

Confidential CMIT Doc. 02/276

**ASSESSMENT OF THE MATERIAL GROUP OF  
VARIOUS TIMBER PRODUCTS USING THE CONE  
CALORIMETER**

Report to the Timber Development Association

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CSIRO Fire Science and Technology Laboratory

November 2002

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**ASSESSMENT OF THE MATERIAL GROUP  
OF VARIOUS TIMBER PRODUCTS  
USING THE CONE CALORIMETER**

By

B. W. Paroz

In confidence to:

Timber Development Association  
PO Box 50  
Surry Hills NSW 2010

November 2002

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## 1. OBJECTIVE

The purpose of this report is to assign the timber samples under test their group classifications as per the criteria given in the ABCB document, “Proposal to Amend the Building Code of Australia – Fire Hazard Properties of Building Materials and Assemblies”, July 2002 [1].

## 2. TEST STANDARD

The samples were tested to AS3837 – “Method of Test for Heat and Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter” [2] at 50 kW/m<sup>2</sup> irradiance.

## 3. SPECIMEN DETAILS

Product specifications, as supplied by the Client, are shown in table 1.

Table 1.

	<b>Product</b>	<b>Species</b>	<b>Botanical</b>	<b>Thickness</b>	<b>Treatment</b>
1	Panelling	Turpentine	Syncarpia glomulifera	19 mm	No
2		Victoria Ash		19 mm	No
3		Iron bark	Eucalyptus sideroxylon	19 mm	No
4		Western red cedar	Thuja plicata	12 mm	No
5		Radiata pine	Pinus radiata	12 mm	No
6	Cladding	Western red cedar	Thuja plicata	19 to 6 mm	Yes Fire-X*
7	Sheet Product	Medium Dense Fibre (MDF)		12 mm	No
8		Particleboard with Tasmanian Oak veneer		12 mm	No
9	Plywood	Radiata	Pinus radiata	12 mm	No
10		Meranti	Shorea spp.	4 mm	No

\*Fire-X fire retardant treatment is from Worthington Industries. The method of treatment is pressure impregnated. Type, load and level are unknown.

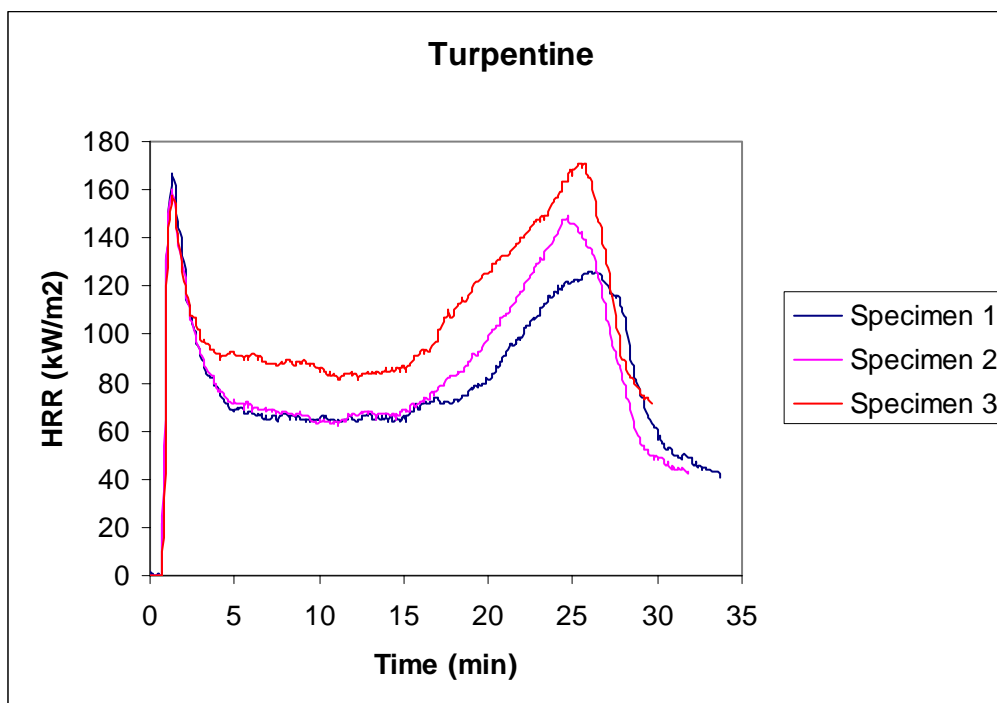
The Western red cedar cladding sample, when cut to the required size, varied in thickness from 19 to 11 mm.

The test specimens were conditioned to constant mass at 50 ± 5 %RH and 23 ± 2 °C. The samples were tested in triplicate.

## 4. RESULTS

### 4.1 Heat Release

The heat release rate plots and summary for each sample follow.



