A Review of Fire Retardant Treatments, Fire Performance Test Methods and Building Codes in United States of America and Australia, and their Influence on the Marketing Opportunities for Forest Products

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N.S.W. TIMBER ADVISORY COUNCIL
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A REVIEW OF FIRE RETARDANT TREATMENTS, FIRE PERFORMANCE TEST METHODS, AND BUILDING CODES IN UNITED STATES OF AMERICA AND AUSTRALIA, AND THEIR INFLUENCE ON THE MARKETING OPPORTUNITIES FOR FOREST PRODUCTS

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Abstract

Fire test methods used to regulate building materials in USA are reviewed, as is the range, application and acceptance of fire retardant treatments for forest products. Some provisions of one USA building code relating to forest products are compared to those contained in Ordinance No. 70, which is the main building code used in New South Wales, and is based on the Australian Model Uniform Building Code (AMUBC).
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1. INTRODUCTION

The allowable uses for forest products in buildings is controlled by the provisions of the relevant building codes. The building codes regulate materials of construction according to their properties as determined by standard test methods. Therefore, the market opportunities for forest products in buildings is controlled by the provisions of the building codes and the manner in which they perform when tested by standard test methods.

The fire safety of materials of construction is one of the properties regulated by the provisions of the building code regulations.

Ideally, building codes will specify standard test procedures that accurately predict the particular property of the material that is being assessed. The codes should also allow the maximum freedom of use of materials in building construction, consistent with acceptable levels of occupant and building safety being maintained.

As a first step in a review of the affect of building codes and fire test methods on the market opportunities for forest products in Australia, a study tour of the United States of America (USA) and Canada was completed by the author in October 1984.

The aims of the tour were to evaluate:

(a) The fire test methods used to regulate the use of forest products in buildings in USA;

(b) The state of the art of fire retardant treatments for forest products in USA, including quality control procedures;

(c) The allowable uses for forest products under the building codes in USA.

To achieve these aims, research establishments, forest products companies, forest products industry associations, a building code organisation, and third party testing laboratories were visited, as detailed in Appendix A.

2. TEST METHODS

There are two categories of fire test methods. The tests are used for a) demonstrating compliance with code requirements, or b) research and quality control purposes. The Australian test methods are published as Australian Standards, and will be referred to as AS test methods. The USA test methods are published as American Society for Testing and Materials Standards, and will be referred to as ASTM test methods.

2.1 Standard tests for code compliance

These tests are specified in the building codes and describe the properties of building materials in terms of either combustibility, flame spread, or fire resistance.
2.1.1 Combustibility

The building codes sometimes require that materials be non-combustible. All timber and timber based products are classified as combustible. Treatment with fire retardants does not confer non-combustibility to timber or timber based products when they are tested by the standard methods required in the building codes.

The method specified in Australia is AS 1530, Part 1 "Combustibility Test For Materials".

The USA codes specify ASTM E136 "Behaviour of Materials in a Vertical Tube Furnace at 750°C".

2.1.2 Surface spread of flame

The surface spread of flame property of a material describes the manner in which that material allows flame to be propagated across its surface from an ignition source and is determined by testing to either AS 1530.3 "Test For Early Fire Hazard Properties of Materials" or ASTM E84 "Surface Burning Characteristics of Building Materials".

As the use of building materials is often restricted to those with a specified maximum flame spread rating, testing for this property is of major concern to the forest products industry. The two test methods listed above use different techniques to assess the flame spread properties of materials.

2.1.2.1 AS 1530.3

When material is tested to AS 1530.3, a small (600 x 450mm) panel is exposed to increasing regimes of impressed radiation, and the pyrolysis products emitted are ignited by a pilot flame. The test equipment is shown in Plate 1. The method was based on observations of the performance of wall lining materials in corner burn tests (Ferris, 1955). The corner burn tests were designed to simulate the performance of wall lining materials in the early stages of a developing fire within a room.

Four indices are assigned to materials tested to AS 1530.3

2.1.2.1.1 Ignitability index - defines the tendency for the gaseous pyrolysis products to be ignited during the test. Materials are rated from zero to 20, with materials that do not ignite having an index of zero.

