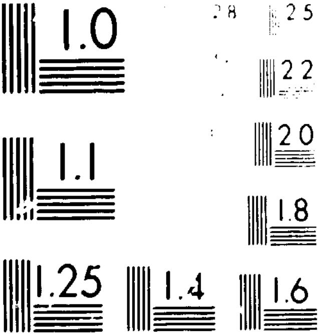
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org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United Nations Industrial Development Organization

Expert Group Meeting on Timber
Stress Grading and Strength Grouping

Vienna, Austria, 14-17 December 1981

REPORT*. (Meeting on timber stress grading).

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EXPLANATORY NOTES

Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO).

The following abbreviations have been used in this report:

ALS/CLS	. .	American Lumber Standards/Canadian Lumber Standards
CSIRO	. .	Commonwealth Scientific, Industrial Research Organization, Australia
ECE	. .	Economic Commission for Europe
FAO	. .	Food and Agriculture Organization of the United Nations
ISO	. .	International Organization for Standardization
IUFRO	. .	International Union of Forest Research Organizations
KAR	. .	knot area ratio
MGR	. .	Malayan Grading Rules
MOE	. .	modulus of elasticity
MOR	. .	modulus of rupture
QA	. .	quality assurance
RF	. .	radio frequency
TC165	. .	Technical Committee 165 of ISO. Timber Structures
TRADA	. .	Timber Research and Development Association, UK
UNCTAD	. .	United Nations Conference on Trade and Development
VTT	. .	Valtion Tieteellinen Tutkimuslaitos - Technical Research Centre of Finland

CONTENTS

INTRODUCTION

The Expert Group Meeting on Timber Stress Grading and Strength Grouping was held in Vienna from 14 to 17 December 1981. The United Nations Industrial Development Organization (UNIDO) arranged the meeting to discuss developments in this field with an emphasis on applications suitable for use in developing countries. It was also intended to create a framework for further information exchange and development work amongst specialists and to provide UNIDO with guidance for activities it might undertake in this sector. The overall objective was to seek means of developing the use of timber in construction.

CONCLUSIONS AND RECOMMENDATIONS

At the closing session, the Group carefully considered and unanimously approved (except where stated) the recommendations that had been formulated and variously amended.

It was recommended that the Governments of developing countries should:

A. (1) Make use in Latin America, of the work done by the Andean Pact countries in developing stress grading rules and a strength grouping system but must carry out their own test programmes to check their validity for their own conditions.

(2) Work towards the use of single agreed standard commercial names for timber species or species groups, at least for structural purposes rather than proliferate names to gain commercial advantage.

(3) Include tests on both small-clear and full-sized samples in their research programmes aimed at developing stress grading rules.

(4) Follow either of two approaches to developing stress grading rules:*

a) Follow the basic principles of the Australian system and use a preferred number series such as ... 38 percent, 48 percent and 60 percent ... for grade strength ratios; or

b) Survey the sawnwood resource for defects and determine an acceptable sawmill yield percentage (e.g. 60 percent) and, from testing results, determine strength properties from this population.

(5) Establish training programmes for graders as part of their programme to implement stress grading rules - using visual aids for increased impact.

(6) Establish a national framework for quality assurance and inspection at four levels as outlined in Chapter VI.

*It was however pointed out after the meeting that 4(a) and 4(b) were not necessarily mutually exclusive since 4(b) could be a sub-set of 4(a) by selecting the appropriate grade strength ratio.

It was recommended that UNIDO:

(1) Publish a document comparing existing stress grading rules which would include the responses to a questionnaire to appropriate research or standard institutes or other relevant national bodies in member states and other potentially interested parties. In this connection, it was recommended that the ISO and the member countries of TC165 be approached as well as the Secretariat of IUFRO.

(2) Review research work on speedy, species-independent, appraisal methods for strength determination, recognizing the importance of this approach for increasing the use of timber from large, clear-cutting programmes or from groups of mixed species and publish the findings.

