WEST COAST LUMBER INSPECTION BUREAU

STANDARD FOR

MACHINE STRESS RATED LUMBER

Portland, Oregon

April, 1992

MACHINE STRESS RATED LUMBER
All Species
2" and Less in Thickness
2" and Wider

PART A.

1 Product Specification, MSR Lumber

1.1 Introduction, Paragraph 206-a

Machine stress rated (MSR) lumber is lumber that has been evaluated by mechanical stress rating equipment. MSR lumber is distinguished from visually stress graded lumber in that each piece is nondestructively tested and marked to indicate the modulus of elasticity (E or MOE). MSR lumber is also required to meet certain visual requirements as set forth herein.

A grade stamp on Machine Stress Rated lumber indicates the stress rating system used meets requirements of the grading agency's certification and required quality control procedures. The grade stamp will show the agency trademark, the mill name or number, will include the phrase "MSR", the species identification and the "E" rating for the grade. The "E" rating is the rated average bending modulus of elasticity in millions of pounds per square inch for the grade when measured on edge (eg. as a joist). Additionally, the grade stamp will include the fiber stress in bending value (Fb), and when required the allowable design tensile stress parallel to grain (Ft). The stamp will also include the Fv, $Fc_{\perp}$, and long span E rating when the value is specifically qualified.

The "E" "Fb" grade combinations which can be qualified are not restricted to those combinations shown in Table 13. If the assigned allowable Ft is different for the MSR grade than that shown in Table 13 for the same Fb level, then the assigned Ft value shall be included on the grade stamp. The remaining three assigned allowable properties (Fc//, $Fc_{\perp}$, Fv) for a grade shall be those listed in Table 13 for the equivalent Fb level. Higher values for Fv and $Fc_{\perp}$ may be assigned as described below.

For some uses it may be desirable to qualify and quality control a bending modulus of elasticity representative of different test conditions (e.g long span MOE per paragraph 154-d.) in addition to the standard edge bending MOE qualification for MSR. When the MSR grade is qualified and quality controlled for this specific MOE, the qualifying MOE value for the grade may be included as an additional mechanical property value for the grade. When so qualified, the MOE value must be included on the grade stamp.

When the Specific Gravity of the grade (based on oven dry weight and volume at 12% MC) exceeds the value for the species average and is controlled as part of the daily quality control program, the allowable stresses for compression perpendicular to grain and horizontal shear may be calculated using the equations listed below. When qualified, these properties must be included on the grade stamp.

1.2 Visual Grading Requirements, Paragraph 206-b

Mechanically Stress Rated lumber must be well manufactured and visually graded to limit certain characteristics even though the actual strength is not affected. All pieces shall be visually graded to assure that the characteristics affecting strength are no more serious than the following limiting characteristics:

Checks —— Seasoning checks not limited. Through checks at ends limited as splits.

Shake —— If through at ends limited as splits. Away from ends through heart shakes up to 2' long, well separated. If not through, single shakes may be 3' or up to 1/4 the length whichever is greater.

Skips —— Hit and miss, and in addition 5% of the pieces may be hit or miss or heavy skip not longer than 2'. See Para. 720(e), (f) and (g).

Splits —— Equal in length to 1-1/2 times the width of the piece.

Wane —— 1/3 thickness and 1/3 width full length, or equivalent on each face, provided that wane not exceed 2/3 thickness or 1/2 the width for up to 1/4 the length (see paragraph 750).

Warp —— Light. See table, Para. 752.

Manufacture —— Standard F.

In addition to the visual limitations listed, knots, knot holes, burls, distorted grain or decay partially or wholly at edges of wide faces, must not occupy more of the net cross-section than:

Fb Class

1/2 for 0 to 900	1/4 for 1500 to 2050
1/3 for 950 to 1450	1/6 for 2100 and over

Characteristics which occur in any end portion of the pieces which are not evaluated by the stress grading equipment shall be limited as follows:

Edge Knots —— limited as listed above.

Non-Edge Knots —— equal to the largest non-edge knot in the tested portion of the piece or the next larger edge knot, whichever is greater.

Cross-Section Knots —— displacement of all knots in the same cross section must not exceed the size of the permitted non- edge knot.

Slope of grain —— the general slope of grain in the untested end portion shall not exceed:

Slope	Fb Class
1 in 12	2100 and over
1 in 10	1500 to 2050
1 in 8	0 to 1450

1.3 Property Values

TABLE 13. Machine Rated Lumber:
2" or less in thickness —— all widths
Design Values, PSI, Normal Loading
Grade Description Para. 206

Modulus of Elasticity E	Extreme fiber in bending Fb *	Tension parallel to grain Ft	Compression parallel to grain Fc//
1,000,000	900	350	1,050
1,200,000	1,200	600	1,400
1,300,000	1,350	750	1,600
1,300,000	1,450	800	1,625
1,400,000	1,500	900	1,650
1,500,000	1,650	1,020	1,700
1,600,000	1,800	1,175	1,750
1,700,000	1,950	1,375	1,800
1,800,000	2,100	1,575	1,875
1,900,000	2,250	1,750	1,925
2,000,000	2,400	1,925	1,975
2,100,000	2,550	2,050	2,025
2,200,000	2,700	2,150	2,100
2,300,000	2,850	2,300	2,150

Note: Design Values for grades intermediate between grades shown in the table may be interpolated. Values interpolated shall be rounded to the nearest increment as indicated below:

Modulus of Elasticity (E)	100,000 psi
Fiber Stress in Bending (Fb)	50 psi at 1000 psi and above 25 psi at 1000 psi and below
Tensile Stress Parallel to Grain (Ft)	25 psi
Compression Parallel to Grain (Fc//)	25 psi

Horizontal Shear (Fv) for all stress levels	Douglas fir	=	95 PSI
	Hem-fir	=	75 PSI
	S-P-F S	=	70 PSI
	Western Cedars	=	75 PSI
	Western Woods	=	70 PSI

When a grade is qualified by test and quality controlled for specific gravity, the allowable horizontal shear value may be calculated from the following formula:

$$Fv = 17.1 + (150.95 * \text{Sp. Gr.})$$

Note: Assigned values shall be rounded to the nearest 5 psi.
Values calculated from the equation above for MC 15 material may be multiplied by 1.05

Compression Perpendicular to Grain ($Fc_{\perp}$)	Douglas fir	=	625 PSI
	Hem-fir	=	405 PSI
	S-P-F, S	=	335 PSI
	Western Cedars	=	425 PSI
	Western Woods	=	335 PSI

When a grade is qualified by test and quality controlled for specific gravity, the allowable compression perpendicular to grain value may be calculated from the following formula:

$$Fc_{\perp} = (2498.9 * \text{Sp. Gr.}) - 537.7$$

Note: Assigned values shall be rounded to the nearest 5 psi.

Values calculated from the equation above for MC 15 material may be multiplied by 1.16.

Compression perpendicular to grain values determined from the equation above are based on a 0.04 inch deformation limit and are for standard design of most structures. Values at .02 inch deformation can be obtained with the following equations:

$$Fc_{\perp}(.02) = (0.71 * Fc_{\perp.04}) - 14.1$$

$$Fc_{\perp}(.02) = (1781.2 * \text{Sp. Gr.}) - 368.6$$

1.4 Physical Requirements

It is the goal of the qualification and quality control requirements shown in Parts B and C of this Standard that machine stress rated lumber meets certain physical requirements for modulus of elasticity, extreme fiber stress in bending, ultimate tensile stress parallel to grain, and when required specific gravity as shown in the following paragraphs: 1.4.1 The average edge bending modulus of elasticity of MSR lumber must equal or exceed the modulus of elasticity assigned to the grade:

$$\bar{E} \geq Eg$$

1.4.2 The 5th percentile non-parametric point estimate of edge bending modulus of elasticity of MSR lumber must equal or exceed 81.9% of the modulus of elasticity assigned to the grade:

$$E_{5th} \geq 0.819\ Eg$$

This ensures that for design purposes the population can be considered normal (Gaussian) with a coefficient of variation (COV) for modulus of elasticity not exceeding 0.11 as specified in the National Design Specification for Wood Construction.

1.4.3 The 5th percentile point estimate of the modulus of rupture of the population of a grade of machine stress rated lumber when subjected to a short-term load shall equal or exceed the product of 2.1 and the assigned fiber stress in bending for the grade:

$$MOR_{5th} \geq 2.1\ Fb$$

1.4.4 The 5th percentile point estimate of the ultimate tensile strength (UTS) of the population of a grade of machine stress rated lumber when subjected to a short-term load shall equal or exceed the product of 2.1 and the assigned tension stress for the grade:

$$UTS_{5th} \geq 2.1\ Ft$$

1.4.5 The mean specific gravity of the population of a grade of machine stress rated lumber shall be maintained at the level qualified when the compression perpendicular ($Fc_{\perp}$) to grain or shear parallel to grain (Fv) are determined from the equations under section 1.3.

2.0 Product Specification, E-Rated Structural Laminations

2.1 Visual Grading Requirements, Paragraph 154-d.

154-d. Conforms to all provisions for Paragraph 154 except for Knot Spacing. Knots, knot holes, burls, and distorted grain occurring at the edges of the wide faces shall be measured and limited in conformance with the Visual Grading Requirements of Paragraph 206-b, Mechanically Stress Rated Lumber. The ends of lumber not tested by the stress grading equipment shall be limited as follows:

Edge Knots - as limited above.

Non-Edge Knots - equal to the largest non-edge knots in the tested portion of the piece or the next larger edge knot, whichever is greater.

Cross-Section Knots - displacement of all knots in the same cross section must not exceed the size of the permitted non- edge knot.

Slope of Grain - the general slope of grain in the untested end portion shall not exceed:

Slope	Knot Category
1 in 12	1/4 and smaller
1 in 10	1/3 and larger

All E-rated Structural Laminations shall be identified with a West Coast grade stamp containing mill identification, species, seasoning, and the E grade designation followed by the word LAM. The E designation shall be the average long span E of the grade as determined by quality control. The grade stamp may also contain the applicable Machine Stress Rated grade in accordance with provisions of Paragraph 206.

2.2 Physical Requirements

2.2.1 The average long span modulus of elasticity of E-LAM rated MSR lumber must equal or exceed the modulus of elasticity assigned to the grade:

$$\bar{E} \geq Eg$$

2.2.2 The 5th percentile non-parametric tolerance limit of long span modulus of elasticity of E-LAM rated MSR lumber must equal or exceed 81.9% of the modulus of elasticity assigned to the grade:

$$E_{5th} \geq 0.819\ Eg$$

This ensures that for design purposes the population can be considered normal (Gaussian) with a coefficient of variation (COV) for modulus of elasticity not exceeding 0.11 as specified in the National Design Specification for Wood Construction.

3.0 Product Specification, MSR Tension Laminations

3.1 Grading Requirements

3.1.1 MSR tension laminations shall comply with the visual requirements for E-Lam, paragraph 154-d, and MSR paragraph 206-b. This material is intended to meet the requirements of AITC 117-88- Manufacturing, Annex C14.

3.1.2 The grade stamp shall include both the MSR grade designation and general information as described in paragraph 206 and the E- Lam grade designation as described in paragraph 154-d.