2.1.2.1.2 Spread of flame index - describes the rate of radiant heat release once a material has ignited. Materials are rated on a scale of zero to 10. The maximum spread of flame index is 10, and the minimum zero.

The spread of flame indices are based on correlations established by Ferris (1955) in his corner burn studies. He demonstrated that there was a relationship between the time taken for flames to travel from the floor to the ceiling, and the time taken for the burning test panelling to release a specific level of radiant energy.
It is estimated (Standards Association of Australia, 1982) that material with a spread of flame index of 10 will spread flame from the floor to the ceiling up a 2.75 m wall in less than 10 seconds, while material with a spread of flame index of zero will not spread flame from floor to ceiling in 4.5 minutes.

2.1.2.1.3 Heat evolved index - is a measure of the quantity of radiant heat released by the test material in a specified time interval after ignition. Materials are rated on a scale of zero to 10, with increasing indices indicating increasing quantities of radiant heat evolution.

2.1.2.1.4 Smoke developed index - relates to the maximum optical density of the smoke produced during the test. The index has a range of zero to 10, with each increase of one index unit indicating a doubling in the optical density of the smoke produced.
2.1.2.2. ASTM E84

The test materials, 20\(\frac{1}{4}\)" x 24' (514 x 7320mm), are placed as a lining in the top of a tunnel that is 17-3/4" wide, 12" deep, and 25' long (451 x 305 x 7620mm). This test is known as the 25 ft tunnel test. The test equipment is shown in Plate 2.

Plate 2: ASTM E84 apparatus

A standard flame is applied to the sample at one end of the tunnel. The distance travelled by the flame over the test surface, and the rate at which the flame travels, are used to calculate a flame spread index. A material with a higher flame spread index will spread flame further and/or faster down its surface in the test tunnel than material with a lower flame spread index. The smoke produced during the test is photometrically monitored.

Materials are assigned a Flame Spread Index and Smoke Developed Index.

Materials are grouped into one of three classes according to their Flame Spread Index for consideration in the U.S.A. building codes:

- **Class I** - 0 - 25 Flame Spread Index
- **Class II** - 26 - 75 Flame Spread Index
- **Class III** - 76 - 200 Flame Spread Index

Forest products are included in all three flame spread classes.

Some fire retardant treated forest products achieve a Class I rating.
Some untreated forest products have a Class II rating, including sawn western-red cedar, redwood and some Douglas-fir.

Most forest products, including sawn and reconstituted products, have flame spread indices that are in the Class III range.

2.1.2.3 Comparison of AS 1530.3 and ASTM E84

As the two test methods derive their results from different methodologies, it is most unlikely that a tight correlation could be established for test results on the same material obtained by the two methods. However, if both methods are assessing the same potential hazard for materials in a fire situation, then the relative ranking of materials for that potential hazard should be similar.

Unfortunately for the forest products industry, the relative ranking of forest products for flame spread properties is sometimes different, depending upon the test method used.

The flame spread indices of several timber species that have been tested to both AS 1530.3 and ASTM E84 are given in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Flame Spread Index</th>
<th>AS 1530.3</th>
<th>ASTM E84</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas fir</td>
<td></td>
<td>9</td>
<td>69</td>
</tr>
<tr>
<td>Redwood</td>
<td></td>
<td>9</td>
<td>70</td>
</tr>
<tr>
<td>Western red cedar</td>
<td></td>
<td>10</td>
<td>69</td>
</tr>
<tr>
<td>Jarrah</td>
<td></td>
<td>3</td>
<td>42</td>
</tr>
<tr>
<td>Radiata pine</td>
<td></td>
<td>9</td>
<td>77</td>
</tr>
</tbody>
</table>

While the above data indicates a general agreement in overall ranking between the two methods (jarrah < Douglas fir, radiata pine, redwood, western red cedar) the difference in the perceived hazard of the materials in a fire situation is very great. The AS 1530.3 data indicates that the four softwood species listed are likely to spread flame very rapidly in a developing fire situation, while the ASTM E84 data indicates that they would not spread fire rapidly across their surface.

