
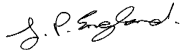


**THE SUITABILITY OF THE USE  
OF VARIOUS UNTREATED TIMBERS  
FOR BUILDING CONSTRUCTIONS  
IN BUSHFIRE-PRONE AREAS**

Report for

National Timber Development Council  
13 Nichols Street  
Surry Hills 2010

<b>Report</b>	<b>Name</b>	<b>Signature/* Authorization</b>	<b>Date</b>
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\* For and on behalf of Warrington Fire Research Group.

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## EXECUTIVE SUMMARY

A range of untreated timbers of minimum thickness of 18 mm have been tested in a cone calorimeter with an irradiance level of 25 kW/m<sup>2</sup> following the procedure specified in AS/NZS 3837:1998. The results obtained from the tests have been assessed against the criteria specified in AS 3959-1999 incorporating Amendments Nos. 1 and 2 for fire-retardant-treated timbers which are summarized below:

*For the purpose of AS 3959-1999, fire-retardant-treated timber is timber that when tested to AS/NZS 3837 meets the following parameters, after having been subjected to the regime of ASTM D 2898 Method B:*

- (a) *Ignition does not occur when the material is exposed to an irradiance level of 10 kW/m<sup>2</sup>.*
- (b) *The maximum heat release rate is not greater than 100 kW/m<sup>2</sup> and the average heat release rate for 10 min following ignition is not greater than 60 kW/m<sup>2</sup> when the material is exposed to an irradiance level of 25 kW/m<sup>2</sup>.*

The above criteria were derived from the properties of fire-retardant-treated timbers that are available in the US but not in Australia at the time of preparation of this report. It is understood the above criteria are currently under review by the relevant Standards Australia committee due to difficulties experienced in achieving compliance and limited correlation of the performance and test criteria with bushfire data.

It is noted that AS/NZS 3837 allows the cone calorimeter test to be terminated if the specimens did not exhibit evidence of heat evolution during the first 10 minutes of the test. A design fire front duration for bushfires of 10 minutes has also been proposed.

At the time of this report a study is being undertaken by Warrington Fire Research to develop appropriate test methods and performance criteria for the assessment of elements of construction and materials exposed to bushfires.

The following alternative criterion for cone calorimeter testing to determine the suitability of the use of the timber species for building constructions in bushfire-prone areas is currently being considered in lieu of the current criteria in AS 3959-1999:

When subjected to a cone calorimeter test in accordance with AS/NZS 3837:1998:-

- (a) Ignition does not occur in the first 10 minutes when the material is exposed to an irradiance level of 25 kW/m<sup>2</sup>.

The timber species considered in this report can be classified as follows:

<b>Timbers Satisfying the Definition of Fire-Retardant-Treated Timber Specified in AS 3959-1999 Incorporating Amendments Nos. 1 and 2</b>	<b>Timbers Which Do Not Satisfy the current AS 3959-1999 definition of Fire-Retardant-Treated Timber but satisfy the Proposed Performance Criteria</b>	<b>Timbers Which Do Not Satisfy the Definition of Fire-Retardant-Treated Timber Nor the Proposed Performance Criteria</b>
Blackbutt Kwila (Merbau) Red Iron Bark River Red Gum Silver Top Ash Spotted Gum Turpentine	Balau (Selangan Batu) Forest Red Gum Jarrah Tallowwod Yellow Stringybark	Hoop Pine Mountain Ash Messmate Radiata Pine Weathered Hoop Pine Weathered Messmate Weathered Radiata Pine

