50**	**8.00**
24	40	22	25	1	Length			12				*57.8*	*34.7*	*23.1*	*40*	*9.60*
				2				14				*65.5*	*45.9*	*19.6*	*30*	*11.20*
												123.3	**80.6**	**42.7**		
25	23	16	21	1	Length			6				*18.5*	*10.1*	*8.4*	*45*	*8.73*
				2				5				*26.2*	*10.9*	*15.3*	*58*	*6.67*
												44.7	**21.0**	**23.7**		
26	12	26	27		Length			6				**46.0**	**23.0**	**23.0**	**50**	**8.00**
27	41	13	19	1	Length			2				*14.0*	*2.2*	*11.8*	*84*	*2.46*
				2				8				*19.6*	*11.2*	*8.4*	*43*	*9.14*
				3				4				*24.8*	*7.1*	*17.7*	*71*	*4.57*
												58.4	**20.5**	**37.9**		
28	40	6	9	1	Length			14				*5.5*	*3.9*	*1.6*	*29*	*11.20*
				2				13				*7.9*	*5.1*	*2.8*	*35*	*10.40*
												13.4	**9.0**	**4.4**		
29	8	16	23		Length			2				**17.1**	**4.3**	**12.8**	**75**	**4.00**
30	20	5	6		Length			14				**3.3**	**2.3**	**1.0**	**30**	**11.20**
31	38	21	25	1	Length			12				*47.6*	*31.7*	*15.9*	*33*	*10.67*
				2				10				*62.9*	*31.5*	*31.4*	*50*	*8.00*
												110.5	**63.2**	**47.3**		
32	11	16	17		Length			4				**16.3**	**5.9**	**10.4**	**64**	**5.82**
33	21	21	26	1	Length			4				*27.7*	*11.1*	*16.6*	*60*	*6.40*
				2				1				*37.6*	*3.4*	*34.2*	*91*	*1.45*
												65.3	**14.5**	**50.8**		

Appendix 12 -- (Continued)

National Cubic Test Log Data

Gross				Defect Deductions								Volume Summary				
Log	Len	d1	D2	Seg	Defect Type	Dia	Dia	Len	% Ded	End Dim. W x H	Avg W x H	Gross	Defect	Net	% Rem	Defect Factor
34	20	17	20		Length			4					7.5			3.20
								8					15.0			6.40
												37.6	**22.5**	**15.1**	**40**	**9.60**
35	32	21	24	1	Length			6					15.9			6.00
								2					5.3			2.00
												42.3	*21.2*	*21.1*	*50*	*8.00*
				2	Length			4					12.1			4.00
								4					12.1			4.00
												48.2	*24.2*	*24.0*	*50*	*8.00*
												90.5	**45.4**	**45.1**		
36	31	11	15	1	Length							*11.9*	*0.0*	*11.9*	*100*	*0.00*
				2				10				*17.2*	*10.8*	*6.4*	*37*	*10.00*
												29.1	**10.8**	**18.3**		
37	18	17	18		Length			12				**30.1**	**20.1**	**10.0**	**33**	**10.67**
38	14	6	6		Length			8				**2.7**	**1.5**	**1.2**	**44**	**9.14**
39	44	16	17	1	Length							*20.8*	*0.0*	*20.8*	*100*	*0.00*
				2				8				*22.1*	*12.6*	*9.5*	*43*	*9.14*
				3				10				*25.2*	*15.8*	*9.4*	*37*	*10.00*
												68.1	**28.4**	**39.7**		
40	9	9	13		Length			3				**6.1**	**2.0**	**4.1**	**67**	**5.33**
41	26	14	15	1	Length			6				*13.8*	*6.9*	*6.9*	*50*	*8.00*
				2	Length/Percent			14	10			*17.2*	*1.7*	*15.5*	*90*	*1.60*
												31.0	**8.6**	**22.4**		
42	34	15	19	1								*22.4*	*0.0*	*22.4*	*100*	*0.00*
				2	Length/Percent			4	25				1.8			0.89
								6	20				2.1			1.07
												31.9	*3.9*	*28.0*	*88*	*1.96*
												54.3	**3.9**	**50.4**		
43	22	8	9	1	Length/Percent			10	35			*4.0*	*1.4*	*2.6*	*65*	*5.60*
				2				12	30				1.6			4.80
								2	70				0.6			1.87
												5.3	*2.2*	*3.1*	*58*	*6.67*
												9.3	**3.6**	**5.7**		

Appendix 12 -- (Continued)

National Cubic Test Log Data

Gross				Defect Deductions								Volume Summary				
Log	**Len**	**d1**	**D2**	**Seg**	**Defect Type**	**Dia**	**Dia**	**Len**	**% Ded**	**End Dim. W x H**	**Avg W x H**	**Gross**	**Defect**	**Net**	**% Rem**	**Defect Factor**
44	40	28	34	1	Sq. Area/Percent			10	80	10 x 13		*95.2*	*7.2*	*88.0*	*92*	*1.66*
				2	Length/Percent			20	65			*115.5*	*75.1*	*40.4*	*35*	*10.40*
												210.7	**82.3**	**128.4**		
44	40	28	34	1	Sq. Area/Percent			10	80	10 x 13		*95.2*	*7.2*	*88.0*	*92*	*1.66*
				2	Length/Percent			20	65			*115.5*	*75.1*	*40.4*	*35*	*10.40*
												210.7	**82.3**	**128.4**		
45	20	13	17		Sq. Area/Percent			20	90	3 x 5 - 8 x 11	6 x 8	**25.0**	**6.0**	**19.0**	**76**	**10.08**
46	17	19	20		Sq. Area/Percent			10	50	6 x 10		**35.3**	**2.1**	**33.2**	**94**	**1.76**
47	10	16	20		Sq. Area/Percent			4	30	8 x 10		**17.9**	**0.7**	**17.2**	**96**	**1.32**
48	20	16	19		Sq. Area/Percent			20	60	1 x 10 - 1 x 13	1 x 12		1.0			1.20
					Squared Area			6		4 x 6			1.0			1.20
												33.7	**2.0**	**31.7**	**94**	**2.40**
49	18	26	29		Length/Percent			12	60				29.8			6.40
								6	80				19.9			4.27
												74.5	**49.7**	**24.8**	**33**	**10.67**
50	40	5	8	1	Length/Percent			10	50			*4.0*	*1.0*	*30*	*75*	*4.00*
				2				14	60			*6.2*	*2.6*	*3.6*	*58*	*6.72*
												10.2	**3.6**	**6.6**		
51	20	20	22		Diameter/Percent	6		20	66			**48.2**	**15.5**	**32.7**	**68**	**6.41**
52	20	43	44		Diameter/Percent	11		20	50			**206.4**	**45.6**	**160.8**	**78**	**3.77**
53	8	10	11		Diameter/Percent	3		8	25			**4.8**	**0.6**	**4.2**	**88**	**2.00**
54	16	37	39		Diameter/Percent	14		10	67			**126.1**	**31.7**	**94.4**	**75**	**4.23**
55	12	16	20		Diameter/Percent	7		12	85			**21.5**	**11.3**	**10.2**	**47**	**10.20**
56	32	18	24	1	Diameter/Percent	4		16	50			*33.4*	*6.1*	*27.3*	*82*	*3.81*
				2	Diameter	4		8				*44.4*	*7.2*	*37.2*	*84*	*3.20*
												77.8	**13.3**	**64.5**		
57	32	8	11	1	Diameter	2		16				*7.2*	*2.8*	*4.4*	*61*	*5.33*
				2	Diameter/Percent	2		6	25			*9.6*	*0.3*	*9.3*	*97*	*0.75*
												16.8	**3.1**	**13.7**		
58	17	19	24		Diameter/Percent	8		17	95			**43.4**	**24.6**	**18.8**	**43**	**10.76**
59	10	13	15		Diameter/Percent	5		10	35			**10.7**	**2.2**	**8.5**	**79**	**3.92**