This difference in perceived fire hazard by the two test methods can have a major impact on the market opportunities for forest products. The AS 1530.3 spread of flame index of 10 for western red cedar classifies it as a sufficiently fire hazardous material that it cannot be used in any building other than detached single dwellings in New South Wales (Local Government Act, 1919). In USA, its fire spread classification of Class II allows it to be used in those areas of public buildings requiring materials of low flame spread properties, e.g. public access corridors in hotels. Hence, the market opportunities for western red cedar are directly affected by the flame spread test and performance specified in the building code.

There are other major anomalies in test results from the two techniques. Alexiou and Gardner (1982), reported that overlaying untreated face veneers on fire retardant treated plywood negates the value of fire retardant treatment with respect to AS 1530.3 Spread of...
Flame Index. Therefore, it is not possible to use fire retardant treated plywood manufactured with untreated face veneers where low flame spread properties are required. The surface finish does not seem to have the same significant effect on the Flame Spread Index when materials are tested to ASTM E84. Fire retardant grade particleboard gives a Class I result when tested to ASTM E84, and this result is not changed when the board is overlaid with an untreated face veneer (Underwriters Laboratories Inc., 1984a). Indeed, the use of surface finishes up to 1mm in thickness is allowed on fire retardant treated forest products substrates, provided the finish is not of a greater fire hazard than paper (Building Officials and Code Administrators International Inc., 1984).

The difference in the perceived hazard of the surface finish of fire retardant treated panel products significantly affects their acceptability as candidate interior finish materials. The need to fire retardant treat face veneers increases the production problems for the Australian forest products industry, and hence the cost of the product.

From the above examples, it appears that forest products may be being more severely rated for their flame spread properties when they are tested to AS1530.3, when compared to ratings achieved by testing to ASTM E84. As the use of materials in buildings is controlled in part by their flame spread properties, it is essential that the anomalies for test results between the two test methods be resolved. This can be achieved by correlation testing between AS1530.3, ASTM E84, and arbitration tests such as ASTM E603 "Room Fire Experiments" and ASTM E906 "Heat and Visible Smoke Release Rates for Materials and Products".

The ASTM E84 results for jarrah (Forest Products Laboratory) indicate that Australian hardwood timber species may give much lower flame spread indices than the majority of North American timber species, and hence there may be export market opportunities for our hardwoods to be used as panelling or partitions in fire sensitive areas of public buildings in USA and Canada.

2.1.3 Fire resistance

The fire resistance of materials, or their assemblies, is that property which prevents or retards the passage of excessive heat, hot gases, or flames, under the standard conditions of test.

Materials, or their assemblies, are assigned a fire resistance rating, which is the time in hours, or fractions thereof, that they will resist fire exposure as determined by the standard fire test. Materials or assemblies are tested as used - e.g. as columns, beams, walls, floors, ceilings, doors. The test used in Australia is AS 1530.4 - "Fire Resistance Tests of Elements of Building Construction", while the USA test method is ASTM E119 "Fire Test of Building Construction and Materials". The test methods are very similar. A typical furnace for testing the fire resistance of a vertical element (wall or door) is shown in Plate 3.

Materials may be tested and rated as either load bearing or non load bearing.
Many timber based assemblies have been tested, and their ratings are published (Underwriters Laboratories Inc., 1984b). Data has been published on the fire resistance of timber columns (Underwriters Laboratories Inc., 1939). This data is used as the basis for building design when fire resistance ratings are specified for a material or assembly.

The USA building codes have recently accepted new data for the calculation of the fire resistance of glued laminated timbers. Designers can calculate the fire resistance of a beam or column from a single equation (American Institute of Timber Construction, 1984). This is a much simpler approach than that proposed in Australia (Standards Association of Australia, 1983), where the designer must first calculate residual sections after charring at a nominal rate. Schaffer (1980) states that many factors affect charring rate of timber members, not only density as implied in the Australian document. As the charring rates of Australian timber species have never been published, the proposed Australian fire resistance calculation method is based on theory and speculation.
It is recommended that relevant Australian timber species, in size and form that may be used for structural members, be tested to determine both charring rate and fire resistance. Data produced from such testing will allow more accurate design formulae to be developed for Australian timber species, and increase confidence in the ability of timber to perform as required in a fire situation.