3.2 Physical Requirements

It is the goal of the qualification and quality control requirements shown in Parts B and C of this Standard that Machine Stress Rated Tension Laminations meet certain physical requirements for modulus of elasticity, extreme fiber stress in bending as stated in section 1.4 and 2.2 of Part A. In addition, it is the goal of the qualification and quality control that the following provision is met:

3.2.1 The fifth percentile tolerance limit of the ultimate tensile strength (UTS) of the population of a grade of machine stress rated tension lamination lumber when subjected to a short-term load shall equal or exceed the product of 2.1 and the assigned tension stress for the grade:

$$UTS_{5th\text{-}TL} \geq 2.1\ Ft$$

PART B

QUALIFICATION PROCEDURES

FOR MACHINE STRESS RATING OF LUMBER

1.0 Scope

This standard sets forth procedures under which lumber manufacturers may become qualified to grade stamp machine stress rated (MSR) and E-LAM lumber as described in Standard Grading Rules No. 17. and MSR tension laminations as described in AITC 117-88-MANUFACTURING, ANNEX C14.

It provides minimum standard methods by which inspection agencies approved by the American Lumber Standards Committee (ALSC) shall qualify lumber manufacturers. It also provides for minimum standards for plant quality control. These requirements are supplementary to the provisions of PS 20-70 and enforcement regulations of the ALSC.

The requirements stated in this standard are the minimum for qualification and quality control. Where data is lacking for specific sizes, species, grades or end uses, rules- writing agencies may specify additional methods and/or procedures.

2.0 Definitions

2.1 Agency: rules writing or inspection agency, association or bureau certified by the ALSC.

2.2 Agency Supervisor: an employee of the agency.

2.3 Machine: equipment used for machine stress rating.

2.4 Machine Stress Rated Lumber: lumber that has been rated for stiffness through a nondestructive test by an approved machine and has been visually graded to machine stress rating rule requirements.

2.5 Plant: the lumber manufacturer's facility where machine stress rating takes place.

2.6 Plant Quality Control Procedure: a specific set of instructions that incorporates the quality control functions required for machine stress rating at a plant.

2.7 Machine grade: a machine stress rated "f-E" classification as specified in a rules-writing agency's grading rules. The "f-E" classification represents the assigned design value for extreme fiber stress in bending "Fb" and the assigned average edge modulus of elasticity "E" as defined in Part A.

2.8 Grade E: the assigned average edge modulus of elasticity of an "f-E" machine grade classification.

2.9 Edge E: the modulus of elasticity of an individual piece determined by loading, at a maximum rate of 16,000 psi per minute, a randomly selected edge of a piece at the one-third points for a span to depth ratio of 21, where possible, and the piece centered in the test span.

2.10 Long Span (LS) E: The LS modulus of elasticity of an individual member is determined from the deflection measured in a flat-wise test of lumber with centerpoint loading and a span-depth ratio (l/d) of approximately 100.

2.11 Pelster E: The shortspan (Pelster) modulus of elasticity on a section of an individual piece is determined from the flat-wise test of lumber with one-third point loading over a 48 inch span.

2.12 Fb: the extreme fiber stress in bending (psi) assigned to the machine grade.

2.13 Ft: the tension stress parallel to the grain (psi) assigned to the machine grade.

2.14 MOR: the modulus of rupture in bending of an individual piece determined by loading, at a maximum rate of 16,000 psi per minute on a randomly selected edge of a piece at the one- third points, with a span to depth ratio of 21 (where possible) and with the maximum edge defect included Within or as close to the middle 1/3 of the span as possible.

2.15 UTS: The ultimate tensile strength of an individual piece determined by loading, at a maximum rate of 4000 psi per minute on a piece with a test span of eight feet or longer (when possible) and with the maximum edge defect located within the test span and a minimum of one foot from the grips (when possible).

2.16 Maximum edge defect: a strength reducing characteristic that is judged to be the most weakening defect along the edge of a piece, without regard to test orientation. If two or more characteristics are determined to be of equal severity, choose the one on the tension edge closest to the center of the piece.

2.17 Machine calibration check: the process followed by plant quality control personnel to assure that the machine is accurately adjusted.

3.0 Qualification

3.1 General

3.1.1 Upon request for qualification, the agency will determine whether the plant has acceptable and reliable grading machinery, and also testing equipment capable of performing required quality control tests.

3.2 Test Methods

The test methods described in this section follow one or more of the following ASTM Standards D4761, D198, D2395, D4444. Long Span MOE determination complies with AITC Test 116.

3.2.1 Modulus of Elasticity (MOE)

3.2.1.1 The edge modulus of elasticity (edge E) shall be determined as follows:

Selection of loaded edge -- random
Loading location -- 1/3 points
Span/depth ratio -- 21 where possible (minimum 17)
Lengthwise orientation -- center piece in the test span or locate the maximum edge defect within or as close to the middle 1/3 of the test span as possible.
Rate of loading -- 16,000 psi per minute maximum

3.2.1.2 The flat-wise long span modulus of elasticity (LS E) shall be determined as follows:

Selection of loaded edge -- random
Loading location -- center point
Span/depth ratio -- 100 where possible (minimum 80)
Lengthwise orientation -- center piece in test span
Pre-Load -- 5 pounds
Increment load should be sufficient to produce approximately 0.2 inch deflection in a piece with an MOE of 2.0 million psi. The following loads are recommended:

Size	Load (lbs.)
2X4	10
2X6	10
2X8	15
2X10	15
2X12	20

3.2.1.3 The flat-wise short span modulus of elasticity (Pelster E) shall be determined as follows:

Selection of loaded wide face -- random
Loading location -- 1/3 points
Span -- 48 inches
Lengthwise orientation -- center characteristic in test span
Pre-Load -- 25 pounds
Increment load in pounds shall be the following (by width):

Size	Load (lbs.)
2X3	75
2X4	100
2X6	150
2X8	200
2X10	250
2X12	300

3.2.2 The modulus of rupture (MOR) in bending of an individual piece shall be determined as follows:

Selection of loaded edge -- random
Loading location -- 1/3 points
Span/depth ratio -- 21 where possible (minimum 17)
Rate of loading -- 16,000 psi per minute
Lengthwise orientation -- locate the maximum edge defect within or as close to the middle 1/3 of the span as possible.

The maximum edge defect is the strength reducing characteristic that is judged to be the most weakening defect along the edge of a piece without regard to test orientation (compression vs. tension). If two or more characteristics are determined to be of equal severity, choose the one on the tension side closest to center span.

3.2.3 The ultimate tensile strength shall be determined as follows:

Test Span -- 8 feet or longer when possible
Rate of loading -- 3500 psi/min. $^{+}$ 500 psi/min.
Defect location -- the maximum edge defect shall be located within the test span, and when possible, a minimum of one foot from the grips.

The maximum edge defect is the strength reducing characteristic that is judged to be the most weakening defect along the edge of a piece. If two or more characteristics are determined to be of equal severity, choose the one closest to mid-length of the piece.

3.2.4 The specific gravity shall be measured following the procedures of ASTM D2395, Method A. The specific gravity for each specimen shall be determined at the moisture content at the time of test. Since the specific gravity basis is oven dry weight/ volume at 12% moisture content, if the range of moisture content in the sample is greater than ± 3 percentage points of 12%, the specific gravity of each specimen shall be adjusted to the oven dry weight/volume at 12% MC basis using the appropriate adjustment equation from ASTM D2395 Appendix X1. Specific gravity shall be determined to the following specifications:

Specimen dimensions shall be measured to the nearest .01 inches in thickness and width, and to the nearest 1/4 inch in length. Specimen weight shall be measured as either the full specimen weight or 1/2 weight using a calibrated weighing device measuring to the nearest 1/2 ounce for weights up to 30 pounds and the nearest 1 ounce for all others. Moisture content shall be determined using a calibrated surface or pin type moisture meter adjusted for the species.

3.3 Sampling

3.3.1 After determining that the machine has been calibrated and set for the size, species and machine grade to be qualified, the agency will select at least 106 pieces (53 for testing in bending and 53 for testing in tension) at random from machine output of the grade, size

and species to be qualified. The selected pieces shall meet all visual requirements of the machine grade being qualified. The edge E shall be determined for at least 53 pieces which also shall be loaded in bending as specified in Section 3.2.2 to a stress of 2.1 times the assigned Fb value for the machine grade being qualified. For pieces which fail, the MOR shall be recorded. The remaining pieces, at least 53, shall be tested in tension as specified in Section 3.2 to a stress of 2.1 times the assigned Ft value for the machine grade being qualified. For pieces that fail, the UTS shall be recorded. When specific gravity is to be qualified, the specific gravity shall be determined for each specimen in the bending sample or the combined bending and tension samples.

3.3.2 Alternate Procedure

Select two 106-piece samples for testing (53 in bending and 53 in tension). One of the two samples in each test mode must meet the requirements as given above to qualify the grade. If neither sample passes, the grade does not qualify. Both samples should be collected prior to testing with specimens picked in a random manner.

3.4 Qualification Tests

3.4.1 The edge E shall be determined for at least 53 pieces which also shall be loaded in bending as specified in Section 3.2.2 to a stress of 2.1 times the assigned Fb value for the machine grade being qualified. For pieces which fail, the MOR shall be recorded. When specimens are to be proof loaded, the proof load shall be set at a level which will permit estimation of the fifth percentile for use in section 5 calculations.

3.4.2 The remaining pieces, at least 53, shall be tested in tension as specified in Section 3.2.3 to a stress of 2.1 times the assigned Ft value for the machine grade being qualified. For pieces that fail, the UTS shall be recorded. When specimens are to be proof loaded, the proof load shall be set at a level which will permit estimation of the fifth percentile for use in section 5 calculations.

3.4.3 When specific gravity is to be qualified, the specific gravity shall be determined for each specimen in the bending sample or the combined bending and tension samples.

3.4.4 When long span MOE is to be qualified or if Pelster MOE or long span MOE are to be used for quality control, the MOE shall be measured using the same samples used for determination of edge MOE.

3.4.5 Lumber that is to be qualified as an E-Rated Structural Lamination shall have a minimum of 53 pieces tested in flat-wise long span bending as specified in Section 3.2.1.2.

3.4.6 To qualify for a MSR Tension Lamination grade, a minimum of 53 pieces shall be tested in tension as specified in Section 3.2.3 to a stress equal or exceeding the requirements specified in AITC 117-88-Manufacturing, Annex C14.6.1.1.

3.5 Interpretation of Qualification Tests

3.5.1 The requirements of this section must be met for qualification of E.

3.5.1.1 The sample mean edge E shall meet the following criteria:

$$\bar{E} \geq 0.95\ E_G$$

where:

$\bar{E}$ = sample mean edge E

E_G = Assigned value for the grade

3.5.1.2 The fifth percentile point estimate calculated nonparametrically for the sample edge E values shall be at least 81.9% of the assigned value for the grade.

3.5.2 The requirements of this section must be met for qualification of Fb and Ft.

3.5.2.1 To meet the acceptance requirements of section 3.4, the maximum number of pieces failing below 2.1 times the assigned stress or below the required fifth percentile MOE for each sample size is given in Table 1. If the acceptance requirements of the 53-piece sample are not met, the sample size may be increased to the next larger sample size shown in Table 1 to a maximum of 193. If the requirement is not met at a sample size of 193, the grade does not qualify. The machine must then be adjusted and the procedure repeated until the grade is fully qualified.

TABLE 1. PROOF LOADING ACCEPTANCE REQUIREMENTS

Sample Size	Failures Allowed
53	2
78	3
102	4
125	5
148	6
170	7
193	8

Note: This table is for Fifth percentile point estimates. Tolerance Limit (75% Conf.) estimates permit one fewer failures at each sample size.

