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History of Lumber Submissions under ASTM D 1990 since the North American In-Grade Testing Program

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Abstract

The framework of ASTM D 1990 has been used numerous times to determine design values for development of imported and domestic species since ASTM D 1990 was first utilized in 1991 to determine allowable properties for the major commercial species in North America. The interpretations of this standard and judgments applied to these submissions are described in this report. The major issues that have been sources of controversy in D 1990 are also summarized.

Keywords: American Lumber Stancard Committee, In-Grade Testing, Foreign Species Submissions, Design Value Calculations.

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History of Lumber Submissions under ASTM D 1990 since the North American In-Grade Testing Program

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Introduction

The North American In-Grade Testing Program—begun in the mid-1970s and completed in the mid-1980s—tested more than 70,000 full-size specimens of production lumber (Fig. 1). Sampling material that was representative of the total population of material over the entire geographic range of production in the grade for which it was produced commercially, lumber "In-Grade" was a key guiding principle of this program. A detailed summary of the objectives and procedures of this program can be found in the *In-Grade Testing of Structural Lumber Proceedings* (Green and others 1989). The North American In-Grade Testing Program Technical Committee that oversaw the execution of the program reached agreement on many of the fundamental issues with full-size In-Grade lumber testing. Most of these decisions ended up in two new ASTM International (formerly the American Society for Testing and Materials) standards—D 4761 and D 1990 (adopted in 1988 and 1991, respectively)—to govern how allowable properties for dimension lumber would be developed according to PS 20 (DOC 2005). These standards have become the template by which allowable properties for visually graded dimension lumber are developed. ASTM D 1990, however, as the word template implies, had a few holes in it. Some areas in the standard were intentionally left vague at the time of adoption, and other sections did not anticipate future varied uses of this standard. As a result, a number of interpretations have been required over the past 18 years of use.

In 2008, the American Lumber Standard Committee Board of Review (ALSC BOR) contracted with U.S. Department of Agriculture Forest Service, Forest Products Laboratory (FPL), to compose a General Technical Report that chronicals the history of submissions to the ALSC BOR since the adoption of D 1990. The resulting report presented here is divided into two sections. The first section contains a chronological history of interpretations of allowable property development for submissions before the American Lumber Standard Committee Board of Review that have occurred since D 1990 was adopted. It discusses the unique analysis and technical judgments that were made when guidance was not provided explicitly from D 1990. The second section, while repetitious, addresses major issues that have occurred multiple times and have been sources of controversy in D 1990 and the Forest Products Laboratory's positions on them. For individuals not familiar with ALSC BOR submissions, it may be best to start with the recurring issues section of the paper for an overview of the issues and then proceed with the chronological history of submissions.

Figure 1—In-Grade testing using portable equipment in 1980.

Background

ASTM D 1990 was first utilized in 1991 to determine allowable properties for major commercial species in North America. The framework of ASTM D 1990 has been used numerous times since it was first approved in 1991 to determine design values for development of imported species. Interpretations of this standard and judgments applied to these submissions addressed various unique circumstances that were presented with each new imported species submission.

In the early 1990s, the cut of timber from Federal lands in the West was substantially reduced following the spotted owl habitat controversy. This reduction, coupled with a desire for trade with Eastern European countries whose currency had little value, created a demand by U.S. industry for the importation of lumber from foreign countries to be used as structural lumber. At that time no adequate approval procedure existed for assigning allowable properties to lumber from non-Canadian foreign sources. Based on D 1990 principles and known property relationships, guidelines

were developed for applying D 1990 to foreign species—*Guidelines for Assigning Allowable Properties to Visually Graded Foreign Species Based on Test Data from Full Sized Specimens* (Green and Shelley 1992)—referred to as VSR Guidelines in the rest of this report.

The use of grade quality index (GQI) adjustments for Russian Spruce in 1994 for submitted data and grouping techniques are two examples of how interpretation of D 1990 has evolved since its first application in 1991. The North American In-Grade Program was developed on the basis of established commercial grading practices throughout the United States and Canada that had a long-established track record of yields and market mixes. Later, as potential graded lumber from other sources became available for testing, there was some uncertainty about how this production from smaller geographic regions and sub-regions would relate to North American practices. In some cases, limited inventory was available for selection of test samples or incomplete testing matrixes. Therefore, it was thought necessary to re-examine some of the resource and grade quality assumptions as well as the analysis approaches. A chronology of foreign and domestic lumber submissions involving D 1990 that have been put before the ALSC BOR is shown in Table 1.

Some of the procedures that were developed over the course of these submissions have been incorporated into ASTM D 1990; for example, a consensus procedure for GQI adjustment procedures has now been added, and cell-by-cell analysis of each grade size GQI is now believed to be a necessary method for ensuring representativeness of a given sample (ASTM D 1990–07). Work is continuing on revising the language of the grouping procedure. The authors hope that this report will provide valuable background information on the rationale behind previous decisions that were made by the ASLC BOR to permit commerce to continue while standards were being developed.

Chronologic History of Non-North American In-Grade Testing Program Submissions under ASTM D 1990

Almost immediately after the initial domestic values for allowable properties from the North American In-Grade program were adopted, West Coast Lumber Inspection Bureau (WCLIB) in March 1992 submitted a request for developing allowable properties for Douglas-fir from New Zealand (WCLIB 1992a). This would be the first of more than 35 subsequent submissions. The following section presents discussion of the various submissions that have occurred over the past 17 years. They are organized primarily chronologically based on the date of submission of the initial sampling plan for a given species and country. Within each section, the principal issues raised by the submissions are highlighted in an introductory paragraph, followed by a more in-depth discussion of these issues.

WCLIB Douglas-fir from New Zealand (1992)

In March 1992, WCLIB asked for approval to visually grade Douglas-fir from New Zealand with a 2 year monitoring program that involved determination of specific gravity and modulus of elasticity (MOE) (WCLIB 1992a). In April 1992, the BOR approved the sampling plan and required that WCLIB monitor production of lumber under the proposed program and that they submit the results of a monitoring program to the BOR (at the end of the 2-year period) to verify the initial sampling and approved properties. This test program was never completed, but it set the precedent for submitting sampling plans to the ALSC BOR before a foreign lumber property submission. The primary issue that came out of this submission was the importance of approval of sampling plans by the Board of Review (BOR) of the American Lumber Standard Committee (ALSC).

The Douglas-fir from New Zealand submission pointed out the need for some type of guideline to act as a blueprint for development of allowable properties for foreign lumber species based on D 1990 principles. In March 1992, David Green from the Forest Products Laboratory (FPL) and Brad Shelley from the West Coast Lumber Inspection Bureau (WCLIB) produced the VSR Guidelines. After revisions, this guideline was adopted by the ALSC BOR in 1992 as a method for developing allowable properties for non-North American species (Green and Shelley 1992). This guideline provided the mechanism that allowed free trade of foreign lumber into the United States yet assured the U.S. consumer that structural lumber from foreign species would meet requirements equivalent to those demanded of domestic species. A summary of the purpose and procedure was presented to the broader wood products community through the Forest Products Society in November 1994 (Shelley and Green 1994). The VSR Guideline was updated in 2006 (Green and Shelley 2006).

WCLIB Submission on Siberian Species (1992)

In June 1992, WCLIB submitted another sampling plan for the development of design values for Siberian lumber (WCLIB 1992b). Siberian species were to be evaluated according to provisions given in the draft VSR Guidelines. A review of the letters from FPL sent to the the ALSC BOR on the Siberian Submission to the ALSC BOR showed that the letters were different in tone than those that were made in the case of the WCLIB submission the year before for Douglas-fir from New Zealand. This time there were two principal issues of concern:

- Ensuring the representativeness of samples
- Monitoring

Ensuring Representativeness of the Sample—In the case of the Douglas-fir from New Zealand, much more information about the testing sample had been obtained in

Table 1—Chronology of D 1990 lumber submission after 1992

Meeting date	Request topic	Agency
April 1992	Sampling plan design values for Douglas-fir from New Zealand	WCLIB
June 1992–1993	Request for testing and monitoring program for Siberian species	WCLIB
June 1994	Sampling plan for Archangel Russian Spruce	NeLMA
October 1994	Sampling plan for Norway spruce from Sweden	WCLIB
July 1995	Austrian Whitewood (spruce) from Austria and Czech Republic	WCLIB
April 1997	Norway spruce from Lithuania	WCLIB
April 1998	Sampling plan for Romanian spruce	WCLIB
July 1998	Swedish retest	WCLIB
October 1998	Scots pine from Lithuania	WCLIB
January 1999	Sampling plan Douglas-fir larch and European larch from Austria, Czech Republic, FRG	WCLIB
April 1999	Sampling plan 2 by 4 Norway spruce and Scots pine from Germany, except Baden-Wurttemberg and Saarland	WCLIB
April 1999	Sampling plan Scots pine from Sweden	WCLIB
July 1999	Scots pine 2 by 4 from Germany, except Baden-Wurttemberg and Saarland	WCLIB
October 1999	Sampling plan for Norway spruce from Karelia region of Russia	NeLMA
October 1999	Sampling plan for Norway spruce and Scots pine from Latvia	WCLIB
October 1999	Norway spruce 2 by 4 from Germany, except Baden-Wurttemberg and Saarland	WCLIB
January 2000	Sampling plan 2 by 6 Norway spruce and Scots pine from Germany, except Baden-Wurttemberg and Saarland	WCLIB
July 2000	Norway spruce and Scots pine from Finland	WCLIB
October 2000	Scots pine from Kingdom of Sweden	WCLIB
October 2000	Scots pine from Estonia	WCLIB
April 2001	Norway spruce from Estonia	WCLIB
July 2001	Silver fir from Austria and Czech Republic	WCLIB
October 2001	Sampling plan silver fir from Germany, Switzerland, and France	WCLIB
October 2001	Sampling plan spruce and pine from Germany, Switzerland, and France	WCLIB
January 2002	Sampling and testing request for three pine species grown in South Africa	WCLIB
July 2002	Allowable properties for Norway spruce from Estonia, Latvia, and Lithuania	WCLIB
February 2003	Sampling and testing plan for Southern Pine from Argentina	SPIB
October 2002	Alternate GQI adjustment models	WCLIB
July 2003	Sampling plan for spruce from Romania and Ukraine	WCLIB
February 2004	Montane pine from South Africa (approved)	WCLIB
April 2004	Scots pine and Norway spruce from Romania and Ukraine (2003–2004)	WCLIB
April 2004	Southern Pine from Misiones Argentina	SPIB
February 2005	Determination of NGR grade lumber design values for Alaska yellow-cedar	WWPA
February 2005	Determination of NGR grade lumber design values for Alaska hemlock	WWPA
February 2005	Determination of NGR grade lumber design values for Alaska spruce	WWPA
March 2005	NeLMA eastern spruce balsam fir species group	NeLMA
November 2005	Pinus Sylvestris for Lithuania, Latvia, and Estonia	WCLIB
November 2005	Yellow-cedar and Sitka spruce in Canada	NLGA
December 2005	Northern species recalculation	NLGA
January 2006	Norway spruce from Estonia, Latvia, and Estonia	WCLIB
July 2006	Sampling plan Douglas-fir from France and Germany	WCLIB
February 2007	Swedish Scots pine recalculation	WCLIB

advance by WCLIB, so there were fewer questions about the "representativeness" of the sample that would be collected. In the proposed sampling plan for material from Russia, it was much more difficult for WCLIB to specify exactly where the sample lumber would come from and how many geographic locations would be represented. This difficulty was reflected in the approach WCLIB took with this submission. It was felt that once WCLIB actually had the sample in hand they may be able to say more about it. However, because it was apparently not practical for WCLIB to take a specific sample in Russia to help ensure representativeness, questions were raised that may have become moot once a sample arrived in the United States.

This submission was the "worst case" situation that David Green and Brad Shelley envisioned when they wrote the VSR Guidelines. It was a situation in which little is known about the properties in advance, and there is little ability to know where the sample originates. It was felt at that time that the procedure outlined in the Siberian submission by WCLIB was a reasonable approach, given the situation. There was, however, a real concern about the "representativeness" of the initial sample. In letters to the ALSC BOR, Dave Green discussed at length the importance of representativeness. These letters are summarized in the following paragraphs.

Representativeness is a critical concern in D 1990 because all other calculations and procedures are based on the assumption that the lumber being tested is representative of future production. For the special case of a foreign species, VSR Guidelines attempt to compensate somewhat for our possible lack of knowledge about how representative the sample might be by requiring a wider range of quality in the lumber to be tested than just the grades to be produced. However, the VSR Guidelines state that at least two geographic locations should be sampled. In FPL's discussions with WCLIB, Brad Shelley indicated that he did not know if he would be able to tell if there were more than one geographic location represented in the original sample. FPL encouraged WCLIB, if at all possible, to have more than one location represented. However, if WCLIB could not determine this information on the first shipment, then FPL suggested WCLIB also test some light-framing grades and have a more extensive monitoring program for the first 2 years as reasonable.

Although not specifically stated in the testing proposal, FPL assumed that MOE and modulus of rupture (MOR) measurements will be taken on all lumber tested. If not, FPL urged the ASLC BOR that this be made a requirement. Otherwise, no estimate of the average MOE of the lumber would be available.

Monitoring—The proposal from WCLIB stated that the grading agency would monitor the quality control data every 6 months and would discontinue the added monitoring after 2 years if there were no substantial deviations from the original sample. FPL suggested that because of the nature of the source of lumber and our lack of knowledge, the WCLIB should submit a summary of the quality control data to the BOR and request permission to discontinue the accelerated monitoring program.

FPL also pointed out that the proposed monitoring program suggested by WCLIB did not appear to require that any pieces be broken and only monitored physical properties. This type of program would not let FPL judge the adequacy of the property assignment at the end of the 2-year period.

Given the uncertain nature of the original shipment and the proposed 2-year intensified monitoring program, FPL suggested that some specimens be tested to failure to give better data on which to make judgments during the 2 years. FPL did not believe that all specimens needed to be broken for all test modes to provide the needed information. It was felt at the time that it would be adequate to break samples only in bending. Further, it was suggested that only 2 by 8's, or a smaller width closest to 2 by 8, be broken. The rationale for this was that 2 by 8 is the size closest to the "characteristic size" specified in D 1990. Because this was part of the interim monitoring program, it would also seem acceptable to collect the specimens over a period of time (perhaps 6 months) and then break the specimens all at once.

Even though considerable discussions about sampling and monitoring took place during 1993, allowable property values for Siberian lumber were never developed. Allowable properties for another Russian submission involving Norway spruce lumber from the Archangel region of Russia, however, would be the first foreign lumber properties that would be developed and approved by the ALSC BOR.

NeLMA Russian Spruce Submission (1994–1995)

The first foreign dimension lumber submission that completed the process of development of allowable properties by using the VSR Guidelines was a submission by the Northeast Lumber Manufacturers Association (NeLMA) for Russian Spruce from the Archangel region of Russia tested in MOR and MOE. In spring 1994, Wood Advisory Services (WAS), on behalf of NeLMA, submitted a "Request for Approval of the Procedures for Assigning Allowable Properties to Russian Spruce (*Picea abies*)" (WAS 1994a). This request sought to develop allowable properties for 2 by 4 and 2 by 6 spruce lumber from the Archangel region of Russia. This submission laid the groundwork for how many subsequent submissions would be handled. It raised nine principal issues:

- Sample size of size–grade cell
- Representativeness of sample
- Use of D 1990 F_t and F_c equations on foreign temperate softwoods
- Not a full test matrix
- Data failed the GQI tests, so something needed to be done
- Elimination of pieces with 100% strength ratios in GQI evaluations
- Quality control program
- Dry/green ratio adjustments for clearwood strength values
- Correct adjustment for randomly oriented c-perp specimens

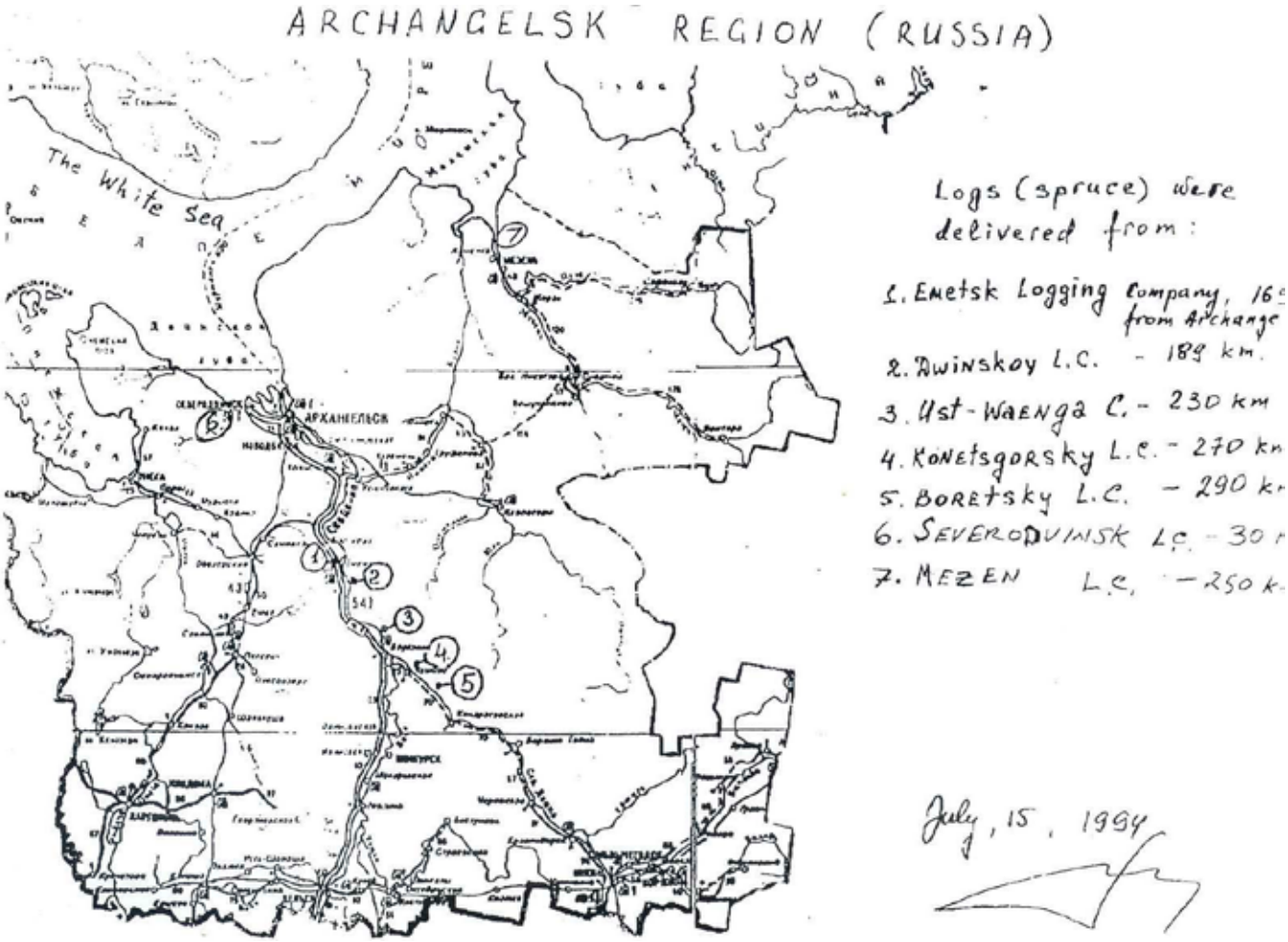

Figure 2—Location of logs collected for Archangel Russian Spruce Sample (figure from WAS 1994b).

The Wood Advisory Services allowable property calculations were submitted first on September 19, 1994, and then revised two more times after comments (WAS 1994b,c, 1995).

Sample Size of Size–Grade Cells—WAS had proposed to sample 360 pieces per grade–size cell for the Russian Spruce material. This sample size was similar to the target sample sizes for major domestic North American species. FPL made a judgment that the proposed sampling matrix (360 pieces each of S.S. and No. 2 grade 2 by 4 and 2 by 6 lumber) was sufficient for establishing flexural properties of 2 by 4 and 2 by 6 lumber according to procedures given in ASTM D 1990. It was noted by FPL, however, that allowable properties could be assigned only to these two sizes (approval of only two sizes was requested by NeLMA). This submission points out one of the areas for which procedures are not provided in the current language of standard D 1990. The only clear way to assign properties to all sizes of lumber in D 1990 is to have a "full" matrix of two grades and three sizes.

Representativeness of Sample—WAS felt that the proposed sampling procedure presented would provide a representative sample of Russian Spruce from western Russia as discussed in VSR Guidelines. WAS argued that although the lumber was to be obtained from one mill, it was determined that the logs were obtained from throughout the sampling region by floating or barging the logs down the river drainage basin shown in the proposal (Fig. 2). FPL stated that this type of sample might not be appropriate for the entire growth range of the species group but should be adequate for the reduced sampling and production range proposed. The sampling plan for Russian Spruce was approved at the July 21 meeting of the ALSC BOR.

Only bending tests of lumber were to be conducted in this testing program. Therefore, tension and compression values for lumber properties would have be inferred from bending test results. Questions arose about the applicability of the compression and tension from bending test equations available in D 1990.

Use of D 1990 F_t and F_c Equations on Foreign Temperate Softwoods—The geographic distribution of the species suggested that this submission be classified as a "temperate softwood" as discussed in the VSR Guidelines. Clear wood test data obtained from the Russian Spruce lumber indicate

Table 2—Observed and recalculated GQI and minimum allowable for each grade–size combination

Size	Grade	Submission	Recalculated	Allowable range	Adjustment
2 by 4	SS	64	73	(60)–65–(70)	0.959
	No. 2	54	54	(40)–45–(50)	0.926
2 by 6	SS	71	74	(60)–65–(70)	0.946
	No. 2	46	46	(40)–45–(50)	—

that the properties are typical of that reported by the Building Research Establishment (BRE 1977) and are similar to those of North American spruces. These data added further confidence to the conjecture that D 1990 procedures are applicable to Russian Spruce. FPL therefore believed that it was appropriate to use the conservative equations of ASTM D 1990 to estimate F_t and F_c from the bending information. The data for this submission were submitted in December 1994 (WAS 1994c).

Not Full-Size Test Matrix—The data being collected for this submission were for only two grades and two sizes and not a full test matrix of two grades and three sizes. In discussing this submission with the ALSC BOR, FPL pointed out that the cell-by-cell approach used by WAS for NeLMA is acceptable under D 1990. There was, however, an alternative approach that could have been employed in calculating the number that would have been just as acceptable—a matrix approach, whereby the two sizes for a given grade would be combined to establish the characteristic value. This is similar to the method that is employed with a full matrix of three sizes and two grades. A comparison of 2 by 4 allowable properties determined by these two methods (cell-by-cell and matrix) shows that the two methods produced allowable properties for the two sizes with little difference. There were several advantages, however, to the matrix approach outlined to the ALSC BOR by FPL:

- The MOE properties in the NeLMA submission had a size effect for MOE. A great deal of data suggests that there is no consistent size effect related to MOE. The matrix approach eliminates any apparent size effect created in MOE as a result of calculating MOE on a cell by cell basis.
- The matrix approach would moderate the shift in 2 by 4 and 2 by 6 values that would occur if in the future one or more additional size is added.
- The matrix approach increases the sample sizes and therefore the stability of the tails of the data.
- Finally, the size models in ASTM D 1990 were a compromise across species. Data checks were incorporated in the standard to help moderate differences between species. A cell-by-cell approach to developing allowable properties for test data with two grades and two sizes renders the 9.3 and 12.6 data checks to be meaningless.

In their response back to ALSC BOR, FPL also pointed out that the current version of ASTM D 1990 was clear on how to handle development of allowable properties from an individual cell and a full matrix of three sizes and two grades. No clear guidance, however, was given for handling two sizes and two grades. In their opinion, the committee on wood D07's section ASTM D 07.02.01 "solid sawn lumber" should consider a modification of ASTM D 1990 standard to clarify which method should be employed. FPL recommended that in the interim the matrix approach be used for this submission. NeLMA agreed to calculate their allowable properties using the matrix approach, and test data were adjusted to a 2 by 12 "base allowable property" and then moved back to 2 by 4 and 2 by 6 by the appropriate size factor.

GQI Adjustment—The submission for spruce from the Archangel region of Russia was the first time that GQI calculations became an issue. This was also the first time that the order of application of the GQI reduction was suggested. GQI was introduced into the ASTM D 1990 to calibrate the test sample results to the National Grading Rule (NGR) grade description. It is used to check the representativeness in all In-Grade sampling programs.

When the submission Recommended Allowable Properties for Russian Spruce (*Picea abies*) by NeLMA dated September 19, 1994, was reviewed, FPL commented, "First and most significantly, there appeared to be a Grade Quality (GQI) calculation error in pieces that have a failure code 20 (combination knots). For example a failure code of 2015 is listed in the submission to have a GQI of 80.2 while FPL determined the GQI to be 87.5. The conversion of all the failure code 20 combination knots will result in an overall increase in the 5th percentile point estimate GQI for two of the four test cells calculated. The increased GQI meant that three of the four cells tested are now outside of the allowable range and require adjustment." (FPL 1994) This original and recalculated GQI values are given in Table 2. The failure code information was corrected, and a revised version was submitted (WAS 1994c). In this newly revised submission, some differences between the 2 by 4 and 2 by 6 data, as pointed out by WCLIB in their January 23, 1995, letter, were also observed by FPL. FPL assumed that perhaps there was some "source" effect between the 2 by 4's and 2 by 6's. FPL suggested that perhaps this illustrates the need for continued quality control.