## THE SUITABILITY OF THE USE OF VARIOUS UNTREATED TIMBERS FOR BUILDING CONSTRUCTIONS IN BUSHFIRE-PRONE AREAS

### 1 INTRODUCTION

- 1.1 This report presents a considered opinion of the suitability of the use of various untreated timbers for building constructions in bushfire-prone areas.
- 1.2 The opinion is based on heat release rates determined by oxygen consumption calorimetry on a range of timbers of minimum thickness of 18 mm, using a cone calorimeter and conducted in accordance with AS/NZS 3837:1998.
- 1.3 The current Australian Standard AS 3959-1999 requires timbers to be fire-retardant-treated for certain components of a building in a bushfire-prone area, subject to the level of risk of bushfire attack. Therefore, test data for each timber species is assessed against the criteria for fire-retardant-treated timbers specified in AS 3959-1999 incorporating Amendments Nos. 1 and 2.
- 1.4 For those timber species which do not comply with the definition of fire-retardant-treated timbers specified in AS 3959-1999 incorporating Amendments Nos. 1 and 2, alternate criteria are proposed to assess the suitability of their use for building constructions in bushfire-prone areas.
- 1.5 The test data considered were obtained from specimens which included Balau (Selangan Batu), Blackbutt, Forest Red Gum, Hoop Pine, Jarrah, Kwila (Merbau), Mountain Ash, Messmate, Red Iron Bark, Radiata Pine, River Red Gum, Silver Top Ash, Spotted Gum, Tallowwood, Turpentine, Yellow Stringybark, weathered Hoop Pine, weathered Messmate and weathered Radiata Pine.
- 1.6 All tests were carried out at the Victoria University (VU) and the relevant data obtained is summarized in tabular form in Appendix 1.

### 2 DISCUSSION

- 2.1 *Definition of Fire-Retardant-Treated Timber*
- 2.1.1 Fire-retardant-treated timbers are defined by Clause 1.5.6 in AS 3959-1999 incorporating Amendments Nos. 1 and 2 as follows:

*For the purpose of AS 3959-1999, fire-retardant-treated timber is timber that when tested to AS/NZS 3837 meets the following parameters, after having been subjected to the regime of ASTM D 2898 Method B:*

- (a) Ignition does not occur when the material is exposed to an irradiance level of  $10 \text{ kW/m}^2$ .
- (b) The maximum heat release rate is not greater than  $100 \text{ kW/m}^2$  and the average heat release rate for 10 min following ignition is not greater than  $60 \text{ kW/m}^2$  when the material is exposed to an irradiance level of  $25 \text{ kW/m}^2$ .

2.1.2 At least three samples of each timber species were tested in a cone calorimeter with an irradiance level of  $25 \text{ kW/m}^2$  in accordance with AS/NZS 3837:1998 and the results are assessed using the above criteria to determine whether they are classified as fire-retardant-treated timbers by AS 3959-1999 incorporating Amendments Nos. 1 and 2.

2.1.3 All samples for each timber species must comply with the criteria listed in Clause 2.1.1 in order to be classified as fire-retardant-treated timber. However AS/NZS 3837:1998 allows the test to be terminated if there is no evidence of heat evolution during the first 10 minutes.

2.1.4 ASTM D 2898 – 94 is designed to ascertain the durability of a fire-retardant treatment of wood under exposure to accelerated weathering as fire retardant material could be leached out during the process. However, all timber species considered in this report had not been treated with fire retardant material and therefore it is considered reasonable to waive this weathering process for the purpose of this assessment. Those timbers that had been naturally weathered prior to fire testing exhibited similar or better results to those that had not been subjected to natural weathering.

## 2.2 *Timber Species Classification*

2.2.1 Spearpoint and Quintiere<sup>1</sup> reported that the lowest radiant heat flux to cause timber ignition within 90 minutes was approximately  $10 \text{ kW/m}^2$  and it is dependent on many factors, such as species, moisture content, density and grain orientation.

2.2.2 It has been reported by Drysdale<sup>2</sup> that piloted ignition of thermally thick wood species may occur after prolonged exposure of a radiant heat flux of approximately  $12.5 \text{ kW/m}^2$ .

2.2.3 The timber species considered in this report are of minimum thickness of 18mm and can be considered thermally thick<sup>3</sup>.

2.2.4 As the timber species considered in this report are of high density, it is considered that ignition is unlikely for an extended period of time if the

<sup>1</sup> Spearpoint M J and Quintiere J G, *Fire Safety Journal*, **36**, 2001.

<sup>2</sup> Drysdale D, *An Introduction to Fire Dynamics*, 2<sup>nd</sup> ed, Wiley, New York, 1999.