4.0 Adjustments to daily quality control limits.

4.1 Quality control for MOE is based on the edge bending MOE. If the LS or Pelster MOE are to be used in place of edge bending MOE as part of a plant's daily QC program, the alternate MOE (LS or Pelster) QC requirements shall be established based on the results

of the qualification test. The QC requirements shall be determined from the following equation:

$$E_R = E_G * (E_A / E_B)$$

where

E_G = required grade MOE
E_A = Qualification test MOE value for test mode to be used in daily QC.
E_B = Qualification test MOE value for edge bending test mode.

The above adjustment procedure shall be used for both mean MOE and fifth percentile MOE. The value of E_A/E_B shall not be less than 1.0.

4.2 Daily quality control tests for strength shall be performed in bending or tension parallel to the grain or both.

4.2.1 If the test mode used for daily QC is not the more limiting property as determined by the qualification tests, the required quality control test value (R) for the test mode used shall be adjusted as shown in the equation below:

$$R = 2.1 * F_G * ((T_1 * R_2) / (T_2 * R_1))$$

where

F_G = Allowable grade property value for test mode property.
T_1 = Qualification test 5% PE value for test mode to be used in daily QC.
T_2 = Qualification test 5% PE value for other strength test mode.
R_1 = minimum qualification value for test mode to be used in daily QC.
R_2 = minimum qualification value for other strength test mode.

The value of $(T_1 * R_2)/(T_2 * R_1)$ shall not be less than 1.0.

4.3 When required, specific gravity shall be determined for all daily QC specimens in accordance with section 3.2.4 of Part B.

4.4 LS MOE testing shall be performed as part of the daily quality control for E-LAM grades.

PART C

QUALITY CONTROL REQUIREMENTS

FOR MACHINE STRESS RATED LUMBER

1.0 Agency Quality Control

1.1 Following qualification, production of the operating plant shall be inspected by an agency supervisor at least ten times each year at approximately monthly intervals.

1.2 The agency supervisor shall submit a report of his inspection to the inspected plant and to the agency. The report shall include a record of any production stoppages during the preceding month. It shall also indicate whether the plant production conforms to the requirements of Section 2.1 of Part C. The report shall be on forms supplied by the agency.

1.3 At least annually the accuracy of plant test equipment shall be measured to insure the integrity of the deflection and load measuring apparatus. If the plant equipment is found to be inaccurate, the equipment shall be made acceptable prior to continuation of production.

1.4 A quality control test and analysis shall be conducted at least semiannually by the agency supervisor to evaluate conformance to this standard. The agency supervisor shall review with the plant quality control supervisor the results of the test analysis. The agency supervisor shall also submit a written report of the results to the agency and the inspected plant.

1.5 At the option of the agency, pieces may be selected from production and tests performed to determine conformance with Part A, Section 3.4.

1.6 Record Keeping

1.6.1 The inspection agency shall maintain a current list of qualified plants, and grades, sizes and species which are qualified.

1.6.2 The agency shall keep on record for a minimum of three years the monthly mill reports furnished by the agency supervisor.

2.0 Plant Quality Control Requirements.

2.1 General

2.1.1 The plant must have a written quality control procedure which shall be designed in accordance with recognized quality control practices to provide that bending (MOR), tension parallel to grain (UTS) requirements are maintained as well as Edge, LS, or Pelster MOE throughout production.

2.1.2 The plant quality control procedure must be approved by the agency prior to use and must be followed for the plant to retain qualification.

2.2 Daily Quality Control

2.2.1 The plant shall keep records of daily production sampling and testing. The plant record shall be made available for inspection at the request of the agency supervisor.

2.2.2 The plant shall provide to the agency supervisor a summary of production stoppages occasioned by the plant quality control provisions of Section 2.1 and action taken regarding such stoppages during the preceding month.

PART D

SUGGESTED PLANT QUALITY CONTROL PROCEDURE

1.0 Scope

Part D sets forth a plant quality control procedure for machine stress rating of lumber which meets the requirements set forth in Section 2 of Part C to provide that either MOR or UTS or both, and MOE (Edge, LS, or Pelster) requirements are maintained throughout production. Procedures are also provided for quality control of specific gravity. Other procedures designed in accordance with recognized quality control practices may be used when approved by the agency.

2.0 General

2.1 Plant quality control shall be directed by the plant supervisor.

2.2 Plant quality control records shall include: (1) changes in machine calibration, (2) records of grades produced, (3) the results of all quality control tests, and (4) production stoppages. These records shall be maintained at the plant on a regular basis and all such records shall be available to the agency.

2.3 Lumber sampling and testing shall meet the minimum requirements of Sections 6.0, 7.0, 8.0, and 9.0.

2.4 The test results from Section 2.3 shall be recorded on Control Forms provided by, or approved by, the agency.

2.5 Production shall be stopped immediately for any machine grade which fails to satisfy the requirements of the Control Forms and shall not resume until appropriate corrective action has been taken by the plant supervisor to bring the grading process back into control.

3.0 Definitions

3.1 Plant: the lumber manufacturer's facility where machine stress rating takes place.

3.2 Plant Supervisor: an employee of the plant who is responsible for the quality control of machine stress rating of lumber.

3.3 Plant Quality Control Procedure: a specific set of instructions that incorporates the quality control functions required for machine stress rating at a plant.

3.4 Operator: an employee of the plant, responsible to the plant supervisor, who performs all quality control activities as specified in the plant quality control procedure.

3.5 Machine: equipment used for machine stress rating.

3.6 Proof Load: the load sufficient to stress the piece to 2.1 times the allowable Fb (applied at third points) or Ft.

3.7 Bending Proof Loader: test equipment capable of accurately determining edge E and MOR at the plant. The loader shall accurately measure applied load with an error of 3% or less and produce repeated MOE measurements (of the same piece) which agree within 3%.

3.8 Tension Proof Loader: test equipment capable of accurately determining the UTS at the plant. The loader shall accurately measure applied load with an error of 3% or less.

3.9 Machine Calibration Check: the process followed by plant quality control personnel to assure that the machine is accurately adjusted.

3.10 Proof Loader Calibration: the process followed by plant quality control personnel to assure that the bending or tension proof loader is accurately adjusted.

3.11 Edge E: the modulus of elasticity of an individual piece determined by loading, at a maximum rate of 16,000 psi per minute, a randomly selected edge of a piece at the one-third points, with a span depth to ratio of 21 (where possible) and with the maximum edge defect included between or as close to the load points as possible.

3.12 Long Span (LS) E: The LS modulus of elasticity of an individual member is determined from the deflection measured in a flat-wise test of lumber with centerpoint loading and a span-depth ratio (l/d) of approximately 100.

3.13 Pelster E: The Pelster modulus of elasticity on a section of an individual piece is determined from the flat-wise test of lumber with one-third point loading over a 48 inch span.

3.14 Fb: the extreme fiber stress in bending assigned to the machine grade.

3.15 MOR: the modulus of rupture in bending of an individual piece determined by loading, at a maximum rate of 16,000 psi per minute on a randomly selected edge of a piece at the one- third points, with a span to depth ratio of 21 (where possible) and with the maximum edge defect included between or as close to the load points as possible.

3.16 Maximum Edge Defect: a strength reducing characteristic that is judged to be the most weakening defect along the edge of a piece, without regard to test orientation. If two or more characteristics are determined to be of equal severity, choose the one on the tension edge closest to the center of the piece.

3.17 Control Forms: forms supplied by or approved by the agency for use in recording and plotting data from quality control tests to determine whether the machine grade meets all requirements shown herein. See Section 11.0 of Part D.

3.18 CUSUM: A shortened form of the term "Cumulative Sum", see Section 11.0. Part D.

3.19 Production Stoppage: a production stoppage is considered to have occurred when it is necessary to regrade MSR lumber. (See Sections 12.2.4, 12.3.3, and 12.4.3.)

3.20 Ft: the tensile stress parallel to the grain assigned to the machine grade.

3.21 UTS: the ultimate tensile strength of an individual piece is determined by loading an eight foot clear span (if possible) at a rate of 3500 psi per minute ($\pm$ 500 psi/min.) with the maximum edge defect positioned a minimum of one foot from the grips, if specimen length permits.

3.22 Pelster Tester: test equipment capable of accurately determining flat MOE. The device shall apply loads which are accurate to 0.5 percent at the 1/3 points of a 48 inch test span. The deflection of the specimen shall be measured to the nearest 0.001 inch.

3.23 Pelster Test Load: the load applied to the test specimen by the Pelster tester in addition to the 25 pound pre-load. The proper loads for various sizes of lumber are:

Nominal Size	Load (lbs)
2x3	75
2x4	100
2x6	150
2x8	200
2x10	250
2x12	300

3.24 Long Span E Test Load: the load applied to the test specimen for Long Span MOE determination in addition to the 5 pound pre-load. The recommended loads for various sizes of lumber are:

Nominal Size	Load (lbs)
2x3	10
2x4	10
2x6	10
2x8	15
2x10	15
2x12	20

4.0 Proof Loader Calibration

4.1 It shall be the responsibility of the plant to maintain the proof loader in good operating condition and accurately calibrated.

4.2 A calibration check shall be performed at least once each week, and at other times if there is reason to suspect the proof loader may not be accurately calibrated.

4.3 Records of calibration checks shall be maintained.

5.0 Machine Calibration

5.1 It shall be the responsibility of the plant to maintain the machine in good operating condition and accurately calibrated.

5.2 A calibration check shall be performed at the beginning of each production period and at approximately every four (4) hours of machine operation.

6.0 Sampling Frequency

During each production shift, a sample of five pieces of each grade being produced shall be selected in accordance with Section 7.0.

7.0 Sample Selection Method

7.1 On the chain, after the first five pieces have passed, the next five pieces available for each grade shall be selected to be tested.

7.2 Alternatively five pieces may be selected throughout each shift. These five pieces will constitute the sample.

Note: Pieces may be selected after final grade has been established by the grader. Pieces shall be accepted in the sample if they have been assigned by the grader to a lower E class grade than that determined by the grading machine. (For example, a 1650f/1.5E grade that has been downgraded from 1.8E as determined by the grading machine.)

8.0 Sample Identification

Each specimen shall be labeled with an identification number. For example, the near end of the upward face of selected pieces may be identified with a test sequence number, date and shift.

An example of Identification Marks:

#1 - 1 - 8/3 First sample selected on day shift August 3rd.

#4 - 2 - 9/5 Fourth sample selected on swing shift September 5th.

9.0 Sample Testing

9.1 Bending Test For MOR and Edge MOE

9.1.1 Preparation of bending proof load machine.

9.1.1.1 Load shoes and reaction supports shall be positioned correctly for the size to be tested.

9.1.2 Placement of sample in bending proof load machine.

9.1.2.1 The sample identification mark shall be positioned so that the mark faces toward the operator and consistently appears either to the operator's left or right.

9.1.2.2 To determine the edge E, the operator may center the piece in the test span or may meet the requirements of 9.1.2.3.

9.1.2.3 To determine the MOR, the operator shall estimate the maximum edge defect and position this portion of the sample piece between the load heads of the tester (center 1/3 of the span) or as near thereto as possible.

9.1.3 Testing of sample piece for edge "E" value.

9.1.3.1 The operator shall carefully follow the testing procedure for the specific proof tester available.

9.1.3.2 The edge E value of each piece shall be recorded on forms provided.

9.1.4 Proof loading of sample piece to 2.1 times the allowable design value.

9.1.4.1 The operator shall carefully follow the testing procedure for the specific proof tester available.

9.1.4.2 A ramp load shall be applied to the sample piece at an approximately uniform rate of increase over a period of approximately 15 seconds to 1 1/2 minutes until the specified proof load is reached for the size and grade being tested.