(3) Examine a synopsis of existing strength grouping systems with a view to reaching agreement on a common system that could be adopted either in its entirety or in part by countries wishing to group timbers for structural uses and report on the possibility of a system suitable for developing countries for further consideration.

(4) Study the principles of stress grading and identification and include in a publication, a classification of all grading methods and equipment together with an analysis of the value of advanced ("third generation") stress grading machines for developing countries.

(5) Commission a special study to draw up a standard framework for stress grading rules for developing countries, together with model rules for softwoods and hardwoods. This should show the main features necessary, and should give the greatest amount of detail possible for the generalized situation where neither country nor species were known. The study should also give due consideration to the two approaches (species-dependent and independent) and to other recommendations included in the report of the meeting.

(6) Obtain the views of experts, prior to publishing the model rules so developed, if necessary through convening a meeting.

I. ORGANIZATION OF THE MEETING

1. The meeting was convened by the United Nations Industrial Development Organization (UNIDO) and was intended to bring together specialists currently active in developing timber stress grading rules, devising grouping systems based on strength characteristics of wood and involved in related activities such as training of stress graders, operating quality assurance schemes or similar quality control programmes. It was attended by people either with long experience in research and development and advisory services in these subjects or who were currently involved in projects to establish such programmes.

2. The Director of the Division of Industrial Operations opened the meeting with a statement in which he drew attention to the fundamental importance of suitable rules and systems for ensuring predictably adequate strength values for timber used in construction - both fully engineered structures and less demanding buildings and components. The Secretariat then explained to the participants how this meeting was expected to assist UNIDO in making a more effective contribution in this field and serve as a complementary programme to the more specific technical assistance provided to individual developing countries. Other similar meetings were cited as being in the fields of adhesives, woodworking machinery and process selection, panels from agricultural residues and the use of wood in housing.

3. The meeting was attended by 11 participants from the following countries: Australia, Austria, Brazil, Canada, France, Malaysia, Mexico, Philippines, the United Kingdom of Great Britain and Northern Ireland, Venezuela and Zimbabwe plus a representative from the Food and Agriculture Organization (FAO).

4. Mr. Amantino Ramos de Freitas (Brazil) was elected chairman and, because the meeting was small, Mr. Robert M. Hallett of the Agro-Industries Branch, Division of Industrial Operations, UNIDO, served as Rapporteur/Secretary to the meeting.

5. The agenda, which is presented in Annex 1, was adopted unanimously.

6. The authors of the five background documents (which were presented in draft form) acted as discussion leaders and assisted the Secretariat in drafting the body of the report.

7. An important feature of the meeting was the ready exchange of information among the experts since most had brought copies of reports (published and unpublished), standards and brochures for this purpose. This also enabled the authors to incorporate much relevant material into their papers.

II. REVIEW OF EXISTING STRESS GRADING SYSTEMS AND RULES

8. Mr. Raymundo Davalos reviewed the development in Mexico of stress grading rules for pine which entailed a programme of testing 5,000 pieces (2,000 of which had been done to date). This programme included a check of the suitability of the ALS/CLS "Rules for dimension lumber"[1/] and the ECE Recommended Standard for Stress Grading of Coniferous Sawn Timber.[2/] An important aspect of the programme was the development of a simple and efficient means of identifying strength-reducing defects emphasizing knot size and position, especially in the margin (edge) region.

9. The conclusions of this work revealed that the United States strength-ratio theory was not entirely satisfactory for predicting strength, and that while the ECE Recommended Standard gave good results, the rules were too complex for developing countries.

10. According to the system developed in Mexico, it appeared that the approximately 50 different pines in the country could safely be treated as a species group and that two grades would suffice. About 90-95 per cent of failures were found to be due to knots; moisture content and density were of secondary importance - density was only important among the better qualities. It was also felt that there were too many visual grades for developing countries in the ALS/CLS system, and that the lower ones overlapped. It was also pointed out that grain deviation caused by knots, rather than knot size itself, was the real cause of failures; the practical aspects, however, indicated that graders looked at knots.