Appendix 12 -- (Continued)

National Cubic Test Log Data

Gross				Defect Deductions								Volume Summary				
Log	Len	d1	D2	Seg	Defect Type	Dia	Dia	Len	% Ded	End Dim. W x H	Avg W x H	Gross	Defect	Net	% Rem	Defect Factor
60	40	16	21	1	Diameter/Percent	3		20	55			*33.7*	*5.8*	*27.9*	*83*	*3.30*
				2	Diameter/Percent	3		12	35			*43.7*	*2.5*	*41.2*	*94*	*1.12*
												77.4	**8.3**	**69.1**		
61	20	15	17		Diameter	4		20				**28.0**	**12.2**	**15.8**	**56**	**8.00**
62	16	15	17		Diameter	6		16				**22.4**	**13.6**	**8.8**	**39**	**11.43**
63	16	17	20		Diameter	7		16				**30.1**	**18.4**	**11.7**	**39**	**10.67**
64	19	15	18		Diameter	6		19				**28.4**	**16.7**	**11.7**	**41**	**11.43**
65	18	32	34		Diameter/Percent	10		18	75			**107.0**	**41.3**	**65.7**	**61**	**6.65**
66	32	18	24	1	Diameter	2		16				*33.4*	*6.5*	*26.9*	*81*	*3.81*
				2		2		16				*44.4*	*7.5*	*36.9*	*83*	*3.20*
												77.8	**14.0**	**63.8**		
67	14	14	16		Diameter	3		14				**17.3**	**6.2**	**11.1**	**64**	**5.82**
68	26	24	29	1	Diameter	4		12				*42.7*	*12.3*	*30.4*	*71*	*4.80*
				2								*59.9*	*0.0*	*59.9*	*100*	*0.00*
												102.6	**12.3**	**90.3**		
69	34	25	27	1	Diameter	5		16				*56.8*	*20.1*	*36.7*	*65*	*6.26*
				2		6		18				*69.0*	*27.7*	*41.3*	*60*	*7.04*
												125.8	**47.8**	**78.0**		
70	40	10	18	1	Diameter	2		20				*16.1*	*4.8*	*11.3*	*70*	*8.00*
				2		5		20				*28.4*	*14.8*	*13.6*	*48*	*10.18*
												44.5	**19.6**	**24.9**		
71	20	36	38		Diameter/Percent	15		20	99			**149.4**	**95.5**	**53.9**	**36**	**10.67**
72	41	6	7	1	Diameter	1		13				*3.0*	*0.8*	*2.2*	*73*	*0.00*
				2	Diameter/Percent	2		14	30			*3.7*	*0.5*	*3.2*	*86*	*1.60*
				3	Diameter/Percent	2		14	80			*3.7*	*1.4*	*2.3*	*62*	*4.26*
												10.4	**2.7**	**7.7**		
73	40	13	17	1	Diameter/Percent	6		6	25			*21.5*	*1.1*	*20.4*	*95*	*0.84*
				2	Diameter	6		14				*28.0*	*11.9*	*16.1*	*58*	*8.00*
												49.5	**13.0**	**36.5**		
74	17	21	23		Diameter	8		17				**45.0**	**26.7**	**18.3**	**41**	**10.67**
75	36	21	25	1								*47.6*	*0.0*	*47.6*	*100*	*0.00*
				2	Diameter/Percent	10		18	90			*56.6*	*33.6*	*23.0*	*41*	*10.61*
												104.2	**33.6**	**70.6**		

Appendix 12 -- (Continued)

National Cubic Test Log Data

Gross				Defect Deductions								Volume Summary				
Log	**Len**	**d1**	**D2**	**Seg**	**Defect Type**	**Dia**	**Dia**	**Len**	**% Ded**	**End Dim. W x H**	**Avg W x H**	**Gross**	**Defect**	**Net**	**% Rem**	**Defect Factor**
76	21	9	10	1	Diameter	3		10				*4.9*	*2.6*	*2.3*	*47*	*8.00*
				2		5		11				*6.0*	*4.5*	*1.5*	*25*	*10.67*
												10.9	**7.1**	**3.8**		
77	13	12	17		Diameter	6		13				**15.4**	**9.8**	**5.6**	**36**	**12.00**
78	39	16	19	1	Diameter	5		10				*30.1*	*7.9*	*22.2*	*74*	*4.74*
				2	Diameter	7		20				*37.4*	*22.9*	*14.5*	*39*	*10.67*
												67.5	**30.8**	**36.7**		
79	9	7	10		Diameter	3		9				**3.7**	**2.1**	**1.6**	**43**	**10.67**
80	43	6	13	1	Diameter	3		14				*4.5*	*2.8*	*1.7*	*38*	*8.00*
				2	Diameter	2		14				*7.7*	*2.7*	*5.0*	*65*	*4.00*
				3	Diameter	4		15				*11.9*	*6.6*	*5.3*	*45*	*9.14*
												24.1	**12.1**	**12.0**		
81	20	16	19		Single Ring	10		10				**33.7**	**1.5**	**32.2**	**96**	**3.51**
82	18	15	18		Single Ring	6	9	18				**26.9**	**1.6**	**25.3**	**94**	**8.03**
83	26	18	23	1	Single Ring	10		12			10 - 13	*25.0*	*2.4*	*22.6*	*90*	*9.19*
				2		15		14			13 - 15	*37.0*	*4.1*	*32.9*	*89*	*7.42*
												62.0	**6.5**	**55.5**		
84	14	17	19		Ring/Percent	11		6	50			**24.8**	**0.5**	**24.3**	**98**	**1.51**
85	32	21	25	1	Ring/Percent	13		16	75		13 - 15	*42.3*	*3.5*	*38.8*	*92*	*5.57*
				2	Single Ring	17		16			15 - 17		6.1			7.18
						6		8					0.4			0.63
												50.4	6.5	43.9	87	7.81
												92.7	**10.0**	**82.7**		
86	21	13	15	1	Single Ring	7		10			7 - 8	*10.0*	*0.8*	*9.2*	*92*	*9.65*
				2		9		11			8 - 9	*12.6*	*1.2*	*11.4*	*90*	*11.68*
												22.6	**2.0**	**20.6**		
87	16	32	33		Ring/Percent	25	27	16	75				12.1			5.18
					Single Ring	11		6					1.1			0.64
												92.2	**13.2**	**79.0**	**86**	**5.82**
88	31	23	26	1	Ring/Percent	13		15	35		13 - 16	*47.2*	*1.7*	*45.5*	*96*	*2.51*
				2	Single Ring	18		16			16 - 18		6.9			6.57
						9		10					1.2			1.53
												56.8	8.1	48.7	86	8.10
												104.0	**9.8**	**94.2**		