9.1.4.3 If partial failure occurs as the required proof load is being applied, continue to apply load until the piece either totally fails or carries the full proof load. If the piece carries the full proof load, the results are recorded and handled as though no damage had occurred to the piece, but the piece may no longer be considered acceptable as structural lumber.

9.1.4.4 If the piece fails at less than the proof load, the highest MOR value obtained shall be recorded.

9.2 Testing in Tension Parallel To Grain

9.2.1 Placement of sample in tension proof load machine

9.2.1.1 The sample identification mark shall be positioned so that mark is consistently either to the operators left or right.

9.2.1.2 To determine the UTS, the operator shall determine the maximum edge defect and position this portion of the sample within the test span, a minimum of one foot from the tension grips, when possible.

9.2.2 Proof loading of sample piece to 2.1 times the allowable design value.

9.2.2.1 The operator shall carefully follow the testing procedure for the specific proof tester available.

9.2.2.2 A tension load shall be applied to the sample piece at an approximately uniform rate of increase over a period of approximately 15 seconds to 1 1/2 minutes until the specified proof load is reached for the size and grade being tested.

9.2.2.3 If partial failure occurs as the required proof load is being applied, continue to apply load until the piece either totally fails or carries the full proof load. If the piece carries the full proof load, the results are recorded and handled as though no damage had occurred to the piece, but the piece may no longer be considered acceptable as structural lumber.

9.2.2.4 If the piece fails at less than the proof load, the highest UTS value obtained shall be recorded.

9.3 Testing for Pelster MOE

9.3.1 Preparation of Pelster Tester.

9.3.1.1 The load to be applied to a given lumber size shall meet the requirements of section 3.23.

9.3.2 Placement of sample in Pelster E testing machine.

9.3.2.1 The sample identification mark shall be positioned so that the mark faces toward the operator and consistently appears either to the operators left or right.

9.3.2.2 To determine the Pelster E, the operator shall take the average of three to four measurements along the length of the piece or alternatively estimate the maximum edge defect and position this portion of the sample between the load heads of the tester (center 1/3 of the span) or as near thereto a possible.

9.4 Testing For Long Span MOE

9.4.1 Preparation for Long Span (LS) MOE testing.

9.4.1.1 The load to be applied to a given lumber size shall meet the requirements of Section 3.24.

9.4.1.1 Reaction supports shall be positioned correctly for the size to be tested (l/d = 100).

9.4.2 Placement of sample for LS MOE testing.

9.4.2.1 The sample identification mark shall be positioned so that the mark faces towards the operator and consistently appears either to the operators left or right.

9.5 Testing For Specific Gravity

9.5.1 Determination of specific gravity when required shall be made following the procedures of ASTM D2395 Method A as described in Part A, Section 9.

9.5.2 Measure the moisture content of the test specimen with a calibrated moisture meter.

9.5.3 Weighing

9.5.3.1 Check the calibration of the weighing device.

9.5.3.2 For full weight measurement, place the specimen on the weighing device so that it is properly balanced. Be sure the specimen is not touching any other supports.

9.5.3.3 For 1/2 weight measurement, place one end of the specimen on the weighing device. Be sure the rest of the piece is not touching any support except at the end.

9.5.4 Dimensional measurement

9.5.4.1 Measure the thickness and width of the specimen at mid-length with calipers reading to 0.001 inches.

9.5.4.2 Measure the length of the specimen with a calibrated tape to the nearest 1/4 inch.

9.5.5 Calculate the specific gravity.

9.5.5.1 If the moisture content of the specimen is not 12%, adjust the specific gravity to 12%.

10.0 Data for Control Forms

10.1 Each five consecutive pieces, and their test results, shall be grouped together and comprise the five-piece sample required for completion of the Control Forms.

11.0 Control Forms

Control forms for each grade, size and species are provided and are to be maintained on a continual basis. Records for each piece shall also be maintained. These forms monitor:

CUSUM for MOR or UTS
CUSUM for mean E
CUSUM for Low E (0.819E)
Average E (Optional plot)
Specific gravity (if required)

12.0 CUSUM Form, Requalification Form - When indicating "Out of Control"

12.1 General

12.1.1 The identity of all MSR lumber produced since the last five-piece sample that indicated process was "in control" shall be maintained.

12.1.2 "Out of control" conditions may be indicated on the CUSUM charts for two basic reasons:

(a) chance
(b) process has changed

12.1.2.1 In the event of (a), "chance", it is necessary to prove that the "out of control" was in fact due to chance and that the production is satisfactory.

12.1.2.2 In the event of (b), "process has changed", it is necessary to identify the cause, correct the process, prove that the corrections have brought the process into control, and regrade lumber produced during the time the process was out of control.

12.2 Requalification - CUSUM for MOR or UTS out of control

12.2.1 Step 1 The plant supervisor shall be notified.

12.2.2 Step 2 Broken pieces shall be checked for visual limitations.

12.2.2.1 If visual characteristics are within grade rules, the operator shall proceed to Step 3.

12.2.2.2 If edge knot or other visual characteristics exceed that allowed by grade rules, the piece shall be discarded as being below grade and replaced with another sample piece selected and tested in the prescribed manner.

12.2.2.3 If this new piece passes the proof load test and the number of failed pieces in the new five-piece sample is one or less, the sample is judged to be "in control" and operations can be continued in the normal manner.

12.2.2.4 If this new piece fails to pass the proof load test, the operator shall proceed to Step 3.

12.2.3 Step 3 Calibration of the grading machine shall be checked.

12.2.3.1 If calibration is correct, operator shall proceed to Section 12.6 Intensive Sampling.

12.2.3.2 If calibration needs adjustment, operator shall make these adjustments and record calibration change on Calibration Record Sheets and proceed to Section 12.6 Intensive Sampling.

12.3 Requalification - CUSUM for E out of control

12.3.1 Step 1 Plant supervisor shall be notified.

12.3.2 Step 2 Calibration of grading machine shall be checked.

12.3.2.1 If calibration is correct, operator shall proceed to Section 12.6 Intensive Sampling.

12.3.2.2 If calibration needs adjustment, operator shall make said adjustments, record changes on grading machine Calibration Record Sheets and proceed to Section 12.6 Intensive Sampling.

12.4 Requalification - CUSUM for Low E out of control

12.4.1 Step 1 Plant supervisor shall be notified.

12.4.2 Step 2 Calibration of grading machine shall be checked.

12.4.2.1 If calibration is correct, operator shall proceed to Section 12.6 Intensive Sampling.

12.4.2.2 If calibration needs adjustment, operator shall make said adjustments, record changes on grading machine Calibration Record Sheets and proceed to Section 12.6 Intensive Sampling.

12.5 Requalification - CUSUM for Specific Gravity out of control

12.5.1 Step 1 Plant supervisor shall be notified.

12.5.2 Step 2 Calibration of grading machine shall be checked.

12.5.2.1 If calibration is correct, operator shall proceed to Section 12.6 Intensive Sampling.

12.5.2.2 If calibration needs adjustment, operator shall make said adjustments, record changes on grading machine Calibration Record Sheets and proceed to Section 12.6 Intensive Sampling.

12.6 Intensive Sampling

12.6.1 Operator shall select six samples of five pieces each (30 pieces total) by pulling every third piece of the grade in question until the six samples have been obtained. These pieces shall be marked sequentially as instructed for sample identification. (See Section 7.0.)

12.6.2 Operator shall test these samples in the prescribed manner, recording results on appropriate Control Forms.

(a) If after testing the 30 pieces (6 samples, 5-pcs. each), the appropriate Requalification criteria are met indicating "in control", and the grading machine calibration check required an adjustment of 3 percent or less for the grade boundaries, all lumber produced shall be considered on grade.

(b) If at the end of testing the 30 pieces (6 samples, 5-pcs. each), the appropriate Requalification criteria are met, and the grading machine calibration check showed that an adjustment of greater than 3 percent was required for the grade boundaries, the lumber produced between the last "in control" test prior to the first "out of control" (Requalification) test is off grade and must be regraded. Production Stoppage must be recorded.

(c) If at the end of testing the 30 pieces (6 samples, 5-pcs. each), the appropriate Requalification criteria are not met indicating "out of control", one more set of 30 pieces may be taken. If the Requalification criteria are met after adding the second set of samples, production may continue (see (a) and (b) above). If the Requalification criteria are still not met, the plant supervisor should be called to determine appropriate action to bring the process back "in control". All lumber produced between the last "in control" test prior to the first "out of control" test is off grade and must be regraded. Production Stoppage must be recorded.

13.0 Control Chart for average E (optional)

13.1.1 If three or more points of the last seven lie above the central line, the process is probably satisfactory.

13.1.2 If five or more points of the last seven points lie below the central line, the process has probably changed and recalibration may be necessary.

TABLE OF MINIMUM VALUES

FOR MSR LUMBER

West Coast Lumber Inspection Bureau

SIZE	2 x 3				2 x 4				2 x 6				2 x 8				2 x 10				2 x 12			
SPAN, L	52.50				73.50				115.50				152.50				186.00				186.00			
a, a=L/3	17.50				24.50				38.50				50.75				62.00				62.00			
f-e CLASS	Bend Proof Load	Ten. Proof Load	Min. E	Min. $\overline{E}$	Bend Proof Load	Ten. Proof Load	Min. E	Min. $\overline{E}$	Bend Proof Load	Ten. Proof Load	Min. E	Min. $\overline{E}$	Bend Proof Load	Ten. Proof Load	Min. E	Min. $\overline{E}$	Bend Proof Load	Ten. Proof Load	Min. E	Min. $\overline{E}$	Bend Proof Load	Ten. Proof Load	Min. E	Min. $\overline{E}$
2700-2.2	1,013	16,931	1.80	2.09	1,418	23,704	1.80	2.09	2,228	37,249	1.80	2.09	2,936	49,101	1.80	2.09	3,912	62,646	1.80	2.09	5,787	76,191	1.80	2.09
2400-2.0	900	15,159	1.64	1.90	1,260	21,223	1.64	1.90	1,980	33,351	1.64	1.90	2,610	43,962	1.64	1.90	3,478	56,090	1.64	1.90	5,144	68,217	1.64	1.90
2250-1.9	844	13,781	1.56	1.81	1,181	19,294	1.56	1.81	1,856	30,319	1.56	1.81	2,447	39,966	1.56	1.81	3,260	50,991	1.56	1.81	4,823	62,016	1.56	1.81
2100-1.8	787	12,403	1.47	1.71	1,103	17,364	1.47	1.71	1,733	27,287	1.47	1.71	2,284	35,969	1.47	1.71	3,043	45,892	1.47	1.71	4,501	55,814	1.47	1.71
1800-1.6	675	9,253	1.31	1.52	945	12,954	1.31	1.52	1,485	20,357	1.31	1.52	1,958	26,834	1.31	1.52	2,608	34,237	1.31	1.52	3,858	41,639	1.31	1.52
1650-1.5	619	8,032	1.23	1.43	866	11,246	1.23	1.43	1,361	17,672	1.23	1.43	1,794	23,294	1.23	1.43	2,391	29,720	1.23	1.43	3,537	36,146	1.23	1.43
1500-1.4	562	7,087	1.15	1.33	788	9,923	1.15	1.33	1,238	15,593	1.15	1.33	1,631	20,554	1.15	1.33	2,174	26,224	1.15	1.33	3,215	31,894	1.15	1.33
1450-1.3	544	6,300	1.06	1.24	761	8,820	1.06	1.24	1,196	13,860	1.06	1.24	1,577	18,270	1.06	1.24	2,101	23,310	1.06	1.24	3,108	28,350	1.06	1.24
1200-1.2	450	4,725	0.98	1.14	630	6,615	0.98	1.14	990	10,395	0.98	1.14	1,305	13,702	0.98	1.14	1,739	17,483	0.98	1.14	2,572	21,263	0.98	1.14
900-1.0	337	2,756	0.82	0.95	473	3,859	0.82	0.95	743	6,064	0.82	0.95	979	7,993	0.82	0.95	1,304	10,198	0.82	0.95	1,929	12,403	0.82	0.95