2.2 Research or quality control tests

This category of tests is divided into 2 sub-groups - small scale tests and full size room burn tests.

Small scale tests are used by researchers, fire retardant manufacturers, and fire retardant treaters to predict the likely performance of materials and assemblies when tested for flame spread or fire resistance by the methods required for code compliance.

Small scale tests are much less expensive to set up and run than the full scale tests. They may not correlate in absolute terms with the standard tests, but correlations are established for the particular material being tested.

Full size room burn tests are designed to simulate the real fire situation, and are used to determine the predictive ability of the standard flame spread tests specified in the building codes.

2.2.1 Small scale flame spread tests

The building codes in USA require flame spread data in terms of ASTM E 84, which is a 25 ft test tunnel. Two smaller test tunnels have been developed - an 8 ft tunnel (American Society for Testing and Materials, 1975) and a 2 ft tunnel.

The 2 ft tunnel (see Plat 4) may be suitable as a quality control test for fire retardant treated forest products in Australia. It is inexpensive, robust, and simple to operate. If correlation could be established between 2 ft tunnel test results and AS 1530.3, it would be possible for fire retardant treaters to use the method as a regular quality control test for their production. The test may also be suitable for checking samples from the market place, as it would require much less sample material than AS 1530.3.

The fire tube-test (American Society for Testing and Materials, 1980) is used routinely as a quality control test by the fire retardant treatment industry in America. The test equipment is shown in Plate 5. Standard Douglas fir test sticks are included with each charge of timber or plywood that is fire retardant treated. This
Plate 4: 2 ft test tunnel (above)

Plate 5: Fire-tube test apparatus (left)
method is a check on the treatment process primarily, and because it has been correlated with ASTM E84 test results as detailed under "Fire Retardants", it can be used to predict the performance of the fire retardant treated materials. This method could not be used to test the performance of material sampled in the market place.

It is recommended that the fire-tube test and the two ft tunnel test be evaluated to determine their suitability as small scale tests to predict the performance of materials tested to AS 1530.3.

2.2.2 Small scale fire resistance tests

Small scale furnaces (see Plate 6) are used by research organisations to predict the performance of materials or assemblies in full scale furnaces. The small furnaces develop the same time/temperature relationships as the large furnaces. A similar furnace to that shown in Plate 6 was used by White (1984) to develop the data on the effect of coatings on the fire resistance of timber.

2.2.3 Room burn tests

The surface spread of flame tests (AS 1530.3, and ASTM E84) are used to predict the potential of materials to propagate flames away from an ignition source.

Materials that allow flames to spread rapidly are considered more likely to aid the development of a fire than materials with low flame spread properties.

The ultimate test of a material's performance in a particular fire situation is to test the material in that situation. The ideal of testing for flame spread properties in a service situation is approached by testing the material in a room burn facility. The test materials are installed in a standard room as either wall and/or ceiling linings, and ignited by a standard ignition source.

There are many aspects of the fire growth pattern that may be monitored - ease of ignition, rate of flame spread across walls and ceiling, rate of increase of room temperature, smoke development, and the occurrence of flashover. Flashover occurs when the fire intensity is sufficient to involve all combustible materials in the room in the fire, and the flames are emitted from the test room. Flashover in a real fire situation would result in the fire being propagated away from the room in which it started and the involvement of other parts of the building.

There have been several types of room burn test procedures reported (Fang, 1975; Ferris, 1955; Brown and Martin, 1983). A room burn facility is shown in Plate 7. There has been an ASTM method (American Society for Testing and Materials, 1983) developed for room testing and this should be the standard method used for future testing.
Plate 6: Small scale fire resistance furnace (left)

Plate 7: Room burn test facility
The room burn test facilities are expensive, and this has resulted in the development of smaller scale test rooms. A one-quarter scale test room is shown in Plate 8.

The data obtained from room burn testing is being used to develop models of fire behaviour for materials when used both alone and in combination.

The room burn test data is also used to determine the ability of standard flame spread test methods to predict the potential fire hazard of a material in a specific fire situation.