WCLIB also correctly pointed out in their January 23 letter that ASTM D 1990 does not give specific directions on how to make adjustments to strength properties if the GQI differs significantly from the minimum value stated in the NGR (note 7 of D 1990). Sampling of lumber in the In-Grade program for domestic species was based on the grades "as produced." Therefore, it was possible for specimens to be in the grade for non-strength-reducing reasons. Initial analysis of the strength ratios associated with the in-grade data yielded 5th percentile strength ratios (the appropriate GQIs, in this case) that were higher than would have been observed if we had sampled pieces on grade just for strength-reducing reasons. Further discussion led to the conclusion that it was more appropriate to discard those pieces that had 100% strength ratio. Analysis of this reduced data set indicated that all grade–size combinations had a 5th percentile GQI that was no higher than 5% above the minimum specified for the grade (there were some data sets that were exactly 5% above grade minimum), thus the recommendation in paragraph 8.2 (and note 7) of D 1990. But as WCLIB pointed out, the ASTM committee was unable to agree further on what to do if a future sample were outside the 5% limit.

The NeLMA-presented sample was taken with the same philosophy as that of the U.S. data: pieces accepted as on grade for all reasons, not just strength-reducing reasons. In three of four test cells, however, the GQI was above the 5% allowed by paragraph 8.2 of D 1990. Therefore, a method for adjusting the data was required.

Two methods for calculating the adjustment factor for GQI were discussed—mean strength ratio adjustment, which reduced the data by a factor determined using the mean target GQI values, and upper bound strength ratio adjustment, which reduced the data by a factor determined using the mean target GQI value plus 5%. Both methods used the equation, Target GQI/Test, but involved different choices for the target.

In both cases, the actual GQI for the sample was the Test in the equation. For the mean strength ratio adjustment method, the Target GQI in the equation was the mean GQI for the target grade. For the upper bound strength ratio adjustment method, the Target GQI in the equation was the mean GQI for the grade plus 5%. So, for example, if a sample was determined to have a Test GQI of 71 for an expected mean GQI of 65, the mean strength ratio adjustment would be 65/71 = 0.92, and the upper bound strength ratio adjustment would be 70/71 = 0.99. FPL pointed out that one interpretation of adjusting GQI would be a more conservative number by adjusting to the middle of the GQI range (minimum GQI of the grade); "evidence" from D 1990 is somewhat ambiguous. Two different arguments were put forth for choosing one over the other. On the one hand, ASTM did not require adjustment of previous In-Grade data for a grade–size combination GQI that was exactly at the limit of the GQI range. Thus, it could be argued that it is harsh to adjust a GQI that was 6% higher than the grade mean GQI to the grade mean GQI when a data set that was 5% high had no adjustment required. But on the other hand, when determining allowable properties for grades with little or limited data, D 1990 uses the minimum strength ratio for the grade, not 5% over the value for Construction, Standard, and Utility. For No. 1 grade, 80% of the interpolated value was used (the No.1 value could also be set equal to the No. 2).

After all the discussion of GQI, it was decided that GQI reductions should occur before the adjustments of ASTM D 1990 section 8.3 to all the data. It was also decided that reduction in GQI must be applied to the MOE data, which was not the case in the originally submitted data. The interpolation of No. 1 values for tension and compression calculated by NeLMA was also found to be inconsistent with previous D 1990 submissions. The method for adjusting data would be based on an adjustment factor going to the upper bound of the GQI limit. The No. 1 values for tension needed to be multiplied by 0.85 and compared with the No. 2 value. If it is lower than the No. 2 value, the No. 2 value should be used. The No. 1 value for compression needed to be multiplied by 0.95 and compared in the same manner against the No. 2 value. In its original submission, NELMA had done a straight line interpolation.

Quality Control Procedures—As with foreign lumber submission discussed previously, FPL expressed a concerned about the need for quality control procedures for the Russian Spruce allowable property values. The VSR Guidelines require some additional quality control of shipments to ensure that lumber quality is similar to that used in the original qualification sample. This was included because it was recognized that we might not be able to ensure the representativeness of a sample from a foreign country with the same confidence that we could for U.S. species. The test results for Select Structural grade (SS) 2 by 4 (not 2 by 6) in the Russian Spruce are comparable to those seen in the U. S. In-Grade test program for Eastern spruces, but the No. 2 results were considerably different than the spruce values observed in the In-Grade program (Table 3). It was suggested by NeLMA that this was because much of the No. 2 material was placed in the grade due to non-strength-reducing defects. FPL pointed out that this difference, however, is not contrary to the In-Grade testing philosophy. Presumably all the No. 2 material was placed in the No. 2 grade according to the NGR.

Some further analysis of the submitted data investigated the reason for material being placed into the No. 2 grade. For the No. 2 grade 2 by 4 and 2 by 6 lumber, 56% and 44%, respectively, were placed in No. 2 because of wane and warp, whereas the strength-reducing defect for this material was in almost all cases SS. It is, therefore, not surprising that little difference exists between the Russian Spruce allowable property results for SS and No. 2 results. In addition, this material was very slow grown and dense. A question was

Table 3—Comparison of Russian Spruce to In-Grade Eastern Spruce

		Russian Spruce				Eastern Spruce[a]			
Size	Grade	F_b (lb/in^2)	Specific gravity	MOE ($\times 10^6$ lb/in^2)	Rings per in.	F_b (lb/in^2)	Specific gravity	MOE ($\times 10^6$ lb/in^2)	Rings per in.
2 by 4	SS	2,300	0.43	1.5	28.6	2,150	0.42	1.45	12.5
	No. 2	1,750	0.41	1.3	21.9	1,150	0.41	1.22	14.6
2 by 6	SS	1,950	0.44	1.4	18.1	1,500	—	1.41	11.6
	No. 2	1,450	0.42	1.4	15.7	1,100	—	1.18	12.4

[a]15% moisture content (MC) values from Mechanical Properties of Visually Graded Lumber:Volume 1, A Summary; 2 by 4 values adjusted to 2 by 4 at 149 in. and divided by 2.1; 2 by 6 values adjusted to 2 by 6 at 162 in. and divided by 2.1; MOE values adjusted to uniform load by multiplying by 1.024.

raised about the possibility of future material having much larger proportions of the grade having more severe strength-reducing defects.

In their response, FPL commented that as long as this quality level is maintained there is no technical reason for disputing the No. 2 values as long as a rigorous quality control effort was undertaken on the first few shipments. NeLMA was asked to propose a quality control program to monitor incoming shipments during an initial period. After the completion of this period, the BOR would reevaluate the frequency and complexity of the monitoring effort. At the point at which the sampling plan was proposed, no lumber had been produced from a foreign species, so we had no real data to use to evaluate monitoring needs. For consistency, it was suggested that the ALSC BOR may consider previous requirements for monitoring properties assigned to visually graded foreign species.

As discussed previously, in 1992 WCLIB had asked for approval to visually grade Douglas-fir from New Zealand and Russian species from Siberia with a 2-year monitoring program that involved determination of specific gravity and MOE. In April 1992, the BOR approved these sampling plans and required that WCLIB monitor production of lumber under the proposed program and that they submit a monitoring program to the BOR to verify the initial sampling and approved properties. As a first position on monitoring for the Archangel region, FPL suggested that the monitoring program follow previous BOR decisions.

FPL suggested that questions concerning shipments from other geographic areas besides the Archangel region of Russia be considered in a future BOR submission. The present submission raised several questions about possible shipments from alternative geographic regions. It was felt that once the exact nature of possible shipments in the future are known, FPL would be in better shape to comment on proposed procedures for sampling and analysis.

In response to FPL's initial concerns about monitoring material, NeLMA proposed a quality control program that would destructively test material for the first year of production of the December 28, 1994, submission material. It was agreed upon by NeLMA and FPL that the purpose of the quality control program was to ensure that the design values obtained from the qualifying sample were truly representative of future shipments. FPL also agreed that destructive tests on each shipment should be conducted for some initial time period. It was believed that because there was a lack of knowledge about the potential variability of lumber coming from foreign sources compared with material from domestic production, collecting some additional data over a period of time was a prudent suggestion. However, FPL preferred to see a more straightforward quality control program than the one suggested in the NeLMA submission.

In their submission of December 27, 1994, NeLMA proposed some destructive testing for an initial period. NeLMA proposed to accumulate data for at least 1 year, or until at least 360 specimens had been accumulated per grade–size cell, whichever took longer. FPL commented that the target sample size for a single species is 360 per cell. But cutting locations could change with the season of the year. Thus, sampling for at least 1 year would help ensure that this variability is included in the eventual property estimate.

NeLMA proposed that at the end of the initial monitoring period they use the data from the initial qualifying sample plus the data taken from the first 20 pieces in each shipment to evaluate the need to revise the design values. FPL commented that depending upon the rate with which data were accumulated; NeLMA could provide informational data to the BOR at an interim period, say half way through.

NeLMA proposed that after the data had been evaluated at the end of the initial quality control period, then they only monitor the quality of incoming shipments nondestructively—unless NeLMA detects a need to requalify. FPL commented that, for example, rings per inch or MOE could be monitored as potential indication of a reduction in material quality from that seen in the initial period.

Many comments were generated by NeLMA's proposed monitoring program. FPL's letter to the BOR of January 19, 1995, recommended a quality control program that we felt was more in line with NeLMA's objective of validating the representativeness of the original sample. A January 23, 1995, letter from WCLIB expressed concern that the proposed destructive testing of the December 27 NELMA

submission was excessive, whereas a January 27, 1995, letter from Western Wood Products Association (WWPA) felt the opposite and suggested even larger samples sizes for destructive testing as being necessary.

The WWPA letter of January 27, 1995, suggests the need for a uniform and consistent sample size to be collected on each shipment for an extended period of time. FPL agreed (and proposed this in its January 19 letter) that the quality control program should continue for at least a year and should contain a minimum of 360 pieces. FPL's letter suggested 20-piece samples be used as a minimum. WWPA's letter suggested a sample size of 40. FPL commented that if there is a desire to get some idea of a tolerance limit for a given shipment, then a compromise of 30 pieces could be used. (ASTM D 2915 table 2 shows that 28 pieces are required to calculate a 75% tolerance limit. A 30-piece sample would allow for an occasional "lost" piece.)

After considering all the various parties' concerns with monitoring, the ALSC BOR approved the following monitoring provisions for Russian Spruce from the Archangel region of Russia at its February 1995 meeting. NeLMA accepted sampling 10 bundles of each width of lumber from throughout a shipment to represent the anticipated range of quality of the lumber in the shipment by removing two pieces of "on-grade" lumber from each bundle for testing for each grade–size–test mode category (therefore a minimum of 30 pieces per shipment). The two pieces should not be selected from the top or bottom rows (to avoid pieces with shipping damage) and should not be within two boards of each other (to avoid consecutive samples). These data would be accumulated for at least 1 year, or until 360 specimens per grade–size cell have been accumulated, whichever takes longer. At the end of the initial monitoring period, the data from the initial qualifying sample plus the data from the first 20 pieces in each shipment would be used to evaluate the need to revise the design values. After the data from the initial quality control period had been evaluated and passed, then and only then could incoming shipments be nondestructively monitored for quality—unless NeLMA detected a need to requalify.

Discussion of Dry/Green Ratio for Clear Wood Properties—Another issue raised with this submission was whether the dry/green ratio for clear wood test data could be used for adjusting shear and compression perpendicular values. WCLIB's January 23, 1995, letter expressed concern about the use of average dry/green ratios in adjusting shear and compression-perpendicular-to-grain data. The WCLIB compression perpendicular submission of December 19, 1991, used a dry/green ratio for all MSR species, DF, HF, ES, and Southern Pine in developing predictive equations (WCLIB 1991). It was also noted that the average trend of dry/green ratios listed in D 2555 have a well-behaved and consistent pattern, which seems to be appropriately applied and is not unlike the philosophy previously used in determining MSR c-perp relationships. The ALSC BOR accepted the use of dry/green ratios for adjusting c-perp and shear based on tabulated spruce values.

Appropriateness of 1.67 Factor for c-perp—The WCLIB letter of January 23, 1995, raised questions about the appropriateness of the 1.67 factor for adjusting the compression-perpendicular-to-the-grain data. It was pointed out by BOR member Dr. Ethington that when calculating allowable properties for Duhurian larch data, obtained by Dr. Ethington, the 1.67 factor was not needed for samples cut in random orientation. Therefore, the application of the factor by NeLMA to their data would be conservative. Hence, the 1.67 factor usage was allowed.

Final ASLC BOR Decisions—At the February 3, 1995, meeting of the ALSC BOR, after all these issues were discussed in great detail over the course of a little over a year, the BOR rendered the following decisions with regard to the NeLMA Russian Spruce submission:

- The 2 by 4 and 2 by 6 lumber from the Archangel region of Russia will be called Russian Spruce (Archangel).
- Adjust for high GQI using an adjustment factor calculated by the formula shown below proposed by Wood Advisory Services:

  $$\text{New property value} = ((\text{GQI target} + 5\%)/(\text{Actual test cell GQI})) \times (\text{Current property value}) \quad \text{Eq. (1)}$$

- Request that ASTM task group investigate filling in holes in ASTM D 1990.
- The monitoring program will be destructive, with 30-piece sample size until 360 or 1 year, whichever is longer.
- The dry/green ratio adjustment will use only spruces.
- The 1.67 factor will be used to adjust c-perp data.

With these decisions, the era of foreign lumber submission based on the VSR Guidelines began. Note: No lumber was ever sold using this approach, because changing economic conditions in Russia made it easier to ship material to Japan.

WCLIB Norway Spruce from Sweden (1994–1999)

At the same time much of the discussion of Russian Spruce was going on, a wave of foreign lumber submissions by WCLIB began that would continue for 10 years. On October 11, 1994, a sampling plan was submitted by WCLIB to determine allowable properties for Norway spruce from Sweden (WCLIB 1994). Testing and review of this program took over 2 years. Some of this was caused by the delay in determining how to handle a lack of failure code information in the test data that were submitted. The other major factor causing a delay in acceptance of allowable properties for spruce from Sweden was the lengthy

discussion of grouping test results for foreign species. When the allowable properties for Swedish Spruce were first calculated by WCLIB, they were based on grouping test information from Sweden and the Archangel region of Russia. This was the first time that the issues of grouping of foreign species and collecting additional data were brought before the ALSC BOR. It resulted in extended discussions of concerns with grouping. Allowable properties for the Swedish Spruce would not be approved by the ALSC BOR until July 1999. They were further revised in 2007 after new equations for GQI adjustment were adopted in D 1990. The principal issues raised with the Swedish Spruce were the following:

- Sampling plan
- Lack of failure code information
- Grouping with an existing species group
- Collection of additional data
- Originally proposed GQI adjustment procedure
- Assigning 100% GQI to missing GQI data
- Too small a sample size for individual cell data

Sampling Plan—The major comments FPL had on the Swedish sampling plan were that (1) a discussion should be included in the sampling plan explaining the documentation of and procedures to be used for testing machine calibration because some type of a machine adjustment may be required; (2) additional data should be collected during testing: strength-reducing defect codes and pith or no pith (also, moisture content (MC) should, if at all possible, be based on ovendry evaluation, not a moisture meter reading); and (3) there should be more discussion about how the development of shear and compression perpendicular to grain results will be handled. These comments reinforced the minimum information that is required in a proposed sampling plan.

Lack of Failure Code Information—The primary difficulty faced with WCLIB's Swedish submission was the lack of good failure code information. WCLIB's cooperators in Sweden failed to obtain a failure code at point of failure on a high percentage of the lumber tests (page 8 of the submission, WCLIB 1997). Instead, they obtained a failure code at the location of the minimum MOE as determined by the Cook–Bolinder grading machine. Only when the minimum MOE location coincided with the failure location could the specified GQI be obtained. In past submissions, a failure code for a specimen may have occasionally been lost, but the percentage of pieces without failure codes was small. In this submission the percentage of pieces with no failure code is substantial (Table 4).

This lack of failure code information presented a major problem in determining allowable property values for the Swedish Spruce as the failure information is used in ASTM D 1990 to calculate a GQI which is normally used to measure the grade representativeness of the sample. Without adequate failure code information, it is impossible to get a good sense of the representativeness of the sample. WCLIB recognized this problem and proposed an adjustment to the GQI after the missing grade quality indexes were assigned a value of 100%.

When WCLIB supplied a report to the BOR in 1996, FPL still had concerns about the report and the analysis of these data, expressed in a letter discussing the WCLIB submission "Proposed Design Values for Norway Spruce (*Picea abies*) from Sweden" in September 1996. FPL expressed frustration with the lack of failure information (985 specimens were tested in MOE, but only 195 had GQI information) and considered it to be a serious failure to follow past practices and the spirit of ASTM D 1990. The authors of this report recognized this problem and proposed an adjustment to the GQI values calculated. In such circumstances, FPL believed that only a very conservative procedure different from the one proposed by WCLIB could be justified. It was felt that the concerns about representativeness were sufficiently severe to cause FPL to report to the ALSC BOR that the initial design values for Swedish Spruce proposed by WCLIB were not appropriate based on the information provided with the report. Struggles with how to deal with these GQI concerns continued on for three more years.

Grouping with an Existing Species Group—As a way to handle the lack of GQI information in their submission, WCLIB proposed grouping the Swedish test data with already approved Russian Spruce data from the Archangel region. As submitted and using the revised data, FPL did not believe the properties derived from the grouped data met the same interpreted requirements of D 1990, as was previously applied to domestic species. Because these interpretations are not all specifically addressed in D 1990 section 10, FPL included some background information following in their "responses" to the BOR.

As interpreted by FPL, for domestic species, D 1990 procedures do not allow a small data set for a weaker "species" to be grouped with a large data set for a stronger "species" and assigned two design values for the two subsets. Although not intended in this submission, such a procedure could result in sample sizes much less than those judged necessary to obtain a "representative" sample for domestic species under D 1990. FPL felt that allowing such a procedure could allow future submissions to group some species with an existing species just to avoid obtaining a larger, more representative, data set.

It was pointed out by FPL that if the Swedish and Russian data were to be grouped, the MOR values would be controlled by the Swedish data. For the data provided, the MOR point estimates and tolerance limits for the data adjusted to the "characteristic size" of 2 by 8, with a span of 144 inches, the group value should be based entirely on Swedish Spruce values because the Swedish Spruce values were highly

Table 4—Tabulation of percentage of pieces with no failure information

Grade	Size	This submission	In-Grade Douglas Fir	In-Grade Southern Pine	In-Grade Hem–Fir
SS	2 by 4	59.5	0	0	0
	2 by 6	37.6	—	0	—
	2 by 8	50.6	0	0	0
	2 by 10	—	0	0.2	0
No. 2	2 by 4	50.5	0	0	0
	2 by 6	49.8	—	0	—
	2 by 8	37.8	0.2	0	0
	2 by 10	—	0	0	0

significantly different from the Russian values. Thus, no matter how FPL looked at the chi-squared values for grouping, the same conclusion was drawn: MOR, UTS, and UCS design values would be calculated using the Swedish data.

The following background information on grouping was supplied to the BOR at the time of the Swedish Spruce submission. Allowable property calculation sample sizes for species groupings or individual species to this point in the United States have been about 360 pieces per grade–size cell for domestic species. There were two major groupings that were done with U.S. In-Grade data: SPF(S), where all species in the grouping were grouped together grouped, and Western Woods, where four species were used to establish the properties for the group and additional species of demonstrably higher properties were added for marketing convenience.

FPL felt, as D 1990 was written in the standard book of 1996, there were just three ways to get allowable properties for foreign species:

- Sample a full matrix with 360 pieces per size–grade cell (smaller if restricted geographic region involved).
- Sample a full matrix and show that your values are higher than those of some species group to which you would be added (DF in Western Woods grouping is an example).
- Form a marketing group using the grouping criteria in ASTM D 1990, which requires that all species used to create it take on the design values of the grouped species.

FPL was very concerned about grouping two species and letting each claim different design values. It was believed that this was not equivalent to the way U.S. species had been handled.

It was pointed out that in past submission, when the intent was to market a species by itself, U.S. species had to meet a minimum sample size (suggested as 360 for major species having a large geographic distribution, as stated in note 6 of D 1990). FPL also reminded the BOR that it had historically suggested shooting for a minimum of about 200 if there is a reduced geographic area (or limited standing timber volume). DF(S) and minor Southern Pines constitute the absolute minimums accepted for a species intended to be marketed alone. When "grouped," approximately 60 pieces were allowed per individual species, size, and grade cell. But if a species in the group were to be listed separately, its design value is that of the group. To allow a group to be formed while not require all species used to create the group to take on the grouped values could create an inequity with the current U.S. species groups. Any species with 60 pieces per size–grade cell could find another species to group with, do the grouping, and perhaps get a higher design value than it would get by itself. When this species is sold as the only member of this "group," the design value it uses would not meet the requirements that were met by existing species groups.

Another concern involves potential problems when a larger data set is grouped with a small data set. In this case the properties of the small data set may have little effect on the properties of the larger data set, so the small set could get an artificial boost in properties. All grouping of U.S. species to this point had been done with data sets of approximately equal sample sizes. In the extreme, the chi-squared test may not be sensitive enough to protect against potential problems of grouping vastly different size samples. We did not want to encourage someone in the future to start "looking" for a domestic data set that would group and provide the largest possible "boost" to the properties of the smaller set, especially if there was no real intent to market the two species under one name.

Collection of Additional Data—When additional data are collected, a decision needs to be made about whether this additional data verifies original results, should be pooled with original data, or will replace original results. FPL recognized that in this particular instance, the material being grouped is indeed the same botanical species, and WCLIB had made a special effort to obtain a sample with the maximum strength-reducing defect for SS and No. 2 grade, so it was felt that the resulting design values calculated based just on the Swedish data alone were most likely conservative. Therefore, FPL felt that these data could be pooled with

the original data in order to make the sample more representative. FPL proposed one possible alternative: to allow WCLIB to calculate properties based on the Swedish numbers alone (which the FPL could check). It was suggested that WCLIB could calculate allowable property values under the condition that they continue to collect and test material for a minimum of 1 year or until an additional 360 pieces were tested, similar to what was agreed to by NeLMA for its Russian Spruce lumber in its letter to the ALSC BOR dated January 30, 1995. The sample size for destructive monitoring of each shipment should be 30. Then, at the end of the monitoring period, a new submission to the BOR should be made that either verified the existing numbers or calculated new numbers using a sample size sufficient to meet ASTM D 1990 criteria for an individual species.

Originally Proposed GQI Adjustment Procedure—In their original submission, WCLIB chose to develop an adjustment to the GQI values for each size–grade cell. WCLIB assumed 100% strength ratios for pieces with missing information. The submission proposed an interpolation procedure between the calculated GQI cell values and those pieces with 100% strength ratio. FPL pointed out that past practice would allow exclusion of clear wood failures and pieces with failure codes for which we cannot calculate a strength ratio. There is no way to tell if an interpolation procedure would give us a value similar to what would have been obtained if failure codes were available on all pieces.

FPL pointed out that even if the philosophy of the WCLIB procedure were accepted, it appears to FPL that the weighting scheme used is applied backward. For example, in the 2 by 4 SS cell used as the example in the report, 61.9% of the pieces in the bottom 10% of MOR data had a failure code and 38.1% did not. This means that most of the pieces without failure codes have MOR values above the bottom 10% of the data and hence should have higher strength ratios on average than those with the failure codes. Higher GQIs calculated from failure codes, but with a GQI less than 100, added to a sample lead to higher cell GQI values which in-turn can cause greater reductions in design values. A better weighting scheme would be to use the percentage of pieces outside the bottom 10%. A weighting scheme based on the percentage of pieces with and without a failure code may be another approach to weighting. Unfortunately, there is no way to know if any of these weighting schemes protect us from underestimating the cell GQI value we would have gotten if we had taken the failure information on every piece. FPL recognized that GQI (strength ratio) may not be the strongest predictor of strength properties , but it was thought that the calculation method WCLIB proposed could be overestimating property values. The ALSC BOR rejected this method for calculating the GQI adjustment.

Assigning of 100% to Missing Data—ASTM D 1990, section 8.2, requires a test of the representativeness of lumber quality based on failure code information (GQI). If the average GQI of the grade is more than 5 points above the minimum grade GQI, then an adjustment must be made. Thus, a sample with too high a GQI will have the allowable property adjusted downward. The report assigns a GQI of 100% to any piece failing in clear wood. This is consistent with past practice. However, any piece without failure code information is also assigned a GQI of 100%. This is inconsistent with past practice. FPL disagreed with the assignment of a 100% GQI for pieces with missing failure information or for pieces with failure information that does not allow calculation of a strength ratio. Since pieces with 100% strength ratio are excluded when looking at the representativeness of the sample, the assignment of 100% GQI values to these specimens will eliminate them and force an assumption to be made that the pieces that remain with failure information are a random sample of all the pieces tested. In tables 5 and 6, the WCLIB report shows clearly that the pieces with failure information tend to fall in the bottom of the MOR distribution. If we had failure information on the pieces where it is missing, one would expect them, on average, to have higher strength ratios, which would raise the 5th percentile strength ratio that we use to assess the representativeness of the sample. A 5th percentile GQI over 5% above the assumed grade GQI value requires the lowering of MOR and MOE values; therefore, any procedure that underestimates the actual 5th percentile GQI of the whole sample could produce higher design values than warranted. FPL thought that the lack of failure information was a serious failure to follow past practices and the spirit of ASTM D 1990. In such circumstances, we believed that only a conservative procedure could be justified. In this case a conservative procedure was to retain all pieces without failure information in the GQI representativeness determination by assigning those pieces a strength ratio of 99%. This was the method approved by the ALSC BOR for calculating the GQI for pieces with no failure code information.

WCLIB's GQI Adjustment Procedure— WCLIB proposed an interpolation procedure to develop an adjustment to the GQI values for each size–grade cell. FPL thought that this method was weighted incorrectly. After assuming 100% strength ratios for pieces with missing information, WCLIB proposed an interpolation procedure between the calculated GQI cell values and those that would be obtained if all pieces with 100% strength ratio were left in the data set.