NOTE: Proof load Values are for 1/3 Point Loading

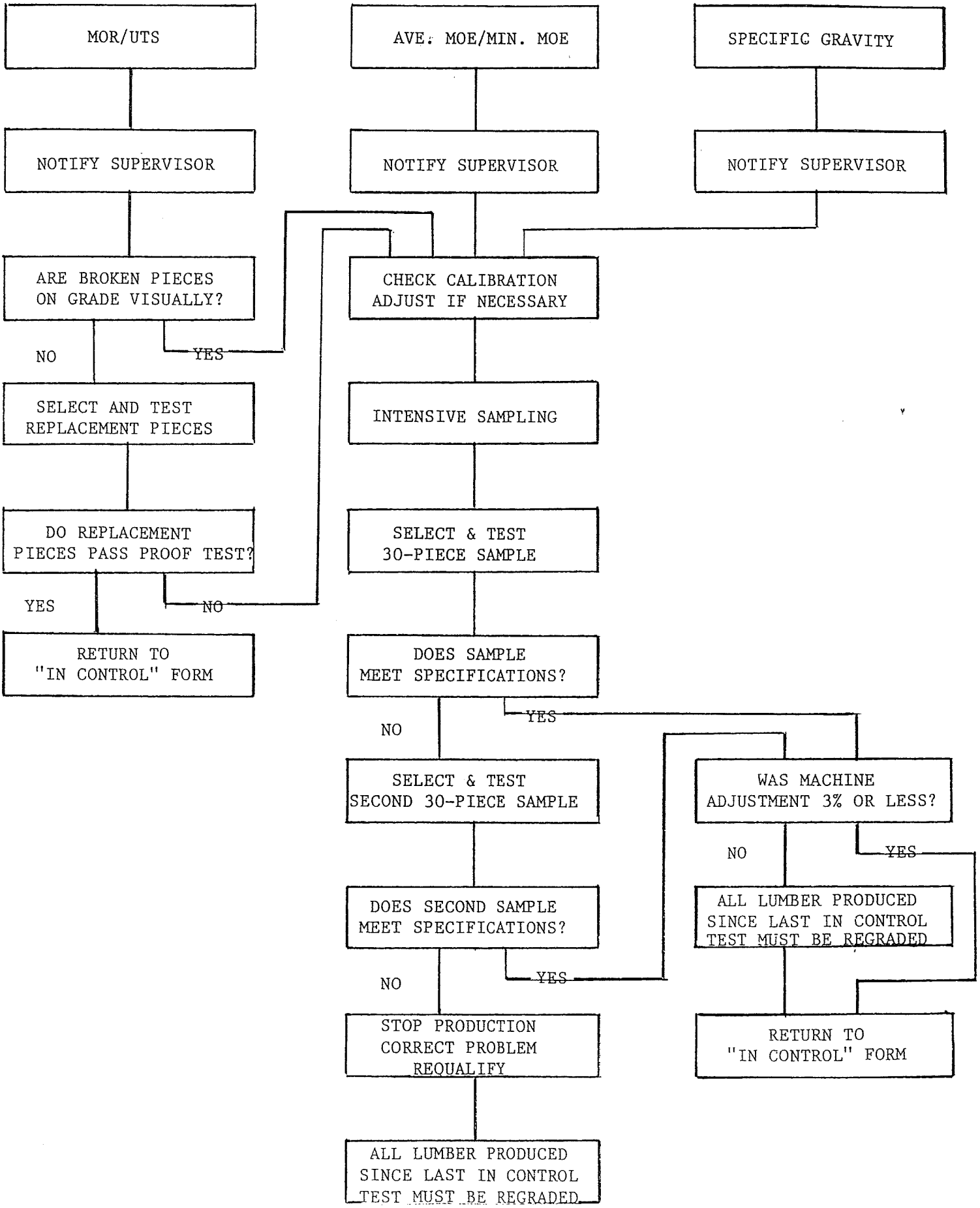
TABLE NO. 1 Values for Use with CUSUM Forms

Grade E (10^6 PSI)	Designation	Min. MOE (M)	Target MOE	MOE Control Limit (C)
1.2	120	98	1150	120
1.3	130	106	1250	141
1.4	140	115	1350	163
1.5	150	123	1450	190
1.6	160	131	1550	211
1.8	180	147	1750	262
1.9	190	156	1850	288
2.0	200	164	1950	316
2.1	210	172	2050	380
2.2	220	180	2150	372

TABLE NO. 2 Calculation of Proof Load Values
For Test Spans = 21 times Specimen Depth

Specimen Depth (Nominal)	Proof Load =
3	0.375 F-b
4	0.525 F-b
6	0.825 F-b
8	1.0875 F-b
10	1.3875 F-b

REQUALIFICATION FLOW DIAGRAM
PROCESS "OUT OF CONTROL"



SAMPLE CUSUM CONTROL FORMS

Monthly Quality Supervisor Report - MSR Production

Mill Name_____ Mill Location_____

1. Plant Records Checked:

   CUSUM Control Forms /__/ Yes /__/ No

   If No, explain_____

   _____

   _____

2. Requalification - Out of Control:

   Was Requalification necessary since last report? /__/ Yes /__/ No

   If Yes, attach copies of Requalification forms.

3. Visual Grade Check:

   If available, a visual grade check will be made monthly.

   Was visual grade check made? /__/ Yes /__/ No

   If Yes, attach visual grade check results.

   If No, estimate date material will be available_____

4. Estimate of Production:

Specie	Size	Grades	No. Shifts

5. Semi-Annual Test

   At least semi-annually, test 30 or more pieces to determine whether the requirements of Part B, Section 3, of the current MSR Standard are met. Attach test results to this report.

   Was Semi-Annual Test made? /__/ Yes /__/ No

Bureau Supervisor_____ Date_____

MSR CUSUM CONTROL FORM

MILL _____

SPECIES _____

SIZE _____

Tested By:_____

Min. MOE = M = _____

CUSUM Control Limit = C = _____

Proof Load Limit = F = _____
(from Table)

MSR Grade _____

Proof Load: _____ Tension
(Check one) _____ Bending

Width	3"	4"	6"	8"	10"
Span (in.)					
Proof Load (lbs.)					

Line #	Date/Shift	/		/		/		/		/		/	
1	TEST VALUES	MOE[1]	Load[2]	MOE[2]	Load[2]	MOE[1]	Load[2]	MOE[1]	Load[2]	MOE[1]	Load[2]	MOE[1]	Load[2]
2	Piece No. 1												
3	No. 2												
4	No. 3												
5	No. 4												
6	No. 5												
7	Targe MOE												
8	Test Ave. (2 X Sum)	-		-		-		-		-		-	
9	Difference (line 7-line 8)												(5)
10	Last CUM. Dif.	+		+		+		+		+		+	
11	Current CUSUM (3)(4)												
12	No. Pcs. Below Min.												
13	Machine Settings	Ave.	Min.	Ave.	Min.	Ave.	Min.	Ave.	Min.	Ave.	Min.	Ave.	Min.

(1) If 2 or more of the 5 test values, or 4 or more of the last 30 test values are less than the minimum MOE; M= [ ], the process is OUT-OF-CONTROL. Go to REQUALIFICATION.

(2) If 2 or more of the 5 test values, or 4 or more of the last 30 test values are less than the minimum Proof Load; F= [ ], the process is OUT-OF-CONTROL. Go to REQUALIFICATION.

(3) If the total is more than CUSUM Control; C= , the process is OUT-OF-CONTROL. Go to REQUALIFICATION.

(4) CUSUM cannot be less than 0. If cumulative difference is less than 0, enter 0.

(5) Enter value as last CUM. Dif. on next sheet.

Date/Shift	/		/		/		/		/		/	
	Def.	MOE	Def.	MOE	Def.	MOE	Def.	MOE	Def.	MOE	Def.	MOE
Sample 1												
2												
3												
4												
5												
Total												
Total												
2 X Total												

Notes / Comments: _____

_____

_____

NO. 340R-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.

MSR CONTROL CHART

MSR GRADE

SPECIES ____________

SIZE

MONTH/YR ____________

MOR FAILURES	MIN. MOE	CUSUM AVE. MOE	AVERAGE MOE	DATE

Mill: _____

Date: _____
Shift: _____
Tested by: _____

MSR
SEMI-ANNUAL TEST AND ANALYSIS

Species: _____
Size: _____
Grade-Class: _____
Proof Load (Check one):
_____ Bending _____ Tension

Target MOE: _____
Proof Load Limit: _____
Min. MOE Limit: _____

Current Machine Settings
Average _____ Low Point _____

Piece No.	MOE	Break Load	Piece No.	MOE	Break Load	Piece No.	MOE	Break Load
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		
						Total		

Number of Pieces Below Minimum	MOE	Proof Load	Average (Total ÷ 3)		
			Ave. Last Req.		
			Comb. Average		

Test Criteria
(1) Sample Average MOE must meet or exceed required Target MOE.
(2) Not more than 3 pieces can fail below the Proof Load Limit.
(3) Not more than 3 pieces can have an MOE less than Minimum MOE Limit.
(4) Does the sample meet or exceed requirements? Yes ____ No ____

DATA WORK SHEET

SAMPLE NO.	DEF	MOE	BREAK LOAD (LBS)	SAMPLE NO.	DEF	MOE	BREAK LOAD (LBS)
1				16			
2				17			
3				18			
4				19			
5				20			
6				21			
7				22			
8				23			
9				24			
10				25			
11				26			
12				27			
13				28			
14				29			
15				30			
TOTAL				TOTAL			
				TOTAL FROM C.1			
				COMB. TOTAL			

NOTES/COMMENTS

Mill: _____

Date: _____
Shift: _____
Tested by: _____

MSR
REQUALIFICATION

Species: _____

Target MOE: _____
+36

Size: _____
Grade-Class: _____
Process OUT-OF-CONTROL for:
Ave. MOE ☐ Min. MOE ☐ Load ☐

Required Ave. MOE (1) _____
Proof Load Limit: _____
Min. MOE Limit: _____
Proof Load: _____ Bending
(Check one) _____ Tension

Last Mach. Setting
Ave. ____ L.P. ____

Current Mach. Setting
Ave. ____ L.P. ____

% Change (5)
Ave. ____ L.P. ____

Piece No.	MOE	Break Load	Piece No.	MOE	Break Load	Piece No.	MOE	Break Load
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		
						Total		

Number of Pieces Below Minimum	MOE	Proof Load	Average(Total ÷3)		
			Ave. Last Req.		
			Comb. Average		

Requalification Criteria

(1) Sample Ave. MOE (combined ave. MOE for second test) must meet or exceed required ave. MOE above.

(2) Not more than 2 pieces can fail below the Proof Load Limit.

(3) Not more than 2 pieces can have MOE less than Minimum MOE Limit.

(4) If sample meets requalification criteria, production may continue. Enter 0 in Last Cum. Dif. line for next column of CUSUM Control Form.