Appendix 12 -- (Continued)

National Cubic Test Log Data

Gross				Defect Deductions								Volume Summary				
Log	Len	d1	D2	Seg	Defect Type	Dia	Dia	Len	% Ded	End Dim. W x H	Avg W x H	Gross	Defect	Net	% Rem	Defect Factor
89	10	26	30		Single Ring	20	23	10					6.9			8.96
					Ring/Percent	8	9	10	73				0.8			1.88
												43.0	**7.7**	**35.3**	**82**	**10.84**
90	40	12	16	1	Single Ring	7		20			7 - 9	*18.5*	*1.9*	*16.6*	*90*	*12.06*
				2		10		20			9 - 10	*24.7*	*2.7*	*22.0*	*89*	*13.05*
												43.2	**4.6**	**38.6**		
91	20	19	23		Multiple Rings	13		8								
						10		8				**48.5**	**5.0**	**43.5**	**90**	**3.75**
92	18	24	25		Multiple Rings	18		8								
						15		8				**59.0**	**8.2**	**50.8**	**86**	**4.16**
93	20	21	28		Multiple Rings	10	16	20								
						8	11	20								
						6	8	20				**66.8**	**19.3**	**47.5**	**71**	**9.74**
94	40	16	19	1	Multiple Rings	9		20			9 - 11					
						8		20			8 - 10	*31.6*	*5.1*	*26.5*	*84*	*10.01*
				2		13		20			11 - 13					
						11		20			10 - 11	*37.4*	*8.1*	*29.3*	*78*	*9.19*
												69.0	**13.2**	**55.8**		
95	43	20	25	1	Multiple Rings	14		14			14 - 16					
						10		14			10 - 13	*33.7*	*11.7*	*22.0*	*65*	*10.96*
				2				14			16 - 18					
								14			13 - 15	*40.5*	*13.1*	*27.4*	*68*	*11.54*
				3		20		15			18 - 20					
						17		15			15 - 17	*49.1*	*16.7*	*32.4*	*66*	*11.01*
												123.3	**41.5**	**81.8**		
96	16	19	24		Multiple Rings/ Percent	13	17	16	85							
						9	13	16	85			**40.9**	**12.4**	**28.5**	**70**	**12.39**
97	20	17	21		Multiple Rings/ Percent	11	15	20	50							
						8	11	20	50			**39.8**	**7.0**	**32.8**	**82**	**7.75**

Appendix 12 -- (Continued)

National Cubic Test Log Data

Gross				Defect Deductions								Volume Summary				
Log	Len	d1	D2	Seg	Defect Type	Dia	Dia	Len	% Ded	End Dim. W x H	Avg W x H	Gross	Defect	Net	% Rem	Defect Factor
98	21	17	20	1	Multiple Rings/ Percent	11		10	26		11 - 13					
						8		10	26		8 - 11	*17.7*	*1.3*	*16.4*	*93*	*3.33*
				2		15		11	50		13 - 15					
						13		11	50		11 - 13	*22.8*	*3.2*	*19.6*	*86*	*5.36*
												40.5	**4.5**	**36.0**		
99	40	21	25	1	Multiple Rings/ Percent	14		20	50		14 - 17					
						10		20	50		10 - 12	*52.9*	*10.2*	*42.7*	*81*	*6.20*
				2	Multiple Rings	19		20			17 - 19					
						14		20			12 - 14	*62.9*	*26.6*	*36.3*	*58*	*12.15*
												115.8	**36.8**	**79.0**		
100	45	19	25	1	Multiple Rings	13		14			13 - 15					
						8		14			8 - 11	*30.6*	*12.1*	*18.5*	*60*	*13.28*
				2	Multiple Rings/ Percent			15	75		15 - 17					
								15	75		11 - 13	*39.7*	*11.2*	*28.5*	*72*	*8.80*
				3		19		16	50		17 - 19					
						15		16	50		13 - 15	*50.4*	*9.5*	*40.9*	*81*	*5.58*
												120.7	**32.8**	**87.9**		

Appendix 12 -- (Continued)

National Cubic Test Log Data

Gross				Defect Deductions								Volume Summary				
Log	**Len**	**d1**	**D2**	**Seg**	**Defect Type**	**Dia**	**Dia**	**Len**	**% Ded**	**End Dim. W x H**	**Avg W x H**	**Gross**	**Defect**	**Net**	**% Rem**	**Defect Factor**
101	34	21	24	1	Squared Area			4		3 x 11			0.9			0.67
								16		1 x 8	1 x 10		1.1			1.07
												42.3	*2.0*	*40.3*	*95*	*1.74*
				2	Squared Area			8		2 x 11			1.2			0.75
								18		1 x 16	1 x 14		1.8			1.26
												54.2	*3.0*	*51.2*	*94*	*2.01*
												96.5	**5.0**	**91.5**		
102	34	18	20	1	Squared Area			16		2 x 13	2 x 14		3.1			3.05
								8		3 x 4			0.7			0.76
												29.9	*3.8*	*26.1*	*87*	*3.81*
				2	Squared Area			18		2 x 17	2 x 16		4.0			3.33
					Length/Percent			6	20				2.5			1.07
												37.4	*6.5*	*30.9*	*83*	*4.40*
												67.3	**10.3**	**57.0**		

Appendix 12 -- (Continued)

National Cubic Test Log Data

Gross				**Defect Deductions**								**Volume Summary**				
Log	**Len**	**d1**	**D2**	**Seg**	**Defect Type**	**Dia**	**Dia**	**Len**	**% Ded**	**End Dim. W x H**	**Avg W x H**	**Gross**	**Defect**	**Net**	**% Rem**	**Defect Factor**
103	34	18	20	1	Diameter/Percent	4		16	50				9.1			2.72
					Squared Area			6		1 x 6			0.3			0.12
												68.8	*9.4*	*59.4*	*86*	*2.84*
				2	Diameter/Percent	7		16	50				17.1			3.40
					Length/Percent			10	20				10.9			2.00
					Squared Area			6		1 x 6			0.3			0.09
												86.8	28.3	58.5	67	5.49
												155.6	**37.7**	**117.9**		
104	34	29	39	1	Squared Area			16		4 x 10	4 x 11		4.9			1.84
					Length/Percent			6	25				8.2			1.50
												87.1	*13.1*	*74.0*	*85*	*3.34*
				2	Squared Area			18		4 x 14	4 x 13		6.5			1.40
					Length/Percent			18	50				65.7			8.00
												131.4	*72.2*	*59.2*	*45*	*9.40*
												218.5	**85.3**	**133.2**		
105	18	35	36		Squared Area			18		1 x 8 - 5 x 23	3 x 16		6.0			1.27
								4		5 x 22			3.1			0.52
								8		3 x 13			2.2			0.40
								8		2 x 6			0.7			0.16
					Single Ring	12		8					1.7			0.81
												123.7	**13.7**	**110.0**	**89**	**3.16**
106	34	34	37	1	Length/Percent			10	70				46.8			7.00
					Diameter/Percent	2		6	50				2.2			0.23
					Squared Area			8		2 x 15			1.7			0.40
												107.0	*50.7*	*56.3*	*53*	*7.63*
				2	Length/Percent			18	33				43.2			5.28
					Squared Area			6		2 x 15			1.3			0.23
					Diameter/Percent	2		18	25				3.5			0.52
												130.8	48.0	82.8	63	6.03
												237.8	**98.7**	**139.1**		