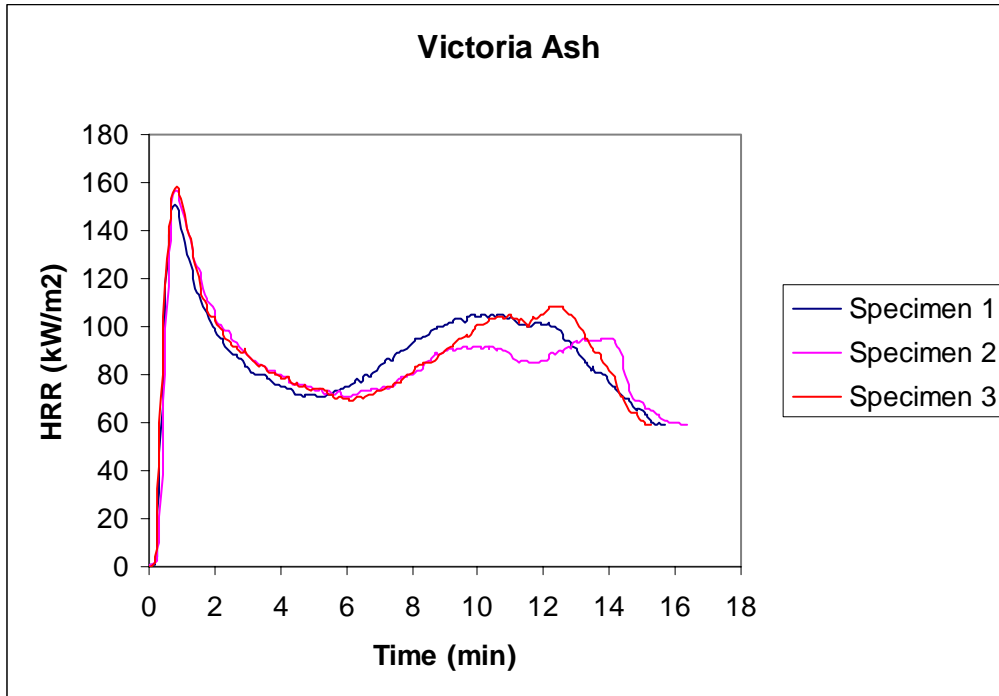
**Figure 1.** Heat Release Rate plot for Turpentine

**Table 2.** Heat Release Rate summary for Turpentine

	$\dot{q}''_{\text{peak}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 60}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 180}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 300}}$ (kW/m <sup>2</sup> )
Specimen 1	167	144	113	96
Specimen 2	160	139	111	96
Specimen 3	171	135	114	105

**Table 3.** Heat release and ignitability indices for Turpentine

	$I_{\text{ig}}^1$ min <sup>-1</sup>	$I_{\text{Q1}}$ s <sup>0.66</sup> kWm <sup>-2</sup>	$I_{\text{Q2}}$ s <sup>0.07</sup> kWm <sup>-2</sup>	$I_{\text{Q, 10min}}$	$I_{\text{Q, 2min}}$	$I_{\text{Q, 12min}}$	<b>GROUP</b>
Specimen 1	1.091	19236	1102	6211	2295	1470	<b>3</b>
Specimen 2	1.091	19356	1103	6211	2295	1470	<b>3</b>
Specimen 3	1.091	22227	1122	6211	2295	1470	<b>3</b>



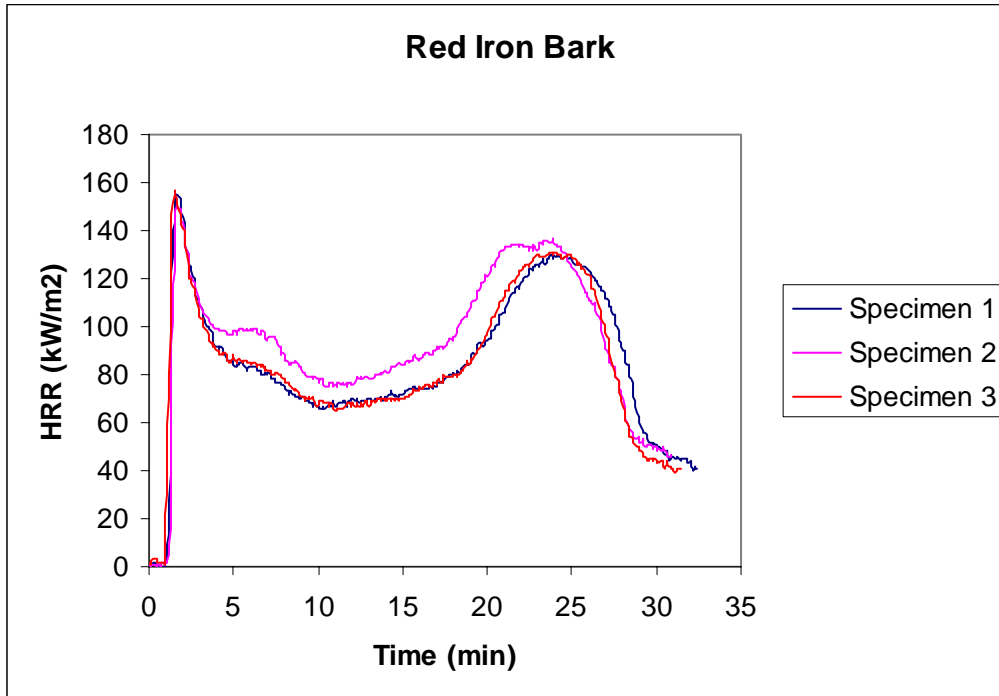
**Figure 2.** Heat Release Rate plot for Victoria Ash

**Table 4.** Heat Release Rate summary for Victoria Ash

	$\dot{q}''_{\text{peak}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 60}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 180}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 300}}$ (kW/m <sup>2</sup> )
Specimen 1	150	129	105	93
Specimen 2	157	137	111	97
Specimen 3	158	133	110	97

**Table 5.** Heat release and ignitability indices for Victoria Ash

	$I_{\text{ig}}$ min <sup>-1</sup>	$I_{\text{Q1}}$ s <sup>0.66</sup> kWm <sup>-2</sup>	$I_{\text{Q2}}$ s <sup>0.07</sup> kWm <sup>-2</sup>	$I_{\text{Q, 10min}}$	$I_{\text{Q, 2min}}$	$I_{\text{Q, 12min}}$	<b>GROUP</b>
Specimen 1	2.4	12762	972	5504	2079	1254	<b>3</b>
Specimen 2	2	12911	1029	5720	2145	1320	<b>3</b>
Specimen 3	3	12657	918	5180	1980	1155	<b>3</b>