FPL noted that there is no way to tell if any interpolation procedure would give us a value similar to what would have been obtained if failure codes were available on all pieces. In any case, if one were to propose such an interpolation scheme, the weighting scheme used is backward. FPL also expressed concern that even if weighted differently, it would be difficult to show this adjustment was appropriate.

In a September 29, 1998, letter to the ALSC BOR, FPL discussed why they thought the scheme was backward and proposed an alternative scheme. Later FPL provided a hypothetical example to the ALSC BOR: "Suppose in a cell,

only 10% of the pieces had failure information and that these 10% of pieces were the bottom 10% of the cell's MOR values. We could assume that the pieces with no failure information and higher MOR values probably had on average higher strength ratios and the 5th percentile strength ratio of these specimens would be higher. Thus if we had failure information on all the specimens, the 5th percentile strength ratio would be higher than the 5th percentile strength ratio of the bottom 10% of the MOR specimens. The WCLIB weighting scheme would cause one to use the 5th percentile strength ratio of the bottom 10% of the specimens, thus underestimating the true 5th percentile. Since you lower MOR and MOE values only if you get values more than 5 points above the assumed grade GQI, any procedure that underestimates the GQI of the whole sample can overestimate design values. If the weighting scheme were reversed, as we proposed, the GQI in this example would have been the one calculated with all the pieces."

WLICB also provided a report to the ALSC BOR which compared their Swedish results with other spruce test results (WCLIB 1998b). In the section beginning on page 22 of the report "Comparison of ALSC-Approved Design Values for *Picea abies* and *Picea excelsa*," the WCLIB submission attempted to show that 2 by 4 from this submission and its calculation methods would be in the range of values approved by the BOR in previous submissions. FPL pointed out that, as discussed in their letter of September 29, 1998, if the conservative approach of using 99% GQI values for specimens missing failure information were followed, the values would also be in the range of the other submissions with values very near the Lithuania Spruce submission. There is no indication in this section on why being at the lower end of the range would be inappropriate.

To better get an idea about how conservative this procedure might be, FPL calculated design values using several procedures to investigate how sensitive the final results are to the methods used. Table 5 presents design values calculated several different ways. The first data column (column 3) gives the values in the WCLIB submission. Column 4 gives values using the conservative procedure suggested by FPL of assigning a 99% strength ratio to any piece without failure information. Column 5 give values if FPL only used the pieces with failure information to calculate design values. This method was devised by looking at MOR versus MOE plots where we identified which pieces had failure information. In every size–grade cell, the pieces with failure information were scattered throughout the plot, with a slightly heavier concentration at the lower end. This showed that this procedure might be a little conservative for all the data, even if it did potentially underestimate the GQI value. Column 6 is WCLIB's weighting procedure with the corrected weighting scheme that we proposed. Column 7 is the values FPL got when using the WCLIB data provided and the procedure exactly as they proposed.

The numbers calculated using the conservative procedure of putting a 99% strength ratio in for pieces with no failure information does not appear overly conservative when compared with the other procedures. FPL argued that because this method can be shown to be conservative, it provides values that would be easier to defend and yet do not greatly lower values from other procedures. Failure to follow a conservative procedure would appear to require a more extensive monitoring program than the one proposed (that is, one that requires some testing of the strengths of specimens sampled in the monthly checks proposed). This would be consistent with the Russian Spruce submission, which proposed a more extensive monitoring program to validate design values that might have been lower if a full matrix had been tested. The discussions for determining allowable properties for Swedish Spruce would continue for a number of more years. The method that was finally used to calculate the GQI adjustment factor for this submission was the conservative procedure of putting a 99% strength ratio in for pieces with no failure information and the upper bound adjustment procedures using a factor calculated by adding 5% to that target GQI for the size–grade cell and dividing that number by the actual GQI for the size–grade cell.

***Too Small a Sample Size for Individual Cell Data*—**At the October 30, 1996, ALSC BOR meeting, the BOR in executive session thoroughly discussed the status of the WCLIB Swedish Norway spruce proposal. The BOR took into consideration the points presented by WCLIB supporting their position to group the data from Swedish Norway spruce with the data from Archangel Norway spruce. The Board also considered the position of the FPL on grouping the data from the two regions. The BOR unanimously declined to accept the WCLIB proposal to group the Swedish Norway spruce data with Archangel Norway spruce data to derive allowable design values for the group. The board also considered alternative methods presented and discussed by FPL and WCLIB to develop allowable design values. The BOR noted the concern of FPL that the Swedish Norway spruce data did not contain enough pieces in certain test cells because GQI information was missing. WCLIB was given permission to test additional pieces to meet the required number of samples per test cell. The additional data obtained would then be added to the original data set and adjustments made if necessary. The BOR unanimously approved this procedure permitting WCLIB to develop design values from existing data of Swedish Norway spruce to be submitted to the BOR for approval with the understanding that WCLIB agreed to sample and test enough pieces to bring each test cell up to 200 pieces if WCLIB could demonstrate Sweden is a limited geographic area. Supplemental data were collected and pooled with original Swedish.

On October 22, 1998, the ALSC BOR finally adopted values for Swedish Spruce.

Table 5—Calculated allowable properties by various methods[a]

Grade	October 20 submission	Using 99% SR	Pieces with SR	Reverse weighted	WCLIB weighted
		MOR (lb/in^2)			
SS	1,300	1,250	1,250	1,300	1,300
No. 1	850	825	800	850	850
No. 2	700	700	600	700	700
No. 3	400	400	350	400	400
Stud	550	550	475	550	550
CONST	800	775	700	800	800
STD	450	450	375	450	450
UTIL	200	200	175	200	200
		UTS (lb/in^2)			
SS	575	575	575	575	575
No. 1	375	375	350	375	375
No. 2	325	300	275	325	325
No. 3	175	175	150	175	175
Stud	250	250	225	250	250
CONST	350	350	300	350	350
STD	200	200	175	200	200
UTIL	100	100	75	100	100
		UCS (lb/in^2)			
SS	1,200	1,200	1,200	1,200	1,200
No. 1	1,050	1,050	1,000	1,050	1,050
No. 2	925	925	850	925	950
No. 3	550	525	500	525	550
Stud	600	575	550	600	600
CONST	1,150	1,150	1,100	1,150	1,150
STD	975	950	875	950	975
UTIL	625	625	575	625	625
		MOE ($\times 10^6$ lb/in^2)			
SS	1.6	1.6	1.6	1.6	1.6
No. 1	1.4	1.4	1.4	1.4	1.4
No. 2	1.3	1.2	1.3	1.3	1.3
No. 3	1.1	1.1	1.2	1.1	1.1
Stud	1.1	1.1	1.2	1.1	1.1
CONST	1.2	1.2	1.3	1.2	1.2
STD	1.1	1.1	1.1	1.1	1.1
UTIL	1.0	1.0	1.0	1.0	1.0

[a]MOR, modulus of rupture; UTS, ultimate tensile stress; UCS, ultimate compressive stress; MOE, modulus of elasticity; SR, strength ratio.

European Submissions (1995–2004)

While discussion continued to decide how to deal with troublesome Swedish test data, a number of sampling plans and submissions were introduced and allowable properties developed for other European countries. Values for Spruce from Austria, Czech Republic, Lithuania, Latvia, Finland, Estonia, Romania, and Ukraine; Pine from Lithuania, Germany, Finland, Estonia, Romania, and Ukraine; Silver fir from Germany, France, and Switzerland; and Douglas-fir from Austria, Czech Republic, Germany, and France would eventually be developed. During this time, consensus was developing on how to make GQI adjustments and grouping of new data with existing data sets. Subtle modifications were also made to the methods for calculating allowable properties with D 1990 to suit these later submissions.

WCLIB Austrian Whitewood and Scotts Pine from Austria and Czech Republic (1995)

In spring 1995, FPL was asked to review a sampling plan from WCLIB for 2 by 4 Austrian Whitewood (spruce). The methods of this sampling plan would be used later for 2 by 4 Austrian Scots Pine. In a letter dated July 17, 1995, FPL expressed concern about the representativeness of the material that would be tested. FPL had several phone conversations with WCLIB about this concern. WCLIB contacted the supplier and obtained more detailed information of the source. The principal issues raised with these submissions were as follows:

- Representativeness of the sample
- Quality control program

- GQI calculation method
- Moisture corrections for moisture meter for Scots pine
- Failure code issues
- Collection of additional data

Representativeness of Sample—The original WCLIB sampling scheme detailed in their June 10, 1995, proposal discussed sending a Quality Supervisor to Houston, Texas, to select SS and No. 2 specimens from a boat-load of material stored there. The supplier instead sent three units of material to Portland, Oregon, before the WCLIB inspector saw the material. The supplier sold off the rest for nonstructural purposes. After inspection of the three units by a Quality Supervisor, WCLIB determined that 250 were SS, 200 were No. 1, and 100 were No. 2. It was felt that there was a need to sample another boat-load of lumber to obtain enough additional material to complete a 360 sample for SS and No. 2 grade lumber. Both WCLIB and FPL agreed that this should be done to ensure the representativeness of the quality of the sample with respect to grade. The second sample also had the advantage of giving additional information on the variation in properties for a later sample. ALSC BOR approved this sampling method. It was not until July 1996 that the second set of 2 by 4 data was available for analysis.

Quality Control—It was pointed out in a July 24, 1996, FPL response letter to the ALSC BOR that WCLIB proposed that no monitoring (physical or mechanical) be conducted on lumber received into the U.S. because the geographic range is limited and the property assignments are believed to be conservative. FPL's interpretation of the BOR's *Guidelines for Assigning Allowable Properties to Visually Graded Lumber* ... was that waiving some sort of monitoring is not an option. Quoting from the Quality Control section, "In general, visual grading alone is not considered sufficient to assure consistency in lumber quality from an unknown source. The guiding principle in this guideline has been that at least one grade-size combination must be monitored at all times that lumber is being graded."

It was clearly FPL's feeling at the time that some sort of quality control is desirable for any foreign species in the initial stages of production. At the point of acceptance of a submission by the BOR, only the assigned properties are known to be conservative relative to the properties of the samples that were tested. FPL pointed out that although it is true that Austria and Czech Republic is a relatively small geographic area, it is also a very mountainous area and we lack the degree of knowledge about the origins of the tested sample that we have for U.S. data. Some monitoring of physical or mechanical property quality therefore seems desirable for an initial period of time. At a minimum, FPL suggested records be kept on growth rate and rings per inch for 1 year, or until a minimum of 360 pieces have been monitored. This degree of intensity would be consistent with that approved for Russian Spruce from the Archangel region of Russia.

WCLIB proposed the monitoring of rings per inch, percentage summerwood, and visual strength-reducing characteristics in a letter dated January 14, 1997. It was felt by FPL that this monitoring would be in compliance with the VSR Guidelines. At the January 30, 1997, ALSC BOR meeting, the BOR approved the design values for 2 by 4 white spruce from Austria and Czech Republic because WCLIB had developed a monitoring program.

In February 1998, WCLIB reported results for their resource monitoring program for 2 by 4 Austrian spruce (*Piecea exelsa)*. FPL reviewed the report and indicated in a letter back to the BOR that the data sampled over the course of 1 year supplied by WCLIB indicated that the resource was as good as or better than the material originally used for design value calculation. It was felt that the requirements of ALSC VSR Guidelines had been met.

Moisture Meter Correction for Scots Pine—There were not the same issues with sampling for the Scots pine material from Austria. The method of moisture meter correction, however, was a concern. The species-specific moisture meter correction used in the report was for Redwood. This was originally suggested by Delmhorst, but later conversations with Delmhorst confirmed that this was likely California Redwood not "Scots Pine," also known as "Redwood" in Europe. After further discussions with WCLIB, FPL agreed the most appropriate species correction would be a combined curve fit to the Delmhorst hard pine corrections. This approach is similar to the approach previously taken with foreign spruce submittals where domestic species that are expected to be similar are combined to produce an estimate of the species correction.

Failure Code Issues—There were also subtle failure code issues with these submissions, but they were less detrimental than those found in the Swedish Norway spruce data. The original failure code information supplied by WCLIB would not allow for calculation of the GQIs. The failure codes were not expressed in the format associated with D 4761. Conversions of coded information were required. WCLIB supplied corrected failure codes. Looking at these results for cell by cell GQI values, it was apparent that all GQIs were above the 5% upper boundary on the target grade GQI provided for in section 8.2 of D 1990 and therefore required adjustment. The data suggested a problem with the GQI information for No. 2 grade 2 by 4. When adjusted to 2 by 8, this cell had the highest GQI but the lowest properties for the No. 2 grade.

During telephone conversations between FPL and WCLIB, WCLIB indicated that this cell's failure coding was not done by a WCLIB grader. FPL proposed, and WCLIB accepted, the alternative for GQI calculation: Calculate the suggested combined 5th percentile GQI from 2 by 6 and 2 by 8 and use this as an estimate of the 2 by 4 cell GQI. Then, similar to the previous Russian and Swedish Spruce submission, the

GQI adjustment used on the 2 by 4 data was based on this GQI estimate and the ratio from Equation (1).

Collection of Additional Data—In October 1997, WCLIB proposed a sampling plan to gather data for an expansion of the previous WCLIB submission for 2 by 4 Austrian Spruce to include National Grading Rule (NGR) grades and sizes for Austrian Spruce and Scots pine from Austria and the Czech Republic. As noted in the Swedish Spruce submission, when additional data are collected, a decision needs to be made about whether these additional data verify original results, should be pooled with original data, or will replace original results. The ALSC BOR unanimously approved the sampling plan, which suggested pooling the additional data with the original data, on October 23, 1997. WCLIB's proposed design values for NGR grades and sizes for Scots pine and for Norway Spruce from Austria and the Czech Republic were approved by the ALSC BOR in April and July of 1998, respectively.

Norway Spruce and Scots Pine from Lithuania, Estonia, Latvia (1997–2006)

The original sampling plan for Lithuania was submitted in April 1997. This was the first of a series of submissions for the Baltic Countries of Lithuania, Estonia, and Latvia involving Norway spruce and Scots pine. The allowable properties for Lithuanian Norway spruce were approved in July 1998, followed in October by Scots pine from Lithuania.

In October 1999, the ALSC BOR approved a sampling and testing plan to develop allowable properties for Norway spruce and Scots pine NGR grades and sizes from Estonia proposed by WCLIB. The collection of Estonian test data presented WCLIB with an opportunity to group an existing species from one country with a new set of data for another country. This combination of data sets from Lithuania and Estonia started a series of discussions that would eventually establish the precedence for how the ALSC BOR would handle grouping species from different countries. Allowable properties for Estonian Norway spruce and Scots pine were approved in 2001 (WCLIB 2001a,c), and for Latvian Spruce and Scots pine in 2004 and revised in 2005 and 2006, respectively (WCLIB 2004a, 2005c, 2006a). The principal issues encountered with these submissions were as follows:

- Grouping
- Treatment of GQI for species being combined

Grouping—In their initial grouping proposal, WCLIB wanted to consider Lithuanian Spruce as an existing species group and compare the Estonian data to it using sections 10.2.2 and 10.3.2 in ASTM D 1990. The properties that WCLIB wished to claim were developed from characteristic values for Lithuanian Spruce, which had gone through the section 9.3 and section 12.6 data checks, whereas the report as written compares pre-data-checked characteristic values. In reviewing the WCLIB approach, FPL commented that because the primary reason for failing the 9.3 and 12.6 data checks is a sample that does not have a GQI within 5% of what is claimed for a cell, it seems reasonable and logical that for the comparison WCILB is attempting, the comparison should be conducted with Estonian Spruce characteristic values that have also undergone the same data checks. Otherwise, we might be allowing a set of allowable properties for a species that are substantially higher than the allowable properties that the data for the species alone would produce. In the Estonian Pine submission, this concern made no difference in the 10.2.2 and the 10.3.2 comparisons. In the Estonian Spruce case, however, it did.

Table 6—Characteristic values of Norway spruce[a]

Grade	MOR ($\times 10^3$ lb/in^2)	MOE ($\times 10^6$ lb/in^2)
SS		
Lith.	3.099	1.506
Esto.	3.067	1.549
No. 2		
Lith.	1.777	1.184
Esto.	1.725	1.193

[a]MOR, modulus of rupture; MOE, modulus of elasticity.

The characteristic values for Lithuanian spruce used to develop the Lithuanian Spruce properties are shown in Table 6. The characteristic values that would be developed for the Estonian Spruce data with the 9.3 and 12.6 checks are also given in Table 6. Given the expressed desire in the standard (section 9.3.1) to "minimize the probability of developing non-conservative property estimates," it appeared to FPL that the standard's intent is to compare characteristic values after the data checks have been performed in the case of adding a new species to an existing species group. FPL felt that when done in this manner, the 10.3.2 criteria for grouping a new species with an existing species were not met. Allowable properties for Estonian Spruce are lower in 10 cells than the existing Lithuanian Spruce allowable properties (see Table 7). FPL reminded WCLIB that they could still use 10.3.1 grouping to try to recover the higher Lithuanian Spruce values. WCLIB agreed to compare the characteristic values after the data checks had been performed. WCLIB received approval from ALSC BOR for Estonian and Lithuanian Norway spruce values on July 26, 2001. The final values for a similar combination of Estonia and Lithuanian Scots pine were approved on February 8, 2001.

The proposal for sampling and testing material from Lithuania, Estonia, and Latvia was approved in October 2001. The data for developing allowable properties for Latvia with Estonia and Lithuania Norway spruce were submitted in spring 2002. FPL indicated that the methodology for combining species from the Baltic had already been addressed in spring 2001 with the Estonia and Lithuania grouping. The 2001 Submission for Estonia and Lithuania values approved by

Table 7—Rounded properties for Norway spruce based on characteristic values[a]

Grade	F_b (lb/in^2)	F_t (lb/in^2)	F_c (lb/in^2)	MOE ($\times 10^6$ lb/in^2)
SS	—	—	—	—
Lith.	1,200	550	1,200	1.5
Esto.	1,200	550	1,200	1.6
No. 1	—	—	—	—
Lith.	800	375	1,050	1.4
Esto.	800	350	1,000	1.4
No. 2	—	—	—	—
Lith.	700	300	925	1.2
Esto.	675	300	900	1.2
No. 3	—	—	—	—
Lith.	400	175	525	1.1
Esto.	400	175	525	1.1
CONST	—	—	—	—
Lith.	800	350	1,150	1.1
Esto	775	350	1,150	1.1
STD	—	—	—	—
Lith.	450	200	950	1.0
Esto.	425	200	950	1.0
UTIL	—	—	—	—
Lith.	200	100	625	1.0
Esto.	200	100	600	1.0
Stud	—	—	—	—
Lith.	550	250	600	1.1
Esto.	525	225	575	1.1

[a]F_b, bending stress; F_t, tensile stress; F_c, compressive stress; MOE, modulus of elasticity.

the BOR were calculated using section 10 of ASTM D 1990. The method outlined by WCLIB for determining the allowable properties for Latvia, Lithuania, and Estonia originally did not follow the methods of section 10 of ASTM D 1990. FPL felt that it was inconsistent that this method would have been used for Estonia and Lithuania being combined, but not for all three. It was their belief that the three species should be grouped according to section 10.

It was argued by WCLIB that the method being applied to the Baltic data is no different than that used in to produce Douglas-fir, Hem-fir, and SPF numbers in North America. FPL pointed out that there was, however, a major difference in how the sampling was conducted in the North American In-Grade program. The sampling of Douglas-fir, Hem-fir, and SPF was done in proportion to production, whereas the sampling in Estonia, Lithuania, and Latvia was not. The BOR in executive session accepted the advice of the FPL and requested that WCLIB resubmit allowable properties for NGR grades and sizes for Norway spruce (*Picea abies*) from the countries of Estonia, Lithuania, and Latvia utilizing D 1990 section 10 methodologies.

Treatment of GQI Values for Species Being Combined—The treatment of GQI values from each species being combined was reemphasized with all these submissions. WCLIB originally did not treat GQI for the samples from the three countries separately. FPL pointed out that this check is important to help identify sampling and testing differences between countries and test labs for species being grouped. FPL pointed out that just looking at the differences in GQI values for the Russian or Swedish samples shows the significance of GQI checks. In the end, GQI values for each of the countries were examined.

The final values for the combined data of Lithuania, Estonia, and Latvia Norway Spruce were finally approved by the ALSC BOR at the July 25, 2002, BOR meeting.

Douglas-Fir and European Larch from Austria, Czech Republic, and Federal Republic of Germany (1999)

In April and March 1999, FPL reviewed WCLIB's proposed design values for two species, Douglas-fir (*Pseudotsug menziesii*) and European Larch (*Larix decidua*) from Austria, the Czech Republic, and the state of Bavaria in the Federal Republic of Germany. There was one princpal issues with this submission:

- Implied length and size factors

Implied Length and Size Factors—Historically, with In-Grade data, all agencies except SPIB used a calculated 2 by 12 "base allowable property" design values approach where "size factors" were applied to published values to obtain design values at specific widths and implied lengths. Implied length is relevant for submissions that use this base allowable propety approach. FPL agreed with the characteristic values calculated by WCLIB at a 144-inch length resulting from a revised version of tables 7 and 8 of the submission supplied by WCLIB in a fax dated March 31, 1999. Previous submissions for full matrix samples had adopted the approach for tabulating allowable properties at a the 2 by 12 size and applying size factors to these values to adjust to other sizes. FPL raised concerns that the implied lengths associated with size factors tabulation methods were not followed in this submission.

FPL noted that the length at which the unrounded 2 by 4 allowable properties in the WCLIB March 31, 1999, fax were calculated was not consistent with previous submissions on domestic or foreign species. Historically, with In-Grade data, all agencies except SPIB calculated design values using the approach where "size factors" were applied to published values. For SS, No. 1, No. 2, and No. 3 grade lumber the published allowable properties were for 2 by 12 at a length of 240 inches. The use of size factors resulted in implied lengths for design values that varied by width. For 2 by 4's, applying a factor of 1.5 to 2 by 12 values at 240 inches results in an implied length of 149 inches. Southern Pine did not use the "size factor" approach in deriving design values. Southern Pine allowable properties for 2 by 4's are based on 2 by 4's at a length of 144 inches.

FPL informed the ALSC BOR that to this point all "full matrix" submissions for foreign species had used the size factor approach, with implied lengths. The NeLMA submission for

the Archangel Region of Russia, which was for two sizes, also used the size factor approach. For consistency with past submissions, FPL expressed a preference for calculating values based on an implied length of 149 inches. WCLIB argued that the use of 149 inches implied length as proposed by the FPL was used in only the Norway spruce from the Archangel region of Russia submission and indicated for most of the submission the length does not have any effect on the recommend design values.

The ALSC BOR met in executive session and approved the values for the WCLIB submission as revised April 22, 1999, using 144-inch length as presented by WCLIB. The BOR asked that in future submissions the length of 144 inches be used on 2 by 4 for consistency.

Norway Spruce and Scots Pine from Finland (1999–2000)

Proposed design values for Norway spruce (*Picea abies*) from Finland were submitted by WCLIB on September 20, 1999. By October 20, 1999, FPL had reached agreement with WCLIB on the data and procedures to be used to calculate allowable properties for bending, compression, tension and MOE. There were no significant issues with this submission. WCLIB followed up the spruce submittal from Finland with a submission, "Proposed design values for Scots pine (*Pinus sylvestris*) from the Country of Finland," on December 17, 1999. By January 11, 2000, FPL had reached agreement with WCLIB on the data and procedures to be used to calculate allowable properties for bending, compression, tension, and MOE. The procedures used to calculate the allowable properties followed ASTM D 245, ASTM D 1990, and other technically sound criteria using methods that had been worked out in prior submissions. The BOR at its meetings in executive session approved the WCLIB submissions for Scots pine and Norway spruce from Finland on January 20 and July 27, 2000, respectively.

Spruce and Pine from Germany, Switzerland, and France (1999–2005)

The development of allowable properties for Norway Spruce and Scots pine from Germany was achieved in many steps. Initially, base values were developed only for 2 by 4 dimension lumber for the entire country of Germany except for the German States of Baden-Wurttemberg and Saarland in Southwest Germany (Fig. 3; WAS 1999a,b). The 2 by 4 material was tested by Wood Advisory Services of Millbrook, New York. The results of these tests were approved by the BOR at the July 29 and October 21, 1999, BOR meetings, respectively. Further testing of 2 by 6 were then conducted (WCLIB 2000a,b) New design values were calculated for 2 by 4 and 2 by 6 using the same method used to determine allowable properties for spruce from the Archangel region of Russia and approved at the April 2000 BOR meeting. Allowable property values for both of these species were adopted first for a combination of 2 by 4 and 2 by 6 lumber and then for the full test matrix of 2 by 4, 2 by 6, and 2 by 8 lumber once 2 by 8 testing was completed (WCLIB 2000c,d). In the course of developing design values for the 2 by 6 submissions, a lengthy discussion of implied lengths for lumber occurred between the FPL, the BOR and the rules-writing grading agencies.

The exclusion of Norway spruce in certain regions of Germany was problematic for mills in those region of Germany. The Association of the German Sawmill Industry (VDS) contracted with WCLIB to develop design values for the entire country of Germany in July 2001. In October 2001, FPL reviewed WCLIB's proposal for the sampling and testing of Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*) from portions of France, Switzerland, and the states of Baden-Wurttemberg and the Saarland in the Country of Germany (WCLIB 2001d) (Fig. 3). The collection of these samples and subsequent calculation of allowable properties posed unique problems for allowable property calculations. Two principal issues were addressed over the course of developing the German allowable properties:

- Implied length
- Addition of data to existing design values by Grouping

Implied length—Historically, with In-Grade data, all agencies except SPIB calculated a 2 by 12 "base allowable property" design values approach where "size factors" were applied to published values to obtain design values at specific widths. For SS, No. 1, No. 2, and No. 3, the published allowable properties were for 2 by 12's at a length of 240 inches. The use of these size factors could suggest the acceptance of implied lengths for design values that varied by width if the size adjustment adopted in D 1990 was applied literally to test matrix material. For example, if lumber is converted from 2 by 12 values at 240 inches to 2 by 4's, by applying a factor of 1.5 to the 2 by 12 values, then an implied length of 149 inches is suggested by the volume adjustment formula in D 1990. For 2 by 6 lumber the agreed upon size adjustment factor of 1.3 would suggest an implied length of 162 inches.