Appendix 12 -- (Continued)

National Cubic Test Log Data

Gross				Defect Deductions								Volume Summary				
Log	Len	d1	D2	Seg	Defect Type	Dia	Dia	Len	% Ded	End Dim. W x H	Avg W x H	Gross	Defect	Net	% Rem	Defect Factor
107	40	18	22	1	Length/Percent			6	30				3.6			1.44
					Squared Area			20		1 x 7	1 x 8		1.1			1.52
												39.5	*4.7*	*34.8*	*88*	*2.96*
				2	Squared Area			20		1 x 9	1 x 8		1.1			1.14
								2		3 x 6			0.3			0.17
					Length/Percent			4	15				1.4			0.48
												48.2	*2.8*	*45.4*	*94*	*1.79*
												87.7	**7.5**	**80.2**		
108	40	25	30	1	Squared Area			20		4 x 5	6 x 8		6.7			2.43
								6		3 x 12			1.5			0.52
					Diameter/Percent	4		8	75				6.4			1.67
												76.8	*14.6*	*62.2*	*81*	*4.62*
				2	Squared Area			20		11 x 15	10 x 12		16.7			4.14
								2		2 x 20			0.6			0.14
												91.8	*17.3*	*74.5*	*81*	*4.28*
												168.6	**31.9**	**136.7**		
109	41	16	21	1	Diameter	2		6					2.1			2.31
					Squared Area			13		1 x 6	2 x 8		1.4			3.00
												20.6	3.5	17.1	83	5.31
				2	Squared Area			6		3 x 11			1.4			1.63
								14			2 x 10		1.9			2.29
												27.6	*3.3*	*24.3*	*88*	*3.92*
				3	Length			4					9.2			4.57
					Single Ring	11		10					1.8			3.24
					Squared Area			10		2 x 14	2 x 13		1.8			1.64
												32.1	*12.8*	*19.3*	*60*	*9.45*
												80.3	**19.6**	**60.7**		
110	20	16	21		Length			4					7.6			3.20
					Ring/Percent	7	8	16	40				0.5			1.93
					Squared Area			10		1 x 13			0.9			1.50
								6		2 x 14			1.2			1.20
					Diameter/Percent	3		16	75				6.7			3.60
												38.0	**16.9**	**21.1**	**56**	**11.43**

Appendix 13 -- Cull Factor Algorithms for Cubic Scaling

This Appendix sets out the text of a guide on the use of cull factor algorithms for cubic scaling.

Table of Contents

Appendix 13 -- (Continued)

Cull Factor Algorithms for Cubic Scaling

List of Variables

VARIABLE	MEANING
DED	Diameter reduction for perimeter defect
DFACT	Segment defect factor
$DFACT_{DED}$	Defect factor for a diameter reduction
$DFACT_{LEN}$	Defect factor for a length deduction
$DFACT_{(inner)}$	Defect factor for an inner ring
$DFACT_{(outer)}$	Defect factor for an outer ring
ΣDFACT	Sum of defect factors for a segment
DLEN	Perimeter defect reduction length that is less than the segment length
DPCT	Defect percent of the circumference of a diameter reduction
DVOL	Defect volume (Scribner)
$GROSS_{16}$	Gross Scribner volume of a 16 foot log of a given small end diameter
IDF	Interior Defect Factor
LEN	Defect length cut
MERCHFACT	Merchantability factor determined from utilization percent (UTIL%), maximum factor for a sound segment
$MERCHFACT_{25}$	Merchantability factor for ¼ sound (25 percent) utilization
PCT	Defect percent cut deduction; may be used with a defect length cut (LEN) to create a pie cut
PDF	Perimeter Defect Factor
RA	Rectangular area (width times height) of a defect
RCD	Replacement core diameter
RINGSIDE	Large end square based on ring size
$ROUND_0$	Round to nearest whole number
$ROUND_2$	Round to nearest 0.01 decimal place
RPCT	Defect percent of a ring deduction
RVOL	Replacement core volume (Scribner)
SECD	Small end core diameter
SED	Small end diameter of a segment
SEGLEN	Segment length
SPCT	Defect percent of a squared area deduction
SPRC	Shake and Ring Correction Factor
SQUARESIDE	Integer length of one side of a square with equivalent area to a rectangular defect
TAPER	Ring taper from small end diameter to large end diameter
UTIL	Utilization fraction, usually 1/3 or ¼ sound as listed in section A2 of the timber sale contract

Cull Factor Algorithms for Cubic Scaling

Defect Factor Table Algorithms

Software developers find using cubic scaling cull factor lookup tables inefficient for software programming. This National Forest Cubic Scaling Handbook does not describe the mathematics behind the key factor tables in Appendixes 6, 7, 8, and 9 for determining cull. The following equations may be used to make software more efficient. These equations are based on determining the equivalent length cut for interior, perimeter, and ring defect.

Scribner Volume Equations

1. Use Scribner volume factors or volumes from Table 1 in this Appendix (Northwest Log Scaling Rules, revised 7/1/72) to determine 16-foot log volumes to calculate cubic defect factors.

TABLE 1. Scribner Decimal C Volume Factors and Volumes for 16-Foot Logs

Diameter	Volume Factor	Volume	Diameter	Volume Factor	Volume	Diameter	Volume Factor	Volume
1	0.000	0	36	57.660	92	71	239.317	383
2	0.143	0	37	64.319	103	72	246.615	395
3	0.390	1	38	66.731	107	73	254.040	406
4	0.676	1	39	70.000	112	74	261.525	418
5	1.070	2	40	75.240	120	75	269.040	430
6	1.249	2	41	79.480	127	76	276.630	443
7	1.608	3	42	83.910	134	77	284.260	455
8	1.854	3	43	87.190	140	78	292.503	468
9	2.410	4	44	92.501	148	79	300.655	481
10	3.542	6	45	94.990	152	80	308.970	494
11	4.167	7	46	99.075	159	81	317.360	508
12	4.900	8	47	103.501	166	82	325.790	521
13	6.043	10	48	107.970	173	83	334.217	535
14	7.140	11	49	112.292	180	84	343.290	549
15	8.880	14	50	116.990	187	85	350.785	561
16	10.000	16	51	121.650	195	86	359.120	575
17	11.528	18	52	126.525	202	87	368.380	589
18	13.290	21	53	131.510	210	88	376.610	603
19	14.990	24	54	136.510	218	89	385.135	616
20	17.499	28	55	141.610	227	90	393.380	629