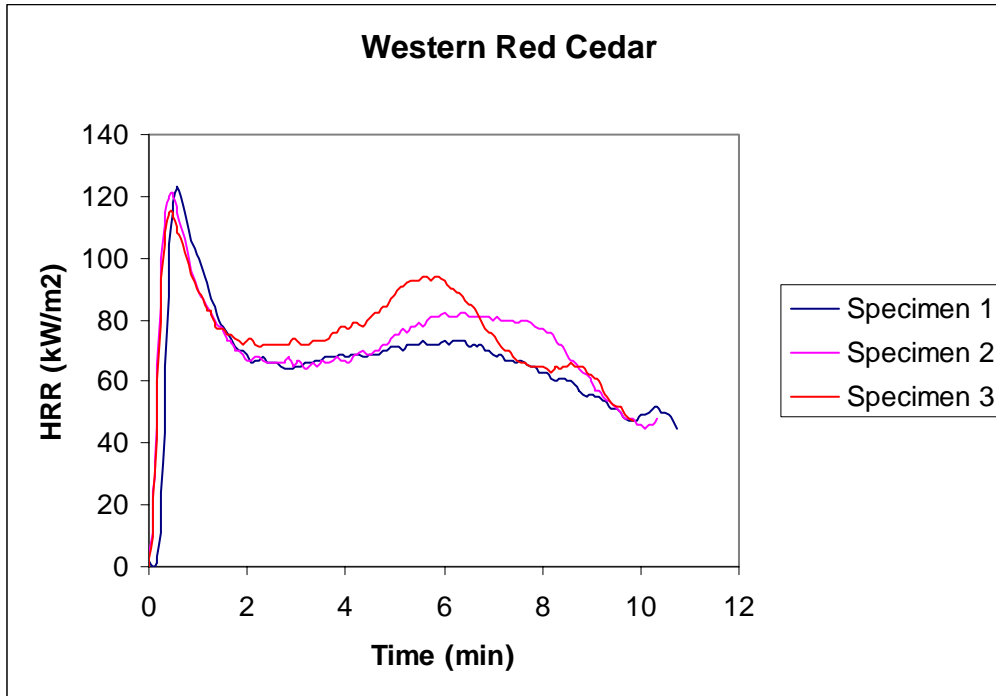
**Figure 3.** Heat Release Rate plot for Iron Bark

**Table 6.** Heat Release Rate summary for Iron Bark

	$\dot{q}''_{\text{peak}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 60}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 180}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 300}}$ (kW/m <sup>2</sup> )
Specimen 1	155	136	116	104
Specimen 2	151	133	116	109
Specimen 3	157	139	116	104

**Table 7.** Heat release and ignitability indices for Iron Bark

	$I_{\text{ig}}^{\text{min}^{-1}}$	$I_{\text{Q1}}$ s <sup>0.66</sup> kWm <sup>-2</sup>	$I_{\text{Q2}}$ s <sup>0.07</sup> kWm <sup>-2</sup>	$I_{\text{Q, 10min}}$	$I_{\text{Q, 2min}}$	$I_{\text{Q, 12min}}$	<b>GROUP</b>
Specimen 1	0.8	19873	1079	6368	2343	1518	<b>3</b>
Specimen 2	0.75	20974	1120	6395	2351	1526	<b>3</b>
Specimen 3	0.857	19569	1113	6337	2334	1509	<b>3</b>



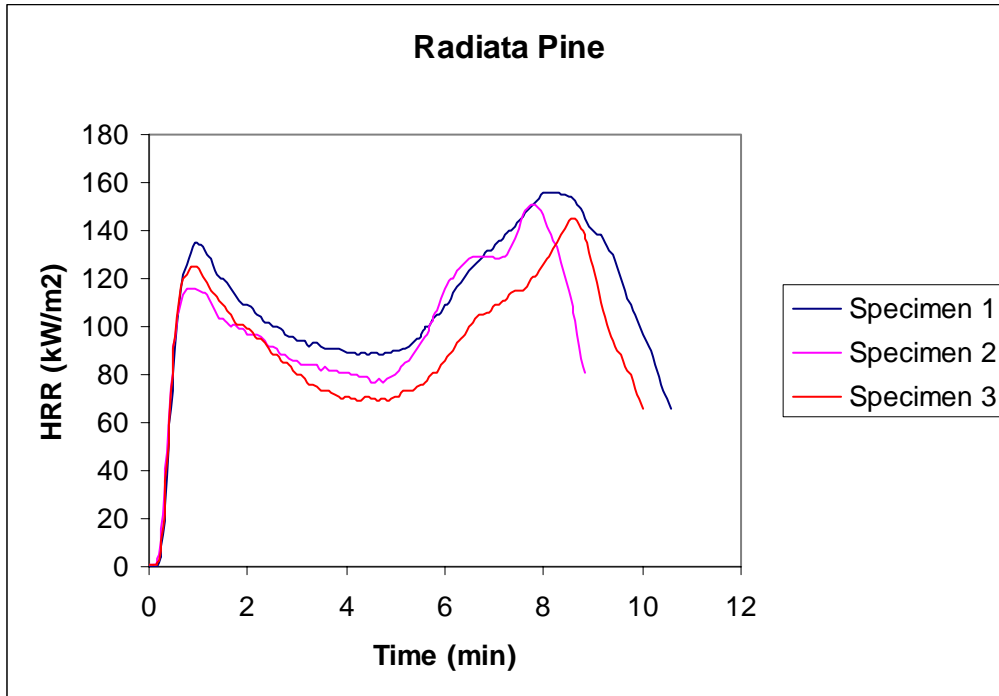
**Figure 4.** Heat Release Rate plot for Western Red Cedar

**Table 8.** Heat Release Rate summary for Western Red Cedar

	$\dot{q}''_{\text{peak}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 60}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 180}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 300}}$ (kW/m <sup>2</sup> )
Specimen 1	123	100	79	75
Specimen 2	121	99	80	76
Specimen 3	115	96	81	81