All "full matrix" submissions for foreign species analyzed by FPL to this point in time had used the 2 by 12 and size factor approach, with its associated implied lengths. The NeLMA submission for the Archangel region of Russia, which was the only other example of both 2 by 4 and 2 by 6 cells being tested (Russian Spruce 1995), also had used the size factor approach and was evaluated with the associated implied length. In the Archangel submission, the test data were adjusted to a 2 by 12 "base allowable property" and then moved back to 2 by 4 and 2 by 6 by the appropriate size factor. The issue of implied lengths became important in this report because WCLIB and FPL values for 2 by 4 differed because of the lengths they chose to adjust their data. The small differences in length that occurred in previous 2 by 4 calculations had rarely created a difference in an allowable property calculated. The most notable

Figure 3—Excluded sampling areas for original 2 by 4 and 2 by 6 German samples, Baden-Wurttemberg (1) and Saarland (2) and sawmill locaiton in Friesau, Thuringen, for second sampling (figure from WCLIB 1999).

exception was the German Douglas-fir Larch. WCLIB had typically made its computations using a standard length of 144 inches, whereas FPL had consistently checked the submissions using an implied length suggested by the size factors. The lengths at which the unrounded 2 by 4 and 2 by 6 allowable properties calculated by WCLIB were not consistent with FPL's previous treatment of length in prior submissions on domestic or foreign species.

FPL maintained that using the agreed-upon size factors produces the most consistent allowable property when compared to previous submissions. ASTM D 1990 contains specific procedures for adjusting properties for volume. If the different approach used by the two parties resulted in differences greater than allowed by the rounding rule, then FPL believe the differences were significant within the context of the standard. FPL felt that any acceptance of deviations from the standard should properly be made by a consensus body such as ASTM or the BOR. In the case of the 2 by 4 and 2 by 6 lumber submissions, calculating the allowable properties with implied lengths results in four occasions where the choice of length affects the allowable property by one rounding rule.

WCLIB argued that it is much more practical for the adjustments to be made to an even production length. The last time this issue arose at the April 22, 1999, BOR meeting, the BOR in Executive Session approved using 144-inch length for future 2 by 4 submissions for consistency. In the current submission, however, both 2 by 4 and 2 by 6 lengths were tested. In this submission, 144 inches is used for the 2 by 6 calculations, which is different than any previous practice. FPL and WCLIB advised the BOR that ASTM D 1990 is silent on this issue and recommended that the BOR select one alternative to guide rules-writing agencies in calculating allowable properties. In executive session at the April 27, 2000, meeting the BOR approved the set of lengths given in Table 8.

Using these agreed-upon lengths, the addition of the 2 by 6 lumber was approved at the April 27, 2000, meeting with the provision that the stability of these values would be

Table 8—Lengths to be used in calculating ASTM D 1990 submission

Nominal width (in.)	Length (in.)
4	144
5	144
6	144
8	144
10	192
12	240

monitored. These lengths were then to be used for the evaluation of future submissions. The data from testing of additional data for 2 by 8 Norway spruce and Scots pine lumber to complete the three-size two-grade full matrix were submitted in June 2000 (WCLIB 2000b,c) and approved at the July 27, 2000, BOR meeting the using the lengths shown in Table 8.

Addition of Data to Existing Design Values by Grouping—To establish properties for Norway spruce and Scots pine for all of Germany, additional samples were collected in 2 by 4, 2 by 6, and 2 by 8 sizes of these species and tests conducted to complete the NGR grade–size matrix for the entire country of Germany.

The initial sampling plan for the addition of data from the southwest part of Germany, northeast France, and Switzerland developed by WCLIB was built on the assumption that the new data will group with the existing data set without changing the current allowable property value. FPL pointed out that if the assumption was correct, there would be no issues with the resulting allowable properties; however, there is a possibility that the existing allowable property values could be lowered as a result of this testing. In this case the new data will need to be combined with the old data set using the grouping procedures of section 10.2 and 10.3 of D 1990.

The test data for Norway spruce from the States of Baden-Wurttemberg and Saarland in the Country of Germany, the country of Switzerland, and portions of France were submitted in September 2004. Initially there was a difference of opinion about how this data should be combined with existing results. FPL wanted the allowable properties to be calculated by treating the new data set as a new species to be added to the existing Norway spruce data. It was not until WCLIB's revised report "Proposed design values for Norway spruce (*Picea abies*) from the countries of Switzerland, Northeast France (Alsace, Lorraine, and Franche-Comte), and Germany," dated January 21, 2005, was prepared treating the new data sets as new species that FPL and WCLIB agreed upon calculated allowable properties. The allowable properties for Norway spruce for this expanded region were approved by the BOR at the February 3, 2005, meeting.

Scots Pine from Sweden (2000–2001)

"Proposed Design Values for Scots Pine *(Pinus Sylvestris)* from the Kingdom of Sweden" were submitted by WCLIB on September 26, 2000 (WCLIB 2000c). The development of these design values were less problematic than the design values determined for Norway spruce from Sweden. FPL did, however, find a number of inconsistencies in the data that required further clarification from WCLIB. Duplication errors occurred in spreadsheet, and that all MOE values are miscalculated. WCLIB made corrections and recalculated the MOE values. The principle issues encountered with this submission were as follows:

- Missing failure codes
- Inconsistent GQI values
- Inconsistent measurement of load and displacement

Missing Failure Codes—Failure code information was missing for a number of pieces for this Swedish submission but not nearly to the extent of the prior spruce submission. Eventually, WCLIB was able to supply the correct failure code info for these pieces.

Inconsistent GQI Values—The GQI values calculated from the failure code information and the GQI column provided for the grade–size cells in the appendix of the WCLIB submission produced different values from each other and the GQI values reported in table 3, page 4 of 18 of the report. When FPL tried to calculate strength ratios from the failure code information provided, there were more than 310 pieces that differed by more than 1%. In the 2 by 6 Select Structural data alone, FPL found 252 pieces that differed. If the GQI column given in the report is used, the Select Structural 2 by 6 is considerably off from that reported in table 3 of the submission. WCLIB was able to identify which of the GQI values were correct.

Inconsistent Measurement of Load and Displacement—After examining further the MOE calculations provide by WCLIB, FPL noted that there seemed to be an inconsistency in how the P1 and P2 loads and D1 and D2 displacements were measured. WCLIB contacted Tratek to clarify why the methodology appears to have changed in the middle of testing.

By December 27, 2000, FPL had received WCLIB's revised Proposed Design Values for Scots Pine *(Pinus Sylvestris)* from the Kingdom of Sweden Final Report dated December 21, 2000. FPL was now in agreement with the allowable properties tabulated in Proposed Allowable Base Values for Scots Pine (*Pinus sylvestris*) from Sweden. Swedish Scots pine values were approved by the BOR on January 23, 2001. WCLIB would later revise this submission using the recently approved ASTM consensus methods for calculating GQI adjustments in February 8, 2007.

Silver Fir from Austria and Czech Republic (July 2001)

In July 2001, WCLIB proposed a method for the Sampling and Testing of Silver fir (A*bies alba*) from the countries of Austria and the Czech Republic for establishment of Allowable properties for NGR Grades. In their review of the sampling plan, FPL expressed concern that the sampling plan did not provide information that described the methods needed to determine allowable properties for NGR Grades for these countries according to D 1990 and D 2915. The discussion describing the sampling was not detailed enough and caused serious reservations about the representativeness of the samples that will be collected.

Representativeness of the Sample—Questions about representativeness of concern to FPL were where will the test materials be coming from in Austria and the Czech Republic, and how will the proportions of such a sample, if taken, be established. There was no indication in the original sampling plan of the effort being made to ensure that the samples are representative of the entire region for which properties are being claimed. It seemed to FPL that at a minimum, more information needed to be added that indicates the geographic locations from which the test specimens will be sampled and how the proportioning and distribution of these test specimens had been or would be determined to ensure representativeness.

In October 2001, WCLIB supplied a revised proposal for the Sampling and Testing of Silver fir (A*bies alba*) from the countries of Austria and the Czech Republic for establishment of allowable properties for NGR grades dated. Data for this sampling plan was never submitted.

Silver Fir from Germany Switzerland and France (October 2001–2004)

On July 12, 2001, WCLIB presented a proposal to the ASLC BOR for the Sampling and Testing of European Silver fir (*Abies alba*) from the countries of Germany, Switzerland, and portions of France for establishment of allowable properties for NGR grades and sizes. The plan for sampling Silver Fir from Germany raised questions about the representativeness of the sample and was not accepted until the October 17, 2001, BOR meeting. The test data were not submitted until 2004. Principal issues raised in this submission were as follows:

- Representativeness of the sample
- Data checks

Representativeness of the Sample—In a letter from FPL dated October 23, 2001, questions were raised about discrepancies in samples from different countries and the representativeness of the sample. The discussion describing the sampling was not detailed enough and as then written caused us to have serious reservations about the representativeness of the samples to be collected. Questions of concern to FPL were as follows: Will any of the test material be coming from Switzerland or France, and how will the proportions of such a sample, if taken, be established? If no samples are taken from these countries, then what justifies the expansion to regions not tested? It seemed to FPL that at a minimum more information needed to be included in the sampling plan that indicated the geographic locations from which the test specimens would be sampled and how the proportioning/distribution of these test specimens had been or would be determined to ensure representativeness. WCLIB provided additional background information.

Data Checks—Data checks significantly reduced the allowable properties calculated for Silver fir from Germany. The design values for Silver fir were lowered by the data checks on the two 2 by 6 cells. The data for these cells were the most questionable for the sample collected. Further examination of the rest of the data indicated that the sample provided, while not the most ideally representative, was most likely a conservative method of estimating allowable properties for Silver fir in the limited region of Switzerland, Northeast France (Alsace, Lorrain, and Fanche-Comte), and Germany.

The allowable properties for Silver fir from Switzerland, Northeast France, and Germany were approved by the ALSC BOR in Ocotber 21, 2004.

Southern Pine Species Grown in South Africa (2002–2004)

A sampling and testing plan for determining allowable properties for Southern Pine from South Africa was submitted to the ALSC BOR in January 2002, and a revised version on February 11, 2002. As with all sampling plans before it, FPL had concerns about the representativeness of the sample being collected and the locations from which the samples would be obtained.

Representativeness of the Sample—FPL raised concerns that the sample might not be representative of all the regions over which the species might be produced in the future. map 4 in the submission (Fig. 4a) showed the regions over which there are commercial plantations, and map 3 (Fig. 4b) showed the location of the two regions to be sampled. Map 1 (Fig. 5) of the submission showed that much of the eastern region to be sampled is classified as mountain (Montane) grasslands, while the regions in the south and east are Mediterranean scrub. This suggested to FPL the possibility of different climates across the growth range.

Figure 6 shows a map from a reference found in the FPL library (USDA 2002). The dark green dots represent the locations of forests. Although this map is from 1980, these locations generally correspond with those shown in the submission. The light green shaded areas show regions with annual rainfalls of 800 mm (31.5 inches). This indicated that annual rainfall would appear to be similar throughout the forested regions.

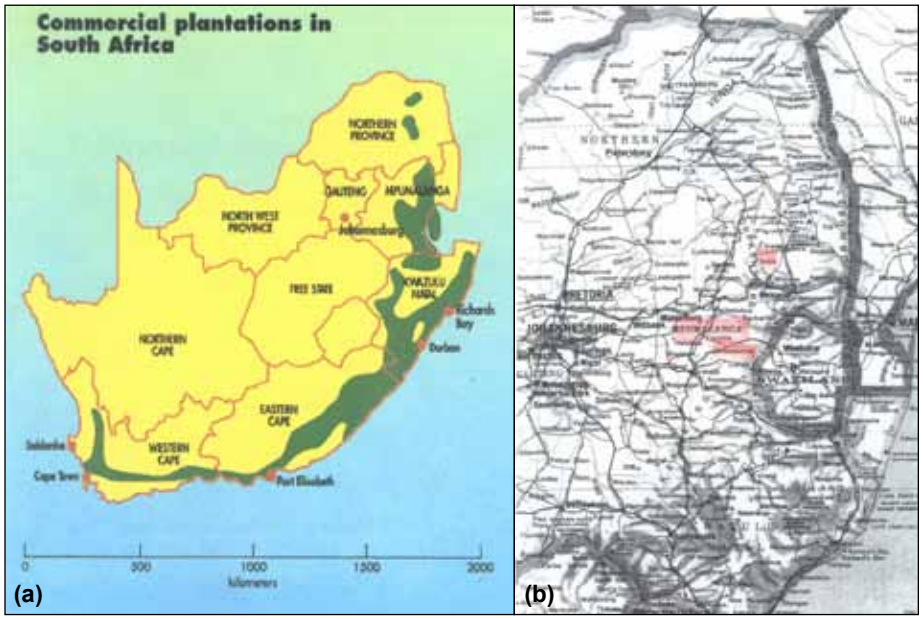

Figure 4—(a) Growth plantations in South Africa, (b) Location of proposed WCLIB sample (figure from WCLIB 2002a).

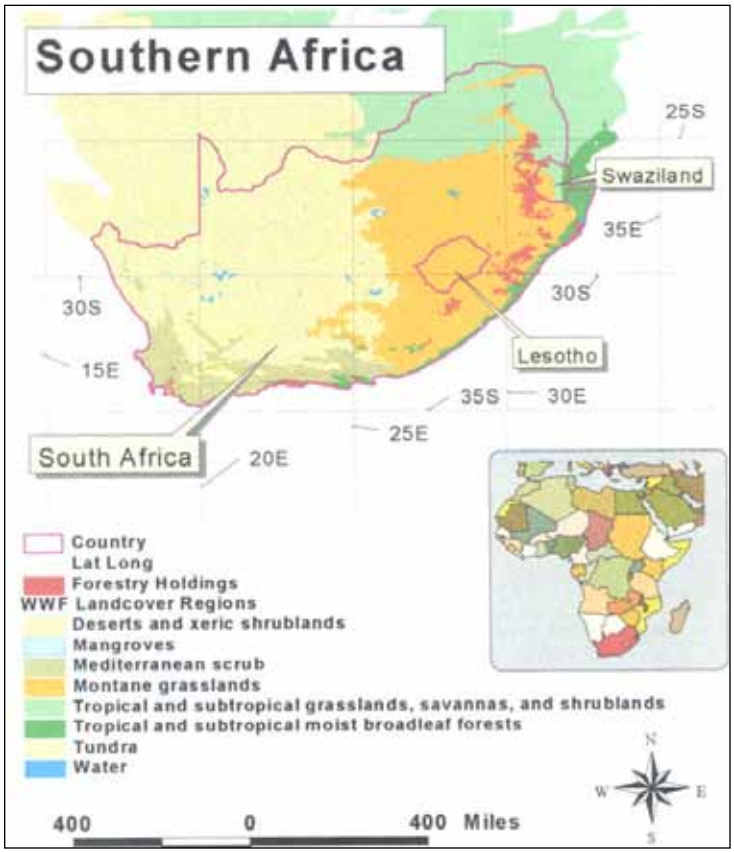

Figure 5—Vegetation climate classification (figure from WCLIB 2002a).

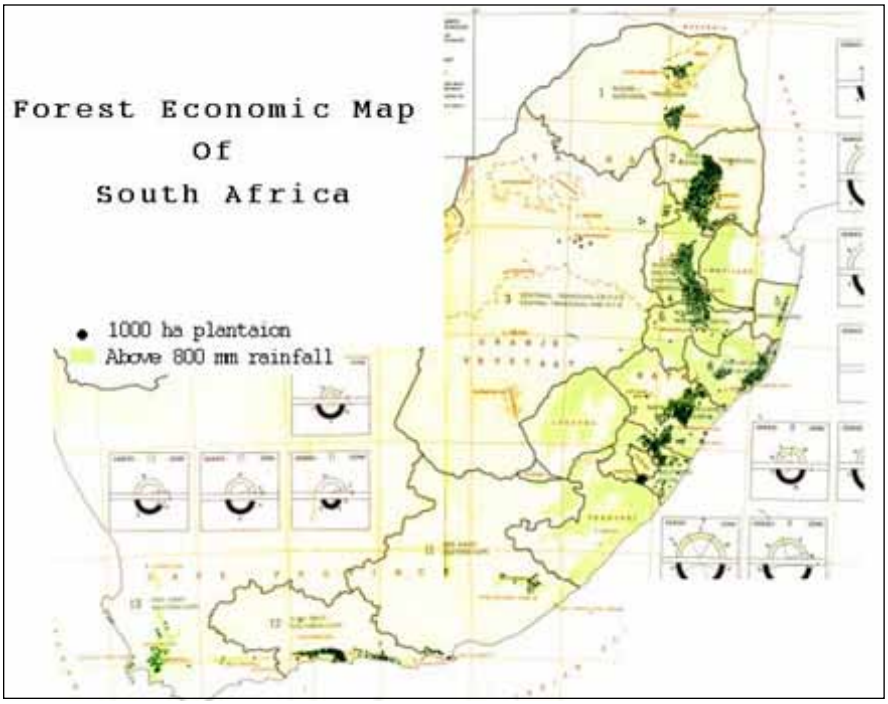

Figure 6—Forest economic map of South Africa (figure from USDA 2002).

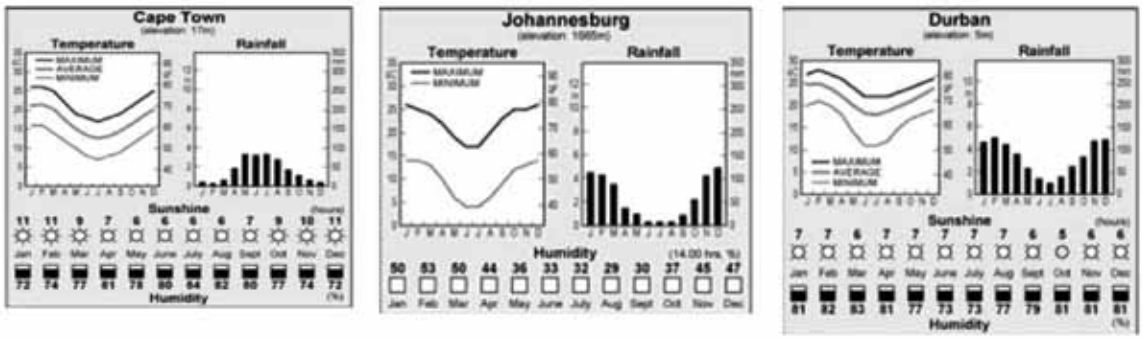

Figure 7—Temperature, rainfall, and humidity for Capetown, Johannesburg, and Druban (figure from USDA 2002).

FPL further presented to the Board information on the temperature and rainfall for three towns—Cape Town, Johannesburg, and Durban (Fig. 7). Temperatures are similar in Johannesburg and Cape Town and slightly higher in Durban. However, the pattern of rainfall in Cape Town is much different than that in Johannesburg and Durban. Most of the rainfall in Johannesburg and Durban is during the summer growing season (November through March), whereas that in Cape Town is during the winter months (April through October) (Fig. 7). Thus FPL wondered if this difference in rainfall patterns might not effect tree growth and properties.

From this gathered information, FPL expressed concern that the proposed sampling sites may not be adequate to characterize the properties of the South African pines for the whole country. FPL suggested that WCLIB collect part of the sample from the area from Cape Town to Port Elizabeth. This would help to alleviate FPL's concerns about the representativeness of the sample.

WCLIB responded back to FPL's concerns at the April 25, 2002, ALSC BOR meeting, indicating the WCLIB felt the proposed sampling and testing plan was sufficient as stated in the WCLIB letter dated February 11, 2002. WCLIB did, however, agree to obtain sample from these areas if the BOR felt it was necessary. The ALSC BOR met in executive session and unanimously approved the WCLIB request as submitted in its letters of January 8 and February 11, 2002, contingent upon WCLIB including in the sampling and testing plan samples from the areas of Cape Town and Port Elizabeth. Samples from across South Africa were collected. The final values for allowable properties for Southern Pine grown in South Africa were approved at the January 29, 2004, ALSC BOR meeting.

Southern Pine Species Grown in Argentina (2003)

The sampling and testing plan for determining allowable properties for Southern Pine from Argentina was submitted to the board on December 17, 2002 (WAS 2002). In its January 17, 2003, letter back to the board FPL indicated it had reviewed the proposed sampling plan for "assigning properties to imported southern pine dimension lumber from the Misiones Province of Argentina" submitted by Wood Advisory Services, Inc. (WAS), on behalf of Southern Pine Inspection Bureau (SPIB). It was determined that the proposed sampling procedures for grades, sizes, and number of samples to be tested conformed to the requirements of ASTM D 1990 and BOR guidelines for Foreign Species and should yield a representative sample of the lumber that could be produced from the Misiones Province. The principal issues addressed by these submissions were as follows:

- Free of heart and medium grain material
- Representativeness of the sample
- Specific gravity calculation method

Free of Heart and Medium Grain— The ALSC BOR approved the sampling plan for two groups of lumber, "A" and "B." Group A was to be lumber conforming to NGR as well as being free of heart center and medium grain as defined in the grading rules of WCLIB and WWPA; group B was to be lumber conforming to the NGR.

Representativeness of the Sample—Initially, it was unclear in the sampling plan whether sample groups designated as A and B were distinctly different pieces of lumber. FPL confirmed with WAS that the A and B sample groups would be composed of distinctly different pieces of lumber, each with a target sample size of 360 pieces per grade–size combination. FPL also confirmed that the edge of the lumber to be stressed in tension will be selected by a randomized procedure.

In March 2004, Wood Advisory Services (WAS) submitted "The Recommended Allowable Properties For Southern Yellow Pine (*Pinus taeda* & *Pinus elliottii*) from Misiones, Argentina" dated March 9, 2004. Wood Advisory Services also was interested in determining allowable properties for a specialty grade Free of Heart Center and Medium Grain Density from Misiones, Argentina. In May 2004, FPL reviewed Wood Advisory Services Recommended Allowable Properties for Southern Yellow Pine (*Pinus taeda* & *Pinus Elliottii*) "Free of Heart Center and Medium Grain Density" from Misiones, Argentina dated May 20, 2004. FPL found typographical errors and some calculation errors in the data that were originally supplied by WAS, and these were corrected. FPL was in agreement with the allowable property values calculated, with the exception of the bending value for Standard Grade in the Free of Heart Center (FOHC) and Medium grain submission, for both reports. The allowable properties appeared to be derived in accordance with the appropriate ASTM standards or other technically sound criteria.

Specific Gravity Calculation Method—Recent In-Grade testing submissions to the board have contained summaries of the specific gravity (based on ovendry weight–ovendry volume) estimates for the tests conducted. The data provided to FPL by WAS for analysis contained information on the specific gravity of the pieces tested. These data indicated that the average ovendry weight–ovendry volume specific gravity value was 0.45. The appendix V contained summaries by grade size of the specific gravity; the main body of the submission, however, contains no summary information on the specific gravity for the tests. For consistency, it was recommended that a summary of ovendry weight –ovendry volume specific gravity values be included in the main body of the report.

The values calculated by WAS were judged to be developed in accordance with ASTM D 1990, D 245, and the current policies of the ALSC BOR, and values for Southern Pine from Misiones were approved for the FOHC and Medium material "B" sample at the April 29, 2004, meeting and for the NGR "A" sample at the July 22, 2004, ALSC BOR meeting.

Alaska Yellow Cedar, Hemlock, and Spruce (2003–2004)

Sampling and testing plan for determining allowable properties for Alaska Yellow Cedar, Hemlock, and Alaska Spruce was submitted by Western Wood Products Association (WWPA) on July 6, 2001, and approved at the July 26, 2001, meeting of the ALSC BOR. FPL was directly involved in the development of the sampling and testing program to determine allowable properties for Alaskan species. A great deal of effort was put forth in sampling procedures to ensure a representative sample.

Dave W. Green from FPL, along with Kevin Cheung from WWPA, visited the Ketchikan Wood Technology Center (KWTC) during the initial stages of testing to make sure that bending and tension test procedures were similar to those used in the previous North American In-Grade testing program. They also discussed how data should be analyzed.

FPL reviewed WWPA's Determination of NGR Grade Lumber Design Values for Alaska Yellow Cedar (*Chamaecyparis nootkatensis*) by In-Grade Testing of Full-Size Lumber Specimens in 2003; FPL found typographical errors and some calculation errors in the Yellow Cedar data set that was originally supplied to us for calculating allowable properties. After several discussions with WWPA and the KWTC, FPL reached agreement on the corrections to the data. WWPA recalculated and provided the ALSC BOR with a revised report dated October 9, 2003. The ALSC BOR approved these values at the October 16, 2003, meeting.