It is recommended that the Australian timber industry should test candidate wall lining materials by the currently accepted room burn test method to determine the ability of AS 1530.3 to predict the performance of materials in a room fire situation.

3. FIRE RETARDANTS

Fire retardant formulations are applied to forest products to reduce their flame spread indices.

Fire retardants may be applied by vacuum/pressure impregnation techniques, inclusion in the manufacturing process for reconstituted products, or by brush, roller or spray application to the surface. The retardants may also be formulated such that they are resistant to leaching.

The choice of fire retardant system will be governed by either the end use of the treated material, or the situation of the material which needs to be treated.
3.1 Impregnated fire retardants

The first generation fire retardants that were applied to forest products by vacuum/pressure techniques were water-borne solutions of borates and/or phosphates and/or sulphates. These retardants were very effective, but they were also hygroscopic. In conditions where the relative humidity exceeded 80%, fire retardant treated forest products absorbed moisture, and major problems of corrosion of fixings and stability of finishes were encountered. The fire retardant manufacturers have developed formulations with lower hygroscopicity and corrosion properties, and most plants operating in USA will be using these formulations by 1986.

Current usage of fire retardant formulations in USA is 10,000 tonnes/annum (American Wood Preservers Association, 1982). The retardants are applied at 40 treatment plants in USA. An additional 11 treatment plants are treating with fire retardant formulations in Canada.

Most plants are treating sawn timber and plywood to achieve reduced flame spread properties when tested to ASTM E84. Most of the material is treated to achieve fire retardant-structural (FR-S) rating. Material that achieves FR-S rating can be used in specified areas of buildings that are otherwise required to be non-combustible. This is discussed further under "Building Codes".

Approximately 6 plants in USA and Canada are treating roof shingles and shakes with leach resistant fire retardants. This treatment is required to improve the fire test performance of the shingles to specified classes when tested to ASTM E108 "Fire Tests of Roof Coverings". The treated shingles and shakes are tested after leaching by ASTM D 2898 "Accelerated Weathering of Fire-Retardant Treated Wood for Fire Testing".

3.2 Fire retardant treated composite products

Fire retardant treated hardboard and particleboard are manufactured in USA. Approximately 625,000 square metres of fire retardant treated particleboard is produced annually (Eckert, 1984, pers. comm.). This material achieves a Class I Flame Spread Index (<25) when tested to ASTM E84.

The fire retardant treated particleboard can be finished with untreated timber veneers, and test results demonstrate that the flame spread performance of the finished composite product is the same as the fire retardant treated particleboard core.

Therefore it would be possible to use fire retardant treated particleboard with untreated face veneers in any part of a public building that requires a Class I Flame Spread Index material. The major use area would be access corridors leading to fire exits. As discussed under "Test Methods", it is unlikely that the veneered product would have the same Spread of Flame Index as the core particleboard when tested to AS 1530.3, and hence would not be acceptable for use in similar situations within buildings in Australia.

The prediction of the fire hazard posed by the material when tested to ASTM E84 is supported by ¼ room burn tests of particleboard
(untreated and treated) with untreated timber face veneers. The composite with untreated core flashes over in 6-7 minutes, while the material with treated core takes at least 18 minutes to flashover, and in many cases flashover is not achieved (Richardson, 1984, pers. comm.).

The fire retardant treated particleboard is also used for manufacturing office furniture and fittings. It is recognised that the increased cost (the treated material is approximately 3 times as expensive as untreated particleboard) of such furniture is insignificant compared to the cost of the equipment it contains or supports.

3.3 Surface coatings

3.3.1 Fire retardant coatings

The flame spread performance of building materials may be improved by the application of fire retardant coatings to their surface. The coatings are normally of an intumescent type, and are either clear or opaque.

Coatings can reduce the Flame Spread Index (ASTM E84) of Douglas fir from 70-100 to 5 (Underwriters Laboratories Inc., 1984a).

Approximately 200 000 square metres of lining material is coated with fire retardants annually in USA (Radovic, 1984). Surface coatings are mainly used to upgrade the interior linings of a building that is required when either the occupancy or use is changed.