Cull Factor Algorithms for Cubic Scaling

TABLE 1. Scribner Decimal C Volume Factors and Volumes for 16-Foot Logs (Continued)

Diameter	Volume Factor	Volume	Diameter	Volume Factor	Volume	Diameter	Volume Factor	Volume
21	18.990	30	56	146.912	235	91	402.499	644
22	20.880	33	57	152.210	244	92	410.834	657
23	23.510	38	58	157.710	252	93	419.166	671
24	25.218	40	59	163.288	261	94	428.380	685
25	28.667	46	60	168.990	270	95	437.449	700
26	31.249	50	61	174.850	280	96	446.565	715
27	34.220	55	62	180.749	289	97	455.010	728
28	36.376	58	63	186.623	299	98	464.150	743
29	38.040	61	64	193.170	309	99	473.430	757
30	41.060	66	65	199.120	319			
31	44.376	71	66	205.685	329			
32	45.975	74	67	211.810	339			
33	48.990	78	68	218.501	350			
34	50.000	80	69	225.685	361			
35	54.688	88	70	232.499	372			

2. If programming stand-alone cubic software, create a lookup table that keys off the diameter column and returns the Scribner decimal C volume.

3. If programming combined cubic and Scribner software, create a lookup table that keys off the diameter column and returns the Scribner volume factors. Multiply the 16-foot log length by the volume factor for the appropriate diameter, round to the nearest ten board feet, and drop the last digit, a zero, to obtain the Scribner decimal C volume. Warning: Log factors for 1-foot to 15-foot logs (and 32-foot to 40-foot logs for Scribner 40 foot rule) use different volume factors.

Rectangular Area (Appendix 9)

The following algorithm will provide the same values found in the table in Appendix 9 of this Handbook. This algorithm is used in conjunction with the algorithm for the Interior Defect Factor Table in Appendix 6, to obtain the factor for an interior defect. The algorithm determines the length of a side for a square equal to the lower limit of each one-inch size class. This is a three-step process.

Appendix 13 -- (Continued)

Cull Factor Algorithms for Cubic Scaling

Step One:

Determine the rectangular area (*RA*) of the defect by multiplying the width times the height. If RA = 0 or 1, then SQUARESIDE = 0; if RA = 2, then SQUARESIDE = 2; otherwise use the equation below.

RA = Width x Height

Example: The rectangular area of a heart check measuring 3 inches by 16 inches.
RA = 3 x 16 = 48 square inches

Step Two:

Determine whether the square root of the rectangular area falls above or below the lower limit ($\boldsymbol{xx.6^2}$, where ***xx*** is the class) of the one-inch class. If the square root of *RA* falls below the lower limit of $\boldsymbol{xx.6^2}$, then use the next lower one-inch class, otherwise use the one-inch class found by the square root of *RA*. $ROUND_0$ indicates round to nearest whole number. $ROUND_2$ indicates round to the nearest 1/100 decimal place.

IF: $RA \prec (ROUND_0(\sqrt{RA} - 0.4))^2$

Example: *RA*=48;

$\sqrt{48} = 6.93, rounded = 7$

7 - 0.4 = 6.6

$6.6^2 = 43.56$, rounded 44

RA < 44 is FALSE, go to ELSE

Step Three:

Determine the equivalent length of the side of a square (*SQUARESIDE*).

If *RA* is less than the lower limit, then take the square root of *RA*, round to the nearest whole number, and subtract one from *SQUARESIDE*.

THEN: $SQUARESIDE_0(\sqrt{RA}) - 1$

Cull Factor Algorithms for Cubic Scaling

If the *RA* is greater than the lower limit, then take the square root of *RA* and round to the nearest whole number to find *SQUARESIDE*.

ELSE: $SQUARESIDE_0(\sqrt{RA})$

Example: $SQUARESIDE_0(\sqrt{44})$

$SQUARESIDE = 7$

Interior Defect Factor (Appendix 6)

The following algorithm will provide the same values found in the table in Appendix 6 of this Handbook. This algorithm is used in conjunction with the rectangular area algorithm for Rectangular Area Table in Appendix 9 to obtain the factor for an interior defect. The algorithm determines the interior defect factor (*IDF*) based on the variable *SQUARESIDE* that was explained in the RECTANGULAR AREA section, above. The variable *DVOL* is an interim determination of defect volume. The variable $GROSS_{S16}$ is the gross Scribner volume of a 16 foot log of a given small end diameter (*SED*).

$$DVOL = ROUND_0[\frac{(SQUARESIDE + 1)^2 \text{ x } 16}{150}]$$

$$IDF = ROUND_2[\frac{DVOL}{GROSS_{S16}} \text{ x } 16]$$

Example: Let SED = 13 inches; then from Table 1, $GROSS_{S16} = 10$
$SQUARESIDE = 7$

$$DVOL = ROUND_0[\frac{(7+1)^2 \text{ x } 16}{150}] = 7$$

$$IDF = ROUND_2[\frac{7}{10} \text{ x } 16] = 11.20$$

Appendix 13 -- (Continued)

Cull Factor Algorithms for Cubic Scaling

Perimeter Defect Factor (Appendix 7)

The following algorithm will provide the same values found in the table in Appendix 7 of this Handbook. This algorithm is used to obtain the factor for a perimeter defect. The algorithm determines the perimeter defect factor (*PDF*). The variable *RVOL* is a determination of replacement core volume based on the replacement core diameter (*RCD)* that is a function of diameter reduction (*DED*).

$$RCD = SED - DED$$

$$PDF = ROUND_2[\frac{GROSS_{S16} - RVOL}{GROSS_{S16}} \text{ x } 16]$$

Example: Let *SED* = 20; *DED* = 4
RCD = 20 - 4 = 16
RVOL for *RCD* = 16 is 16 (from Table 1)
$GROSS_{S16}$ for *SED* = 20 is 28 (from Table 1)

$$PDF = ROUND_2[\frac{28 - 16}{28} \text{ x } 16] = 6.86$$

Shake and Pitch Ring Correction Factor (Appendix 8)

The following algorithm will provide the same values found in the table in Appendix 8 of this Handbook. This algorithm is used to obtain the shake and pitch ring correction factor (*SPRC*). The variable *RINGSIDE* is a determination of a large end square based on the small end core diameter (*SECD)* and the taper (*TAPER*). The variable *DVOL* is an interim determination of defect volume. The variable *RVOL* is a determination of replacement core volume based on the replacement core diameter (*SECD).*

$$RINGSIDE = ROUND_0[\frac{TAPER}{2} + SECD]$$

$$DVOL = ROUND_0[\frac{(RINGSIDE + 1)^2 \text{ x } 16}{150}]$$

$$SPRC = ROUND_2[\frac{DVOL - RVOL}{DVOL}]$$

Cull Factor Algorithms for Cubic Scaling

If *TAPER* = 0; then:

$RINGSIDE = ROUND_0\ (SECD)$

Example: Let *SECD* = 20; *TAPER* = 3
RVOL for *SECD* = 20 is 28 (from Table 1 of this Appendix)

$$RINGSIDE = ROUND_0[\frac{3}{2} + 20] = 22$$

$$DVOL = ROUND_0[\frac{(22+1)^2 \text{ x } 16}{150}] = 56$$

$$SPRC = ROUND_2[\frac{56-28}{56}] = 0.50$$

Cubic Cull Segment Determination

Cubic Scaling Rules

Use the rules for cubic scaling as provided by this Handbook. Section 22.2 provides the basic defect deduction rules; the rules for each defect method are also provided. When calculating cubic cull for a segment, treat a ring within 2.5 inches of the perimeter as a perimeter cull deduction. These basic rules must be used in conjunction with the following algorithms to provide the correct cubic cull determination.