11. It was reported that Zimbabwe used the old South African rules.[3/] The new, visual South African rules have only three stress grades which

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1/ American Lumber Standard/Canadian Lumber Standard - applies to sawnwood surfaced on four sides and stress graded according to the respective national standards.

2/ Supplement 4 to Volume XXVII, Timber Bulletin for Europe, Geneva, 1975. (These have since been revised and appear as Annex 1 of TIM/WP.3/AC.3/10, 31 July 1981.)

3/ SABS 563 - Stress-graded softwood general structural timber.

coincide with the strength classes in the South African building codes.[4/] In addition, Zimbabwe wished to adopt the classes, and were developing their own stress grading rules which were different from the South African rules, but still fitted in well with their strength classes. A test programme was about to begin to enable this to be achieved.

12. Recent research in France supported the move towards simplification and tests on six species (of Abies, Picea and Pinus) supported the recommendation of combining them into one species group. The research also agreed with the finding that density was only important for upper grades. The knot area ratio (KAR) approach was only an advantage in dealing with knot clusters such as those found in Pinus pinaster.

13. The question was raised as to which countries were drafting or revising existing grading rules. Mr. Centeno pointed out that Chile and several Central American and Scandinavian countries were looking into this matter. He felt that UNIDO could help the people involved in this type of research in developing countries by collecting and disseminating the relevant available material. He said that it was generally difficult to guarantee the flow of such information to developing countries.

14. In this connection, it was recommended that ISO and the member countries of TC165 WG.1 (Grouping of timber based on structural properties), other government bodies and R and D institutes active in this field and IUFRO (Division 5 - Forest Products) should be approached.

15. Mr. Centeno [illegible]ained that at a recent UNCTAD meeting in Geneva,[5/] the Latin American countries agreed to form a Latin American Association for Forestry Research and Development. The relevant information would

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[4/] SABS 0163: Part I - 1980. Code of Practice for the design of timber structures. Part I: Structural Design and Evaluation.

[5/] Intergovernmental Group of Experts in Research and Development for Tropical Timber. 16-20 November 1981.

be co-ordinated through the Latin American Forestry Institute, Mérida, Venezuela. The African and Asian regions would soon be discussing ways and means of achieving similar co-ordination, but in the meanwhile, they would probably rely on FAO for regional information services.

16. In connection with hardwoods, Mr. Lew informed the meeting that the stress grading rules (Section J) of the Malayan Grading Rules (MGR) were not much used owing to the predominance of the export trade under General and Special Market Specifications. The Forest Research Institute, Kepong, had just acquired a Computermatic stress-grading machine to revise or redefine their rules over the next few years.

17. Mr. Centeno reported that the Andean Pact countries (Bolivia, Columbia, Ecuador, Peru and Venezuela) had agreed officially on hardwood grading rules (one grade only) and upon a 3-group system including sizes and tolerances. The effect of size for solid wood elements from 40 x 140mm to 40 x 300mm in cross-section was not considered significant enough to include it in the rules. The design values were based on the smaller values obtained because of size. At least 60 per cent of the mill run (output) from sawmills was taken as an acceptable level for structural grades in order to promote and gain acceptance for the system, rather than to attempt to achieve higher yields at the early stage. Their research had discovered that density could be used for an initial placement of a species in a strength group if the predicted strength value were in the upper two thirds of the population. A timber construction manual had been published in December 1981 which incorporated this system.

18. Since the system's acceptance, nine prefabricated housing factories were in the process of being established in five countries and a wood-cement building board plant was being set up in Ecuador to supply panels for timber-frame construction. The Governments supported the rules and they were being adopted into their building codes.

19. Mr. Centeno gave a clarification of the reasons for selecting visual stress grading over machine stress grading and explained that the Andean Pact countries agreed that visual grading adapted itself better to local conditions, and would be more acceptable to producers, users and official agencies. It was more easily implemented, he said, since visual grading was not totally unknown. He felt that machine stress grading would eventually become necessary, but it was still at an initial stage.