<sup>3</sup> Mikkola E and Wichman I, *J Fire & Materials*, **14**, 1990.

timber species are subjected to an irradiance level of 10 kW/m<sup>2</sup> and therefore criterion (a) specified in Clause 2.1.1 is deemed to be satisfied to the degree necessary.

- 2.2.5 *Timber Species Which Satisfy Criterion (b) Specified in Clause 2.1.1*
- 2.2.5.1 It is observed from the test results that heat release rates of six timber species, Kwila (Merbau), Red Iron Bark, River Red Gum Silver Top Ash, Spotted Gum and Turpentine, when ignited did not reach 100 kW/m<sup>2</sup> and their average heat release rates for 10 minutes after ignition were below 60 kW/m<sup>2</sup>. Therefore, these species can be classified as fire-retardant-treated timber in accordance with AS 3959-1999 incorporating Amendments Nos. 1 and 2.
- 2.2.5.2 One sample of Blackbutt tested was found to satisfy criterion (b) specified in Clause 2.1.1. In the other two tests (Tests 1 and 3), although the average heat release rates for 10 minutes after ignition were below 60 kW/m<sup>2</sup>, the maximum heat release rates obtained were greater than 100 kW/m<sup>2</sup>. However, the samples did not ignite until after 10 minutes and a heat release rate of 100 kW/m<sup>2</sup> was reached more than 15 minutes after ignition.
- 2.2.5.3 The cone calorimeter test procedure outlined in AS/NZS 3837:1998 states that *if the specimen does not ignite in 10 min, remove and discard, unless the specimen is showing signs of heat evolution.*
- 2.2.5.4 In Tests 1 and 3, the Blackbutt specimens did not ignite in 10 minutes and there were no signs of heat evolution that could be attributed to the onset of ignition. Therefore, the cone calorimeter tests can be considered to have ceased at 10 minutes and could be deemed to satisfy the requirements of AS/NZS 3837:1998. On this basis, Blackbutt may be deemed-to-satisfy criterion (b) specified in Clause 2.1.1 and be regarded as a fire-retardant-treated timber in accordance with AS 3959-1999 incorporating Amendments Nos. 1 and 2.
- 2.2.5.5 The results and the classification above can also be applied to timber species of thickness greater than 18 mm.
- 2.2.6 *Timber Species Which Do Not Satisfy Criterion (b) Specified in Clause 2.1.1*
- 2.2.6.1 Timber species which did not satisfy criterion (b) specified in Clause 2.1.1 include Balau (Selangan Batu), Forest Red Gum, Hoop Pine, Jarrah, Mountain Ash, Messmate, Radiata Pine, Tallowwood, Yellow Stringybark, weathered Hoop Pine, weathered Messmate, and weathered Radiata Pine.
- 2.2.6.2 These timber species cannot be classified as fire-retardant-treated timbers in accordance with AS 3959-1999 incorporating Amendments

Nos. 1 and 2. However, alternate criteria are proposed to assess the suitability of their use for building constructions in bushfire-prone areas.

2.3 *Proposed Criterion for Suitability of the Use of Timber in Bushfire-prone Areas*

2.3.1 The following alternative performance criterion is proposed to assess the suitability of a particular timber species to be used for building constructions in bushfire-prone areas.

When subjected to a cone calorimeter test in accordance with AS/NZS 3837:1998:-

(a) Ignition does not occur in the first 10 minutes when the material is exposed to an irradiance level of 25 kW/m<sup>2</sup>.

2.4 *Appropriateness of the Proposed Criteria*

2.4.1 The existing criteria in AS 3959-1999 were derived from the properties of fire-retardant-treated timbers that are available in the US but not in Australia at the time of preparation of this report. It is understood the above criteria are currently under review by the relevant Standards Australia committee due to difficulties experienced in achieving compliance and limited correlation of the performance and test criteria with bushfire data.

2.4.2 It is noted that AS/NZS 3837 allows the cone calorimeter test to be terminated if the specimens did not exhibit evidence of heat evolution during the first 10 minutes of the test.

2.4.3 At the time of preparation of this report a study is being undertaken by Warrington Fire Research to develop appropriate test methods and performance criteria for the assessment of elements of construction and materials exposed to bushfires. The proposed criterion in Section 2.3 of this report is intended to provide an acceptable level of resistance to ignition when exposed to radiant heat while the fire front passes. The effect of direct flame impingement is not considered in the proposed criteria.