Merchantability Factor

The merchantability factor (*MERCHFACT*) is determined from the utilization fraction (*UTIL*) listed in the timber sale contract. The factor is calculated on a 16-foot log basis.

$MERCHFACT = (1.00 - UTIL) \text{ x } 16$

Example: *UTIL*= 1/4 sound
$MERCHFACT = (1.00 - 1/4) \text{ x } 16 = 12.00$

Cull Factor Algorithms for Cubic Scaling

Defect Factor

Each segment defect is converted to a 16-foot length cut basis. If the sum of the segment defect factors ($\Sigma DFACT$) exceeds the merchantability factor, the segment is a cull. Each defect factor is rounded to the nearest hundredths place prior to summing the defect factors for a segment. Merchantability factor for examples below is 12.00, based on a 25 percent minimum for utilization.

If $\Sigma DFACT > MERCHFACT$, segment is *CULL*

Converting Segment Defect To Defect Factors

Various defects require different conversion methods to convert to a defect factor (*DFACT*), a length cut on a 16-foot segment basis. The length of the segment (*SEGLEN*) is used in many conversions. Each method is discussed in the following sections.

Length and Percent Cuts

Length Cut Conversion

A scaler takes a length cut (*LEN*) on a segment and wishes to convert it to a defect factor (*DFACT*).

$$DFACT = \frac{16}{SEGLEN} \text{ x } LEN$$

Example: A scaler deducts an 8-foot length cut from a 14-foot segment; the defect factor is given below:

$$DFACT = \frac{16}{14} \text{ x } 8 = 9.14$$

DFACT of 9.14 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Percent Cut Conversion

A scaler takes a percent cut (*PCT*) on a segment and wishes to convert it to a defect factor (*DFACT*).

$$DFACT = PCT \text{ x } 16$$

Cull Factor Algorithms for Cubic Scaling

Example: A scaler deducts 80 percent from a 12-foot segment; the defect factor is give below:

$DFACT$ = .80 x 16 = 12.80

$DFACT$ of 12.80 > $MERCHFACT_{25}$ of 12.00, the segment is a cull.

Combination Length and Percent Conversion (Pie Cut)

A scaler takes a length cut (*LEN*) with a percent cut (*PCT*) on a segment and wishes to convert it to a defect factor (*DFACT*).

$$DFACT = \frac{16}{SEGLEN} \text{ x } LEN \text{ x } PCT$$

Example: A scaler deducts 50 percent of 4-foot length cut to a 14-foot segment; the defect factor is given below:

$$DFACT = \frac{16}{14} \text{ x } 4 \text{ x } .50 = 2.29$$

$DFACT$ of 2.29 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Perimeter Reduction

Perimeter Reduction Conversion

A scaler takes a perimeter reduction (*DED*) on a segment and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) to calculate the perimeter defect factor (*PDF*), described under the Perimeter Defect Section.

$DFACT = PDF$

Example: A scaler makes a 4-inch diameter reduction on a 12-foot segment with a small end diameter of 18 inches; the defect factor is given below:

$DFACT = PDF$ = 7.62

$DFACT$ of 7.62 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Cull Factor Algorithms for Cubic Scaling

Perimeter Reduction with Percent Attribute Conversion

A scaler takes a perimeter reduction (*DED*) with a percent of diameter circumference (*DPCT*) on a segment and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) to calculate the perimeter defect factor (*PDF*) as described under the Perimeter Defect Section, then multiplies the result by the percent.

$$DFACT = PDF \text{ x } DPCT$$

Example: A scaler makes a 6-inch diameter reduction on a 14-foot segment with a small end diameter of 20 inches affecting 66 percent of the segment circumference; the defect factor is given below:

$$DFACT = 9.71 \text{ x } 0.66 = 6.41$$

$DFACT$ of 6.41 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Perimeter Reduction with Length Attribute Conversion

A scaler takes a perimeter reduction (*DED*) with a length of less than the segment length (*DLEN*) on a segment and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) to calculate the perimeter defect factor (*PDF*) as described under the Perimeter Defect Section, then adjust the result by the proportion of defect length divided by the segment length.

$$DFACT = PDF \text{ x } \frac{DLEN}{SEGLEN}$$

Example: After making a 6-foot length cut, a scaler makes a 2 inch diameter reduction on 12 feet of an 18-foot segment with a small end diameter of 22 inches; the defect factor for the perimeter reduction is calculated below:

$$DFACT_{DED} = 2.42 \text{ x } \frac{12}{18} = 1.61$$

Cull Factor Algorithms for Cubic Scaling

The defect factor for the 6 feet length cut is calculated below:

$$DFACT_{LEN} = 6 \text{ x } \frac{16}{18} = 5.33$$

$\Sigma DFACT = 1.61 + 5.33 = 6.94$

$\Sigma DFACT$ of 6.94< $MERCHFACT_{25}$ of 12.00, the segment is good.

Perimeter Reduction with Length and Percent Attributes Conversion

A scaler takes a perimeter reduction (*DED*) with a length of less than the segment length (*DLEN*) and a percent of diameter circumference (*DPCT*) on a segment and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) to calculate the perimeter defect factor (*PDF*) as described under the Perimeter Defect Section, then adjust the result by the proportion of defect length divided by the segment length multiplied times the percent.

$$DFACT = PDF \text{ x } \frac{DLEN}{SEGLEN} \text{ x } DPCT$$

Example: A scaler makes a 7 inch diameter reduction on 75 percent of 8 feet of a 14-foot segment with a small end diameter of 23 inches; the defect factor for the perimeter reduction is calculated below:

$$DFACT = 9.26 \text{ x } \frac{8}{14} \text{ x } .75 = 3.97$$

$DFACT$ of 3.97 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Appendix 13 -- (Continued)

Cull Factor Algorithms for Cubic Scaling

Interior Deduction

Defect Showing on Both Ends

Interior Defect Conversion

A scaler makes an interior defect deduction on a segment and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) and the average defect dimensions to calculate the interior defect factor (*IDF*) as described under the Interior Defect Section.