20. It was stated that the reasons the Andean Pact countries decided to develop a stress grading and grouping system were the need to make up for serious hosuing shortages, to make use of a valuable natural resource and to stimulate industry and employment. The 15 or so ISO Standards relating to testing procedures for determining strength properties of wood[6/] were found to have been useful in providing a uniform and internationally acceptable testing programme, especially in the light of potential exports.

21. It was agreed that although other countries in Latin America could benefit from this work, they would each have to carry out a test programme to check its validity in view of regional and provenance differences.

22. The importance of the acceptance of timber stress grades in building codes was emphasized by the meeting and was fundamental to the discussions throughout.

23. The meeting noted that nomenclature posed special problems. Although not wishing to restrict commercial possibilities which applied to species for decorative and utility purposes, it was recommended that new species should have single agreed names. However, it was acknowledged that, where commercial practices had been established, dual names should be accepted or maintained.

[6/] Such as: ISO 738, 1029, 1030, 1031, 1032; 2299, 2300, 2301; 3129, 3130, 3131, 3132, 3133; 3179 and 3349.

24. Finally, the meeting requested that UNIDO publish a document comparing the existing grades, including the responses to a questionnaire drafted by Messrs. Davalos and Mettem which would shortly be sent to Governments and other potentially interested parties.

III. EXAMINATION OF PRINCIPLES INVOLVED IN STRESS GRADING

25. Mr. Mettem presented part 1 of his draft paper (dealing with general considerations and visual stress grading) and highlighted the following:

(a) The need for stress grading, which seemed obvious to the design engineer, even though stress grading was not easy to achieve, even in industrialized countries. The needs of the designer for a set of grade stresses and guidance on how to specify. The situations likely to be found in specifications of timber quality in various types of country throughout the world;

(b) Derivation of stresses - the small-clear, and structural-sized testing approaches;

(c) Types of visual stress grading system - the simplicity of KAR; the possible continued usefulness of knot-diameter rules for specific end uses; rules for tropical hardwoods.

26. Discussion took place on how to take advantage of the "leading edge" of technology to apply to developing countries and on a variety of more specific matters.

27. The meeting took note that different problems were involved in designing fully engineered structures as opposed to semi- or non-engineered constructions although the full range was within the scope of the meeting. With regard to house construction (except for roof trusses) simplified stress grading rules and methods might be more appropriate and might contribute to more economic constructions. However, the general feeling was that stress grading was, in fact, being demanded by a number of approving authorities, and that it was an important factor in satisfying housing needs through industrialized building programmes. Methods of building which did not depend on such control were unlikely to be as effective as those which were traditionally followed in many countries and which relied upon skilled carpenters and designs tested by time.

28. The meeting recognized that the use of sawnwood for construction

purposes could be approached from either of two directions. The first, and more traditional one, relied on species identification, at least to the species group level. The second attempted to cope with mixed lots of unidentifiable raw material. This situation might arise either from large, clear-cutting programmes or from groups of mixed species.

29. Each viewpoint involved entirely separate technical problems - in the case of the "species-independent" approach, the problems were especially related to further processing and other wood technology considerations such as drying, preservative treatment (if needed) and machining. This factor raised other, more broad issues, which were considered beyond the scope of the meeting, but which should, it was felt, be accorded full recognition.

30. The meeting strongly recommended that work be reviewed on speedy, species-independent appraisal methods for strength determination, and that further effort in this direction should be accorded a high priority.

31. Among the methods discussed were hardness testing techniques for estimating strength, density sorting or in-line weighing methods, and proof testing.

32. On the subject of proof testing, the question of damage (compression) caused during proof testing but which did not bring out gross fracture was discussed. Work was reported by B. Madsen which was aimed at determining if the strength of the remaining (proof-tested) population had been reduced; the result was that it showed no harmful effects. Current work by R. H. Leicester also indicated that this need not be a problem. The possibility of using proof-testing machines in tandem to load in tension the previously compressed side was also mentioned.