**Table 9.** Heat release and ignitability indices for Western Red Cedar

	$I_{\text{ig}}^{\text{min}^{-1}}$	$I_{\text{Q1}}$ s <sup>0.66</sup> kWm <sup>-2</sup>	$I_{\text{Q2}}$ s <sup>0.07</sup> kWm <sup>-2</sup>	$I_{\text{Q, 10min}}$	$I_{\text{Q, 2min}}$	$I_{\text{Q, 12min}}$	<b>GROUP</b>
Specimen 1	3	7713	728	5180	1980	1155	<b>3</b>
Specimen 2	6	7954	730	3560	1485	660	<b>3</b>
Specimen 3	6	7995	713	3560	1485	660	<b>3</b>



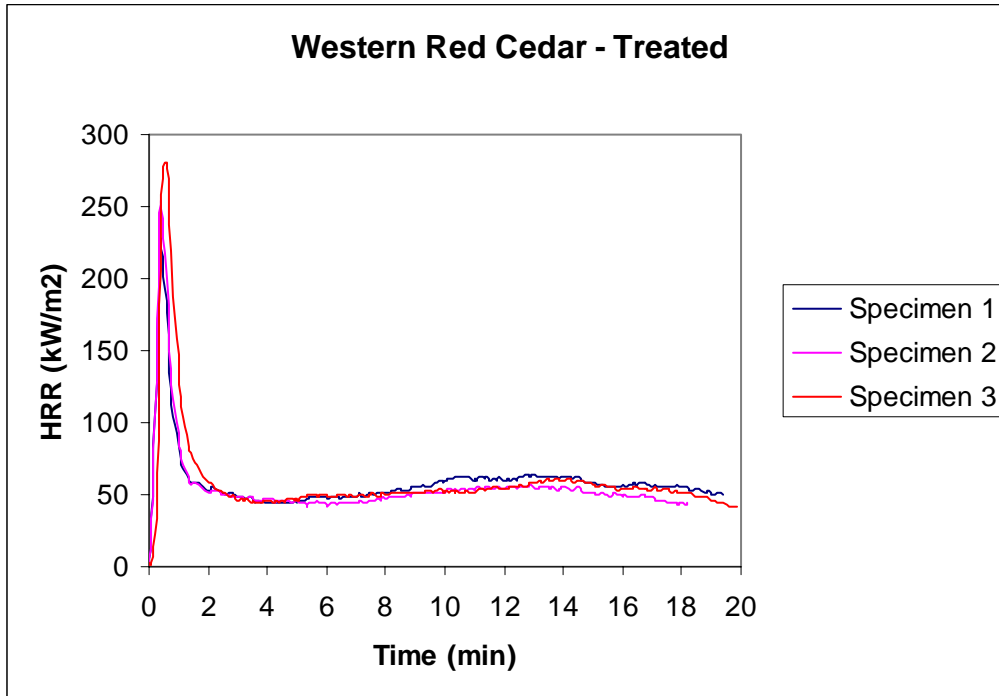
**Figure 5.** Heat Release Rate plot for Radiata Pine

**Table 10.** Heat Release Rate summary for Radiata Pine

	$\dot{q}''_{\text{peak}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 60}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 180}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 300}}$ (kW/m <sup>2</sup> )
Specimen 1	156	109	106	100
Specimen 2	151	100	96	90
Specimen 3	145	104	96	87

**Table 11.** Heat release and ignitability indices for Radiata Pine

	$I_{\text{ig}}^{\text{min}^{-1}}$	$I_{\text{Q1}}^{\text{s}^{0.66}\text{kWm}^{-2}}$	$I_{\text{Q2}}^{\text{s}^{0.07}\text{kWm}^{-2}}$	$I_{\text{Q, 10min}}$	$I_{\text{Q, 2min}}$	$I_{\text{Q, 12min}}$	<b>GROUP</b>
Specimen 1	2.4	11750	864	5504	2079	1254	<b>3</b>
Specimen 2	2.4	9608	798	5504	2079	1254	<b>3</b>
Specimen 3	2.4	9890	808	5504	2079	1254	<b>3</b>



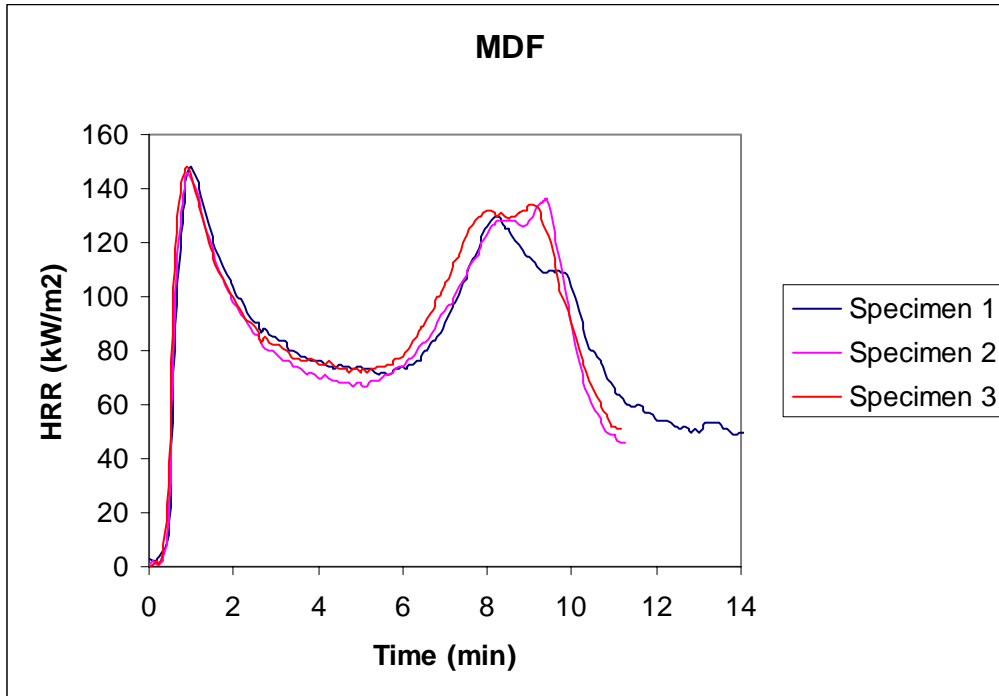
**Figure 6.** Heat Release Rate plot for Western Red Cedar - Treated