In April 2004, WWPA submitted the Determination of NGR Grade Lumber Design Values for Alaska Hemlock (*Tsuga*

Species) by In-Grade Testing of Full-Size Lumber Specimens, mistakenly dated January 13, 2003. The ASLC BOR approved these values at their April 29, 2004, BOR meeting. In late November 2004, FPL reviewed KWTC submission Determination of NGR Grade Lumber Design Values for Alaska Spruce (*Picea glauca* and *Picea sitchensis*) by In-Grade testing of full-size lumber specimens dated November 12, 2004. The ALSC BOR approved Alaska Spruce values at the February 3, 2005, meeting contingent upon WWPA addressing all points raised in the January 25, 2005, FPL letter. The principal issues raised with these submissions were as follows:

- High shear stress values in Yellow Cedar
- Items needed to complete report
- Comparison of Alaska Hemlock and Hem-fir
- Cell by cell GQI check

High Shear Stress Values—FPL noted that for the Alaskan cedar data, the calculation process for determining the allowable shear strength appears to be correct but the resulting F_v value is quite high. The allowable property of 225 lb/in^2 would be the highest shear strength given in the current NDS for any species. The average shear strength of the dry specimens tested by KWTC was 1,445 lb/in^2 at an average MC of 14.7%. This was not that far off from the average value of 1,413 lb/in^2 at 11% MC reported for Alaskan cedar in USDA FS Bulletin 479 (Markwardt and Wilson 1935). It seemed to FPL that it would be worthwhile for WWPA to review the raw data to be sure the calculated shear values are correct. WWPA reviewed the data and found no reason for correction.

Items Needed to Complete Report—In reviewing the submissions for yellow cedar and Hemlock, FPL found a number of things that were missing from the report that had been provided by others to the ALSC BOR in previous submissions. Information that was requested to be included by WWPA in a revised report is listed below. This information was requested to make it easier for someone in the future to understand what was done in their program and is included in this report as a guide for what others should be sure to include in future programs.

- The raw MOE value used for calculations should be included in the appendix data set, and then a thorough explanation of how adjustments are made to get the test results to 17 to 1 should be given in the main body of the submission. This explanation should have the equations used for adjustments spelled out.
- Discussion of the span used in the tension testing needs to be included so that someone can know what portion of the full-length piece was actually being tested.
- During the testing, failure codes that were outside of those given in ASTM 4761 were applied. Their meaning needs to be explained in the submission.
- WWPA's explanation of how MC was determined for each piece should be expanded. They should explicitly state ovendry MCs were not available for all specimens tested. WWPA used moisture meter values as the actual MC of the specimens for some of their calculations. Information should be included in the report that explains in more detail the conservative nature of this decision. WWPA supplied a plot to the BOR to demonstrate the conservative nature of this decision. It was recommended that plots like this should be included in the submission text.
- The MOE values are calculated using both the bending and tension results. A summary table showing the GQI values for size and grade of this combined data set should be added.
- It has been traditional to include the 5th percentile, 75th tolerance limit, 75% upper confidence limit (UCL), and 75% lower confidence limit (LCL) for MOE in the submission. This allows for flexibility in future years if a tail property is proposed for MOE calculation.
- Recent In-Grade testing submissions to the BOR have contained summaries of the specific gravity (based on ovendry weight–ovendry volume) estimates for the tests conducted. The data provided to us by KWTC for analysis contained information on the specific gravity of the pieces tested. It would be good to include the specific gravity summary and size grade statistics in the appendix.
- When there are some obvious outliers in the data set, an explanation indicating outliers were investigated and that there was no reason to throw out these points should be voiced.
- The report needs to have more detail added that explains the formulas that were applied to the raw data to determine the allowable properties. With this information someone looking at the report in 20 years can have a hope of reproducing the same results. Also, in the future, adjustments may change and methods may be revised. Without a detailed description of how calculations were made it becomes impossible to fully utilize the raw data.

Comparison of Alaskan Hemlock with Hem-fir—In reviewing the Hemlock data, FPL also commented that there may be some concern by future readers that the values determined by the KWTC for Alaska Hemlock are less than those given for Hem-fir in the NDS (table 9). FPL had just completed testing hemlock lumber from Alaska and test data of their own on full-size hemlock lumber from Alaska (Green and others 2000). Although these data are for only one location in Alaska, they do allow for another check on the expected bending properties of Alaskan hemlock.

A comparison of FPL data with KWTC data for WWPA is shown in Table 10. For MOE, KWTC results are greater

Table 9—Comparison between WWPA Alaska Hemlock and Hem–Fir in NDS

	F_b (lb/in^2)		F_t (lb/in^2)		F_c (lb/in^2)		MOE[a] ($\times 10^6$ lb/in^2)		F_v (lb/in^2)		F_{cp} (lb/in^2)	
Grade name	WWPA	NDS	WWPA	NDS	WWPA	NDS	WWPA	NDS	WWPA	NDS	WWPA	NDS
SS	1,300	1,400	825	925	1,200	1,500	1.7	1.6	185	150	440	405
No. 1	900	975	550	625	1,100	1,350	1.6	1.5	185	150	440	405
No. 2	825	850	475	525	1,050	1,300	1.5	1.3	185	150	440	405
No. 3	475	500	275	300	600	725	1.4	1.2	185	150	440	405
CONST	950	975	550	600	1,250	1,550	1.4	1.3	185	150	440	405
STD	525	550	300	325	1,050	1,300	1.3	1.2	185	150	440	405
UTIL	250	250	150	150	700	850	1.2	1.1	185	150	440	405
Stud	650	675	375	400	650	800	1.4	1.2	185	150	440	405

than the NDS and FPL-RP-583. For the 5th percentile MOR, KWTC results are less than the Hem-fir in the NDS but are greater than the FPL-RP-583 results. For mean MOR, the KWTC results are also greater than the FPL-RP-583 results. Given that the KWTC sample is large and more representative, there is nothing in the existing data set indicating that there is anything unusual about the values determined by KWTC for WWPA.

Cell-by-Cell GQI Check—For all the Alaska submissions, KWTC believed that the relevant GQI check is a check performed on each grade as a whole, including all sizes. FPL felt that this was inconsistent with all previous In-Grade analysis. For all submissions that have been reviewed since the original In-Grade test program, the GQI check has been performed on the grade–size cell values. FPL strongly felt that the appropriate GQI check to be used on submissions is to look at the combined MOE grade–size cell values. This is the method that was suggested in print in the discussion of GQI on page 3 of FPL-GTR-126 (Evans and others 2001). It is worth noting, however, that in this case the final result is not affected by the method of data check. The ALSC BOR requested that in the future, WWPA conduct the GQI check on a cell-by-cell basis.

In the Alaska spruce report that followed from KWTC, the calculations to determine GQI were again done by lumping the relevant GQI values together by grade and performing the check on each grade as a whole, including all sizes. FPL reminded KWTC that this is incorrect and reminded them of FPL's April 8 and April 28, 2004, letters to the BOR concerning Alaskan Hemlock that for all submissions that have been reviewed since the original In-Grade test program, the GQI check has been performed on the grade–size cell values. Again, the ALSC BOR concurred that the appropriate GQI check for MOE is to look at the MOE grade–size cell values. In the Alaska Hemlock submission, the method of GQI check did not matter; for the Alaskan spruce data, it did when determining the characteristic value for MOE. WWPA recalculated the data based on a grade–size cell check.

Scots Pine and Norway Spruce from Romania and Ukraine (2003–2004)

On October 16, 2003, the ALSC BOR approved the sampling and testing program for Scots pine from the countries of Romania and Ukraine. This sampling plan would also be used for Norway spruce from the countries of Romania and Ukraine. The intention of this plan was to collect data that could be grouped with existing spruce and pine data for Austria and the Czech Republic using section 10.2 and 10.3 of D1 990. In January 2004, FPL started their review of WCLIB's January 2004 proposal for developing design values applicable to Scots pine (*Pinus sylvestris*) for the counties of Romania and the Ukraine by grouping with Austria and Czech Republic Scots Pine. FPL made a number of comments on and suggestions for corrections to the report to WCLIB. FPL received an electronic draft of a revised report from WCLIB on February 29, 2004. More issues still needed to be resolved. The values for Scots pine from Austria, Czech Republic, Romania, and Ukraine were approved at the April 29, 2004, BOR meeting. The values for Norway spruce for Austria, Czech Republic, Romania, and Ukraine were approved by the ALSC BOR on July 22, 2004. There was a considerable time between the first approval of a Romanian spruce sampling plan by the ALSC BOR in 1998 and the final approval of an allowable property for Romanian and Ukraine spruce. There were two principal issues with this submission:

- Calculation of moisture content
- Test Span

Calculation of Moisture Content—FPL determined that the initially presented MCs of the specimens in this submission were calculated incorrectly. In the spreadsheets that contain the test data, MC appeared to be calculated as initial weight minus final weight divided by initial weight, instead of initial weight minus final weight divided by final weight. Because MC is used in adjusting all test data, all the calculated values had to be corrected. WCLIB made these corrections.

Test Span—The test span of the test data supplied by WCLIB were a cause for concern. Some of the test materials were extremely short in length. FPL later confirmed with WCLIB that the length of the test specimens for the Ukrainian and Romanian were in fact 118 inches with a 116.1-inch test span even though 118 inches seemed to leave virtually no overhang of the specimen for testing.

The test data from Romania and Ukraine were grouped with existing test data from Austria and Czech Republic

using section 10.2 and section 10.3 methodology by treating each country as a separate species group. By this time, after the struggles with grouping the Lithuanian, Estonian, and Latvian data, there had been a procedure agreed upon how to group additional species data from other countries with existing species data.

NeLMA Eastern Spruce Balsam Fir Species Group (2005–Present)

In March 2005, Northeastern Lumber Manufacturers Association, Maritime Lumber Bureau, and Quebec Forest Industry Council submitted a sampling plan entitled "Proposed Sampling and Testing Plan for Assigning Design Properties of Eastern Spruce–Balsam Fir Species Group." This sampling plan was the first submission involving the application of D 1990 that raised the issue of withdrawal of species from an existing species group, SPF(S). Concern was expressed about how the withdrawal of balsam fir and eastern spruces for a limited geographic region would effect the allowable properties for the remaining species in SPF(S). This sampling plan generated considerable discussion.

In their response to ALSC BOR dated March 28, 2005, in regards to the NeLMA submission, FPL believed that the program outlined follows the practice used in previous submissions and should be able to accomplish the objective of developing design properties for eastern spruce–balsam fir. The major comments expressed by FPL were as follows:

- It was unclear from the write-up how the clear wood properties (shear parallel and compression perpendicular to grain) for the species group would be developed.
- There was no listing of the data they are going to be collecting. In other sampling plans it has been useful to have the test variables spelled out (dimension, mc, mor, moe, failure code, grade, etc.).
- The sub-sample to provide factors to convert the D 4761 information to D 198 17 to 1 may be useful to answer some outstanding questions about MOE difference because of test setup, but they also have the potential of raising more questions than answers with the small sample size being used.
- The method used to sample from the three mill categories based on production will raise questions that otherwise might not have been discussed. In-grade sampling plans in the past had homogeneous regions that had mills randomly sampled, with the number of lots in a region determined by production, but the samples for that region were not based on individual mill production within a homogeneous region. The argument is being made that the area being sampled represents a small geographic area that is homogeneous, but the mill sampling is specifically by production. Perhaps this was done as a means of sharing the load amongst interested parties, but it introduces a level of complexity that is not needed and again will have the potential raising more questions than answers.
- Most importantly, the grading agencies involved need to be thinking about how they are going to handle "withdrawal issues" when a submission on design values is presented. What will be the impact of this grade on the rest of SPF (S)? For example, if the specific mill in a region identified in this sampling plan starts to produce eastern spruce–balsam fir will that mill be allowed to still have an SPF (S) stamp? The approach that will be taken will need to be part of the design value submission.

After a lengthy discussion, ALSC BOR in executive session approved the sampling plan proposed by NeLMA at its Apri 28, 2005, meeting. The sampling and testing for this program took a little less than a year.

A proposal by NeLMA, MLB, and QFIC for "Proposed Design Values for Eastern Spruce–Balsam fir Structural Dimension Lumber" was submitted to the board on March 1, 2006. In their March 27, 2006, response, FPL raised significant question about the submission. FPL indicated that there had been no attempt to group the two species together to see if it made a difference in calculated allowable properties. FPL noted that in the submission these species are treated only as an existing species group. FPL felt that they were really a new group being created. Also, during the sampling section of the report, FPL noted that there was no indication that previous in-grade samples for these species exist. FPL felt that it was important to look at how the new information related to the previous in-grade sample. FPL felt that at the very least an explanation needed to be provided for why it was not there or how the properties of the new sample differ. Finally, FPL noted that the methods used in the submission to develop the adjustment factors converting the D 4761 MOE values to D 198 values were different than those used in the past. The discussion provided was insufficient to determine why the method used was chosen. The concerns with implications of this submission were sufficient to cause a meeting on the subject to be held at the Forest Products Laboratory in Madison on May 23, 2006. The principal issues with the Balsam Fir–Eastern Spruce submittal were as follows:

- Conversion of D 4761 based MOE to D 198 based MOE
- Grouping criteria
- Representativeness of the sample
- Collection of additional data
- GQI cell-by-cell data check

Conversion of D 4761 based MOE to D 198 based MOE–At this May 23 meeting with NeLMA, MLB, CWC, and NLGA, FPL mentioned that they were still looking at the proposed equations to convert MOE measured at D 4761 (head displacement) to D 198 (yoke based). The equations proposed in the NeLMA submission were developed in a different manner than the previous equations used to make this adjustment. FPL pointed out that there were now three

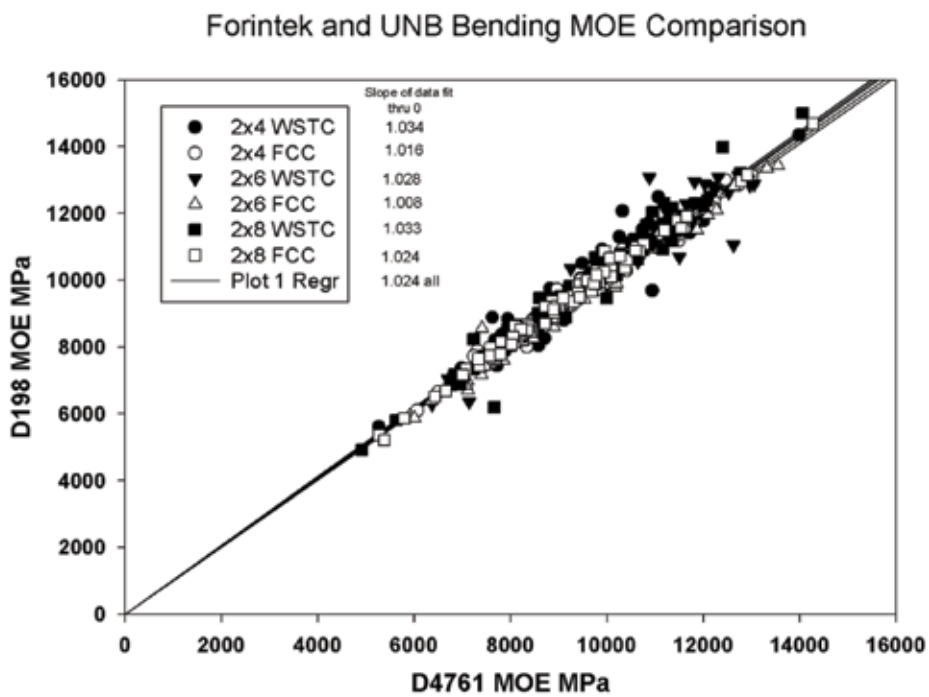

Figure 8—Family of curves fit through the Forintek and UNB MOE comparison data.

different methods for adjusting D 4761 to D 198 proposed:

- That used to correct the original NLGA in-grade submission
- The method recommended by Dr. David Barrett in the NLGA Yellow Cedar, Sitka Spruce submission submitted November 25, 2005
- The new method used in this submission, where a relationship between D 198 and D 4761 is calculated with an intercept term

All these methods are outside an ASTM standard.

FPL believed that it would make more sense to calculate the relationships for the NeLMA correction using the method suggested by Dave Barrett in appendix E of the recent NLGA Yellow Cedar, Sitka Spruce, where this relationship is forced through zero and the slope is reduced so that 95% of the data points are above the slope, rather than introducing a new method. Figure 8 shows the various families of lines resulting from forcing the relationship through zero. The summary of the slopes for these fits (A) from the raw data supplied by NeLMA are given in column 2 of Table 10. The slopes are close to 1. Column 3 shows the slopes for a summary of the slopes (A_{95}) when 95% of the MOE data lie above the regression line. Figure 9 shows the comparison of all the family of curves from Table 11. The results presented in Table 11 indicate that all the slopes calculated result in a small reduction in MOE. FPL felt that these results indicate that no adjustment to MOE is required in this instance.

In July 2006, FPL wrote a letter to follow up on the status of the NeLMA submission and indirectly respond to a NeLMA letter of June 19, 2006. There still were four issues that were outstanding with the NeLMA submission: grouping criteria, sampling, D 4761 to D 198 MOE adjustment, and GQI adjustments.

Grouping Criteria—FPL recognized that NeLMA was interested in determining design values for Eastern Spruce–Balsam fir as a grouping. The difference between NeLMA and the FPL position was the manner in which the allowable properties are determined. NeLMA believed that these two species were treated as one existing species group. In FPL's view NeLMA was creating a new grouping.

FPL agreed with NeLMA that there is a long history of marketing and shipping Eastern Spruce–Balsam-fir (ES–BF) as a commercial combination sold in the marketplace. FPL, however, still disagreed on the determination of the design values for ES–BF, because ES–BF had never been treated as an existing species group.

The title of a NeLMA grading rule book from the 1930s , "Standard Grading Rules for Eastern Spruce and Balsam Fir," indicates the importance of these species commercially to the region. A closer look at the design values presented in this rule book, however, suggest a clear understanding that from a design point of view, Eastern spruce and Balsam fir are different. In this publication, allowable property information was given only for Eastern Spruce, and Balsam fir was not assigned allowable structural properties.

In the 1970s NeLMA Standard Grading Rules for Northeastern Lumber, separate allowable property values are presented for Eastern Spruce and Balsam fir, with a footnote that

Table 10—Flexural properties of Alaskan Hemlock

		2 by 4		2 by 6		2 by 8	
Variable	Reference	Select Structural	No. 2	Select Structural	No. 2	Select Structural	No. 2
Sample size	FPL–RP–583	110	202	203	291	—	—
	KWTC (for MOR)	364	449	374	371	352	317
Specific gravity	FPL–RP–583	0.477	0.468	0.476	0.460	—	—
	KWTC (for MOR)	0.464	0.455	0.461	0.451	0.463	0.452
Moisture content (%)	FPL–RP–583	14.1	13.7	13.5	13.1	—	—
	KWTC (for MOR)	14.7	14.2	14.7	14.7	15.1	14.6
Mean MOE ($\times 10^6$ lb/in^2)	FPL–RP–583	1.756	1.508	1.998	1.819	—	—
	KWTC (for MOR and UTS samples)	1.711	1.528	1.658	1.460	1.620	1.438
Mean MOR ($\times 10^3$ lb/in^2)	FPL–RP–583	7.827	6.156	7.216	5.127	—	—
	KWTC (for MOR)	8.945	6.897	7.486	5.770	6.446	4.899
5th MOR ($\times 10^3$ lb/in^2)	FPL–RP–583	4.796	2.358	3.759	2.174	—	—
	KWTC (for MOR)	4.802	2.950	4.045	2.603	3.337	2.340

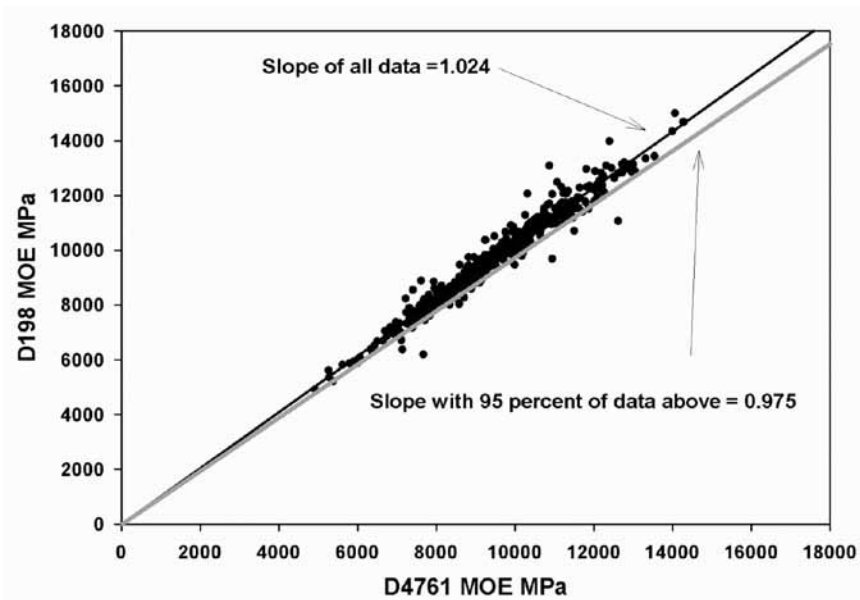

Figure 9—The two regression lines middle trend and with 95% of data above line.

reminds the user that the lower Balsam fir allowable property values are used for design calculations when the shipping combination of Eastern Spruce–Balsam fir is purchased.

Even for the short period of time (1989–1990) when the Eastern Spruce–Balsam fir combination had a design value assigned to it, the values were those developed for SPF eastern using clear wood information and the grouping criteria outlined in D 2555 to establish values for an SPF eastern group. In this case again, Balsam fir and the Eastern spruces were treated as separate species that were grouped together for design value calculation.

Finally, after the In-Grade program was completed, Eastern spruce–Balsam fir was assigned the design value established for the SPF(S) based on test data that was a grouping of In-Grade "track B" species, which had Balsam fir in the controlling subgroup.

In response, NeLMA's June 19, 2006, letter asked the question "When does a species combination become an 'existing' species group?" FPL indicated to NeLMA that there is no guidance or criteria given in D 1990 for this. D 1990 only lists in note 3 the commercial species groups for the North American In-Grade program as Douglas-fir Larch, Hem-Fir, and Southern Pine from the United States and Spruce–Pine–Fir, Douglas fir(N), and Hem-Fir(N) from Canada. As such, the approach FPL preferred to take for this submission was to treat Balsam fir and the eastern spruces according to the "track B" approach for grouping, regardless of the large number of samples tested.

Starting on page 3 of the NeLMA submission, FPL felt that the individual species information should be presented separately, table 1 of the submission should contain information about the sample size by species, and the allowable

Table 11—Slopes for various combinations[a]

Size	Combination	A	A_{95}
2 by 4	WSTC	1.034	—
	FCC	1.016	—
	Both	1.024	0.975
2 by 6	WSTC	1.028	—
	FCC	1.008	—
	Both	1.019	0.968
2 by 8	WSTC	1.033	—
	FCC	1.024	—
	Both	1.029	0.990
	All	1.024	0.975

[a]Determined by method suggested by Dave Barrett in appendix E of November 25, 2005, Sitka spruce and yellow-cedar submission.

properties for Eastern Spruce–Balsam fir should be determined using the D 1990 grouping procedure. There has been no definitive ruling on this yet.

Representativeness of Sample—At a July 30, 2002, meeting in Bangor, Maine, James Evans and David Green advised NeLMA to take sufficient samples of each species to allow the flexibility to develop design values for the individual species in addition to developing values for the Eastern Spruce–Balsam fir grouping. This suggestion resulted in the large sample sizes being collected. The language of the NeLMA sampling plan outlined a program that would allow the development of allowable properties for Eastern Spruce–Balsam fir species through grouping and development of individual species design values. It did not specifically state their intention of treating Eastern Spruce–Balsam fir as an existing species group.

Collection of Additional Data—When additional data are collected, a decision needs to be made about whether these additional data verify original results, should be pooled with original data, or will replace original results. In their submission, NeLMA had removed some of the original In-Grade SPF(S) test results. NeLMA agreed that the reason for eliminating the previous data that were collected for the SPF(S) grouping should be included in the report. The information provided by NeLMA in an April 12, 2006, letter gave the information FPL requested on the rationale for eliminating the previous In-Grade data. Even given this explanation, FPL still feels that the previous In-Grade data should be utilized in evaluating the impact of withdrawing the material from New England on SPF(S).

Data Adjustments for D 4761 and D 198 MOE values—FPL reached an agreement with NeLMA on the correction factors that are applied to the different MOE values from the two test machines. The curve fitting of the test data from the two laboratories was forced to go through the origin, which was similar to the approach taken by Dr. David Barrett in the NLGA Yellow cedar and Sitka Spruce submission. The curve fits indicate that no correction is necessary for the FCC laboratory test data, whereas the WSTC lab test data will have a correction factor of 1.02 applied.

Cell-by-Cell Data Check—FPL firmly believes GQI for the individual grade–size cells should be done on a cell-by-cell basis. A check on the representativeness of the sample is done by looking at GQI. Although it is true that the original in-grade material was assessed by grouping all the GQI for the various sizes together, starting with the Russian spruce submittal of 1994, all subsequent submissions have now been analyzed by looking at the cell-by-cell GQI data. In the cell-by-cell data check, it is worth noting that sample sizes can become small when individual species have small cell-by-cell sample sizes. This adds to the uncertainty of the estimate, but it is still important to try to assess the representativeness of all cells of all species.

Discussion in In-Grade Test Program Technical Committee meetings, leading up to the original In-Grade submissions of 1991, investigated the representativeness of the individual size–grade cell for the samples collected. It was concluded that for the samples collected, the individual size–grade sells were representative of the grades that were targeted. Therefore, the difference between the grade level and cell-by-cell level evaluation of the GQI values was not a concern with the 1991 submissions. Such discussion could not occur with subsequent submissions. The current version of ASTM D 1990 (ASTM 2009) also specifies that a cell-by-cell data check is the appropriate method for assessing GQI.

To date, no design values for a separate species group of ES–BF have been approved.