33. Discussion then began on details of a timber engineering nature in the draft paper, which included:

(a) The importance of slope of grain was recognized, as were difficulties in its measurement;

(b) Anomalies which were apparent when studying more carefully the relationships between the rate of growth and strength characteristics, both in temperate and tropical softwoods;

(c) Statistical distributions currently in use to estimate fifth percentile strengths;

(d) The potential usefulness of the relationship between small-clear and full-sized test pieces.

34. On these points the meeting felt that research programmes aimed at developing stress grading rules should include both small-clear and full-sized tests. This was particularly important for developing countries because of the complementary nature of the information obtained with the use of both methods. The value of past work on the small-clear basis was recognized in this respect.

35. The meeting noted that there seemed to be a consensus among timber researchers that the use of "3-parameter Weibull" distribution resolved several of the problems of estimating fifth percentile levels.

36. Mr. Mettem showed various training aids for visual graders, including slides, which illustrated many of these points.

IV. STRENGTH GROUPING CONCEPTS

37. The presentation by Mr. Keating described the advantages of grouping techniques, for example, the ease of introducing sawnwood into building regulations, the improvement of marketing techniques, facilitating the entry of lesser-known species, and assisting in technology transfer in the form of design codes, manuals etc.

38. Mr. Keating outlined the stages in the development and the current position of the Australian strength classification system, which was based on a set of preferred number stress grades, ranging from 2.8 MPa to 34.5 MPa for bending strength. He explained methods of entering the system such as species strength grouping based on small-clear testing combined with visual grading, machine grading and proof grading. Mention was then made on how the system could be applied to poles and plywood. The subsequent discussion on proof grading revealed considerable interest in this technique for use in regions where there was a multitude of species. The flexibility of the system, with regard to the possibility of using all or part of the set of stress grades was also discussed.

39. The participants at the meeting indicated that several countries had developed or were in the process of developing similar classification schemes. It was thought that it would be useful to examine a synopsis of these schemes in order to see just how close countries were towards reaching a common system. It was thought that a system could be developed that would permit it to be adopted in either its entirety or in part, and that it would satisfy most of a country's requirements.

V. IDENTIFICATION OF STRESS GRADES

40. Mr. Mettem highlighted the derivation of machine stress grading settings, emphasizing the work of the Princes Risborough Laboratory in the United Kingdom. He asked whether work on machine grading for developing countries should be species (or species group) oriented or whether it should be more generalized, i.e., by adopting a species-independent approach. The trend in industrialized countries seemed to be towards more generalization and simplification.

41. It was pointed out that the link between grades and design methods must be considered since limit-state or probabalistic design would be particularly affected by increasing strength population variation and because many countries were moving towards reliability-based codes. The effect was agreed to be a levelling of the strength-stiffness fifth percentile line and the loss of some of the potential advantages of machine stress grading from the point of view of increased design stresses.

42. For machine grading purposes it was recognized that a possible approach would be placing mixed species into three or four groups, each having a different MOR-MOE regression line. The relationship would be based on full-sized specimen data. Other mixed species could be allocated into the appropriate group provided each wood in the mix had been identified and had been tested at the small-clear level. This procedure would require a relationship to be established between small-clear and full-sized regressions.

43. On the other hand, there was a strong feeling that both approaches would be necessary to enable material to be used that would otherwise be wasted or burned to clear large areas. Species-dependent methods would be followed as far as possible, and species-independent methods would be used for the balance - as a "fallback" position.

44. It was noted that this would also enable larger volumes of each size to be placed on the market. The necessity was to know the resource, i.e., to obtain characteristic strength values or "E-bands" (bands of MOE).

45. In actual practice, it was agreed that machines could be operated

using a machine setting either for a particular species or for a generalized situation. The different strength-stiffness (MOR-MOE) relationship for softwoods and hardwoods was also noted.

46. The advantage of directly characterizing the material by design information such as E-values was noted as being better than indirectly characterizing it through another parameter such as hardness (by quick appraisal methods).