2.5 *Assessment of Timber Species Using the Proposed Criteria*

2.5.1 For those timber species which did not comply with the definition of fire-retardant-treated timbers specified in AS 3959-1999 incorporating Amendments Nos. 1 and 2, the proposed criteria, specified in Clause 2.3.1, were used to determine the suitability of their use for building constructions in bushfire-prone areas.

2.5.2 The timber species to be assessed using the proposed criteria include Balau (Selangan Batu), Forest Red Gum, Hoop Pine, Jarrah, Mountain



Ash, Messmate, Radiata Pine, Tallowwood, Yellow Stringybark, weathered Hoop Pine, weathered messmate and weathered Radiata Pine.

- 2.5.3 All samples of each timber species above must comply with the criteria listed in Clause 2.3.1 in order to be considered suitable for building constructions in bushfire-prone areas.
- 2.5.4 It is observed from the test results that five timber species did not ignite for the first 10 minutes when subjected to an irradiance level of 25 kW/m<sup>2</sup> and they are Balau (Selangan Batu), Forest Red Gum, Jarrah, Tallowwood and Yellow Stringybark.
- 2.5.6 Therefore, Balau (Selangan Batu), Forest Red Gum, Jarrah, Tallowwood and Yellow Stringybark of minimum thickness of 18mm satisfy the proposed criteria specified in Clause 2.3.1.
- 2.5.7 Hoop Pine, Mountain Ash, Messmate, Radiata Pine, weathered Hoop Pine, weathered Messmate and weathered Radiata Pine satisfy neither the criteria for fire-retardant-treated timbers specified in AS 3959-1999 incorporating Amendments Nos. 1 and 2 nor the proposed criteria listed in Clause 2.3.1. Therefore, these timber species are considered unsuitable for building constructions in bushfire-prone areas.

### **3 CONCLUSIONS**

- 3.1 On the basis of the above discussion, it is concluded that the following untreated timber species of minimum thickness of 18 mm can be classified as fire-retardant-treated timbers in accordance with AS 3959-1999 incorporating Amendments Nos. 1 and 2 and therefore considered suitable for building constructions in bushfire-prone areas:

Fire-retardant-treated timber:

- Blackbutt
- Kwila (Merbau)
- Red Iron Bark
- River Red Gum
- Silver Top Ash
- Spotted Gum
- Turpentine

- 3.2 For those timber species which do not satisfy the definition of fire-retardant-treated timbers specified in AS 3959-1999 incorporating Amendments Nos. 1 and 2, an alternate criterion has been proposed to assess the suitability of their use for building constructions in bushfire-prone areas. The proposed criterion is as follows:

When subjected to a cone calorimeter test in accordance with AS/NZS 3837:1998:-

(a) ignition does not occur in the first 10 minutes when the material is exposed to an irradiance level of 25 kW/m<sup>2</sup>.

3.3 The following untreated timber species of minimum thickness of 18mm, which cannot be classified as fire-retardant-treated timbers in accordance with AS 3959-1999 incorporating Amendments Nos. 1 and 2 satisfied the proposed alternate criterion specified in Clause 3.2.

- Balau (Selangan Batu)
- Forest Red Gum
- Jarrah
- Tallowwood
- Yellow Stringybark

3.4 On the basis of the above discussion, it is concluded that the following untreated timber species of thickness of 18 mm do not satisfy the criteria for fire-retardant-treated timbers specified in AS 3959-1999 incorporating Amendments Nos. 1 and 2 nor the proposed criteria listed in Clause 3.2 and are therefore considered unsuitable for building constructions in bushfire-prone areas:

- Hoop Pine
- Mountain Ash
- Messmate
- Radiata Pine
- Weathered Hoop Pine
- Weathered Messmate
- Weathered Radiata Pine

## **4 VALIDITY**

4.1 This appraisal is based on the test method and criteria for fire-retardant-treated timbers specified in AS 3959-1999 incorporating Amendments Nos. 1 and 2 with the modifications stated in this report.