$$DFACT = IDF$$

Example: On a segment where both ends show squared area defects, a scaler makes a 4-inch by 6-inch deduction on one end and a 6 inch by 9 inch deduction on the other end of a 12-foot segment with a small end diameter of 18 inches. Calculate the average defect dimensions using the rules for squared defects:

$$Width = \frac{(4+6)}{2} = 5$$

$$Height = \frac{(6+9)}{2} = 7.5 \text{ (round to even number)} = 8''$$

RA = 5 inch x 8 inch = 40 square inches

Using the procedure in the Rectangular Area section, *SQUARESIDE* = 6 inches. Then using the procedure described in the Interior Defect Factor section:

$DFACT = 3.81$

DFACT of 3.81 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Cull Factor Algorithms for Cubic Scaling

Interior Defect with Percent Attribute Conversion

A scaler makes an interior defect deduction with a percent of squared area with a defect (*SPCT*) on a segment and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) and the average defect dimensions to calculate the interior defect factor (*IDF*) as described under the Interior Defect Section.

$$DFACT = IDF \times SPCT$$

Example: On a segment where both ends show squared area defects, a scaler makes a 10 inch by 7-inch deduction on one end and a 10 inch by 10 inch deduction on the other end of a 20-foot segment with a small end diameter of 22 inches. Calculate the average defect dimensions using the rules for squared defects:

$$Width = \frac{(10+10)}{2} = 10$$

$$Height = \frac{(7+10)}{2} = 8.5 \text{ (round to even number)} = 8''$$

RA = 10 inch x 8 inches = 80 square inches

Using the procedure in the Rectangular Area section, *SQUARESIDE* = 9 inches. Then using the procedure described in the Interior Defect Factor section:

$DFACT = 5.33$

$DFACT$ of 5.33 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Defect Showing on One End

Interior Defect Conversion

A scaler makes an interior defect deduction on a segment with one end showing and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) and the defect dimensions to calculate the interior defect factor (*IDF*) as described under the Interior Defect Section. Adjust the result by the proportion of defect length divided by the segment length.

Cull Factor Algorithms for Cubic Scaling

$$DFACT = IDF \text{ x } \frac{DLEN}{SEGLEN}$$

Example: On a segment where one end shows a squared area defect, a scaler makes a 10 inch by 15 inch deduction for 150 square inches for 8 feet of a 14-foot segment with a small end diameter of 18 inches. Using the procedure in the Rectangular Area section, SQUARESIDE = 12 inches. Using the procedure described in the Interior Defect Factor section, the defect factor for a 16-foot segment is 13.71. The adjusted defect factor is calculated below:

$$DFACT = 13.71 \text{ x } \frac{8}{14} = 7.83$$

DFACT of 7.83 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Interior Defect with Percent Attribute Conversion

A scaler makes an interior defect deduction with a percent of squared area (*SPCT*) on a segment with one end showing and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) and the defect dimensions to calculate the interior defect factor (*IDF*) as described under the Interior Defect Section. Adjust the result by the proportion of defect length divided by the segment length multiplied by the percent affected.

$$DFACT = IDF \text{ x } \frac{DLEN}{SEGLEN} \text{ x } SPCT$$

Example: On a segment where one end shows a squared area defect, a scaler makes a 19-inch by 20-inch deduction for 380 square inches where 75 percent of the area is affected for 10 feet of a 20-foot segment with a small end diameter of 32 inches. Using the procedure in the Rectangular Area section, SQUARESIDE = 19 inches. Using the procedure described in the Interior Defect Factor section, the defect factor for a 16 -foot segment is 9.30. The adjusted defect factor is calculated below:

$$DFACT = 9.30 \text{ x } \frac{10}{20} \text{ x } 0.75 = 3.49$$

DFACT of 3.49 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Cull Factor Algorithms for Cubic Scaling

Ring Deduction

Perimeter rings, rings within 2.5 inches of outside perimeter of the segment, are treated as perimeter reductions. Use a squared area deduction for rings of less than 26 percent of the circumference of the segment.

Defect Showing on Both Ends

Ring Defect Conversion

A scaler makes a ring defect deduction on a segment and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) and the average ring dimensions to calculate the interior defect factor (*IDF*) as described under the Interior Defect Section. The interior defect factor is adjusted by the shake and pitch ring correction factor (*SPRC*) determined by the small end core diameter (*SECD*) and taper (*TAPER*).

$$DFACT = IDF \times SPRC$$

Example: On a segment where both ends show ring defects, a scaler measures the small end ring diameter as 11 inches and the large end ring diameter as 15 inches. The small end diameter of the 14-foot segment is 20 inches.

$$Average\ ring\ diameter = \frac{(11+15)}{2} = 13\ inches$$

Using the procedure in the Rectangular Area section, *SQUARESIDE* = 13 inches. Then using the procedure described in the Interior Defect Factor, *IDF* = 12.00. The shake and pitch ring correction factor for the 11 inch core with 4 inches of taper is 0.67.

$$DFACT = 12.00 \times 0.67 = 8.04$$

DFACT of 8.04 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Cull Factor Algorithms for Cubic Scaling

Ring Defect with Percent Attribute Conversion

A scaler makes a ring defect deduction with a percent of ring affected (*RPCT*) on a segment and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) and the average ring dimensions to calculate the interior defect factor (*IDF*) as described under the Interior Defect Section. The interior defect factor is adjusted by the shake and pitch ring correction factor (*SPRC*) determined by the small end core diameter (*SECD*) and taper (*TAPER*). Then it is adjusted by the percent of ring affected.

$$DFACT = IDF \times SPRC \times RPCT$$

<u>Example</u>: On a segment where both ends show ring defects, a scaler measures the small end ring diameter as 17 inches and the large end ring diameter as 23 inches. The ring extends around 50 percent of the segment circumference. The small end diameter of the 20-foot segment is 32 inches.

$$Average\ ring\ diameter = \frac{(17+23)}{2} = 20\ inches$$

Using the procedure in the Rectangular Area section, *SQUARESIDE* = 20 inches. Then using the procedure described in the Interior Defect Factor, *IDF* = 10.16. The shake and pitch ring correction factor for the 17 inch core with 6 inches of taper is 0.62.

$$DFACT = 10.16 \times 0.62 \times 0.50 = 3.15$$

DFACT of 3.15 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Defect Showing on One End

Ring Defect Conversion

A scaler makes a ring defect deduction on a segment with one end of the ring showing and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) and the ring dimensions to calculate the interior defect factor (*IDF*) as described under the Interior Defect Section. The interior defect factor is adjusted by the shake and pitch ring correction factor (*SPRC*) determined by the small end core diameter (*SECD*). Adjust the result by the proportion of defect length divided by the segment length.

$$DFACT = IDF \times SPRC \times \frac{DLEN}{SEGLEN}$$

Cull Factor Algorithms for Cubic Scaling

Example: On a segment where one end shows a ring defect, a scaler measures an outer ring diameter as 15 inches and an inner ring diameter of 11 inches. Rings are closer than 2.5 inches apart. The ring defect is estimated to extend 8 feet. The small end diameter of the 16-foot segment is 21 inches.