Yellow Cedar, Sitka Spruce, and Northern Species (2005–present)

In November 2005, NLGA submitted a proposal for "Design values for NLGA Northern Species Structural Dimension Lumber" and "Proposed Design Values for NLGA Coast Sitka Spruce and Yellow Cedar Structural Dimension Lumber" dated November 25, 2005. There were two principal issues with this submission:

- Failure code information
- Withdrawal of species from existing species group

Failure Code Information—FPL struggled to convert the failure code information supplied in the submission with the accompanying GQI values submitted. The failure codes for the original in-grade tests, new test information for Yellow Cedar and Sitka Spruce, and recently supplied information with the white-bark pine did not follow the failure code system established in table X1.1 of D 4761 (ASTM 2009). The original northern species in-grade test data followed a failure code convention agreed upon when FPL agreed to review the original calculations of SPF for the April 26, 2001, BOR meeting. At that time an agreement was reached for interpretation and conversion of the NLGA more detailed

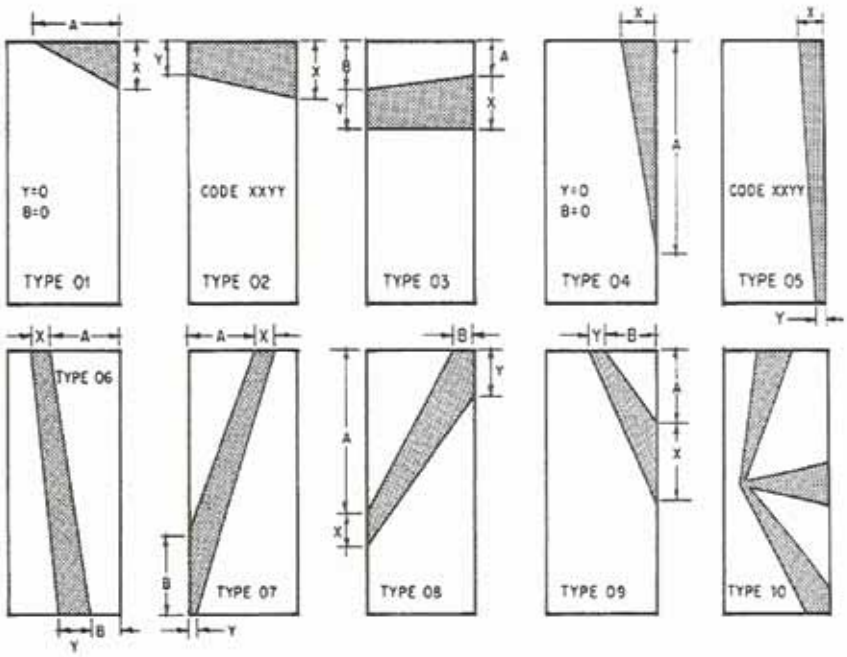

Figure 10—Knot codes from D 4761 figure X1.1.

failure code, based on knot data collected by NLGA using the knot coding scheme described in figure X1.1 (Fig. 10), to the failure codes system described in table X1.1 of D 4761. A Class 1 knot code was treated as 17 edge of wide face (ewf) knot, a Class 2 knot code was a 17 ewf, a Class 3 knot code was a 14 center-line knot, a Class 4 knot code was an 11 narrow face knot (nf), a Class 5 knot code was an 11 nf, a Class 6 knot code was an 11 nf, a Class 7 knot code was a 17 ewf, a class 8 knot was a 17 ewf, and a class 9 knot code was a 17 ewf. There were no class 10 knots.

The new failure code information provided in the Yellow Cedar and Sitka Spruce submission did not in all cases match up with this previously agreed upon system. First, Class 1 knot codes were now treated as narrow-faced knots and no reason for the change was provided. Second, a large number of Class 10 knot codes were now present in the new data for Sitka Spruce and Yellow Cedar and the White-bark pine data. According to the new submission, the new Class 10 knot codes now had three sub classes, 13, 08, and 09 (Fig. 11). Each of these subclasses was converted to Class 03 centerline knot codes for GQI determination, but no information was provided discussing the rationale for this conversion. It seemed to FPL that a more logical conversion would have been to treat the subclass 13 to a class 03, the subclass 08 to a class 2, and the subclass 09 to a class 06 knot.

Also a new dimensional basis for measurement—1/16 inch versus 1/8 inch—and new failure codes showed in the white-bark pine failure code data.

It took until July 2006 for FPL's review of the submission to be completed. A great deal of extra time was required trying to sort out which codes are appropriate for which species. In some cases multiple codes needed translation for one species. Eventually, a translation between the two failure code systems was developed. Once the failure code issues were resolved, FPL and NLGA agreed on the calculated allowable properties for Yellow Cedar and Sitka Spruce.

Withdrawal of Existing Species—There was, however, a disagreement about how Northern species allowable properties should be calculated. NLGA had concerns with how FPL calculated the new allowable properties for Northern species once Yellow Cedar and Sitka Spruce were removed. The reason for the concern was a difference of opinion on how to handle withdrawals. NLGA felt that when FPL recalculated the allowable properties for the Northern species group, they used methods that were different from those used on the original D 1990 Northern species grouping calculation. NLGA reported that the allowable properties for Northern species were impacted by how FPL handled GQI calculations and sample size. FPL responded that the methodology it used for this submission had been used since 1994 and stated that, in its view, D 1990 requires that a reassessment of allowable properties for Northern species is necessary with the withdrawal of coast Sitka Spruce and Yellow Cedar from the grouping.

The BOR in executive session discussed the NLGA proposal, reviewed the requirements of PS 20, and considered the discussions that took place during the July 27, 2006, BOR meeting and all the letters from NLGA and FPL. After this discussion, the BOR unanimously approved allowable properties for Yellow Cedar, Sitka Spruce, and the Northern Species Group with recalculation after withdrawal.

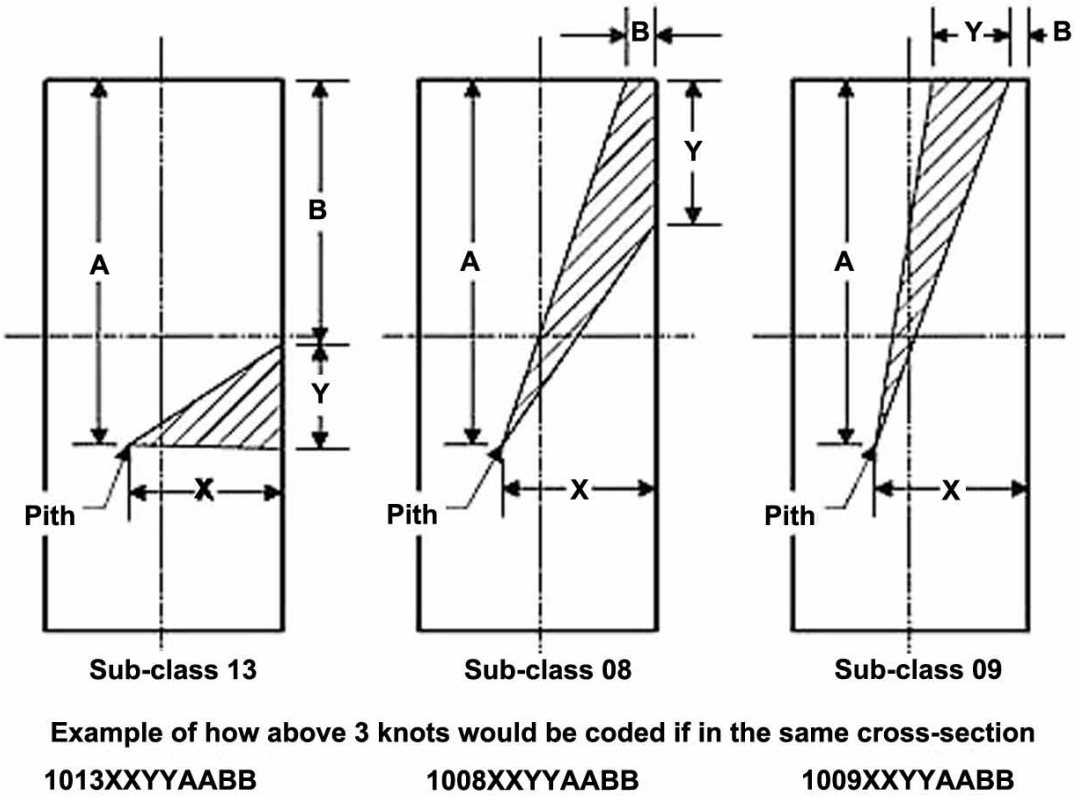

Figure 11—Class 10 knot description.

Douglas Fir from France and Germany (July 6, 2006)

In July 2006, WCLIB submitted a "Proposal for Sampling and Testing of Douglas-fir (*Pseudotsuga menziesii*) from the Countries of France and Germany for the Establishment of Allowable Properties for NGR Grades." FPL reviewed the proposal and indicated that according to table no. 2 of the submission, there appears to be an adequate number of samples being collected to determine a design value for Douglas-fir from the countries of France (202 per grade size cell) and Germany (165 per grade size cell). FPL did have some concerns with how the analysis of this test data will be conducted. The principal issues with this submission were as follows:

- Representativeness of the sample
- Bavarian Douglas-fir

Representativeness of the Sample—FPL felt that the grouping approach should be applied to the material from France and Germany when looking at the French and German data. It was WCLIB's intention to not use the grouping criteria in the analysis of the test data. In looking at the maps presented (figs. 1 and 2), which show the locations of the Douglas Fir resource in France and Germany, there seems to be a clear separation between where the French material is growing and where the German material is growing. There was no technical justification given for choosing to automatically group material from the two countries together. FPL felt that because France is slightly larger than California and Germany is about the size of Montana, it would seem more prudent to take the material from each country being collected, labeled, and tracked from each region throughout the sampling process and treat them as individual samples from the two countries and apply the grouping procedure.

FPL pointed out that WCLIB had been willing to take this approach in the past with other foreign sampling submissions, and WCLIB has indicated that it will be conducting the grouping procedure on the Austrian–Czech–Bavarian 2 by 4 SS and No. 2 material as an additional analysis of test results from this submission.

Finally, FPL stressed that every effort should be made to get material from the full geographic range of the resource that will be processed by each of the four sawmills. FPL was concerned that the method used by WCLIB to determine the allowable properties for Douglas Fir from France and Germany may not take into account the geographic differences in the material. This is not a new concern.

In their July 10, 2006, response, WCLIB provided geographic and topographic detailed information to justify treating the areas as one group. This information was judged to be sufficient by the BOR to allow for one grouped sample. WCLIB proceeded to collect samples and treat the data as one large sample while still maintaining information that allows for looking at the individual mills.

Table 12—2 by 8 144-in. characteristic values

	Germany and France treated as one sample		Germany and France grouped		Bavarian, Czech, Austrian, DF	
	SS	No. 2	SS	No. 2	SS	No. 2
MOE ($\times 10^6$ lb/in^2)	1.875	1.453	1.759	1.389	1.782	1.546
MOR ($\times 10^3$ lb/in^2)	3.794	2.103	3.497	2.103	3.040	1.991

In the end of their July 27, 2006, meeting, the ALSC BOR decided to approve the previously approved sampling plan and allow Douglas Fir values to be calculated by combining all the test data together. The allowable properties developed were allowed to be applied to the region of Bavaria.

In October 2007, after FPL examined the data collected from this sample, FPL reported to the BOR that the material from the four mills sampled seemed to be considerably different depending on latitude. FPL recommended, in light of the differences in latitude shown in the test data, that a more appropriate approach to analyzing the collected data would be grouping the test results from France with the test results from Germany and determining the design values using this method. Grouping the data showed France to be significantly different from Germany controlling the design values for both MOE and MOR in SS and for MOE in No. 2. The design values that were determined using this grouping method would be slightly lower for these properties. There was also a concern raised by FPL with how to handle Bavarian Douglas Fir. A lengthy discussion occurred to resolve these concerns about Bavarian Douglas Fir at the ALSC BOR meeting.

Bavarian Douglas Fir—FPL reported to the BOR that there was no discussion in the WCLIB submission indicating how the region of Bavaria would be dealt with. Bavaria already had allowable properties for 2 by 4 Douglas Fir–Larch. FPL stressed that the 2 by 4 Douglas Fir data from the Czech Republic, Austria, and Bavaria should be examined to see how they compare to the values that would be adopted if Bavaria received the new German–French Douglas Fir number.

When trying to decide what to do with the Bavarian region of Germany, the lack of country of origin information in the original 1999 submission for Douglas Fir was problematic. FPL reported that the information shown in Table 12 shows the characteristic value for two methods of determining allowable properties for France and Germany and the original Bavarian, Czech Republic, and Austrian characteristic value. The test data from the 1999 submission seem to indicate that it was a considerable stretch to assign the allowable property number from German–French treated as one sample to the area of Bavaria. The 2 by 4 Douglas-fir data from Bavaria, Czech Republic, and Austria are much more in line with the grouped Douglas-fir values. FPL suggested that perhaps the assignment of allowable properties to Bavaria based on the grouped German–French number could be a possibility.

At the November 1, 2007, ALSC BOR meeting, WCLIB presented rationale for applying the proposed allowable properties to Douglas-fir lumber from Bavaria. The ALSC BOR in executive session reviewed all the information presented and concluded that the WCLIB proposal was consistent with the prior approved testing and sampling plan and unanimously approved the allowable properties proposed by WCLIB, noting that these properties are also applicable to lumber from the state of Bavaria.

Scots Pine Sweden (2006–2007)

In December 2006, WCLIB's proposed revised design values for Scots Pine (*Pinus sylvestris*) from the Kingdom of Sweden dated December 20, 2006. The only difference in the test data analysis in this report compared to the 2000 report is the way the GQI adjustment factors were determined. By the time of this submission, the upper bound adjustment factor for GQI and equation 7 method for adjusting MOE had become the accepted method for GQI adjustment calculation. The principal issues with this resubmission were as follows:

- New GQI adjustment calculations
- Rounding of GQI values

New GQI Adjustment Calculations—The GQI adjustment factor for the modulus of rupture in this report was derived for a grade–width test sample "cell" using the procedures adopted by consensus in ASTM. When the test sample GQI exceeds the assigned grade GQI by more than 5%, the GQI adjustment factor was

$$(\text{Grade GQI} + 5\%)/(\text{Test sample GQI})$$

The MOE adjustment factors were recalculated using a secondary MOE GQI adjustment factor calculation method adopted by the ALSC BOR in March 2003. Using the Swedish Scots Pine data provided in 2000 and the methods proposed in the 2007 WCLIB submission, FPL was able to calculate all but two of the allowable property values shown in Table 13 of WCLIB's submission. The values for No. 2 bending and tension calculated by FPL differed by one rounding rule from those presented.

FPL and WCLIB investigated the reason for the difference. FPL was in agreement with the data that WCLIB was using for their calculation. The difference occurred in the calculated 5th percentile GQI size–grade cell values when GQI values for the individual samples were rounded. The

Table 13—Differences in calculated GQI

Size	Grade	WCLIB	FPL
2 by 4	SS	67.0	67.5
	No. 2	52.1	52.4
2 by 6	SS	65.0	65.2
	No. 2	49.0	49.3
2 by 8	SS	65.0	65.2
	No. 2	54.0	53.8

different GQI values result in differences in the adjustment factors being used to adjust test data. These GQI differences were a result of different approaches to rounding.

Rounding of GQI Values—In their submission, WCLIB chose to round to the nearest integer immediately after calculation of GQI for each specimen by dropping all the numbers to the right of the decimal point and using those GQI values to determine the 5th percentile GQI. FPL explained to the ALSC BOR that in all previous submissions before the board, FPL had consistently calculated GQI values from the failure code and carried the unrounded values forward until the 5th percentile for each cell GQI was determined. That value was then rounded up to the nearest tenth.

The difference in the calculation methods was just enough to result in the calculated values for No. 2 bending and tension determined by WCLIB and FPL to be on opposite sides of a rounding rule. The ALSC BOR approved the newly calculated values based on prior GQI calculations and rounding methods for Scots Pine from Sweden at its February 8, 2007, meeting.

Recurring Issues with Implementation of D 1990

Multiple recurring issues have been caused by the ambiguities in D 1990. Of particular concern has been a logical order of adjustments, grade quality index (GQI), grouping, collection of additional data, withdrawal of species from existing species groups, quality control monitoring to verify sampling, and reassessment of allowable properties once established. Several interpretations and decision have been made by the BOR regarding these issues. The following discussion outlines FPL's review of these decisions and our position on them.

A Logical Order of Adjustment Procedures Has Developed

Early on, while evaluating foreign submissions, FPL found that a document was needed to outline a logical order of adjustments that took into account the study parameters that were assumed in studies and used to create the adjustments. Some calculations are clearly specified in the D 1990 standard. However, in some cases the standard merely indicates a need to make an adjustment but does not specify how to do so. In addition, 18 years have elapsed since the original submissions were made under ASTM D 1990. Part of any system of developing allowable properties should be consistency in calculations across species. That becomes more difficult as more people become involved in performing the calculations. In most cases, the calculations for recent D 1990 submissions were performed by individuals who did not participate in the original submissions or the In-Grade Program. Confusion over the order in which data adjustments are to be applied to In-Grade data has resulted, on several occasion, in different values for allowable properties between grading agencies and FPL.

For example, in the original In-Grade program, testing was done at ambient temperature and MC. However, moisture models were established by laboratory testing at room temperature with a span to depth ration of 17 to 1, it makes sense to correct for temperature and span before MC adjustments are made. Another subtly is that the original In-Grade testing MC corrections for MOE values were based on MOE values determined with deflections measured at the load head. Before MC correction, MOE values should be adjusted to a value determined by deflections measured at the load head. The order in which the data checks are applied is significant. It only makes sense that data checks are applied on a cell-by-cell basis because the difference in individual sample cells can be disguised.

A guide has been prepared to provide agencies with the preferred logical order of adjustments (Evans and others 2001). This guide provides a step-by-step "walk through" of the standard for a single species. This walk through follows the pattern of the most recent submissions to the ALSC BOR in that it assumes the specimens were tested in bending only. Finally, many of the calculations in the standard are difficult, and mistakes are easily made, particularly when trying to integrate the calculations in a spreadsheet, as most recent submissions have done. The development of computer programs to perform some of the calculations has simplified the process and eliminates some potential errors. The 2001 procedures general technical report FPL-GTR-126 (Evans and others 2001) and historic background information presented here should provide sufficient information for a consistent order of adjustment.

Grade Quality Index

The most frequent principal issue brought up as a concern in the chronology above was GQI. GQI was introduced into the standard to calibrate the test sample results to the NGR grade description. GQI may not be needed if the NGR grade description can be changed to match the characteristics of the sample tested. At this time, GQI is the only recurring issue that has been resolved by consensus in ASTM. Background information for the consensus decisions is provided below.

In section 8.2 of the original version of D 1990, very limited guidance of what to do about being outside the 5% tolerance

was given. The last sentence of that section stated that "If the sample GQI varies from the assumed minimum GQI for the grade by more than the 5% tolerance, the samples and the GQI shall be re-evaluated for appropriateness (Note 9).

Note 9—Failure of the sample to meet 8.2 may be due to any of several causes, some of which may be acceptable or correctable. For example, it may be possible to bring the samples into compliance by resampling the necessary test cells. It may also be desirable to reassess the appropriateness of the GQI scale used. A modification of the GQI scale or calculation methodology may be appropriate. If the GQI procedures are modified, use the modified procedures to re-evaluate all test cells and the assumed minimum GQI of the grades for compliance with 8.2."

Unfortunately there was not any specific recommendation given in note 9 for what that re-evaluation should be. For the past 17 years, submissions have approached this re-evaluation by applying a correction factor adjustment to the test data that were collected. Another option suggested in note 9 of D 1990 is to bring the sample into compliance by resampling. To date, no one has chosen this option.

As detailed in the chronology, when NeLMA submitted design values for spruce from the Archangel region of Russia, GQI adjustments became a significant point of contention (WAS 1994a) The WCLIB letter of January 23, 1995, discussing the NeLMA Archangel spruce submission correctly pointed out that ASTM D 1990 did not give specific directions on how to make adjustments to strength properties if the GQI differs significantly from the minimum value stated in the National Grading Rule (note 7 of D 1990). The NeLMA submission for Norway spruce from the Archangel region of Russia forced the ALSC BOR to make a decision on what could be done to adjust for test cells that were outside the 5% limit.

The NELMA sample for Norway spruce from Archangel Region of Russia was taken with the same philosophy as that of the U.S. data: pieces accepted as on grade for all reasons, not just strength-reducing reasons. In 3 of 4 test cells, however, the GQI was above the 5% allowed by paragraph 8.2. Although FPL agreed in principle with getting a more conservative number by adjusting to the middle of the GQI range (minimum GQI of the grade), FPL did not require adjustment of previous In-Grade data for a grade–size combination GQI that was exactly at the limit of the GQI range. Thus, it would seem hard to argue that for a GQI that was 6% higher than the grade minimum GQI, the data would have to be adjusted to the grade minimum GQI when a data set 5% high had no adjustment required. The approach that was accepted for adjusting the Norway spruce from Russia was to calculate the adjustment factor based on (target GQI + 5%)÷(sample GQI).

When the Swedish spruce submission arrived in 1998, it too had GQI issues. To develop an adjustment to the GQI values for each size–grade cell, WCLIB proposed an interpolation procedure based on weighting of GQI values. In letter to the board on September 29, 1998, FPL discussed why they thought the scheme was backward and proposed an alternative scheme. FPL did not receive any response from WCLIB on their reasoning, possibly because FPL's discussion was not very clear. They then provided a hypothetical example: Suppose in a cell, only 10% of the pieces had failure information and that these 10% of pieces were the bottom 10% of the cell's MOR values. We could assume that the pieces with no failure information and higher MOR values probably had on average higher strength ratios and the 5th percentile strength ratio of these specimens would be higher. Thus, if we had failure information on all the specimens, the 5th percentile strength ratio would be higher than the 5th percentile strength ratio of the bottom 10% of the MOR specimens. The WCLIB weighting scheme would cause one to use the 5th percentile strength ratio of the bottom 10% of the specimens, thus underestimating the true 5th percentile. Because you lower MOR and MOE values only if you get values more than 5% above the assumed grade GQI, any procedure that underestimates the GQI of the whole sample can overestimate design values. If the weighting scheme were reversed, as we proposed, the GQI in this example would have been the one calculated with all the pieces.

FPL concluded that even if weighted differently, the method would have been difficult to be shown appropriate

Also with the Swedish spruce, WCLIB presented an interpretation of how to calculate GQI values by assigning 100% GQI to those pieces with a failure code where a GQI cannot be calculated. FPL objected to this method because no information existed to suggest that these pieces were in fact clear material. The ALSC BOR decided that the assignment of 99% was an appropriate method for incorporating data with no GQI information.

In October 2002, WCLIB continued the discussion of GQI by providing proposed alternative procedures for adjusting MOE lumber test data for compliance with Grade Quality Requirements of D 1990. FPL reviewed the "Proposed Alternative Procedure for Adjusting Lumber Test Data for Compliance with Grade Quality Index (GQI) Requirements of D 1990" (WCLIB 2002c). In this review FPL expressed the point of view that ASTM D 07 committee on wood's section ASTM D 07.02 (solid-sawn lumber) was the appropriate place to make decisions on GQI adjustment procedures. However, FPL was also aware that it is often difficult to get an ASTM task group to focus on such technical minutia as GQI adjustment procedures. The WCLIB proposal identified a significant problem with GQI adjustments for MOE and proposed an approach to solving the problem. FPL had some technical problems with the equations currently being proposed, but agreed that there was a need to have a better approach for MOE than the one that has been used in the past. FPL recommended using the WCLIB

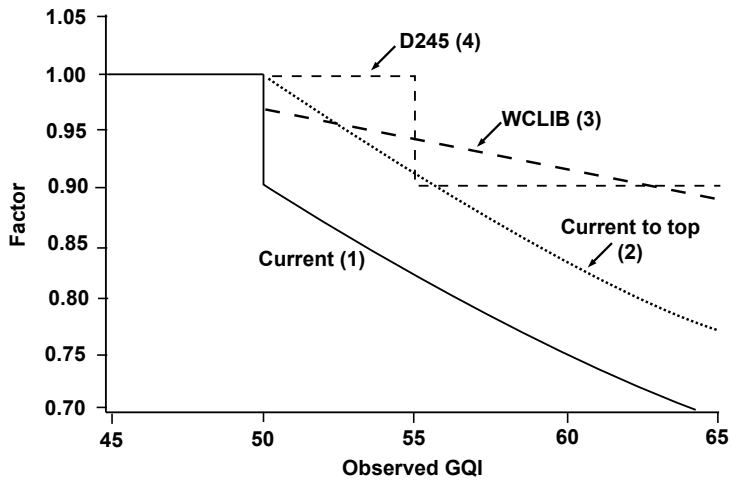

Figure 12—Comparison of current GQI options with WCLIB proposal (No. 2 Grade).

proposal as a starting point, to see if all the agencies could develop and agree upon a procedure for adjusting MOE for GQI and, if necessary, another for MOR. It was suggested that these procedures could be then be adopted as a BOR guideline and also submitted to ASTM. The discussion of proposed alternative procedures is summarized below.

Summary Technical Review of WCLIB Proposed Alternative GQI Procedures—In their 2002 proposal, WCLIB pointed out that D 1990 requires something be done if the quality of the lumber sampled was outside the GQI limit specified in the standard. Other than allowing additional samples to be taken (always an option), the standard provided little other guidance on what should be done. To that point in time, at least four different ways had been used in BOR foreign species submissions to make analytical adjustments for GQI problems. By far the most common adjustment method was the ratio calculated by taking a target GQI value and dividing it by an actual test value. WCLIB recommended that the procedure presented in their proposal be approved as an "optional procedure." FPL in its initial review of the proposal expressed concern that there were already too many "options" and recommended that the BOR adopt one procedure, or at least identify one procedure as preferred.