47. Mr. Mettem presented a series of colour slides which showed some of the current stress grading machines such as Computermatic, Sontrin, Cook-Bolinder and Raute, and he described the technical aspects of each.

48. Mr. Crubilé drew the attention of the participants to factors which he considered important with regard to the types of grading machines based on visual grading through morphologic analysis. The simpler versions of these machines were the multiguard models which measured the slope of grain by means of an RF rotating field, and the Isogrecomat which measured general and local densities and was now in use in a factory in the Federal Republic of Germany.

49. Another more sophisticated model (the Finnograder), was being tested in the Finnish VTT (Technical Research Centre) laboratory and this could be viewed as the first of a new generation of multi-purpose grading machines able to grade sawnwood against various end-use criteria and combining morphologic parameters more efficiently than could be done by man alone.

50. Another example was at a developmental stage in many parts of the world which included optical analysis of sawnwood and was interesting because it operated in the visible spectrum.

51. Many participants expressed the opinion that the relatively sophisticated types of commercial stress grading machines should not be recommended to developing countries at this time. The technology might be more appropriate later, when considerable experience

with visually graded sawnwood had been obtained. If the modulus of elasticity is to be used for species-independent strength prediction, then relatively simple stiffness-measuring devices should be developed (e.g., a fixed weight on the wood supported as a plank on two supports). As an intermediate step it was suggested that simplified methods including grading by proof testing warranted investigation.

52. It was recommended that the study commissioned by UNIDO on this subject include a classification of all grading methods and equipment and an analysis of the value of such advanced machines for developing countries.

53. With regard to the establishment of strength groups and mechanical property relations for large clear-felling programmes, it was pointed out that sufficient warning was normally possible to allow the several years work required following field studies to determine resource characteristics.

54. A discussion followed the presentation of Mr. Mettem's paper "Problems - and some suggestions in the identification of appropriate stress grading techniques for developing countries", which suggested a rough framework for the guidance of developing countries in this area as follows:

(a) Developing countries should strive for a "just sufficient" degree of discrimination without overly rigid rules;

(b) Four main types of timber must be served:

(i) softwoods, both indigenous and plantations;
(ii) hardwoods of tropical rain forest;
(iii) timbers of montane and savannah trees, often of very mixed species or intractable woods;
(iv) plantation hardwoods.

(c) A recent trend was to reduce the number of stress grades;

(d) Stress grading rules should first be developed for general purpose use rather than for specific end uses;

(e) Strength grouping and stress grading system were inter-dependent.

55. The following proposals were then discussed:

(a) That the Australian strength grouping system offered a good framework for others to use based as it was on the established tables of minimum mean species values from small-clear testing and international experience. This was agreed to by the majority of participants with reservations expressed by Mr. Centeno who pointed out that while this system could be used as a reference point, recent work showed the need to take into consideration the results of in-grade testing and characteristic values from small-clear and full-sized testing.

(b) That grades following the preferred number series such as ... 38, 48 and 60 per cent ... should be used with the implication that the first two, in practice, would be for softwoods and the third for hardwoods. (Separate rules should naturally be developed for softwoods and hardwoods.) With regard to the suggested grade ratios, there were differing opinions. Some participants felt that the use of the established figures was an advantage while others believed that it was not appropriate to set particular levels until other objectives were realized, since this could be the reverse of the actual procedure followed in a given country. This alternative is described below.

Sawnwood resources in the sawmills and timber yards of any particular developing country should be surveyed at the outset. Types, locations and frequency of defects should be sought in the survey. The next step would be to make a policy decision as to what percentage of production e.g. 60 per cent was to be classed as acceptable for a given purpose. The grading rule would then be prepared and would be based on this decision. This would discriminate in favour of the best 60 per cent of the resource. The material accepted by this grading rule could then be tested, either with small-clears, full-sized, or both, to determine its strength properties. Strength ratio could be calculated at this stage. Training implications were also important with systems having more than one grade.