3.3.2 Fire resistant coatings

Another potential use for coatings is to increase the fire resistance of structural timbers. White (1984) showed that significant increases in fire resistance can be achieved by using fire resistant coatings. This concept should be pursued by the timber industry, as it would be possible to improve the fire resistance of structural timbers in old buildings that are being remodelled. The application of a fire resistive coating would be simpler and cheaper than cladding the members in fire resistive board materials, or replacing the timber member with a concrete or steel member.

4. REGULATION OF FIRE RETARDANTS & FIRE RETARDANT TREATMENTS

4.1 Impregnated fire retardants

The fire retardant treatment industry in U.S.A. is regulated by a treatment approval system operated by private testing laboratories.

The testing laboratory supervises the fire retardant treatment of the candidate material and tests the treated product by the relevant test method.

A vouchered sample of the fire retardant is retained by the testing laboratory. This sample can be used to check for unauthorised formulation variations by the fire retardant manufacturer or treater.
A certificate is then issued for that particular commodity and fire retardant combination. A testing laboratory brand relating to that certificate is then applied to all timber treated in accordance with the conditions specified in that certificate. There is a charge levied by the testing laboratory for the use of the brand, and this supports a regular follow-up inspection service by the laboratory to ensure that the material is being treated as specified. The testing laboratories also require regular sampling of treatment solutions, and adherence to quality control procedures. The quality control procedures are normally based on the inclusion of standard fire-tube test sticks with each charge. Test sticks are treated with the original certification charge of forest products, and the subsequent production test sticks must give at least as good a test result as those included with the certification treatment charge.

The USA building codes then require that fire retardant treated forest products must bear a certified brand from a recognised testing laboratory.

This procedure varies from that practised in New South Wales, where the treatment of timber with fire retardants is controlled by the government under the Timber Marketing Act 1977. The Act requires disclosure of the fire retardant formulations, and this may cause difficulties when the new retardant formulations are introduced into Australia. Fire retardant formulations may be proprietary, and not patented, and it is most unlikely that manufacturers will willingly disclose their formulations. It is possible that a system of vouchered samples, as operated by the American testing laboratories, may be acceptable, providing suitable chemical analytical equipment is available to monitor the formulations. Such monitoring is required to ensure that the manufacturers do not alter the composition of their formulation without approval.

It is recommended that the fire retardant manufacturers or suppliers, and the fire retardant treatment industry, develop a quality control system that can be applied nationally.

4.2 Fire retardant coatings

In USA fire retardant coatings are applied by personnel who are licensed by the retardant manufacturers. The applicator is required to audit the quantity of retardant used on each site. The audit details are provided to the building inspector responsible for the site.

The building inspector may also test the coating to confirm its intumescent nature by applying a flame from a small gas torch or cigarette lighter to a small section of the coated material.

5. BUILDING CODES

There are three building codes used in different regions of USA. For simplicity, discussion will be limited to the BOCA Basic National Building Code/1984. This code is produced by Building Officials and Code Administrators International Inc., Illinois, and is the main code used throughout the northeast and midwest regions of the country.
Each state in Australia has its own building code and this discussion will be limited to that currently operative in New South Wales - Ordinance No. 70 under the Local Government Act, 1919.

In general terms, the BOCA code and Ordinance No. 70 are based on the same principles. The size, situation, and occupancy of a building determine the code requirements for construction and materials. The major difference between the two codes is that the provision for fire zones in Ordinance No. 70 are not included in the BOCA code.

Both codes have requirements for non-combustible construction. However, there are differences between the requirements and allowances of the two codes that significantly affect the acceptability of forest products in building construction. Some of these differences shall be examined in detail, but it is not possible within the limitations of this report to do a full comparison of both building codes.

Some of the areas within the codes where different requirements for materials and/or construction exist include:

a) Allowable size of residential buildings in combustible construction;

b) Use of fire retardant treated timber in non-combustible construction;

c) Use of fire retardant coatings;

d) Allowances for automatic fire suppression installations.

5.1 Allowable size of residential buildings in combustible construction

Residential buildings include the residential portions of hotels and motels, and multi-family unit buildings. Single, detached domestic dwellings are not included in the category of residential buildings.