In a February 5, 2003, letter FPL continued the discussion of GQI with the ALSC BOR (FPL 2003). They stressed that there were currently mainly two procedures (described in the letter as equations 1 and 2) that had been used to adjust data to bring it into compliance with the requirement of section 8.2 of D 1990:

Current model to the claimed GQI for the grade (that is, target for grade 2 is 45)

$$E_{target} = E_T = [GQI_{target}/GQI_{actual}]E_{actual} = [Q_T/Q_A]E_A \qquad \text{Letter eq. 1}$$

Current model to the upper limit GQI for the grade (that is, target for grade 2 is 50)

$$E_{target} = E_T = [GQI_{target}/GQI_{actual}]E_{actual} = [Q_T/Q_A]E_A \qquad \text{Letter eq. 2}$$

FPL stressed to the ALSC BOR that the second of these two equations is the one virtually all submissions for foreign species had used to this point. WCLIB did respond that some previous foreign species submissions had adjusted the data to the target GQI of the grade (for example, 45 for No. 2 dimension lumber) and others to the upper bound (50 for No. 2 grade). The difference between the adjustment factors for these two alternatives for No. 2 grade lumber presented to the BOR is shown in Figure 12, in which adjusting to the mean target GQI of 45 is shown as equation 1 and adjusting to the upper bound is equation 2. For comparison, the WCLIB model for MOE from the bottom of page 8 of their October 7, 2002, WCLIB submission is given below as equation 3 and shown in Figure 12 as equation 3.

WCLIB proposed model for MOE adjustment

$$((0.0047(SR2)+0.531) \div (0.0047(SR1)+0.531))MOE1 = MOE2 \qquad \text{Letter eq. 3}$$

Also for comparison, the D 24 5 model as is included as equation 4.

ASTM Model

$$((100 - (\text{Target grade level in \%} - \text{Actual GQI in \%})) \div 100)MOE1 = MOE2 \qquad \text{Letter eq. 4}$$

Equation 4 adjusts from a GQI that is too high for the grade to a target grade level. Thus for No. 2 grade lumber with an actual GQI of 60, this would be a 10% reduction. The D 245 boundaries do not correspond with those of D 1990, so a piece with a GQI of 53 would require no adjustment by

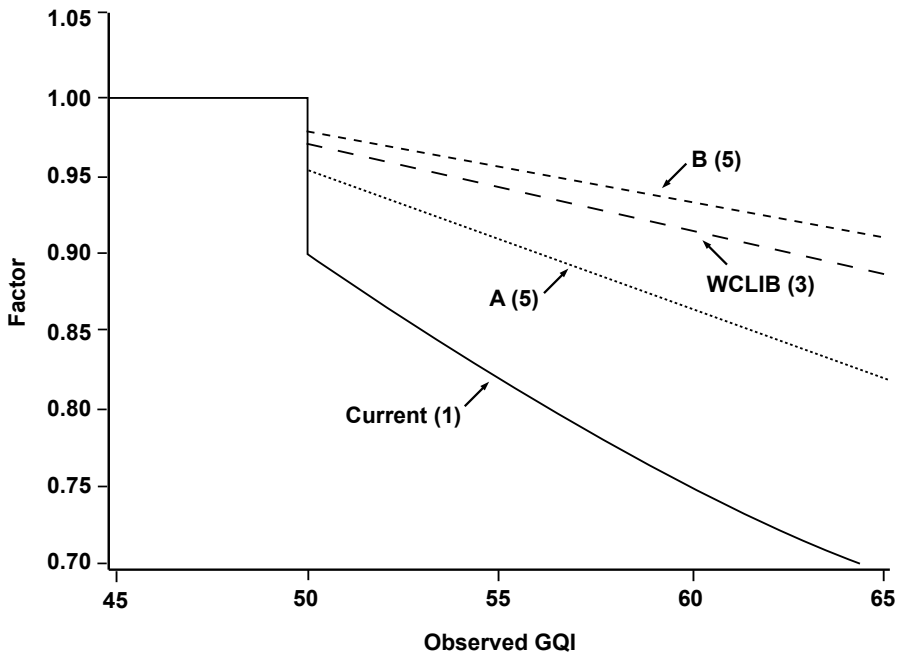

Figure 13—Comparison of GQI models for equation 5.

D 245, although D 1990 says there must be an adjustment. So we cannot actually use the D 245 model, except for comparison.

FPL suggested in a letter response to the ALSC BOR in October 2002 that there could be at least three other approaches to getting GQI MOE adjustments that were either based on an accepted D 1990 concept, such as the grade model for MOE, or were somehow based on the major in-grade species that were deemed to not have a GQI problem. These three approaches were presented as examples in the February 5 letter and are illustrated in Figure 13 and 14. The detailed derivations for equations 5, 6, and 7 shown in Figures 13 and 14 are given in Appendix A.

The first alternative equation explored by FPL, labeled equation 5, was a model based on the grade model concept of determination of slopes for MOEs referenced to GQIs of 65 (Select Structural), 45 (No. 2), and 9 (Utility). For No. 2 grade lumber that might have to be adjusted for GQI, the curve is shown in Figure 13. The actual MOE value would be that resulting from the test of a foreign species, called "E_A" in the model. Because FPL needed real numbers for MOE, FPL chose two examples. Species "A" in Figure 13 is a large knotted species with a distinct difference between earlywood and latewood. Species "B" is the opposite. For comparison, FPL included the "current model" (1) and the WCLIB model (3). FPL stressed that a future species "C" could be anywhere on this plot, and generalization of this model for all GQIs gets "messy."

The second equation type examined by FPL, labeled equation 6, used characteristic MOE values from the major in-grade species for Select Structural and No. 2 grade lumber to establish the "slope." The "E_A" values would be from the foreign species tests. FPL pointed out that a number of options are possible with this approach, a few of which are shown on Figure 14. For example, one could chose Select Structural as the basis and determine the slope between that and No. 2. These slopes are shown in the Table A2 of Appendix A (Douglas Fir = 0.00770, for example). For the same species used in Figure 13, the curves are shown as "A SS" and "B SS". The curves change if one were to use No. 2 as the base. For species A, this is shown in Figure 14 as "A No. 2". The current equation 1 and WCLIB equation 3 curves are given as reference. One could also use the average of the slopes for the group of four species having the steepest slope (0.00770, 0.00715, 0.0074, and 0.00735 in Table A2 of Appendix A). This curve is shown as "Avg (6)" in Figure 14. FPL advised that the fact that the selection of a either Select Structural or No. 2 as a base effects the adjustment could be viewed as a problem with using equation 6 from Appendix A.

The final equation, labeled equation 7 in Figure 15, solves this problem. In Figure 15, the adjustment for No. 2 grade lumber is shown with the assumption of a slope of 0.0077 (other slopes could be chosen). FPL felt that of all the methods presented, equation 7 would be an appropriate interim procedure for adjustment of MOE lumber test data for compliance with GQI requirements of ASTM D 1990.

$$E_T = E_A \left\{ \frac{1+\left[0.00908\left(Q_T - 45\right)\right]}{1+\left[0.00908\left(Q_A - 45\right)\right]} \right\} \qquad \text{Letter eq. 7}$$

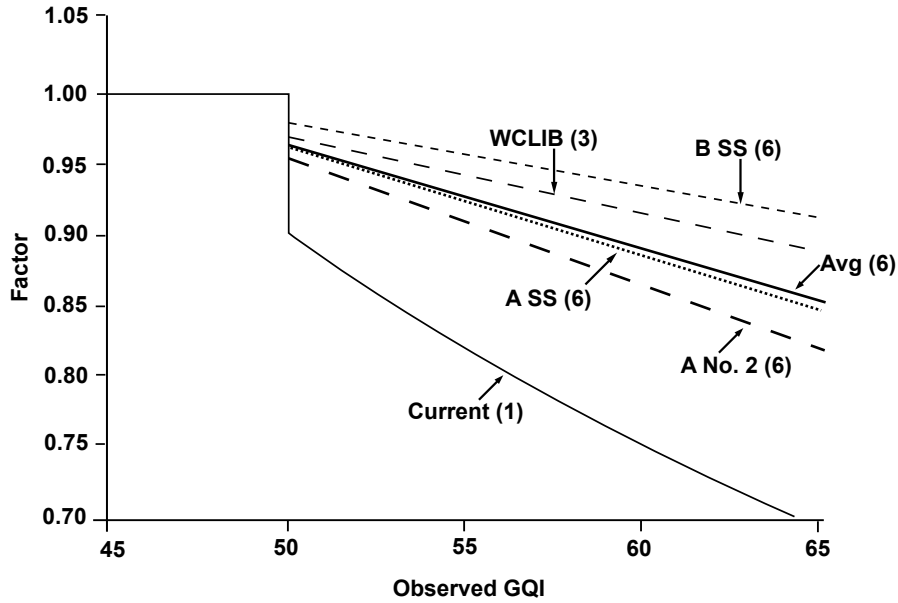

Figure 14—Comparions of GQI Models for equation 6.

FPL also emphasized that other models are possible. For example, there is a possibility for using the in-grade model to re-establish the D 245 model, perhaps using the major species in-grade pieces that had 100% strength ratio as one anchor and then using the remaining pieces at each grade to determine a ratio with the value for the 100% strength ratio pieces. This model was never developed.

For FPL, the bottom line was that many options are possible, only some of which are given here. In the absence of more clear-cut technical data and little guidelines from D 1990, it would seem that a consensus of knowledgeable experts is needed. FPL felt that if a consensus among the grading agencies could be reached, a decision might be possible at the BOR. If there is no consensus, then an ASTM task group would seem to be a more appropriate place for this discussion.

It took many months and considerable discussion to reach a decision on alternative MOE GQI adjustments methods. The WCLIB proposal was first included in the agenda of the October 31, 2002, BOR meeting and was considered at that meeting, but no final decision was reached until March 2003. At the October meeting, the BOR accepted the FPL recommendation made in the FPL comments that all the agencies and FPL confer to try to develop and agree upon a procedure for adjusting MOE for GQI, and if necessary another for MOR, and that those procedures could be adopted as a BOR guideline and also be submitted to ASTM. In the following months, comments were received from the Canadian Wood Council, WWPA, WCLIB, and FPL. Following the further consideration of this proposal at the February 6 BOR meeting, the BOR on March 5, 2003, announced its acceptance of the advice of the FPL given during the February 6 BOR meeting that FPL "equation 7" as presented in the FPL letter of February 5, 2003, would be an appropriate interim procedure for adjustment of MOE lumber test data for compliance with GQI requirements of ASTM D 1990 pending consideration of this matter by the appropriate ASTM committee. WWPA made an appeal of this decision. The decision to use equation 7 was upheld at an April 24 hearing of an appeal brought by WWPA. The complete rationale for this opinion is given in Appendix B

In their final decision on the appeal, the BOR reaffirmed its March 5, 2003, decision. On consideration of the WWPA appeal and the issues raised, the BOR was of the view that it was appropriate to accept the advice of the FPL that FPL equation 7 could be utilized as an interim procedure for adjustment of lumber test data for compliance with grade quality index requirements of ASTM D 1990 pending action by ASTM. As noted above, that advice was given to the BOR as "other technically sound criteria" per section 6.3.2.1 of PS 20. The BOR emphasized its view that this was an interim decision and, on the basis of representations made, expected the appropriate ASTM body to develop and standardize a process for making these adjustments. It would take another 4 years for these changes to work their way through the ASTM consensus process. In December 2007, GQI adjustments using equation 2 for MOR and equation 2 or the alternative equation 7 for MOE were incorporated by consensus in D 1990 (ASTM 2007).

Grouping Concerns

The second most significant issue that has been addressed with submissions to the ALSC BOR has been "grouping"

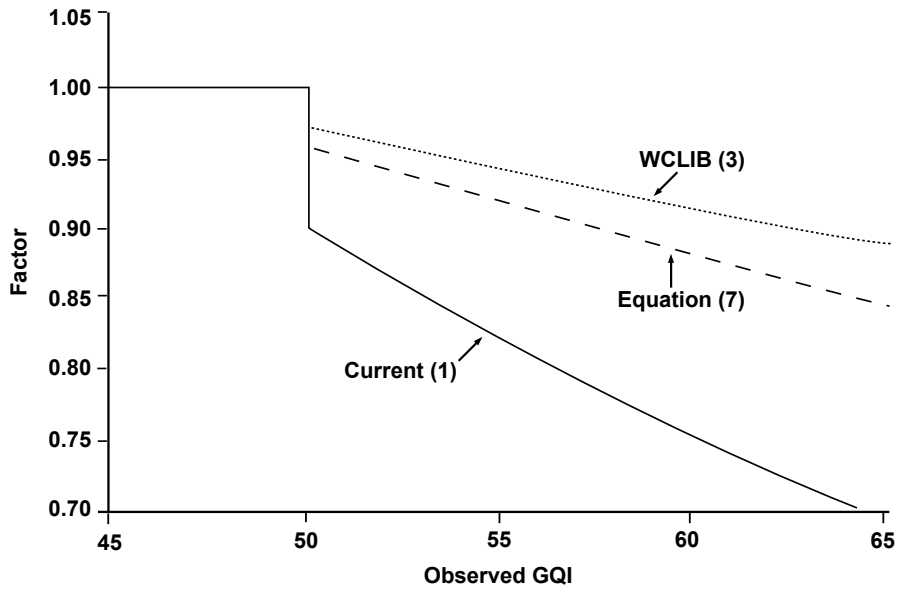

Figure 15—Comparions of GQI Models for equation 7.

of data within D 1990. Grouping was first raised as an issue with the July 1996 submission for Swedish and Archangel spruce data and continued with the majority of submission throughout the next 13 years. The ALSC BOR has accumulated a number of precedents with regard to grouping. In submissions such as combining Swedish Spruce and Archangel Spruce, the ALSC BOR has commented on the appropriate sample sizes required for grouping. The ALSC BOR has also made ruling on methods for adding in supplemental data to existing data, such as for Swedish Spruce and the German, French, and Swiss Spruce and Pine submissions. The ALSC BOR has also put forth rulings on how to add in similar species from neighboring countries to existing species groups, such as Lithuanian, Estonian, and Latvian, and the Austrian, Czech Republic, Romania, and Ukraine species. There have also been extensive discussions on how grouping should be conducted on species that remain after withdrawal of existing species, such as the Eastern Spruce Balsam-Fir and Northern Species submissions. The issues with withdrawal still need to be resolved. This section documents what FPL feels are the current precedents or preferred procedures for grouping of species with these various cases.

Lessons Learned while Trying to Group Small Sample Size Swedish Data with Archangel Spruce—In the original submission for Swedish spruce WCLIB proposed grouping a small data set of Swedish Spruce data directly with the Archangel Russian Spruce data while maintaining the larger strength value for the Russian Spruce. FPL and WCLIB disagreed with how grouping of these two species should be performed. FPL believed that if there was a significant difference between the MOR values for No. 2 grade 2 by 4's and 2 by 6's, then the Swedish data would "control" the group property for that grade. It was pointed out by FPL that D 1990 only makes provisions for considering grouping within a given grade. It makes no provisions for getting a higher number if properties are similar for six of eight comparisons. Thus for U.S. species, if all species grouped for Select Structural, then the combined number controlled the property. But if one species was significantly lower in properties, as defined in D 1990, then the properties of the low species controlled the group property for No. 2.

FPL did not believe the properties derived from the grouped data as proposed by WCLIB met the same interpreted requirements of D 1990 as previously applied to domestic species. As interpreted by FPL, for domestic species, D 1990 procedures do not allow a small data set for a weaker "species" to be grouped with a large data set for a stronger "species" and assigned two design values for the two subsets. Although not intended in this submission, such a procedure could result in sample sizes much less than those judged necessary to obtain a "representative" sample for domestic species under D 1990. Allowing such a procedure could allow a future submission to group some species with an existing species just to avoid obtaining a larger, more representative, data set.

FPL argued that if the Swedish and Russian data were to be grouped, the MOR values would need to be controlled by the Swedish data. For grouping SS pieces, the chi-squared value we get is 12.723, which is significant at the 0.001 (or lower) level. This means that the group value would be based entirely on Swedish spruce values. For No. 2 in Table 2, the chi-squared number is also highly significant. Thus, no matter how we look at the chi-squared values, we draw the same conclusion: MOR, UTS, and UCS design values would be calculated by the Swedish data.

FPL identified three alternatives for deriving allowable property values for Swedish spruce as D 1990 currently exists:

1. Sample a full matrix with 360 pieces per size–grade cell (smaller if restricted geographic region involved).
2. Sample using a smaller sample size for every size–grade cell and show that your values are higher than those of some species group to which you would be added (DF in Western Woods grouping is an example).
3. Form a marketing group using the grouping criteria in ASTM D 1990, which requires that all species used to create it take on the design values of the grouped species.

Each method had issues when applied to the Swedish spruce data. The first method, calculating an independent value for Swedish Spruce by the full matrix approach, was not possible because of limited sample size. With only 82 pieces in No. 2 grade 2 by 4 and 89 in No. 2 grade 2 by 6, there were not enough pieces to get independent values for Swedish spruce. Additional sampling would be required. The second method, demonstrating Swedish spruce was stronger than Archangel spruce, did not fit the Swedish spruce data. The values for No. 2 grade Swedish spruce were lower than those of No. 2 grade Russian spruce, so the Swedish data could not be "added" to the Russian data and the Russian values used for both. The third method, using the provisions of section 10.2 and 10.3 of D 1990, was a possibility, but the Swedish numbers would control. FPL felt that this was valid only if both species are assigned the same design value. FPL had major concerns about grouping two species and letting each claim different design values. FPL believes this is not equivalent to the way U.S. species have been handled. Also, MOE values for the Swedish data appeared to be higher than those of the Archangel data. Thus, D 1990 would suggest that the Archangel E-values should be used for the Swedish data.

Because in this particular instance the material being grouped was indeed the same botanical species and because WCLIB made a special effort to obtain a sample with the maximum strength-reducing defect for SS and No. 2 grade, FPL felt that the resulting design values calculated based just on the Swedish data alone would most likely be conservative. A possible alternative suggested by FPL was to allow WCLIB to calculate properties based on the Swedish numbers alone (which the FPL can check), under the condition that they continue to collect and test material for a minimum of 1 year or until an additional 360 pieces are tested, similar to what was agreed to by NeLMA in its for Archangel spruce. The sample size for destructive monitoring of each shipment should be 30. Then, at the end of the monitoring period, a new submission to the BOR could be made that either verifies the existing numbers or calculates new numbers using a sample size sufficient to meet ASTM D 1990 criteria for an individual species.

None of the above approaches were desirable to WCLIB. WCLIB instead chose to collect additional data and calculated an individual Swedish number.

***Historic Sample Sizes*—**FPL has repeatedly pointed out during the past 18 years that allowable property calculation sample sizes for species groupings or individual species be approximately 360 pieces, if possible. This is based on the fact that to this point sample sizes for the major domestic species have been at least 360 pieces per grade–size cell. When the intent was to market a species by itself, U.S. species have had to meet a minimum sample size (suggested as 360 for major species having a large geographic distribution as stated in note 6 of D 1990). FPL has also over the past 18 years repeatedly recommended a minimum sample size of about 200 per grade–size cell if there is a reduced geographic area (or limited standing timber volume). DF(S) and minor Southern Pines constitute the absolute minimums accepted for a species intended to be marketed alone.

Two major groupings were done with U.S. In-Grade data: SPF(S), where all species grouped together, and Western Woods, where four species were used to establish the properties for the group and additional species of demonstrably higher properties were added for marketing convenience. Each of these groupings ended up with sample sizes of at least 360 pieces in the grade–size cell. When "grouped," approximately 60 pieces were allowed per individual species. But if a species in the group were to be listed separately, its design value is that of the group. To allow a group to be formed while not requiring all species used to create the group to take on the grouped values could create an inequity with the current U.S. species groups. Any species with 60 pieces per size–grade cell could find another species to group with, do the grouping, and perhaps get a higher design value than it would get by itself. When this species is sold as the only member of this "group," the design value it uses would not meet the requirements that were met by existing species groups.

***Extreme Differences in Samples Sizes of Species Being Grouped*—**There are potential problems when a larger data set is grouped with a small data set. In this case the properties of the small data set may have little effect on the properties of the larger data set, so the small set could get an artificial boost in properties. All grouping of U.S. species has been done with data sets of approximately equal sample sizes. In the extreme, the chi-squared test may not be sensitive enough to protect against potential problems of grouping vastly different size samples. And we do not want to encourage someone to start "looking" for a domestic data set that would group and provide the largest possible "boost" to the properties of the smaller set, especially if there was no real intent to market the two species under one name. Grouping of Lithuanian, Estonian, and Latvian spruce and pine partially addressed the sample size challenge. The grouping of data from these countries established the precedent for

adding new data sets with limited sample size from adjacent countries to an existing species groups using sections 10.2 and 10.3 of ASTM D 1990.

Grouping of Species from Baltic Countries—In October 2000, WCLIB proposed developing allowable properties for Estonian species with Lithuanian species using limited data sets. ASTM D 1990 includes a grouping procedure for combining "two or more species into a single marketing group" (sections 10.2.1 and 10.3.1). It also provides for adding a new species to an existing species group if the new species properties are greater than or equal to the exiting species value (sections 10.2.2 and 10.3.2). When FPL applied the grouping criteria of sections 10.2.1 and 10.3.1 to determine the allowable properties for the grouping of Estonian and Lithuanian species, they got virtually the same allowable property values as WCLIB. FPL disagreed, however, with how WCLIB initially calculated their numbers. FPL felt that WCLIB was not following the intent of ASTM D 1990 in what they had proposed in their submissions. FPL first pointed out that ASTM D 1990 did not provide a procedure for adding species to another species without a grouping test. Second, and of greater importance, the method WCLIB initially used did not follow ASTM D 1990 grouping procedures. FPL argued that the standard says characteristic values for new species added to an existing species in a group have to be greater than or equal to the existing groups characteristic value. The standard provides no guidance for determining statistical equivalence if the characteristic value of the new species is not greater than or equal to that of the existing species group. If a new characteristic value is less than that of an existing characteristic value, as was the case with the Estonian No. 2 MOE value, then according to sections 10.2.3 of ASTM D 1990 this requires WCLIB to subject the MOE values to the requirements of "new species groups" section 10.2.1. FPL continued that without guidance on statistical procedures in section 10.2.2 and 10.3.2, in the future others might want to run different confidence levels or other statistical tests, and they may argue that their method is more appropriate than the method WCLIB has used. Thus, FPL was concerned that acceptance of WCLIB's statistical procedures could establish a precedent that might have unintended future consequences. The ALSC BOR agreed and requested that WCLIB combine the Estonian and Lithuanian data using the grouping methodology in sections 10.2 and 10.3 of D 1990.

WCLIB followed the Estonian submission for Norway spruce with a Scots pine submission. Again FPL had a major concern with the submission because WCLIB chose not to group the two species according to the specification of the standard for a new species grouping as contained in sections 10.2.1 and 10.3.1 and discussed in section 10 and appendix X9 of ASTM D 1990. FPL suggested that the first substantive question that must be answered in grouping under section 10 was whether you are creating a new species group as a "single marketing group" or whether you are adding a new species to an existing species group. WCLIB wanted to consider the single species of Scots Pine from Lithuania as an existing species group. FPL could see nothing in the standard suggesting any intent to consider one species as an "existing species grouping." In fact, section 10.1 of the standard specifically introduces the concept of grouping with the following sentence: "Frequently, because of species similarities or marketing convenience, it is desirable to combine two or more species into a single marketing group." Lithuanian Scots Pine is not a combination of two or more species that were grouped together to form a marketing group.

FPL felt that the WCLIB failed to follow the intent of the standard when applying this approach as well. FPL interpreted the intent of the standard to be as follows: If you have a species that you want to add to an existing species group and it has properties higher than or equal to the existing species group, you can add the species. Otherwise, you need to go through the combining of species as prescribed in 10.2.1 and 10.3.1. For MOE, the authors of the submission used a comparison of means even though the standard clearly states in section 10.2.2.1 to use medians. In addition, for the No. 2 grade data, the median of the Estonia data is less than the median of the Lithuania data. Instead of using the procedure for creating a new species group as specified in 10.2.2.2 for when this happens, WCLIB proposed using a statistical test and tried to show that although the Estonia data is less than the Lithuania data, it is not significantly less statistically. The standard does not give this option. Section 10.2.2.1 says "A new species may be added to an existing species grouping without modification of the group median or mean characteristic value if the median value of the new species is greater than or equal to the existing group median characteristic value." It follows by stating that when "the requirements of 10.2.2.1 are not met, determine the combined group median or mean characteristic value in accordance with 10.2.1." The standard does not offer the option of a statistical test to show that it is not significantly lower statistically. The ALSC BOR agreed with this interpretation.

The Baltic country submissions also forced a discussion of the order of data checks in sections 9.3 and 12.6. If a new species group is being formed, the standard is clear. Section 9.3.2 says "the test cell data check shall be performed after grouping using the combined data of the controlling species in each test cell." When adding a species to an existing species group by showing that its characteristic value is larger than the characteristic value of the existing species group, the standard does not specify whether or not these characteristic values are the ones we get before the data checks or after.

In their Estonian submission, WCLIB wanted to consider Lithuanian Scots Pine as an existing species group and use the characteristic values before the data checks. Although ASTM D 1990 does not clearly specify which characteristic

values to compare, we believe that the expressed philosophy of the data checks clarifies the intent. In section 9.3.1 the standard states, "The purpose of the test cell data check is to minimize the probability of developing nonconservative property estimates." In section 12.6 it says, "The derived estimate for any test cell shall be compared to the nonparametric fifth percentile point estimate of the test data in that size/grade cell appropriately adjusted. If the derived property value exceeds the point estimate of the test data for that cell, reduce the property value to the point estimate." The unadjusted characteristic values for the No. 2 grade data for Lithuanian Scots Pine was 1.805, and for Estonian Scots Pine it was 1.875. During the calculation of the allowable properties for Lithuanian Scots Pine, the characteristic value becomes 1.682. This illustrated the distinct possibility that the characteristic value of a new species being added to an existing species group could be higher initially, but lower if the 9.3 and 12.6 data checks are performed. Given the expressed desire in the standard to "minimize the probability of developing non-conservative property estimates," it appeared to FPL that the standard's intent is to compare characteristic values after the data checks have been performed in the case of adding a new species to an existing species group.