(c) An attempt should be made to agree and draw up a strength class table giving characteristic values and the mean moduli of elasticity. It was generally agreed that this should be approached from small-clear and from full-sized data, probably starting from the former.

56. The meeting recommended that UNIDO should commission a special study to draw up a standard framework for stress grading rules for developing countries, together with model rules for softwoods and hardwoods. This should show the main features necessary, and should give the greatest amount of detail possible for the generalized situation where neither country nor species were known. The study should also give due consideration to the two approaches (species-dependent and independent) and to other recommendations included in the report of the meeting.

57. Endorsement of the study should be sought through correspondence among the experts involved in the meeting, and by a further meeting of these experts if necessary and possible.

58. In this respect the delegate from FAO drew the participants' attention to the fact that, while fully appreciating the initiative of UNIDO in holding the meeting, the interagency agreement relegated work on sawnwood grading to FAO.

59. The participants generally saw the need for increased co-operation in this and related activities between international organizations active in this field.

VI. TRAINING AND INSPECTION

60. The group reviewed current practices in many of their respective countries at the beginning of session. On the basis of this information they formulated a set of recommendations for UNIDO to pass on to any developing country which was contemplating the use of wood in engineered construction, as follows:

(a) Training of graders for visually stress graded timber

(i) Duration: Although a period of three months' duration is not uncommon for countries with well-developed grading systems, this is possibly more than enough. It was thought that five or six weeks would be sufficient and the shorter periods would lessen the reluctance of the employer to pay the grader's salary during the period of the course;

(ii) Location: At a sawmill rather than at a research laboratory;

(iii) Background: It was generally felt useful for the trainee to have had practical experience in a sawmill. If a suitable aptitude test could be developed, it might help to screen people who might not benefit from training. A minimum educational level could be specified if such a test was not available;

(iv) Recognition: Once the grader has passed the course he should take pride in his accomplishment and be aware of the technical responsibility which he now has assumed. Because of his newly acquired skill he should also receive some financial recognition as he now contributes more to his employer's success;

(v) Instructional aids: Instructional aids developed by TRADA, by the Malaysian Timber Industry Board and in Australia by the CSIRO, Building Division, could be used immediately, and could subsequently be modified to suit the needs of a particular country. It was recommended that the visual impact of the aids be improved by professional means with the appropriate use of colour and animation and that they should form an integral part of the programme to implement the rules;

(vi) Progression: In countries where a series of grades had to be learned, it might be more advantageous at the beginning to train a grader in one grade and to allow him upon graduation to deal only with this grade in the mill, subsequently, permit him to return for instruction in the other grades at a later time. It was noted that some products required more training and experience because of their critical end uses.

(b) Quality assurance (QA) and inspection

The possibility of establishing a national framework for QA and inspection, at four levels, was discussed as follows:

(i) First, the national or provincial Government would have the legislative responsibility, in general, for building codes. These codes would adopt, by reference, various standards governing the quality of building materials;

(ii) Secondly, building materials standards (e.g., visually graded timber for structural purposes) should be developed on a consensus basis by committees which had equal representation of producers, consumers and neutral interests (e.g., researchers). The materials standards should include the requirements for both in-plant quality control and externally administered QA programmes.

The organization which operates the QA programme should be treated at the same level. Different possibilities exist in this case, it could be a government agency such as a timber research laboratory, or it could be an industry association. It is important to encourage the view that a QA organization is not necessarily an adversary of the wood producer. On the contrary, both the producer and the QA organization have the same objectives, i. e., the production of sawnwood of a dependable quality;

(iii) The third level in this framework is the grader himself. He might be independent (or freelance), an employee of the mill (more commonly), or associated in any of a variety of ways with the mill or even the owner. His grading ability will be regularly checked by the QA organization. The QA organization should have the right to cancel the grader's licence after less drastic corrective measures have been tried and have failed. Adequate quality control should be undertaken by mill supervisory staff (preferably from a department separate from that responsible for production) to ensure a sustained standard of work by the graders;

(iv) The final level is the individual who actually makes the product - in this instance, the sawyer. Ultimately, this is where quality originates, and a major effort should be made to encourage the sawyer to produce quality products.