**Table 12.** Heat Release Rate summary for Western Red Cedar - Treated

	$\dot{q}''_{\text{peak}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 60}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 180}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 300}}$ (kW/m <sup>2</sup> )
Specimen 1	228	133	82	68
Specimen 2	254	145	85	70
Specimen 3	281	175	98	78

**Table 13.** Heat release and ignitability indices for Western Red Cedar - Treated

	$I_{\text{ig}}^{\text{min}^{-1}}$	$I_{\text{Q1}}^{\text{s}^{0.66}\text{kWm}^{-2}}$	$I_{\text{Q2}}^{\text{s}^{0.07}\text{kWm}^{-2}}$	$I_{\text{Q, 10min}}$	$I_{\text{Q, 2min}}$	$I_{\text{Q, 12min}}$	<b>GROUP</b>
Specimen 1	6	10555	976	3560	1485	660	<b>3</b>
Specimen 2	6	9919	1008	3560	1485	660	<b>3</b>
Specimen 3	3	11469	1294	5180	1980	1155	<b>3</b>



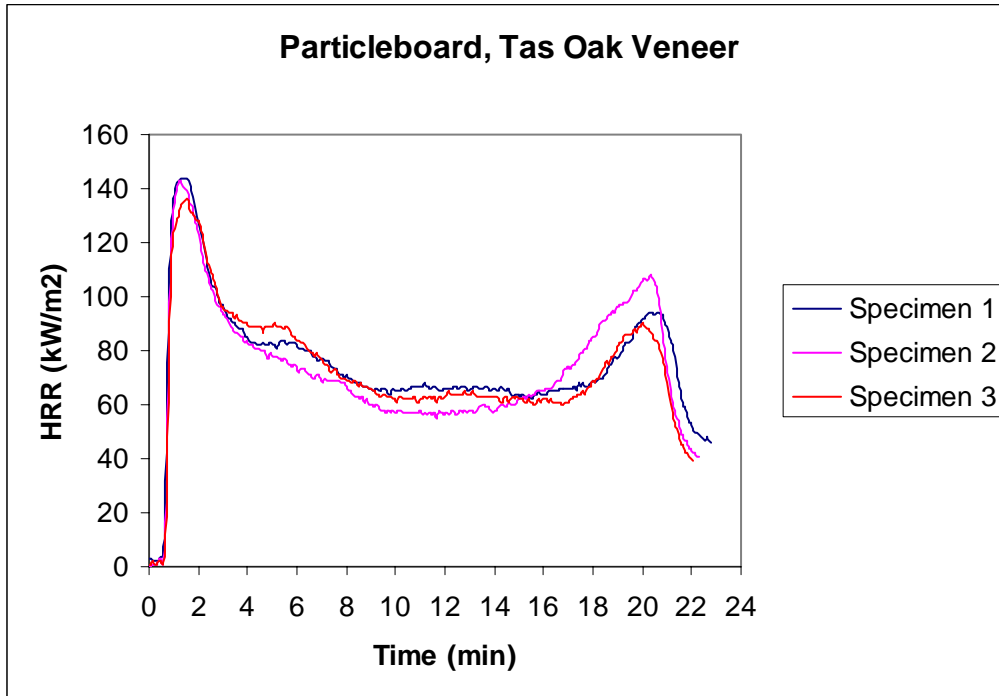
**Figure 7.** Heat Release Rate plot for Medium Dense Fibre

**Table 14.** Heat Release Rate summary for Medium Dense Fibre

	$\dot{q}''_{peak}$ (kW/m <sup>2</sup> )	$\dot{q}''_{avg, 60}$ (kW/m <sup>2</sup> )	$\dot{q}''_{avg, 180}$ (kW/m <sup>2</sup> )	$\dot{q}''_{avg, 300}$ (kW/m <sup>2</sup> )
Specimen 1	148	119	102	91
Specimen 2	146	120	100	88
Specimen 3	148	125	102	91

**Table 15.** Heat release and ignitability indices for Medium Dense Fibre

	$I_{ig, min^{-1}}$	$I_{Q1}$ s <sup>0.66</sup> kWm <sup>-2</sup>	$I_{Q2}$ s <sup>0.07</sup> kWm <sup>-2</sup>	$I_{Q, 10min}$	$I_{Q, 2min}$	$I_{Q, 12min}$	<b>GROUP</b>
Specimen 1	1.714	11616	906	5874	2192	1367	<b>3</b>
Specimen 2	1.714	10443	910	5874	2192	1367	<b>3</b>
Specimen 3	2	10774	882	5720	2145	1320	<b>3</b>