To add further confusion to the grouping process, the standard does allow grouping by other appropriate technical criteria in section X9 where it says, "proposed species groups which do not exceed the variability permitted in the 'major' species groupings should be considered as a single species grouping for sampling and analysis purposes." This might offer the authors the opportunity to combine the Estonia and Lithuania Scots pine data to develop allowable properties if they show that the variability of the Scots pine does not exceed that of the "major" species groupings of Douglas Fir, Hem–fir, and Southern Pine. There are still some very difficult questions that would be needed to be addressed if they want to use this approach, such as the question of what the appropriate number of specimens should be for each species under this approach. Up to now, grouping procedures other than those outlined in sections 10.2 and 10.3 have been applied.

FPL has stressed that the principal problem with proposing a procedure for grouping not specified in ASTM D 1990 is that the standard will not provide any guidance in how to do it, and several alternatives become possible. Attempting to come up with alternative procedures to those specified in the standard tends to negate the thought and effort put forth to come up with the specified procedures. As soon as a user is outside of the standard, FPL has no standardized criteria to judge the acceptability of the procedure. After extensive discussions, WCLIB agreed to combine the Estonian data with the Lithuanian using the grouping procedures of sections 10.2 and 10.3 of D 1990 and the data checks on the individual species data. This method was applied to subsequent submissions involving grouping new country data with existing country data, such as the Latvian spruce and pine data and the Austrian, Czech, Romanian, and Ukraine spruce and pine data.

Another recommended practice for agencies considering grouping species is that they look for patterns in the data that are going to be grouped.

Collection of Additional Data

There have been several times over the past 18 years when additional data have been collected (WCLIB 1995a, WCLIB 1995c, NeLMA 2006). When additional data are collected, a decision needs to be made about whether this additional data verifies original results, should be pooled with original data, or will replace original results.

Withdrawal of Species from Existing Species Group

The most current issue before the ASLC BOR about which D 1990 is silent is the withdrawal of species from existing species groups. This topic has been a source of many hours of discussion within a Lumber Properties Task Group that was formed by the ALSC BOR. The withdrawal issue currently being addressed has two distinctly different cases: (1) withdrawal of whole species from an existing species group, such as the removal of Sitka spruce and Yellow cedar from the Northern species group, or (2) partial withdrawal of a species from an existing species group, such as the removal of eastern spruce and balsam fir from a limited region in the eastern part of North America.

Withdrawal of Whole Species from Group

Withdrawal of species from an existing species group is the most straightforward circumstance involving withdrawal. It can occur when independent allowable properties are developed for species that are currently in an existing species group. This was the circumstances that arose as a result of the NLGA Yellow Cedar Sitka spruce submission. The principal issues that need to be addressed when species are withdrawn from an existing species group are as follows:

- Adequacy of the remaining groups' sample size
- Recalculation

Adequacy of Remaining Groups' Sample Sizes—The remaining species must have approximately 360 samples left.

Recalculation—If a species is withdrawn from an existing species group, recalculation of the resulting group is necessary.

Partial Withdrawal of a Species from an Existing Species Group

The partial withdrawal of a species from an existing species group is a very complicated topic. An example of this type of withdrawal is NeLMA's attempt to develop allowable properties for Eastern spruce–balsam fir for a limited

geographic range while maintaining the current allowable property values for SPF(S). The principal issues of concern with a partial withdrawal are as follows:

- Adequacy of the sample size that is left
- Representativeness of the remaining sample
- Recalculation

Adequacy of the Remaining Sample Size—When a partial sample is removed, it may be impossible to have enough sample left to adequately represent the species within a grouping for the remaining sample.

Representativeness of the Remaining Sample—If data from only one mill are left, data from more mills may be needed for the region left. It may be necessary to sample more mills and decide where to sample.

Recalculation—Recalculation is necessary in all cases when a species or part of a species that was used in calculating the allowable properties for a species group is withdrawn from an existing species group. Basically, if you withdraw something from an existing species group, in this case, you are starting from scratch.

Quality Control Monitoring to Verify Sampling

Because of the lack of historic NGR production information for foreign species submissions, the VSR Guidelines require some additional monitoring of shipments to verify that lumber quality being produced is similar to that used in the original qualification sample (Green and Shelly 1992). The guidelines state that this can be done with nondestructive measures. There have been several ways for monitoring (physical and mechanical) to verify initial sampling that have been proposed.

Because NeLMA wanted to take a more cautious approach to a new foreign species, on December 27, 1994, NeLMA proposed a quality control monitoring destructive testing program for the first year of production. FPL's letter to the Board of January 19, 1995 (USDA 1995), recommended a monitoring program that they felt was more in line with NELMA's objective of validating the representativeness of the original sample. A WCLIB letter of January 23 felt that the proposed destructive testing of the December 27 NeLMA submission was excessive, whereas the WWPA letter of January 27, 1995, expressed the opposite and suggested even larger sample sizes for destructive testing as being necessary. FPL advised the BOR that additional monitoring above the minimum specified in the VSR Guidelines is an agency decision and might vary with agency and the location from which lumber is being obtained. FPL could see why NeLMA would be interested in a more extensive monitoring program because it might be harder to ensure a "representative" initial sample variation in lumber properties from a large country for which we know little than if from a smaller country where a lot of data are readily available.

The other extreme was when in July 1996 WCLIB proposed that no monitoring be conducted on lumber received into the United States because the geographic range is limited and the property assignments are believed to be conservative. FPL responded that their interpretation of the BOR's "Guidelines for Assigning Allowable Properties to Visually Graded Lumber ..." is that waiving some sort of monitoring is not an option. Quoting from the Quality Control section, "In general, visual grading alone is not considered sufficient to assure consistency in lumber quality from an unknown source. … The guiding principle is that at least one grade–size combination must be monitored at all times that lumber is being graded." The ALSC BOR has adopted this guiding principle as their policy for foreign lumber submissions.

FPL has continued to maintain that some sort of quality control is desirable for any foreign species in the initial stages of production. When allowable properties for foreign species are approved by the ALSC BOR, the BOR knows only that the assigned properties should be conservative relative to the properties of the sample that was tested. FPL argued that although it is true that many submissions are from a relatively small geographic area, they lack the degree of knowledge about the origins of the tested sample that they would have for U.S. data. Some monitoring of quality therefore seems desirable for an initial period of time. At a minimum, FPL suggested that records be kept on growth rate and rings per inch for 1 year, or until a minimum of 360 pieces have been monitored.

This is the type of monitoring that has most frequently been conducted. Examples of this monitoring include WCLIB's validation study for 2 by 4 Austrian spruce (*Piecea exelsa*) submitted in February 1998 and Scots Pine from the country of Sweden in March 2001 (WCLIB 1998c, 2001b). The data sets sampled over the course of 1 year supplied by WCLIB indicated that the resource is as good or better than the material originally used for design value calculation. A different result was noted in an April 2002 validation study of pine (*Pinus sylvestris*) from the countries of Austria, Czech Republic, and Germany. There was a large shift noticed in percentage summerwood in the German monitoring sample. If the percentage summerwood had truly been reduced by 60% from that of the original material, then the current material could have a substantially greater portion of lower density earlywood in it than was originally tested. Further review of the German material was conducted.

Reassessment of Allowable Properties Once Established—A final issue that needs to be dealt with in D 1990 is reassessment. Reassessment is a different type of quality control requirement and is broadly outlined in section 13, Reassessment and Affirmation, of ASTM D 1990 (ASTM 2009, D 1990-07). This section addresses the need for a method to detect significant changes in raw material resource or product mix over time. The reassessment section was included in D 1990 because committee members had concerns about the

need to periodically evaluate the applicability of in-grade results that might arise over time due to a "significant" change in the resource. Two examples of the original concern might be the introduction of more and more plantation-grown southern pine, or the effect of the reduction in cut from large amounts of federal land in the west. When D 1990 was originally approved in 1991, it was not known what form such a monitoring program might take.

In 1994, SPIB initiated a resource monitoring program. Working with FPL, a number of alternatives for reassessment were investigated and a method selected for monitoring allowable properties. This is documented in report FPL–RP–576 (Kretschmann and others 1999). SPIB has been conducting this program since 1998. Although there has been some discussion about monitoring programs for the West, none are fully implemented yet.

Final Comments

The ALSC BOR has been faced with numerous situations over the past 18 years where Non-North American In-Grade Testing Program lumber submissions were submitted under ASTM D 1990. The history presented here puts on paper the uses and interpretations of this standard that have occurred in the ALSC BOR. It also outlines FPL's views on the major issues that were and are present when using D 1990. Ideally, solutions to these issues need to be developed through the consensus process in ASTM. A lumber property task group made up of government and industry has been formed by the American Lumber Standard Committee to help with developing this consensus. Until that consensus can be developed, technically sound criteria will continue to be used by the BOR to make decisions on submissions sent to them.

An ASTM standard is a dynamic document that is continually evolving. The initially adopted language of ASTM D 1990 had several sections where language was vague and guidance was in short supply. Even with this vague language, D 1990 has been used successfully to develop allowable properties for many species outside North America (Tables 14 and 15). Some changes to the language of the standard have been made, and more changes are needed. As new situations arise, D 1990 will continue to be interpreted and its language will evolve.

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Table 14—European design values approved by the ASLC BOR (base values for 2 by 12)

Grade	Norway spruce from Archangel Region of Russia[a]	Norway spruce from Sweden	Norway spruce from Finland	Norway spruce from Baltic Countries, Estonia, Latvia, Lithuania	Austrian spruce from Austria, Czech Republic	Norway spruce from Romania, Ukraine	Norway spruce from Germany, NE France, Switzerland	Scots pine from Germany	Scots pine from Finland	Scots pine from Estonia, Lithuania	Scots pine from Austria, Czech Republic, Romania, Ukraine	Scots pine from Sweden	Douglas-fir/ European larch from Austria, Czech Republic, Bavaria[b]	Silver Fir (*Abies alba*) from Germany, NE France, Switzerland
							F_b (lb/in^2)							
SS	1,250	1,250	1,350	1,200	1,500	1,250	1,200	1,200	1,300	1,100	1,300	1,350	1,900	950
No. 2	750	675	625	725	925	750	725	700	925	650	775	625	1350	725
							MOE ($\times 10^6$ lb/in^2)							
SS	1.5	1.6	1.5	1.6	1.7	1.5	1.6	1.6	1.5	1.5	1.7	1.7	1.8	1.5
No. 2	1.2	1.2	1.2	1.2	1.5	1.2	1.2	1.1	1.3	1.1	1.4	1.3	1.6	1.3
							F_{cperp} (lb/in^2)							
SS	275	285	220	430	260	275	355	395	210	430	270	410	440	400
No. 2	275	285	220	430	260	275	355	395	210	430	270	410	440	400
							F_v (lb/in^2)							
SS	100	170	125	150	175	100	170	160	150	130	135	120	195	130
No. 2	100	170	125	150	175	100	170	160	150	130	135	120	195	130
							Approved date							
	2/2/1995	7/29/1999	7/27/2000	7/25/2002	7/24/2003	7/22/2004	2/3/2005	7/27/2000	7/27/2000	2/8/2001	4/29/2004	2/8/2007	4/22/1999	10/21/2004

[a]Only values for 2 by 4 and 2 by 6 are approved for Archangel Region of Russia; value shown is base value.

[b]Only values for 2 by 4 are approved for Austria, Czech Republic, and Bavaria region; value shown is for 2 by 4.

Table 15—Design values for continents other than Europe and North America approved by the ASLC BOR (base values for 2 by 12)

Grade	Montaine pine from Republic of South Africa	Southern Yellow Pine from Misiones, Argentina	Southern Yellow Pine "free of heart center and medium grain density" from Argentina
		F_b (lb/in^2)	
SS	975	1,000	1,700
No. 2	600	725	1000
		MOE (×10^6 lb/in^2)	
SS	1.3	1.2	1.5
No. 2	1.0	1.1	1.5
		F_{cperp} (lb/in^2)	
SS	325	440	710
No. 2	325	150	710
		F_v (lb/in^2)	
SS	135	150	210
No. 2	135	150	210
		Approved date	
	1/29/2004	4/29/2004	7/22/2004

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Appendix A—Derivation of Equations 5, 6, and 7 Grade Effect Models

Equation 5, Grade Effect Model 1

Our current grade effect model for MOE assumes a straight line between our characteristic values for MOE at 45% Strength Ratio and at 65% strength ratio. Any grade between 45% and 65% is interpolated. For grades below 45% SR, it is assumed that a grade with 9% SR will have only 80% of the MOE value at a 45% SR. Graphically this can be show as follows:

```
|                          C /
|                            /
|                           .
|                          /
|                         /
|                        /
|                    B /
|                      /
|                 _A ---.
|            __----
|       __----
|
|_____________________
                  |     |
                 45    65
```

To develop a GQI adjustment procedure based on this model, consider that we have data at two different strength ratio levels. The points A, B, and C will help us enumerate all possible combinations. Any point listed as A will be at a strength ratio less than 45%. Any point listed as B will be between 45% and 65%. Any point listed as C will be above 65%. We will assume that we are trying to adjust our two data points to MOE values associated with 45% SR and 65% SR.

Case 1: A point at B with MOE = $MOE_b = E_b$ and $GQI_b = Q_b$ between 45% and 65%; a point at C with MOE = $MOE_c = E_c$ and $GQI_c = Q_c$ above 65%.

For either point B or C, more than 5% off in strength ratio, the slope of this line from Q_b to Q_c is

$$\left[\frac{E_c - E_b}{c - b}\right]$$

So to adjust an actual value E_A at a GQI of Q_A to a target GQI, we use the equation

$$E_T = \left\{\left[\frac{E_c - E_b}{c - b}\right](Q_T - Q_A)\right\} + E_A$$

This can be used to adjust each value to the correct GQI.

Note that we use the cell value GQI for Q_T and the specimen data for E_A to get the adjusted piece value for each specimen. In case 1, we adjust either or both the points B and C depending upon which ones are over 5% off the strength ratio.

Case 2: A point at B_1 with MOE = $MOE_{b1} = E_{b1}$ and $GQI_{b1} = Q_{b1}$ between 45% and 65%. A point at B_2 with MOE = $MOE_{b2} = E_{b2}$ and $GQI_{b2} = Q_{b2}$ between 45% and 65% with $Q_{b1} < Q_{b2}$.

In this case, the data associated with B_2 do not need adjustment, because they are below the assumed GQI. If B_1 is more than 5% above 45%, then we use the equation in case 1 with point B = point B_1 and point C = point B_2 to get the adjusted B_1 data.

Case 3: A point at A with MOE = $MOE_a = E_a$ and $GQI_a = Q_a$ below 45%. A point at C with MOE = $MOE_c = E_c$ and $GQI_c = Q_c$ above 65%.

In this case, the point A data do not need to be adjusted to get a characteristic value, because $Q_a < 45$. The point C data do need to be adjusted. We could use the case 1 formula with point B = point A. However, the slope between point A and point C is flatter than the slope between the 45% point and the 65% point. If Q_A is "close" to 45%, we might not worry about this. However we can adjust point A to 45% if we want to. According to the grade model, the MOE value at 45% drops by 20% by the time we reach a strength ratio of 9%. So

$$E_A = \left\{\left[\frac{45 - Q_A}{45 - 9}\right](-.20)E_{45}\right\} + E_{45}$$

which means

$$E_{45} = \frac{E_A}{\left\{\left[\left(\frac{Q_A - 45}{36}\right)(.20)\right] + 1\right\}}$$

Then we can use the case 1 equation to adjust the data at point C using point B = point 45 and point C.

Case 4: For all other cases, we do not need to adjust the data.

Equation 6, Simplified Data-Based Ratio Models

The grade model for MOE is based on characteristic values for select structural and number 2 data. For the major In-Grade species, these characteristic values in the original submissions to the BOR are shown in Table A1.

Converting these values to the ratio to the select structural value allows us to calculate a slope of the regression line from select structural to number 2 grade material. This slope is a measure of the percent change as a decimal that MOE is changed for each change of 1 in strength ratio. These results are shown in Table A2.

Table A1. Characteristic values in original submission

Grade	Douglas Fir	Hem–Fir	Southern Pine	Spruce–Pine–Fir	Douglas Fir (North)	Hem–Fir (North)
Select Structural	1.828	1.535	1.836	1.478	1.828	1.686
Number 2	1.547	1.315	1.563	1.356	1.560	1.561

Table A2. Converted values

Grade	Douglas Fir	Hem–Fir	Southern Pine	Spruce–Pine–Fir	Douglas Fir (North)	Hem–Fir (North)
Select Structural	1.000	1.000	1.000	1.000	1.000	1.000
Number 2	0.846	0.857	0.851	0.912	0.853	0.926
Slope	0.00770	0.00715	0.00745	0.00440	0.00735	0.00370

Comparison of the models

Model	GQI: 50	GQI: 60	GQI: 70	GQI: 80	GQI: 90	GQI: 100
1 to claim	0.9000	0.7500	0.6429	0.5625	0.5000	0.4500
2 to upper	1.000	0.8333	0.7143	0.6250	0.5556	0.5000
Brad						
D 245						
5 for A	0.9546	0.8638	0.7730	0.6821	0.5913	0.5005
5 for B	0.9775	0.9325	0.8875	0.8426	0.7976	0.7526
6	0.9625	0.8875	0.8125	0.7375	0.6625	0.5875
6 DF A	0.9615	0.8845	0.8075	0.7305	0.6535	0.5765
6 DF B	0.9546	0.8638	0.7730	0.6822	0.5914	0.5006
6 SPF A	0.9780	0.9340	0.8900	0.8460	0.8020	0.7580
7 SS	0.9565	0.8799	0.8146	0.7584	0.7094	0.6664
7 No. 2	0.9565	0.8799	0.8147	0.7584	0.7095	0.6664

The average slope of the bottom four species is very close to 0.0075. Using this value gives the following equation for adjusting an MOE value E_A in a cell with 5th percentile GQI (Q_A) to a target GQI of Q_T:

$$E_T = [.0075(Q_T - Q_A)E_A] + E_A$$

Note that this model would change if we used No. 2 grade as our baseline. For example, if we used a species-specific slope the model for Douglas Fir using Select Structural as a baseline would be

$$E_T = [.0077(Q_T - Q_A)E_A] + E_A$$

If we used grade 2 as a baseline, the model would be

$$E_T = [.00908(Q_T - Q_A)E_A] + E_A$$

Equation 7, Model that Produces Identical Values for Either Baseline Value

From the second table under model 6, we see that the slope for Douglas Fir is 0.00770, which means for each change of 1 in GQI, the change in MOE should be 0.00770%. So to go from MOE at Select Structural with a GQI of 65 to an MOE with a target GQI of Q_T, we can use the formula

$$E_T = E_{65}\left\{1 + \left[0.00770(Q_T - 65)\right]\right\}$$

To get from the Select Structural MOE with GQI of 65 to the actual MOE with actual GQI of Q_A, we can use

$$E_A = E_{65}\left\{1 + \left[0.00770(Q_A - 65)\right]\right\}$$

Solving this second equation for E_{65} and substituting it in the first equation gives

$$E_T = E_A\left\{\frac{1 + \left[0.00770(Q_T - 65)\right]}{1 + \left[0.00770(Q_A - 65)\right]}\right\}$$

By a similar argument, we can get to a target MOE from grade 2 using

$$E_T = E_{45}\left\{1 + \left[0.00908(Q_T - 45)\right]\right\}$$

and to the actual MOE value using

$$E_A = E_{45}\left\{1 + \left[0.00908(Q_A - 45)\right]\right\}$$

So we get

$$E_T = E_A\left\{\frac{1 + \left[0.00908(Q_T - 45)\right]}{1 + \left[0.00908(Q_A - 45)\right]}\right\}$$

Appendix B—Board of Review Opinion

Board of Review Opinion
In WWPA Appeal of March 5, 2003, Board Decision
Regarding Grade Quality Index Adjustment Procedures

On April 24, 2003 the Board of Review held a hearing on the appeal by WWPA of the Board's March 5, 2003 decision regarding the WCLIB proposed alternate procedure for adjustment of lumber test data for compliance with grade quality index (GQI) requirements of the ASTM D1990 standard.

The WCLIB proposal was included in the agenda of the October 31, 2002 Board of Review meeting and was considered in that meeting. Prior comments on the proposal had been received by the Board from the Forest Products Laboratory (FPL), the Board's technical advisor. Following that meeting the Board accepted the FPL recommendation made in the FPL comments that all the agencies and FPL confer to try to develop and agree upon a procedure for adjusting MOE for GQI, and if necessary another for MOR, and that those procedures could be adopted as a Board of Review guideline and also be submitted to ASTM. Comments were received from the Canadian Wood Council and from WCLIB. On December 27, 2002 the Board reiterated its request to agencies for comment, noting the matter would be on the February 6, 2003 Board meeting agenda. Comments were received from WWPA and the FPL. Following the further reconsideration of this proposal at the February 6 Board meeting the Board on March 5, 2003 announced its acceptance of the advice of the FPL given during the February 6 Board meeting that FPL "Equation 7" as presented in the FPL letter of February 5, 2003 would be an appropriate interim procedure for adjustment of MOE lumber test data for compliance with GQI requirements of ASTM D1990 pending consideration of this matter by the appropriate ASTM committee.

The basis for the Board's March 5th decision was as follows. There was general agreement by the participants in the February 6 Board meeting discussion that the procedures previously approved by the Board for adjustment of lumber test data for compliance with GQI requirements can be overly restrictive. In the February 6 meeting the FPL stated that among the various procedures under discussion FPL Equation 7 would be the FPL- suggested appropriate interim procedure to adjust MOE test data until a procedure could be developed through the ASTM process, and there was general agreement with that FPL statement by those participating in the February 6 discussion. That advice was given to the Board by FPL pursuant to Section 6.3.2.1 of PS 20, which provides in pertinent part "Design values contained in grading rules shall be developed in accordance with appropriate ASTM standards and other technically sound criteria," and denominates FPL as the Board's technical advisor. In its March 5 decision the Board took special note of the agreement of the participants in the February 6 meeting that they would work through the appropriate ASTM committee to resolve the issues pertaining to GQI adjustment. In 1995 the Board had requested such ASTM action but none has been forthcoming.

By letter of March 19 WWPA entered its appeal of the March 5 Board decision. Comments were also received from SPIB and NLGA supporting the WWPA position. The Board heard that appeal on April 24.

In the April 24 hearing Dr. Kevin Cheung of WWPA stated the basis for the WWPA appeal to be that this matter should be considered by the appropriate ASTM committee with its expertise and consensus rather than by the Board of Review. The March 19 WWPA letter was to the same effect. Dr. Cheung acknowledged that there have been prior Board approvals of agency proposals, including WWPA proposals, based upon FPL advice, where the pertinent standard or standards did not specify how the particular matter was to be addressed, and Dr. Cheung stated that he considered these prior Board actions to have been appropriate. (Mr. Searles introduced such a list into the hearing record.) However, Dr. Cheung characterized those past decisions as case-by-case in nature and described the March 5 Board decision as in contrast establishing a procedure for future use. Dr. Cheung did state that the Board of Review can exercise judgment on scientific criteria when needed to supplement an ASTM standard.

In the hearing Dr. Ethington noted that Section 8.2 of D1990 requires that if the GQI tolerance is exceeded in the case of particular test data some action shall be taken, and Dr. Ethington further noted the general agreement that the current GQI adjustment procedures previously approved by the Board of Review place some wood at a disadvantage. Both Dr. Ethington and Mr. Searles noted that above mentioned prior Board approvals where the standard did not lay out the approach, including WWPA proposals, were subsequently used in later Board actions. Dr. Ethington emphasized that the Board followed the same procedure in this matter as in the past ones. Dr. David Green of FPL stated that as to the question of precedent, FPL will, as it has in the past, pay close attention in each future proposal before the Board to the particular data involved and comment thereon regardless of what the Board's past precedent has been.

Dr. Cheung having acknowledged the propriety of the prior Board approvals of agency proposals, including some by WWPA, where the pertinent standard did not specify how the matter under consideration was to be addressed, the issue remaining in the WWPA appeal is WWPA's contention that the Board's March 5 decision differed from the referred-to prior Board actions as establishing a general procedure rather than being independent case-by-case actions. This is not a valid characterization of either the March 5 decision or the prior ones. Both the Board action of March 5 and the referred-to prior Board actions were taken as the

result of particular proposals, but would be applicable in future matters of the same nature. Thus while WWPA maintains this GQI issue should not be addressed by the Board, Dr. Cheung concedes the propriety of the similar prior Board actions so is left with the attempt to characterize the instant matter as different in nature from the similar prior Board actions. There is no such distinction.

The Board hereby affirms its March 5, 2003 decision. On consideration of the WWPA appeal and issues raised the Board is of the view that it is appropriate to accept the advice of the FPL that FPL Equation 7 can be utilized as an interim procedure for adjustment of lumber test data for compliance with grade quality index requirements of ASTM D1990 pending action by ASTM. As above noted, that advice was given to the Board as "other technically sound criteria" per Section 6.3.2.1 of PS 20.

The Board emphasizes its view that this is an interim decision and on the basis of representations made expects the appropriate ASTM body to develop and standardize a process for making these adjustments.

By direction of the Board
Thomas D. Searles
President

May 16, 2003