Ordinance No. 70 allows residential buildings to be built entirely of combustible materials, providing the building height does not exceed one storey, and building separation requirements are satisfied. Residential buildings of two storeys must have non-combustible external walls, party walls, and for hotels and motels, all internal load-bearing and non-load-bearing walls must also be constructed from non-combustible materials. For two storey residential buildings where one unit is above another, the building must be of non-combustible construction. All three storey residential buildings must be of non-combustible construction. The above requirements for residential buildings under Ordinance No. 70 apply in areas that are not classified as fire zones. For residential buildings in secondary fire zones the requirement for non-combustible construction increases, and for primary fire zones, all residential buildings must be of non-combustible construction.

The BOCA code allows residential buildings to be built to three storeys in combustible construction, providing the structural members are protected, and the fire resistance requirements for the structural elements are satisfied. This means that multi-family unit buildings can be built to three storeys in wood-frame construction. Internal
walls that are required to have a nominated fire resistance, would normally be clad in gypsum wall board. Floor/ceiling assemblies would be wood floor over gypsum wall board ceiling.

The different construction requirements for residential buildings between the two codes offers entirely different market opportunities to the forest products industries of USA and Australia. In Australia the forest products industry is excluded from the structural materials market for three storey residential buildings, whereas in USA, this is a major market for the forest products industry.

5.2 Use of fire retardant treated timber in non-combustible constructions

The BOCA code allows the use of fire retardant treated forest products in non load bearing walls and roof construction of buildings that are required to be of non-combustible construction. The fire retardant treated forest products must pass a more severe 30 minute ASTM E84 test, rather than the normal 10 minute test.

Thus it is possible to use fire retardant treated timber framing for walls bounding exit access corridors, walls separating tenant spaces, walls separating dwelling units, and walls in other non load-bearing situations, in buildings of any occupancy or size.

From data supplied by Lattanzi (1985, pers. comm.), it is calculated that approximately 0.3% of all sawn timber produced in America is fire retardant treated for this purpose.

As this allowance is not contained in the Australian building codes, the potential market is not available to the local forest products industry.

While the Australian forest products and fire retardant treatment industries would benefit greatly from an allowance to use fire retardant treated structural material in non-combustible construction, they must also accept the need to be able to demonstrate the adequacy and quality of their material. This presents two immediate problems. There is no test method used in Australia that could be used to grade material similar to the extended ASTM E84 test, and there is no national quality control program operated by the fire retardant treatment industry. An acceptable solution to both these problems should be a pre-requisite for the provision of such an allowance in the Australian building codes.

5.3 Use of fire retardant coatings

Fire retardant coatings are allowed under the BOCA code to reduce the flame spread properties of lining materials to the specified level. Thus it is possible to use untreated forest products in situations requiring low flame spread properties, providing an approved fire retardant coating is applied. This is particularly useful when the occupancy or use of a building is changed, and the new use requires lower flame spread properties of walls, ceilings, or partitions, than the original occupancy.

Ordinance No. 70 prohibits the use of fire retardant coatings to achieve a specified flame spread rating. This prohibition means that untreated forest products must be replaced in a building undergoing a
change of occupancy if their flame spread properties are in excess of the requirements for the new occupancy. It would be beneficial to the forest products industry if Ordinance No. 70 could be amended to allow the use of fire retardant coatings to achieve reduced flame spread indices.

5.4 Allowances for automatic fire suppression installation

Both Ordinance No. 70 and BOCA allow for the floor area of a building to be increased if an approved automatic fire suppression system is installed. The BOCA code also allows the height of the building to be increased by one storey, if an approved automatic fire suppression system is installed.

Therefore, under the BOCA code, it is possible to build residential buildings to four storeys in wood-frame construction, if an approved automatic fire suppression system is installed. An example of a four storey, wood-framed, condominium complex is shown in Plate 9.