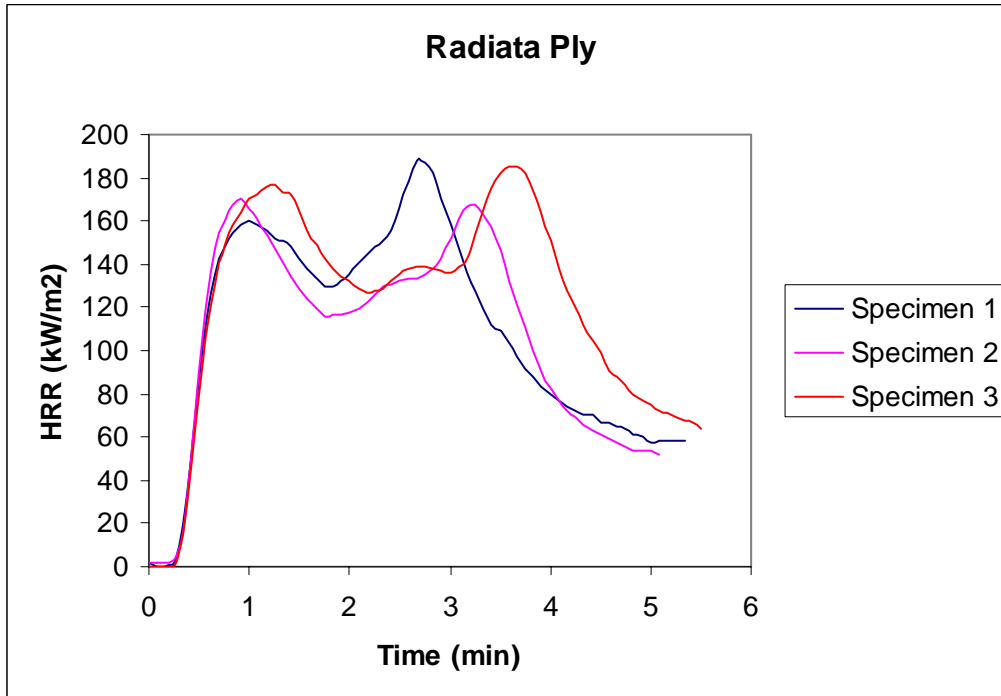
**Figure 8.** Heat Release Rate plot for Particleboard, Tasmanian Oak Veneer

**Table 16.** Heat Release Rate summary for Particleboard, Tas Oak Veneer

	$\dot{q}''_{\text{peak}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 60}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 180}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 300}}$ (kW/m <sup>2</sup> )
Specimen 1	144	129	113	101
Specimen 2	143	130	110	98
Specimen 3	136	116	109	101

**Table 17.** Heat release and ignitability indices for Particleboard, Tas Oak Veneer

	$I_{\text{ig}}^{\text{min}^{-1}}$	$I_{\text{Q1}}^{\text{s}^{0.66}\text{kWm}^{-2}}$	$I_{\text{Q2}}^{\text{s}^{0.07}\text{kWm}^{-2}}$	$I_{\text{Q, 10min}}$	$I_{\text{Q, 2min}}$	$I_{\text{Q, 12min}}$	<b>GROUP</b>
Specimen 1	1.333	14454	952	6080	2255	1430	<b>3</b>
Specimen 2	1.2	13930	985	6152	2277	1452	<b>3</b>
Specimen 3	1.2	13960	966	6152	2277	1452	<b>3</b>



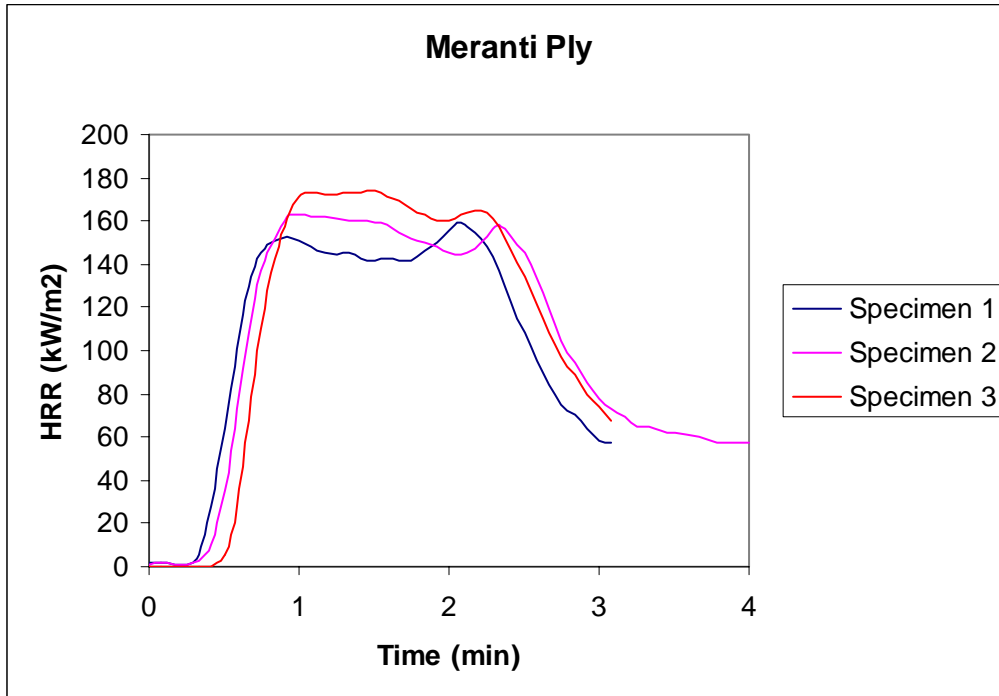
**Figure 9.** Heat Release Rate plot for Radiata Ply

**Table 18.** Heat Release Rate summary for Radiata Ply

	$\dot{q}''_{peak}$ (kW/m <sup>2</sup> )	$\dot{q}''_{avg, 60}$ (kW/m <sup>2</sup> )	$\dot{q}''_{avg, 180}$ (kW/m <sup>2</sup> )	$\dot{q}''_{avg, 300}$ (kW/m <sup>2</sup> )
Specimen 1	188	136	144	116
Specimen 2	170	139	137	112
Specimen 3	185	154	146	132

**Table 19.** Heat release and ignitability indices for Radiata Ply

	$I_{ig}$ min <sup>-1</sup>	$I_{Q1}$ s <sup>0.66</sup> kWm <sup>-2</sup>	$I_{Q2}$ s <sup>0.07</sup> kWm <sup>-2</sup>	$I_{Q, 10min}$	$I_{Q, 2min}$	$I_{Q, 12min}$	<b>GROUP</b>
Specimen 1	2.4	7772	838	5504	2079	1254	<b>3</b>
Specimen 2	2.4	7472	838	5504	2079	1254	<b>3</b>
Specimen 3	2	8793	969	5720	2145	1320	<b>3</b>