Annex I

AGENDA

(1) Election of Chairman.

(2) Adoption of Agenda.

(3) Review of existing stress grading systems and rules:
- Industrialized countries;
- Developing countries;
- Regional and International coordination.

(4) Examination of principles involved in stress grading:
- simple versus complex loading;
- design requirements.

(5) Strength Grouping Concepts:
- Scope, purpose;
- Degree of discrimination (fine or coarse).

(6) Identification of Stress Grades:
- visual;
- mechanical.

(7) Training and Inspection:
- Programmes for graders, machine operators;
- Quality assurance.

(8) Recommendations and follow-up action.

(9) Adoption of Report.

Annex II

LIST OF PARTICIPANTS

PARTICIPANTS	FUNCTION	MAILING ADDRESS
CENTENO, Julio César	Head, Timber Engineering Division	Forest Products Laboratory University of the Andes Aptdo. 220 Merida, Venezuela
CRUBILÉ, P. E. H.	Timber Engineering Division	Centre Technique du Bois 10 Avenue de St. Mandé 75012 Paris, France
DAVALOS, R.	Project Leader, Physical-Mechanical Properties of Wood	LACITIMA/INIREB Km. 2.5 Antigua Carretera a Coatepec, Xalapa Apdo. Postal 63 Veracruz, Mexico
ESPILOY, Jr., E. B.	Timber Physics and Engineering Division	FORPRIDECOM NSDB College 3720 Laguna, Philippines
FAWCETT, D. T.	Manager, Timber Section	Standard Association of Central Africa P. O. Box 591 Umtali, Zimbabwe
FREITAS, A. R. de	Director, Wood Division	Instituto do Pesquisas Tecnologicas do Estado de Sao Paulo P. O. Box 7141 01000 Sao Paulo, Brazil
KEATING, W. G.	Experimental Officer	Division of Chemical Technology, CSIRO P. O. Box 56, Highett 3190 Victoria, Australia

PARTICIPANTS	FUNCTION	MAILING ADDRESS
KEENAN, F. J.	Associate Professor, Faculty of Forestry	University of Toronto 203 College Street Toronto MSS 1A1 Canada
LEW Wing Hing	Director, Technical Services	Malaysian Timber Industry Board 5th Floor, Wisma Bunga Raya Jalan Ampang, Peti Surat 887 Kuala Lumpur, Malaysia
METTEM, C. J.	Senior Engineer,	Timber Research and Development Association T R A D A Stocking Lane Hughenden Valley High Wycombe Bucks HP14 4ND United Kingdom
STINDL, G.	Wood Information Officer	Federal Timber Council Marxergasse 2 1033 Vienna Austria
WAHL, Otto	Forestry Officer, Sawmilling	Forest Industries and Trade Division Food and Agriculture Organization of the United Nations Via delle Terme di Caracalla 00100 Rome, Italy

UNIDO Secretariat

BASSILI, A. V.	Senior Industrial Development Officer, Agro-Industries Branch; Division of Industrial Operations
HALLETT, R. M.	Industrial Development Officer, Agro-Industries Branch; Division of Industrial Operations

BACKGROUND DOCUMENTATION

ID/WG.359/1	List of Participants	
ID/WG.359/2	General Review of Visual Stress Grading Systems	C. Raymundo Dávalos-Sotelo
ID/WG.359/3	The Principles Involved in Stress Grading, with Special Reference to its Application in Developing Countries	C. J. Mettem
ID/WG.359/4	Review of Timber Strength Grouping Systems	W. G. Keating
ID/WG.359/5	Training and Inspection Requirements for Quality Assurance of Stress Graded Structural Wood Products	F. J. Keenan
ID/WG.359/6	Problems - and some Suggestions - in the Identification of Appropriate Stress Grading Techniques for Developing Countries	C. J. Mettem