Plate 9: Wood-framed residential building construction, USA

The BOCA code also increases the flame spread requirements of interior finish materials by one Flame Spread Class if an approved automatic fire suppression system is installed. Under this ruling Class III materials (which include most untreated forest products) could be used in corridors providing exit access. No such relaxation is available under Ordinance No. 70.
The above examples illustrate the much more favourable position enjoyed by forest products under the USA building codes when compared to the provisions of Ordinance No. 70.

The allowable uses for materials, and hence their potential market, is controlled by the building codes. The reasons for the different potential markets for forest products in USA and Australia needs to be carefully considered.

The USA forest products industry is a major contributor to the building code preparation process and the development of fire test methods. The USA industry is united in this area under the National Forest Products Association (NFPA). The Canadian forest products industry is represented in a similar fashion by the Canadian Wood Council.

Both the National Forest Products Association and the Canadian Wood Council have professional fire protection engineers who are involved in all stages of building code and test method development. They ensure that forest products are afforded a reasonable position within the building codes, and that test methods do not favour other materials at the expense of forest products.

The Australian forest products industry must present a united challenge to the building codes if they hope to win more favourable acceptance for their products. They must also develop professional fire protection engineering expertise, which is the basis upon which the building codes are developed.

The major lesson that the Australian forest products industry needs to learn from their USA and Canadian counterparts is that the commitment to building code and test method development needs to be united, professional, and long term. It has taken the USA and Canadian industries approximately 25 years to gain the high level of acceptance for their products they currently enjoy. They need to maintain their level of commitment to ensure that the industry's position is maintained.

It is recommended that the Australian forest products industry develop expertise in the field of fire protection engineering. Such expertise will assist in the development of building codes that will allow the maximum safe usage of forest products.

6. CONCLUSIONS

From the matters discussed in this report, it is obvious that the USA forest products industry enjoy a much wider range of domestic market opportunities than exist for the forest products industry in Australia. There is no reason to doubt that the Australian forest products industry can improve its position and hopefully achieve a similar level to that enjoyed by the USA forest products industry.

Implementation of the following recommendations will provide a foundation upon which the Australian forest products industry can develop strategies to provide greater market opportunities.
7. RECOMMENDATIONS

a) The Australian forest products industry must develop professional fire protection engineering expertise as a united, national industry. The commitment by the industry must be long-term and include active participation in the building code and fire test method development processes;

b) The fire retardant treatment industry must develop an acceptable system of quality control that can operate nationally. The quality control procedures must include acceptable quality control and fire performance test methods, adequate means of verifying treatment quality, and a certification scheme to allow the treated material to be identified in the market place;

c) The fire tests currently used to control the use of building materials in Australia need to be assessed urgently to determine their accuracy of fire behaviour prediction for forest products. AS 1530.3 should be the first test to be assessed.

d) The Australian forest products industry must undertake coordinated research to provide data on fire resistance and other fire performance properties that are required by the specifiers and users of their products.

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9. REFERENCES


Forest Products Laboratory. USDA Forest Service. ASTM E84 Flame Spread Classifications.


10. APPENDIX A: ESTABLISHMENTS VISITED

Research Establishments

1. Forest Products Laboratory
   US Department of Agriculture
   Madison, Wisconsin

2. Wood Science & Forest Products Faculty
   University of Toronto
   Toronto, Ontario

3. Forintek Canada Corporation
   Ottawa, Ontario

4. National Research Council of Canada
   Ottawa, Ontario

Forest Products Companies

1. Osmose Pty Ltd
   Buffalo, New York

2. American Vamag/Port Authority Trading Company
   New York, New York

   Pittsburgh, Pennsylvania

   Orrville, Ohio

5. Willamette Industries Pty Ltd
   Portland, Oregon

6. Weyerhaeusser Company
   Longview, Washington

Forest Products Industry Associations

1. National Forest Products Association
   Hohokus, New Jersey

2. National Forest Products Association
   Huntington Beach, California

3. Canadian Wood Council
   Ottawa, Ontario

4. Council of Forest Industries of British Columbia
   Vancouver, British Columbia

Third Party Testing Laboratories

1. Underwriters Laboratories Inc.
   Northbrook, Illinois

2. Underwriters Laboratories of Canada
   Toronto, Ontario
Building Code Organisation

1. International Conference of Building Officials, Whittier, California