**Figure 10.** Heat Release Rate plot for Meranti Ply

**Table 20.** Heat Release Rate summary for Meranti Ply

	$\dot{q}''_{\text{peak}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 60}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 180}}$ (kW/m <sup>2</sup> )	$\dot{q}''_{\text{avg, 300}}$ (kW/m <sup>2</sup> )
Specimen 1	159	136	114	85
Specimen 2	163	138	125	97
Specimen 3	174	156	126	96

**Table 21.** Heat release and ignitability indices for Meranti Ply

	$I_{\text{ig}}^{\text{min}^{-1}}$	$I_{\text{Q1}}$ s <sup>0.66</sup> kWm <sup>-2</sup>	$I_{\text{Q2}}$ s <sup>0.07</sup> kWm <sup>-2</sup>	$I_{\text{Q, 10min}}$	$I_{\text{Q, 2min}}$	$I_{\text{Q, 12min}}$	<b>GROUP</b>
Specimen 1	2	5578	779	5720	2145	1320	<b>1</b>
Specimen 2	1.714	6544	862	5874	2192	1367	<b>3</b>
Specimen 3	1.5	6096	859	5990	2228	1403	<b>3</b>

## 4.2 Specific Extinction Area

The specific extinction area (SEA) for each product is given in the Figures 11a and 11b below.

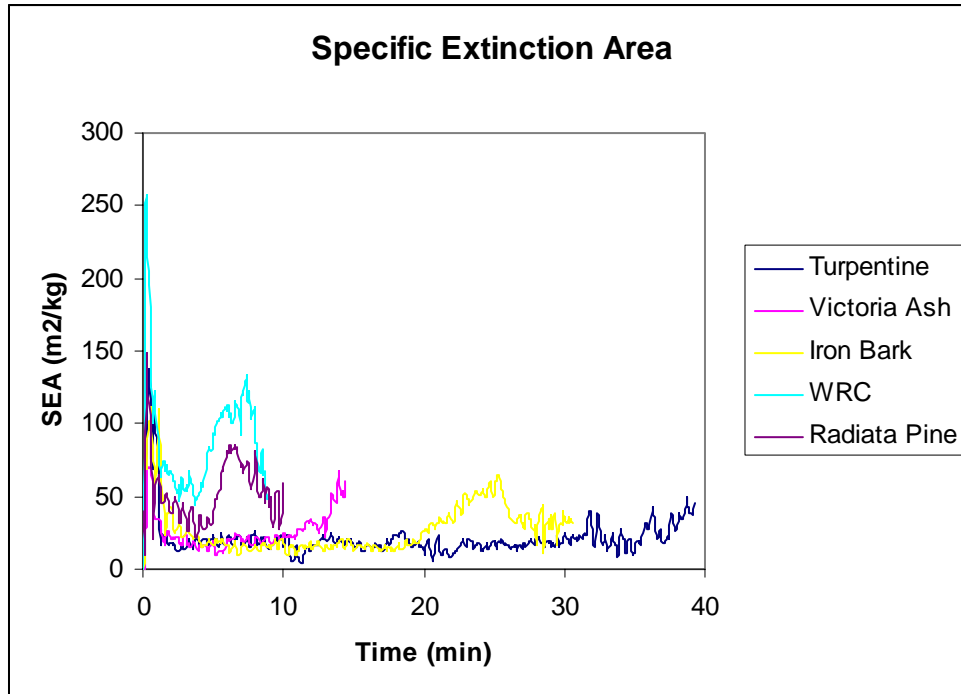


Figure 11a.

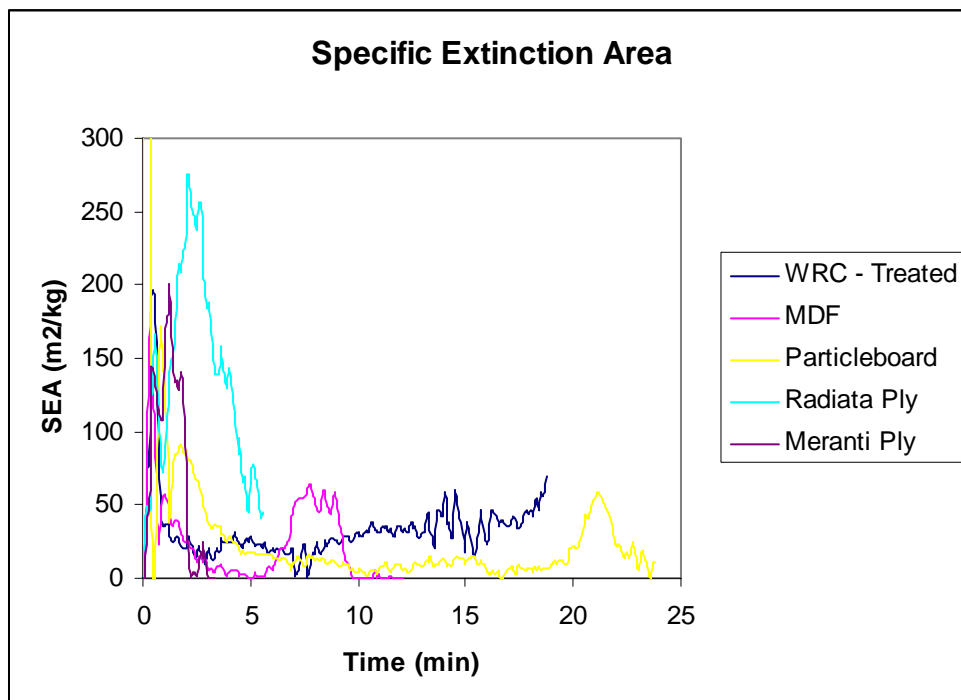


Figure 11b.