4.2 This appraisal is formulated on the basis of information and experience available at the time of preparation. It should be noted that a research study is currently being undertaken to identify appropriate test methods and criteria for elements of construction and materials exposed to bushfire conditions. The proposed criteria may be subject to change pending the outcome of this research and revision of AS 3959-1999.



4.3 This report only assessed those timber species included as summarized in Appendix 1 and should not be used for other purposes.

**APPENDIX 1**

Summary of Support Data

Material*	Thickness (mm)	Time to Ignition (s)	Time for HRR to Reach 100 kW/m <sup>2</sup> (s)	Average HRR for 10 Minutes after Ignition (kW/m <sup>2</sup> )	Test Duration (s)
BA	18	765	1830	59	2444
		764	780	59	2444
		1403	1435	64	2961
BA (s)	18	881	900	60	2330
		1196	1225	58	2816
		813	825	66	2561
BB	19	906	1990	47	2632
		949	n/a	49	2629
		807	1890	41	2359
FR	20	966	n/a	42	1368
		1303	2450	42	3487
		1449	2360	45	3302
HP	20	117	125	60	1470
		140	150	61	1694
		111	120	62	1497
JA	19	742	760	50	1510
		665	675	51	2964
		747	765	46	2905
KW	19	803	n/a	29	1450
		n/a	n/a	n/a	1955
		n/a	n/a	n/a	2055
		n/a	n/a	n/a	2055
MA	19	374	385	58	2165
		390	395	66	2027
		372	385	54	2047
MM	24	615	n/a	35	3600
		344	355	45	3170
		471	485	39	3600
		595	n/a	35	790
		560	590	41	935
MM	18	148	160	50	2110
		123	135	50	1980
		173	175	51	2165
MM	35	615	635	54	3600
		714	735	53	3600
		864	n/a	36	3600
		573	580	53	1420
RI	20	n/a	n/a	n/a	525
		1449	n/a	37	1980
		1165	n/a	33	1875
RP	21	60	75	75	1547
		110	120	68	1380
		140	145	61	1486
RR	20	1506	n/a	18	2060
		1008	n/a	33	1855
		933	n/a	26	1410
SG	18	1358	n/a	47	1850
		1041	n/a	36	1690
		1081	n/a	46	1620

Material*	Thickness (mm)	Time to Ignition (s)	Time for HRR to Reach 100 kW/m <sup>2</sup> (s)	Average HRR for 10 Minutes after Ignition (kW/m <sup>2</sup> )	Test Duration (s)
ST	18	1303	n/a	48	1850
		888	n/a	39	1615
		869	n/a	37	1440
TA	19	914	935	52	2980
		978	1005	57	2875
		1131	2270	50	2908
TU	19	718	n/a	34	1330
		853	n/a	41	2893
		653	n/a	36	971
WHP	19	67	80	55	1404
		69	80	61	1496
		67	80	49	1615
		72	85	47	1734
WMM	18	167	180	53	2042
		145	160	59	1803
		159	160	61	2039
WRP	21	70	85	52	1190
		99	110	60	1524
		70	75	55	1500
YS	18	996	n/a	< 60	3013
		632	660	37	2841
		980	2290	36	2903

**Table A1.1** Results obtained from cone calorimeter tests (25 kW/m<sup>2</sup>) for different timber species.

(n/a signifies that the timber species either did not ignite or did not reach 100kW/m<sup>2</sup>)

- \* Key:
- BA Balau (Selangan Batu)
  - BA (s) Balau (Selangan Batu) (with the reeded side down, smooth surface)
  - BB Blackbutt
  - FR Forest Red Gum
  - HP Hoop Pine
  - JA Jarrah
  - KW Kwila (Merbau)
  - MA Mountain Ash
  - MM Messmate
  - RI Red Iron Bark
  - RP Radiata Pine
  - RR River Red Gum
  - SG Spotted Gum
  - ST Silver Top Ash
  - TA Tallowwood
  - TU Turpentine
  - WHP Weathered Hoop Pine
  - WMM Weathered Messmate
  - WRP Weathered Radiata Pine
  - YS Yellow Stringybark