(5) If machine settings were changed more than 3%, the lumber produced since the last In-Control test is off grade and must be regraded.

(6) If the sample does not meet the requalification criteria, a second 30-piece sample may be tested (repeat of above procedure). If sample does not meet requalification criteria, the plant supervisor should be notified and production stopped. Note time and date of production stoppage. ☐

Sample No.	Def.	MOE	Break Load (lbs)	Sample No.	Def.	MOE	Break Load (lbs)
1				16			
2				17			
3				18			
4				19			
5				20			
6				21			
7				22			
8				23			
9				24			
10				25			
11				26			
12				27			
13				28			
14				29			
15				30			
Total				Total			
				Tot. from Col. 1			
				Comb. Tot.			

Notes / Comments: _____

_____

_____

PART E

Alternate Plant Quality Control Procedure

1.0 Scope

Traditionally, plant quality control for MSR lumber has been done by monitoring flat E using a dead weight devise known as the Pelster tester. This procedure has a long history of satisfactory plant quality control and may be used as an alternate to the proof loading procedure described in Part C. This program is limited to primary manufacturers where a reasonably uniform timber source can be ensured. It does not apply to remanufacturing plants. Although it may be somewhat easier to implement, it is designed to be more conservative as bending strength is only indirectly monitored. Neither does it allow the mill to fine tune the grading process to the extent possible with the proof loading procedure.

Use of this alternate quality control procedure requires that flat E tests be made on the certification sample in addition to the edge E required. A correlation between edge E and flat E is developed for the certification sample.

2.0 General

2.1 Product specifications and qualification procedures are given in Parts A & B of this document.

2.2 Plant quality control shall be directed by the plant supervisor.

2.3 Plant quality control records shall include: (1) changes in machine calibration, (2) records of grades produced, (3) the results of all quality control tests, and (4) production stoppages. These records shall be maintained at the plant on a regular basis and all such records shall be available to the agency.

2.4 Lumber sampling and testing shall meet the minimum requirements of Sections 6.0, 7.0, 8.0, and 9.0.

2.5 The test results from Section 2.4 shall be recorded on the Control Forms provided by the inspection agency, or in a bound notebook approved by the agency.

2.6 Production shall be stopped immediately for any machine grade which fails to satisfy the requirements of the Control Forms and shall not resume until appropriate corrective action has been taken by the plant supervisor to bring the grading process back into control.

3.0 Definitions

3.1 Plant: the lumber manufacturer's facility where machine stress rating takes place.

3.2 Plant Q.C. Supervisor: an employee of the plant who is responsible for the quality control of machine stress rating of lumber.

3.3 Plant Quality Control Procedure: a specific set of instructions that incorporates the quality control functions required for machine stress rating at a plant.

3.4 Operator: an employee of the plant, responsible to the plant Q.C. supervisor, who performs all quality control activities as specified in the plant quality control procedure.

3.5 Machine: equipment used for machine stress rating.

3.6 Test Load: the load applied to the test specimen by the Pelster tester in addition to the 25 pound pre-load. The proper loads for various sizes of lumber are:

Nominal Size	Load (lbs.)
2x3	75
2x4	100
2x6	150
2x8	200
2x10	250
2x12	300

3.7 Pelster Tester: test equipment capable of accurately determining flat MOE at the plant. The device shall apply loads which are accurate to 0.5 percent at the 1/3 points of a 48 inch test span. The deflection of the test specimen shall be measured to the nearest 0.001 inch.

3.8 Machine Calibration Check: the process followed by plant quality control personnel to assure that the machine is accurately adjusted.

3.9 Pelster Tester Calibration: the process followed by plant quality control personnel to assure that the Pelster tester is accurately adjusted.

3.10 Edge E: the modulus of elasticity of an individual piece determined by loading, at a maximum rate of 16,000 psi per minute, a randomly selected edge of a piece at the one-third points for a span to depth ratio of 21, where possible, and the piece centered in the test span.

3.11 Fb: the extreme fiber stress in bending assigned to the machine grade.

3.12 Maximum Edge Defect: a strength reducing characteristic that is judged to be the most weakening defect along the edge of a piece, without regard to test orientation. If two or more characteristics are determined to be of equal severity, choose the one on the tension edge closest to the center of the piece.

3.13 Control Forms: forms supplied by or approved by the agency for use in recording and plotting data from quality control tests to determine whether the machine grade meets all requirements shown herein. See Section 11.0 of Part C.

3.14 CUSUM: a shortened form of the term "Cumulative Sum", see Section 11.0.

3.15 Production Stoppage: a production stoppage is considered to have occurred when it is necessary to regrade MSR lumber. (See Section 12.4.2.)

3.16 Minimum E (Min E) for the CUSUM control forms is the minimum for the individual minimum flat MOE's of the five test pieces in the date/shift samples as measured according to Section 9.2.

3.17 Average E (Ave E) for the CUSUM control forms is the average of the average flat MOE's of the five test pieces in the date/shift sample as measured according to Section 9.2.

4.0 Pelster Tester Calibration Check

4.1 It shall be the responsibility of the plant to maintain the Pelster tester in good operating condition and accurately calibrated.

4.2 A calibration check shall be performed at least once each month and at other times if there is reason to suspect the Pelster tester may not be accurately calibrated.

4.3 Records of calibration checks shall be maintained.

5.0 Machine Calibration

5.1 It shall be the responsibility of the plant to maintain the machine in good operating condition and accurately calibrated.

5.2 A calibration check shall be performed at the beginning of each production period and at approximately every four (4) hours of machine operation.

6.0 Sampling Frequency

During each day's production, a sample of five pieces of each E classification level produced shall be selected in accordance with Section 7.0.

7.0 Sample Selection Method

On the chain, after the first five pieces have passed, the next first five pieces available for each grade shall be selected to be tested. Alternatively five pieces may be selected throughout the shift. These five pieces will constitute the sample. Note: pieces may be selected after final grade has been established by the grader. (Pieces may be accepted in the sample if they have been assigned by the grader to a lower E class grade than that determined by the grading machine. For example, a 1650f/1.5E grade that has been downgraded from 1.8E as determined by the grading machine.)

8.0 Sample Identification

The near end of the upward face of selected pieces shall be identified with a test sequence number.

An example of Identification Marks:

#1 - 1 - 8/3 First sample selected on day shift August 3rd.

#4 - 2 - 9/5 Fourth sample selected on swing shift September 5th.

9.0 Sample Testing

9.1 Preparation of Pester tester.

9.1.1 The Pelster tester shall be in good working condition with the proper dead load weights on the load head for the size to be tested.

9.2 Placement of sample in Pelster tester.

9.2.1 The sample identification mark shall be positioned so that the mark faces up and consistently appears either to the operator's left or right.

9.2.2 To determine flat E, measure the MOE (flatwise) at four representative locations along the length of the piece. At least one measurement shall contain the apparent maximum edge strength reducing defect positioned as near to the center of the test span as possible.

9.2.3 The average flat MOE of the piece is the average of the four measurements made in Section 9.2.2.

9.2.4 The minimum flat MOE for the piece is the lowest MOE measured for the piece in Section 9.2.2.

9.2.5 The average flat MOE and the minimum flat MOE value of each piece shall be recorded on forms provided or in a bound notebook approved by the agency.

10.0 Data for Control Forms

10. Each five consecutive pieces, and their test results, shall be grouped together and comprise the five-piece sample required for completion of the Control Forms.

11.0 Control Forms & Limits

Control forms for each grade, size and species are provided and are to be maintained on a continual basis. Records for each piece shall also be maintained. These forms monitor:

CUSUM for average flat E
CUSUM for minimum flat E

11.1 CUSUM control form limits for average flat E and minimum flat E shall be determined from the initial qualification sample. The control limits shall be reviewed after 3 to 6 months of production (approximately 100 daily quality control test sample pieces) and adjusted as necessary. In no case, however, shall the limits be less restrictive than for the Proof-loaded CUSUM control under Part C.

11.1.1 Limits for the average flat E shall be determined from the Goel & Wu nomogram[1] using the following values.

ua	=	qualification sample average flat E (10^6 psi)
ur	=	ua - 0.10
s	=	qualification sample standard deviation (an estimate of the population standard deviation)
k	=	ua - .05 (Threshold Value on form)
n	=	5
La	=	150
Lr	=	5
h	=	CUSUM control limit (C on form)

1) Reference: Goel, A.L. and Wu, S.M. (1971). Determination of A.R.L. and a Contour Nomogram for CUSUM Charts to Control Normal Mean. Technometrics 13,221-230.

11.1.2 Limits for minimum flat E shall be determined from:

$$\text{Min E} = E_m - 2.0\, s_m$$

where

E_m = qualification sample average low point (minimum) flat E

s_m = qualification sample standard deviation for low point (minimum)

12. CUSUM Form, Requalification Form - When Indicating "Out of Control"

12.1 General

12.1.1 The identity of all MSR lumber produced since the last five-piece sample that indicated process was "in control" shall be maintained.

12.1.2 "Out of control" conditions may be indicated on the CUSUM charts for two basic reasons:

(a) chance
(b) process has changed

12.1.2.1 In the event of (a), "chance", it is necessary to prove that the "out of control" was in fact due to chance and that the production is satisfactory.

12.1.2.2 In the event of (b), "process has changed", it is necessary to identify the cause, correct the process, prove that the corrections have brought the process into control and regrade lumber produced during the time the process was out of control.

12.2 Requalification - CUSUM for average flat E out of control

12.2.1 Step 1 Plant Q.C. supervisor shall be notified.

12.2.2 Step 2 Calibration of grading machine shall be checked.

12.2.2.1 If calibration is correct, operator shall proceed to Section 12.5 Intensive Sampling.

12.2.2.2 If calibration needs adjustment, operator shall make said adjustments, record changes on grading machine Calibration Record Sheets and proceed to Section 12.4 Intensive Sampling.

12.3 Requalification - CUSUM for minimum flat E out of control

12.3.1 Step 1 Plant Q.C. supervisor shall be notified.

12.3.2 Step 2 Calibration of grading machine shall be checked.

12.3.2.1 If calibration is correct, operator shall proceed to Section 12.4 Intensive Sampling.

12.3.2.2 If calibration needs adjustment, operator shall make said adjustments, record changes on grading machine Calibration Record Sheets and proceed to Section 12.4 Intensive Sampling.

12.4 Intensive Sampling

12.4.1 Intensive sampling is intended to demonstrate that the production process has been brought back to "in control" status. Intensive sampling should not be started until the operator is reasonably sure that the cause, if any, of the "out of control" condition has been corrected. Where multiple grades go "out of control" at the same time due to equipment malfunction which can be readily identified, only the grade deemed most critical need be intensively sampled after repair of the problem. If this "critical" grade is found to be "in control", the associated grades will be assumed to be "in control" also. All material produced between the last "in control" and the first "out of control" must be regraded.

12.4.2 Where the condition described in Section 12.4.1 occurs, and the sequence of production can be determined and identified, intensive sampling may be used to locate the point at which equipment malfunction occurred. This may be done by intensively sampling successively earlier units of production of the "critical" grade until a sample is found which meets the appropriate requalification criteria. All material produced after this point until the first "out of control" condition must be regraded.

12.4.3 Six samples of five pieces each (30 pieces total) of the grade in question shall be selected. Pieces may be selected using either a random or serial selection process. Pieces shall be marked sequentially as described in Section 7.0.