The average SEA values for each product over the entire test durations are given in Table 22.

<b>Product</b>	<b>Average SEA (m<sup>2</sup>/kg)</b>
Turpentine	21
Victoria Ash	26
Iron Bark	27
Western Red Cedar	89
Radiata Pine	53
Western Red Cedar – Treated	33
Medium Dense Fibre	25
Particleboard, Tas Oak Veneer	44
Radiata Ply	138
Meranti Ply	74

**Table 22.**

The SEA criterion for all the products above has been met, as all average SEA values are less than 250 m<sup>2</sup>/kg.

The method described in the ABCB proposal document [1] was used to derive a material group for each specimen from the heat release data. The material group for each timber sample is summarised in Table 23. The method of calculation is given in the Appendix.

<b>Product</b>	<b>Material Group</b>
Turpentine	3
Victoria Ash	3
Iron Bark	3
Western Red Cedar	3
Radiata Pine	3
Western Red Cedar - Treated	3
Medium Dense Fibre	3
Particleboard, Tas Oak veneer	3
Radiata Ply	3
Meranti Ply	3

**Table 23.** Material Group summary

## 5. TEST DETAILS

Test dates: 29<sup>th</sup> August, 6<sup>th</sup> September, 23<sup>rd</sup> September and 12<sup>th</sup> October 2002

Tested by: Brad Paroz

.....  
Brad Paroz  
Experimental Scientist

.....  
Vivek Apte  
Project Leader

Date .....

.....

## 6. NOMENCLATURE

$q''_{\text{peak}}$	Peak heat release rate, kW/m <sup>2</sup>
$q''_{\text{avg, 60}}$	Average heat release rate over 60 s after ignition, kW/m <sup>2</sup>
$q''_{\text{avg, 180}}$	Average heat release rate over 180 s after ignition, kW/m <sup>2</sup>
$q''_{\text{avg, 300}}$	Average heat release rate over 300 s after ignition, kW/m <sup>2</sup>
$I_{\text{ig}}$	Ignitability Index, min <sup>-1</sup>
$I_{\text{Q1}}$	Rate of Heat Release Index, s <sup>0.66</sup> kW/m <sup>2</sup>
$I_{\text{Q2}}$	Rate of Heat Release Index, s <sup>0.07</sup> kW/m <sup>2</sup>

## 7. REFERENCES

1. ABCB document, "Proposal to Amend the Building Code of Australia – Fire Hazard Properties of Building Materials and Assemblies", July 2002.
2. Australian Standard AS3837 – "Method of Test for Heat and Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter", 1998.

# **APPENDIX**

## **MATERIAL GROUP CALCULATION METHOD**

The procedure used to derive the material group of the sample under test was as described in the ABCB document, “Proposal to Amend the Building Code of Australia – Fire Hazard Properties of Building Materials and Assemblies”, July 2002.

The Ignitability Index is given by

$$I_{ig} = \frac{60}{t_{ig}}$$

where  $t_{ig}$  is the ignition time (in seconds), defined as the time when the rate of heat release reaches or first exceeds  $50 \text{ kW/m}^2$ .

The Heat Release Indices are given by

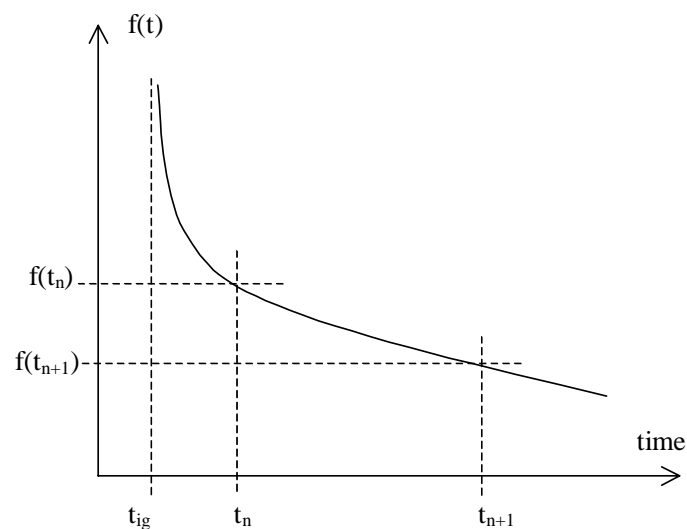
$$I_Q = \int_{t_{ig}}^{t_f} \frac{\dot{q}(t)}{(t - t_{ig})^m} dt$$

where  $m = 0.34$  and  $0.93$

$t$  = time (in seconds)

$\dot{q}(t)$  = rate of heat release (in  $\text{kW/m}^2$ ) at time  $t$

The trapezoid method of integration was used to numerically solve the equation, as shown below:



$$\int_{t_n}^{t_{n+1}} f(t) dt = \frac{f(t_n) + f(t_{n+1})}{2} \times (t_{n+1} - t_n)$$

Since  $f(t)$  behaves asymptotically as  $t$  approaches  $t_{ig}$ , a value of  $f(t)$  can not be calculated for  $t = t_{ig}$ . Therefore, the trapezoidal method of numerical integration

cannot be used for the first time step from  $t_{ig}$  to the next data point. This problem was solved as follows:

Calculate average heat release rate and time over the period between ignition and the first data set after ignition:

$$\dot{q}''_{ave} = \frac{\dot{q}''_{ig} + \dot{q}''_n}{2} \quad t_{ave} = \frac{t_{ig} + t_n}{2}$$

Integrate as follows:

$$\int_{t_{ig}}^{t_n} f(t) dt = \frac{\dot{q}''_{ave}}{(t_{ave} - t_{ig})^m} \times (t_n - t_{ig})$$

The integrals of each time step between ignition and test end are summed to give the rate of heat release indices.