Using the procedure in the Rectangular Area section, SQUARESIDE = 15 inches. Then using the procedure described in the Interior Defect Factor, *IDF* = 14.40. The shake and pitch ring correction factor for the 11 inch core with 4 inches of taper is 0.67.

$$DFACT = 14.40 \text{ x } 0.67 \text{ x } \frac{8}{16} = 4.82$$

$DFACT$ of 4.82 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Ring Defect with Percent Attribute Conversion

A scaler makes a ring defect deduction with a percent of ring affected (*RPCT*) on a segment with one end of the ring showing and wishes to convert it to a defect factor (*DFACT*). The program uses the segment small end diameter (*SED*) and the ring dimensions to calculate the interior defect factor (*IDF*) as described under the Interior Defect Section. The interior defect factor is adjusted by the shake and pitch ring correction factor (*SPRC*) determined by the small end core diameter (*SECD*) and taper (*TAPER*). Adjust the result by the proportion of defect length divided by the segment length and by the percent of ring affected.

$$DFACT = IDF \text{ x } SPRC \text{ x } RPCT \text{ x } \frac{DLEN}{SEGLEN}$$

Example: On a segment where one end shows a ring defect, a scaler measures an outer ring diameter as 21 inches and an inner ring diameter of 14 inches. The outer ring extends around 40 percent of the circumference and the inner ring, 75 percent. Ring defect is estimated to extend 14 feet. The small end diameter of the 20-foot segment is 28 inches.

Cull Factor Algorithms for Cubic Scaling

Using the procedure in the Rectangular Area section, outer ring *SQUARESIDE* = 21 inches, inner ring *SQUARESIDE* = 14 inches. Then using the procedure described in the Interior Defect Factor, outer ring *IDF* = 14.34 and inner ring *IDF* = 6.62. The shake and pitch ring correction factor for the outer 21 inch core with 0 inches of taper is 0.42 and the inner 14 inch core with 0 inches of taper is 0.54.

$$DFACT_{\text{(outer)}} = 14.34 \text{ x } 0.42 \text{ x } 0.40 \text{ x } \frac{14}{20} = 1.69$$

$$DFACT_{\text{(inner)}} = 6.62 \text{ x } 0.54 \text{ x } 0.75 \text{ x } \frac{14}{20} = 1.88$$

$$\Sigma DFACT = \text{DFACT}_{\text{(outer)}} + \text{DFACT}_{\text{(inner)}} = 1.69 + 1.88 = 3.57$$

DFACT of 3.57 < $MERCHFACT_{25}$ of 12.00, the segment is good.

Appendix 14 -- Length Cut Algorithms for Cubic Scaling

This Appendix sets out the text of a guide on the use of length cut algorithms for cubic scaling.

Table of Contents

List of Variables

VARIABLE	MEANING
GROSS16	Gross Scribner volume of a 16-foot log of a given small end diameter
DVOL	Defect volume (Scribner)
W	Scribner Decimal C defect width (defect width plus one inch)
H	Scribner Decimal C defect height (defect height plus one inch)
L	For cubic, Scribner Decimal C length is fixed at 16 feet
SQUARESIDE	Integer length of one side of a square with equivalent area to a rectangular defect.

Length Cut Algorithms

Introduction

Software developers find using the cubic scaling length cut lookup table in Appendix 4 of this Handbook inefficient for software programming. This Handbook does not describe the mathematics behind the table that is used to determine whether to take a length cut or interior defect. The following equations may be used to make software more efficient. The length cut table in Appendix 4 is based on determining the equivalent length cut for interior, perimeter, and ring defect.

Scribner Volume Equations

Use Scribner volume factors (Northwest Log Scaling Rules, revised 7/1/72) or volumes from Table 1 in Appendix 13, “Cull Factor Algorithms for Cubic Scaling” to determine 16-foot log volumes to calculate cubic defect factors.

Length Cut Algorithms for Cubic Scaling

1. If programming stand-alone cubic software, create a lookup table that keys off the diameter column and returns the Scribner decimal C volume.

2. If programming combined cubic and Scribner software, create a lookup table that keys off the diameter column and returns the Scribner volume factors. Multiply the 16-foot log length by the volume factor for the appropriate diameter, round to the nearest ten board feet, and drop the last digit, a zero, to obtain the Scribner decimal C volume. Warning: Log factors for 1-foot to 15-foot logs (and 32-foot to 40-foot logs for Scribner 40-foot rule) use different volume factors.

Length Cut Table (Appendix 4)

The following algorithm will provide the same values found in the length cut table in Appendix 4. Use this algorithm to determine when to use the length cut method rather than the squared area method for an interior defect.

The Forest Service and industry members of the Cubic Committee who developed the cubic rule used the length cut table to emulate the Scribner method to determine when to use a length cut rather than a squared area deduction. They used the standard 16-foot log length and the Scribner Squared-Defect Method to build the table. Although the table does not contribute to the cubic cull determination, the committee needed to develop it because a length cut can be left on the sale area while a squared area deduction must be removed. In order to emulate the Scribner length cut cull deduction, a Scribner comparison is used.

To use the table in a computer application, it is necessary to compare the Scribner volume for a 16 foot log with the Scribner Squared-Defect deduction for 16 feet of defect. The results are compared and if the Scribner Decimal C 16-foot defect deduction is greater than or equal to the Scribner Decimal C volume of the 16-foot log, use a length cut. Otherwise, use the squared area deduction.

This is a three-step process, as follows:

Step One:

Determine the gross volume ***(GROSS16***) of a 16-foot log of the given small end diameter.

Example: ***GROSS16*** for a log of 10 inches small diameter = 6 Scribner Decimal C.

Length Cut Algorithms for Cubic Scaling

Step Two:

Determine the Scribner Squared-Defect deduction for 16 feet of defect. To determine this deduction, use the following Scribner Decimal C equation:

$$DVOL = \frac{W \text{ x } H \text{ x } L}{150}$$

In cubic measurements, the formula becomes:

$$DVOL = \frac{16(SQUARESIDE + 1)^2}{150}$$

For rectangular defects, use the rectangular area table in Appendix 9 of the Handbook to convert rectangular shaped interior defect to a square dimension.

Example: If ***SQUARESIDE*** = 7 inches

$$DVOL = \frac{16(7 + 1)^2}{150} = 7$$

Step Three:

Determine which deduction method to use. If ***DVOL*** is greater than or equal to ***GROSS16***, make a length cut for the portion of the segment affected. If the Scribner defect is less than the Scribner gross volume, proceed to calculate the cubic volume of defect using the squared area method as described in section 22.31 of this Handbook.

Example: ***GROSS16*** = 6
DVOL = 7
DVOL > ***GROSS16***
Therefore use Length Cut Method

Length Cut Algorithms for Cubic Scaling

Computer Applications

For computer applications, use the guide to cull factor algorithms for cubic scaling set out in Appendix 13 of this Handbook to calculate the following variables (defined in Appendix 13), for determining when to take a length cut instead of a squared area.

GROSS16	Gross Scribner volume of a 16-foot log of a given small end diameter
SQUARESIDE	Integer length of one side of a square with equivalent area to a rectangular defect
DVOL	Defect volume (Scribner)

Make a length cut if DVOL => GROSS16