12.4.4 Operator shall test these samples in the prescribed manner, recording results on appropriate Control Forms.

(a) If after testing the pieces (6 samples, 5-pcs. each), the appropriate Requalification criteria are met indicating "in control", and the grading machine calibration check required an adjustment of 3 percent or less for the grade boundaries, al lumber produced shall be considered on grade. Reset CUSUM to 0.

(b) If at the end of testing the 30 pieces (6 samples, 5-pcs. each), the appropriate Requalification criteria are met, and the grading machine calibration check showed that an adjustment of greater than 3 percent was required for the grade boundaries, the lumber produced between the last "in control" test and the first "out of control" test (Requalification) is off grade and must be regraded. Production Stoppage must be recorded. Reset CUSUM to 0.

(c) If at the end of testing the 30 pieces (6 samples, 5-pcs. each), the appropriate Requalification criteria are not met indicating "out of control", one more set of 30 pieces may be taken. If the Requalification criteria are met after adding the second set of samples, production may continue (see a. and be. above). If the Requalification criteria are still not met, the plant supervisor should be called to determine appropriate action to bring the process back "in control". All lumber produced between the last "in control" test and the first "out of control" (Requalification) test is off grade and must be regraded. Production Stoppage must be recorded.

13.0 Control Chart for Average E (optional)

13.1 If three or more points of the last seven lie above the central line, the process is probably satisfactory.

13.2 If five or more points of the last seven points lie below the central line, the process has probably changed and recalibration may be necessary.

14.0 Agency Review and Supervision

14.1 Pelster Tester

14.1.1 At each inspection visit, the agency quality supervisor shall inspect the Pelster tester for proper functioning of the loading and support system.

14.1.2 At each inspection visit, the agency quality supervisor shall verify the accuracy of the Pelster deflection measuring device, using a calibrated test bar.

14.2 Record Review

14.2.1 At each inspection visit, the agency quality supervisor shall review the records of 11.0 for conformance with the requirements of Sections 6 through 10.

14.2.2 If the "out of control" condition has occurred, the agency quality supervisor shall review in detail with the plant supervisor the records of Section 12 to assure conformance of required observations, testing, additional sampling and analysis.

14.3 At least annually, the agency quality supervisor will review with the plant supervisor the CUSUM control limits and plant quality control records with regard to re-evaluation and adjustment.

MSR CUSUM CONTROL FORM

MILL_____

SPECIES_____

SIZE_____

TESTED BY_____

WCLB®

ALTERNATE
QUALITY CONTROL

MIN. MOE = M = _____

CUSUM CONTROL LIMIT = C = _____

DATE/SHIFT	/		/		/		/		/		/	
TEST VALUES	AVE. E	MIN. E(1)	AVE. E	MIN. E(1)	AVE. E	MIN. E(1)	AVE. E	MIN E(1)	AVE. E	MIN. E(1)	AVE. E	MIN. E(1)
PIECE NO. 1												
NO. 2												
NO. 3												
NO. 4												
NO. 5												
THRESHOLD VALUE												
TEST AVE. (2 X SUM)	-		-		-		-		-		-	
DIFFERENCE												
LAST CUM. DIF.	+		+		+		+		+		+	(4)
CURRENT CUSUM (2)(3)												
NO. PCS. BELOW MIN.												
	AVE.	MIN.	AVE.	MIN.	AVE.	MIN.	AVE.	MIN.	AVE.	MIN.	AVE.	MIN.
MACH. SETTINGS												

(1) IF 2 OR MORE OF THE 5 TEST VALUES OR 4 OR MORE OF THE LAST 30 TEST VALUES ARE LESS THAN THE MINIMUM MOE; M= , THE PROCESS IS OUT OF CONTROL. GO TO REQUALIFICATION.

(2) IF TOTAL IS MORE THAN CUSUM CONTROL; C= , THE PROCESS IS OUT OF CONTROL. GO TO REQUALIFICATION.

(3) CUSUM CANNOT BE LESS THAN 0. IF CUMULATIVE DIFFERENCE IS LESS THAN 0, ENTER 0.

(4) ENTER VALUE AS LAST CUM. DIFF. ON NEXT WHITE SHEET.

WORK SHEET

DATE/SHIFT												
	DEF	MOE	DEF	MOE	DEF	MOE	DEF	MOE	DEF	MOE	DEF	MOE
SAMPLE 1												
2												
3												
4												
5												
TOTAL												
TOTAL												
2 X TOTAL												

NOTES/COMMENTS

MILL_____

DATE_____
SHIFT_____
TESTED BY_____

M S R

REQUALIFICATION

ALTERNATE
QUALITY CONTROL

SPECIES_____

SIZE_____

GRADE-CLASS(E-F)_____

TARGET MOE_____

REQUIRED AVE. MOE(1) +36_____

MIN. MOE LIMIT_____

PROCESS OUT OF CONTROL FOR:

AVE. MOE ☐ MIN. MOE ☐

LAST MACH. SETTING	CURRENT MACH. SETTING	% CHANGE (4)
AVE.____ LP ____	AVE.____ LP ____	AVE.____ LP ____

PIECE NO.	AVE. MOE	MIN. MOE	PIECE NO.	AVE. MOE	MIN. MOE	PIECE NO.	AVE. MOE	MIN. MOE
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		
						TOTAL		
						AVERAGE (TOTAL÷3)		
						AVE. LAST REQ.		
						COMB. AVE.		

NO. PIECES BELOW MIN.	MOE

REQUALIFICATION CRITERIA

(1) SAMPLE AVE. MOE (COMBINED AVE. MOE FOR SECOND TEST) MUST MEET OR EXCEED REQUIRED AVE. MOE ABOVE.
(2) NOT MORE THAN 1 PIECE CAN HAVE MOE LESS THAN MINIMUM MOE LIMIT.
(3) IF SAMPLE MEETS REQUALIFICATION CRITERIA, PRODUCTION MAY CONTINUE. ENTER 0 IN LAST CUM. DIFF. LINE FOR NEXT COLUMN OF WHITE FORM.
(4) IF MACHINE SETTINGS WERE CHANGED MORE THAN 3%, THE LUMBER PRODUCED SINCE THE LAST "IN CONTROL" TEST IS OFF GRADE AND MUST BE REGRADED.
(5) IF THE SAMPLE DOES NOT MEET THE REQUALIFICATION CRITERIA, A SECOND 30-PIECE SAMPLE MAY BE TESTED (REPEAT OF ABOVE PROCEDURE). IF SAMPLE DOES NOT MEET REQUALIFICATION CRITERIA, THE PLANT SUPERVISOR SHOULD BE CALLED AND PRODUCTION STOPPED. NOTE TIME AND DATE OF PRODUCTION STOPPAGE.

DATA WORK SHEET

SAMPLE NO.	DEF	MOE	BREAK LOAD (LBS)	SAMPLE NO.	DEF	MOE	BREAK LOAD (LBS)
1				16			
2				17			
3				18			
4				19			
5				20			
6				21			
7				22			
8				23			
9				24			
10				25			
11				26			
12				27			
13				28			
14				29			
15				30			
TOTAL				TOTAL			
				TOTAL FROM C.1			
				COMB. TOTAL			

NOTES/COMMENTS

MILL_____

DATE_____
SHIFT_____
TESTED BY_____

M S R SEMI-ANNUAL TEST & ANALYSIS

ALTERNATE PLANT QUALITY CONTROL

SPECIES_____

SIZE_____

GRADE-CLASS (E-F)_____

TARGET AVE. MOE (1)_____

MIN. MOE LIMIT_____

MIN. TEN. LIMIT_____

CURRENT MACH. SETTING
AVE._____ LP _____

PIECE NO.	AVE. MOE	MIN. MOE	MIN. TEN.	PIECE NO.	AVE. MOE	MIN. MOE	MIN. TEN.	PIECE NO.	AVE. MOE	MIN. MOE	MIN. TEN.
1				11				21			
2				12				22			
3				13				23			
4				14				24			
5				15				25			
6				16				26			
7				17				27			
8				18				28			
9				19				29			
10				20				30			
								TOTAL			

NO. PIECES BELOW MIN.	MOE	TEN-SION

AVERAGE (TOTAL÷3)	
AVE. LAST REQ.	
COMB. AVE.	

TEST CRITERIA

(1) SAMPLE AVE. MOE MUST MEET OR EXCEED TARGET AVE. MORE ABOVE.
(2) NOT MORE THAN 3 PIECES CAN HAVE MOE LESS THAN MINIMUM MOE LIMIT.
(3) TEST RESULTS MEET OR EXCEED REQUIREMENTS? YES ☐ NO ☐

DATA WORK SHEET

SAMPLE NO.	DEF	MOE	BREAK LOAD (LBS)	SAMPLE NO.	DEF	MOE	BREAK LOAD (LBS)
1				16			
2				17			
3				18			
4				19			
5				20			
6				21			
7				22			
8				23			
9				24			
10				25			
11				26			
12				27			
13				28			
14				29			
15				30			
TOTAL				TOTAL			
				TOTAL FROM C.1			
				COMB. TOTAL			

NOTES/COMMENTS

WEST COAST LUMBER INSPECTION BUREAU

Date_____

Monthly Supervisor Report

MSR ALTERNATE QUALITY CONTROL COMPLIANCE

MILL NAME_____

MILL LOCATION_____

1. Pelster Tester:

   Good working condition Yes____ No____

   If "no", list problem and corrective action taken_____

   _____

   _____

2. Pelster Tester Calibration Check:

   Preload ____lbs. Test load ____lbs.

   Predicted Def. ____in. Actual Def. ____in.

   If actual deflection varies more that ±1% from the predicted deflection, delay further testing until a cause is found and corrected. List the corrective action taken below:

   _____

   _____

3. CUSUM Record Review:

   Were records available for inspection? Yes____ No____

   Are records in compliance with sections 6-10? Yes____ No____

   If "no", explain:_____

   _____

   _____

4. Has out of control condition occurred since the last inspection? Yes____
   No____

   If "yes", were the records reviewed with the plant supervisor? Yes____
   No____

5. Other comments:_____

   _____

   _____

"CUSUM" EXAMPLE

PART F

EXAMPLE OF CUSUM QUALITY CONTROL

FOR MSR LUMBER

General Information

Assume for the purposes of this example that a particular mill will be producing Douglas fir 2x6 MSR lumber. One of the grades for which you will be carrying out CUSUM quality control procedures is 1800f-1.6E. According to the suggested quality control procedures in the current MSR Standard, assuming that a proof loader is being utilized, quality control will be maintained on three properties of the lumber:

1) Average E (Edge, LS, or Pelster)
2) Minimum E (Edge, LS, or Pelster)
3) MOR or UTS

During each shift, five pieces of lumber per size/grade/species being produced will be sampled. The data from these samples will be analyzed and recorded according to the procedures described in the following sections. When the process (MSR production) is in control (on grade), all data will be recorded on the In Control forms. When the process is out of control, all data will be recorded on the Requalification forms.

Procedures

A) In Control.

1) Fill in all blanks above and below the data tables. Values for Min. E, Target MOE, CUSUM control unit, proof load and test span are taken from Tables 1-3 for the grade under consideration. For LS E or Pelster E, the appropriate adjustment factor from the qualification tests shall be included.

2) Enter date and shift the sample was taken in the column heading and in the column heading on the work sheet (reverse).

3) Enter deflection readings for test pieces in the work sheet table and convert to MOE, three digits. Record MOE values on data sheet.

4) Record breaking load (bending or tension) of any pieces which fail the proof load under the column marked "Load". Enter the total number of pieces failing under load column, in the line "No. Pcs. Below Min."

5) Count the number of pieces with MOEs less than the min. MOE and enter the number under MOE column on line "No. Pcs. Below Min."

6) Total the MOE values of the five test pieces, multiply by two, and enter the four-digit total on line "Test Ave."

7) Subtract the test average from the target MOE value. Enter on Difference line. Note: be sure to indicate the sign of the difference, either positive or negative. If the target MOE is larger than the test average, the difference will be positive. If the test average is larger than the target MOE, the difference will be negative.

8) Combine the difference value and the last CUSUM value and enter total on line "Current CUSUM".

9) If any of conditions 1-3 at the bottom of the table are met, the process is out of control; go to Requalification sheet.

10) If the current CUSUM is less than the CUSUM control limit, enter the number as last cum. difference in the next column.

B) Out of Control - Requalification Form.

1) Fill in all blank spaces at the top of the form. Information can be copies from In Control Form.

2) If any adjustment was made in grading machine calibration prior to selection of test pieces, record the change on the appropriate lines.

3) Enter deflections readings for the test pieces on the work sheet on the back side of the form. Convert to MOE and enter MOE values in the table.

4) Record the breaking load of any pieces which fail the proof load in the Break Load column. Enter the total number of pieces failing in No. Pieces Below Min. Table, under Proof Load.

5) Record the total number of pieces with MOEs below the min. MOE limit in the No. Pieces Below Min. Table under MOE.

6) Total the MOE values for the 30 pieces, divide by three, and enter the four-digit number on line marked Average.

7) If the average value does not meet or exceed the Required MOE, another 30-piece sample may be tested. The average of the two 30-piece samples must equal or exceed the Required MOE value.

C) CUSUM Graphs

Graphs of the CUSUM values provide an overall representation of how the production is fluctuating over long periods of time. It is easier to visualize general material characteristics and small changes in the process by a visual approach rather than by looking at a group of numbers. For this example graphs of the data above have been included for Average E, Minimum E and MOR (or UTS).

MILL ABC Lumber

DATE 10-25-91
SHIFT DAY
TESTED BY AJT

M S R
REQUALIFICATION

SPECIES D. Fir
SIZE 2 x 6
GRADE-CLASS(E-F) 1800f-1.6E

PROCESS OUT OF CONTROL FOR:
AVE. MOE ☐ MIN. MOE ☐ LOAD ☒

TARGET MOE 1550
REQUIRED AVE. MOE(1) +36 1586
PROOF LOAD LIMIT 1485
MIN. MOE LIMIT 131
PROOF LOAD: (CHECK ONE) ✓ BENDING ____ TENSION

LAST MACH. SETTING	CURRENT MACH. SETTING	% CHANGE (5)
AVE. 1.57 LP 1.28	AVE. 1.60 LP 1.31	AVE. 2 LP 2

PIECE NO.	MOE	BREAK LOAD	PIECE NO.	MOE	BREAK LOAD	PIECE NO.	MOE	BREAK LOAD
1	155		11	138	1420	21	155	
2	143		12	155		22	202	
3	162		13	162		23	162	
4	165		14	162		24	165	
5	158		15	180		25	159	
6	161		16	153		26	160	
7	160		17	159		27	145	
8	159		18	148		28	163	
9	147		19	168		29	151	
10	160		20	192		30	159	
						TOTAL	4808	

NO. PIECES BELOW MIN.	MOE	PROOF LOAD
	0	1

AVERAGE (TOTAL÷3)	1603
AVE. LAST REQ.	
COMB. AVE.	

REQUALIFICATION CRITERIA

(1) SAMPLE AVE. MOE (COMBINED AVE. MOE FOR SECOND TEST) MUST MEET OR EXCEED REQUIRED AVE. MOE ABOVE.
(2) NOT MORE THAN 2 PIECES CAN FAIL BELOW PROOF LOAD LIMIT.
(3) NOT MORE THAN 2 PIECES CAN HAVE MOE LESS THAN MINIMUM MOE LIMIT.
(4) IF SAMPLE MEETS REQUALIFICATION CRITERIA, PRODUCTION MAY CONTINUE. ENTER 0 IN LAST CUM. DIFF. LINE FOR NEXT COLUMN OF WHITE FORM.
(5) IF MACHINE SETTINGS WERE CHANGED MORE THAN 3%, THE LUMBER PRODUCED SINCE THE LAST "IN CONTROL" TEST IS OFF GRADE AND MUST BE REGRADED.
(6) IF THE SAMPLE DOES NOT MEET THE REQUALIFICATION CRITERIA, A SECOND 30-PIECE SAMPLE MAY BE TESTED (REPEAT OF ABOVE PROCEDURE). IF SAMPLE DOES NOT MEET REQUALIFICATION CRITERIA, THE PLANT SUPERVISOR SHOULD BE CALLED AND PRODUCTION STOPPED. NOTE TIME AND DATE OF PRODUCTION STOPPAGE.

DATA WORK SHEET

SAMPLE NO.	DEF	MOE	BREAK LOAD (LBS)	SAMPLE NO.	DEF	MOE	BREAK LOAD (LBS)
1	254	155		16	258	153	
2	276	143		17	248	159	
3	243	162		18	266	148	
4	239	165		19	235	168	
5	249	158		20	205	192	
6	245	161		21	254	155	
7	246	160		22	195	202	
8	248	159		23	243	162	
9	268	147		24	239	165	
10	246	160		25	248	159	
11	286	138	1420	26	246	160	
12	254	155		27	272	145	
13	243	162		28	242	163	
14	243	162		29	261	151	
15	219	180		30	248	159	
TOTAL		2367		TOTAL		2441	
				TOTAL FROM C.1		2367	
				COMB. TOTAL		4808	

NOTES/COMMENTS

NO. 340R-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.

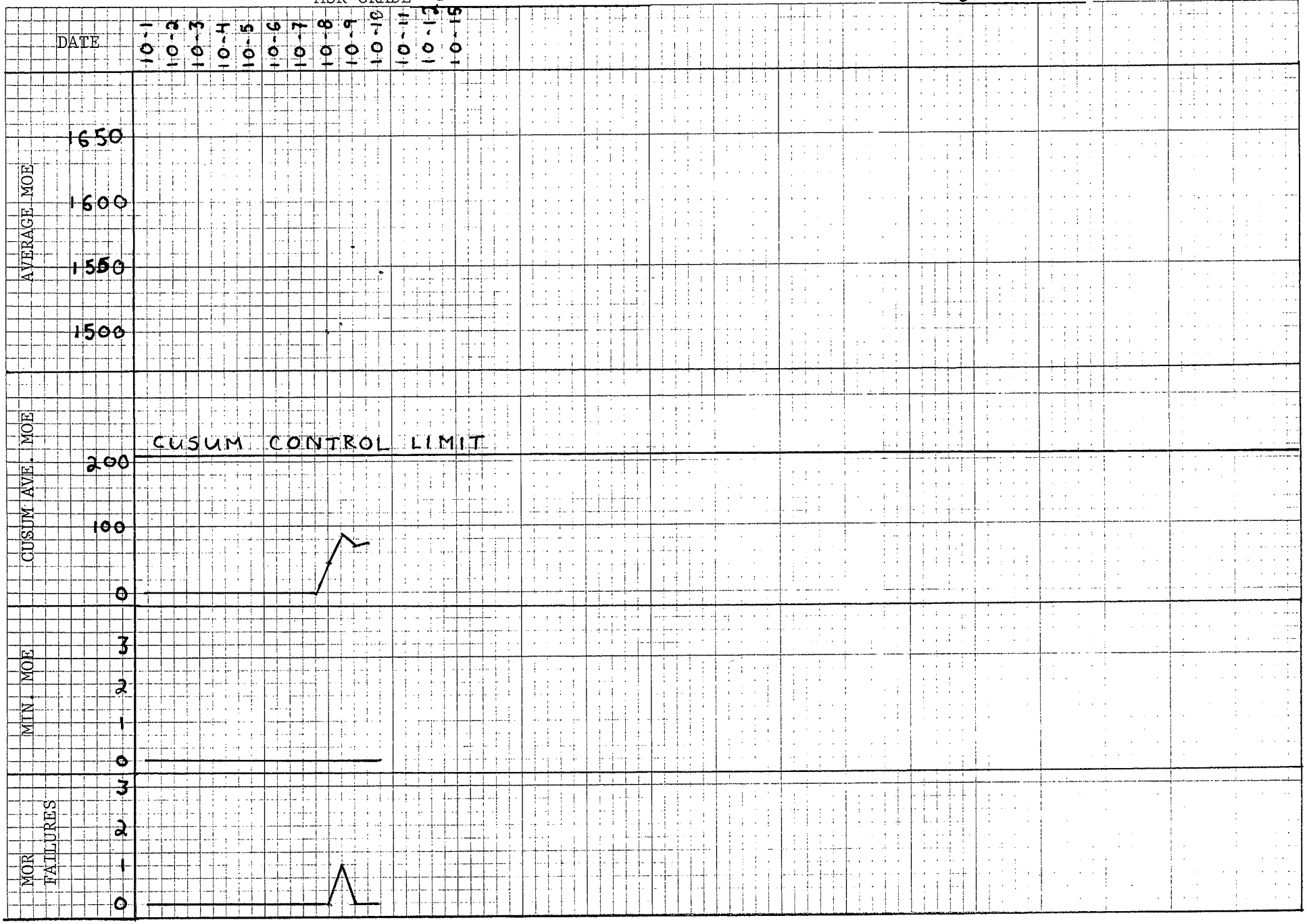
MSR CONTROL CHART

MSR GRADE 1800f-1.6E

SPECIES D. FIR

SIZE 2×6

MONTH/YR



MSR CUSUM CONTROL FORM

MILL _____

SPECIES _____

SIZE _____

Tested By: _____

Min. MOE = M = _____

CUSUM Control Limit = C = _____

Proof Load Limit = F = _____
(from Table)

MSR Grade _____

Proof Load: _____ Tension
(Check one) _____ Bending

Width	3"	4"	6"	8"	10"
Span (in.)					
Proof Load (lbs.)					

Line #	Date/Shift	/		/		/		/		/		/	
1	TEST VALUES	MOE[1]	Load[2]	MOE[2]	Load[2]	MOE[1]	Load[2]	MOE[1]	Load[2]	MOE[1]	Load[2]	MOE[1]	Load[2]
2	Piece No. 1												
3	No. 2												
4	No. 3												
5	No. 4												
6	No. 5												
7	Targe MOE												
8	Test Ave. (2 X Sum)	-		-		-		-		-		-	
9	Difference (line 7-line 8)												(5)
10	Last CUM. Dif.	+		+		+		+		+		+	
11	Current CUSUM (3)(4)												
12	No. Pcs. Below Min.												
13	Machine Settings	Ave.	Min.	Ave.	Min.	Ave.	Min.	Ave.	Min.	Ave.	Min.	Ave.	Min.

(1) If 2 or more of the 5 test values, or 4 or more of the last 30 test values are less than the minimum MOE; M= [ ], the process is OUT-OF-CONTROL. Go to REQUALIFICATION.

(2) If 2 or more of the 5 test values, or 4 or more of the last 30 test values are less than the minimum Proof Load; F= [ ], the process is OUT-OF-CONTROL. Go to REQUALIFICATION.

(3) If the total is more than CUSUM Control; C= , the process is OUT-OF-CONTROL. Go to REQUALIFICATION.

(4) CUSUM cannot be less than 0. If cumulative difference is less than 0, enter 0.

(5) Enter value as last CUM. Dif. on next sheet.