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**Cone Calorimeter Tests for Fire Retarded Timber  
Assessment of Australian Decking Timbers**

**Report to  
Bushfire CRC**

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## Executive Summary

As part of work investigating the bushfire performance of typical Australian timber decking a number of timber species were assessed for the fire retarded timber requirements given in the Draft AS 3959 standard Appendix D. This involves exposing the samples to an irradiance level of  $25 \text{ kW/m}^2$  for a minimum period of 10 minutes in a cone calorimeter.

The parameters investigated included species, weathering and conditioning/moisture content. A total of 120 tests were performed.

The main outcomes were:

- None of the species tested passed the requirement.
- All samples ignited under  $25 \text{ kW/m}^2$ .
- Only 4 specimens passed the requirements, 2 merbau and 2 treated pine.
- The peak heat release varied between 200 and 60  $\text{ kW/m}^2$
- The average heat release over 10 minutes varied between 90 and 20  $\text{ kW/m}^2$  .
- Specimens conditioned to bushfire conditions had higher peak and average heat release rates.
- Specimens subjected to an accelerated weathering regime in general had similar heat release values to those that hadn't been. Merbau however had higher values

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# 1. Introduction

As part of work investigating the bushfire performance of typical Australian timber decking, a number of timber species without fire retarding treatment were assessed for the fire retarded timber requirements given in the Draft AS 3959 - Construction of buildings in Bushfire-Prone Areas, Appendix D [3].

A number of parameters were varied to determine their influence on the timbers combustion. The parameters investigated included species, weathering and conditioning/moisture content. A total of 120 tests were performed.

## 2. Material

### 2.1 General

The timbers tested reflect the variety of timbers used for decking in Australia. The common timbers used for decking include spotted gum, blackbutt, merbau, cypress pine, jarrah and treated radiata pine. These timbers were easy to source and are likely to be used in the future. Currently spotted gum, blackbutt, cypress pine and radiata pine form the bulk of solid timber production in Australia. This is likely to continue with the current preference for spotted gum, blackbutt and radiata pine plantation development.

Some of the timbers selected that are less widely used include LOSP treated mountain ash, yellow balau and brushbox. Other timbers such as redgum, tallowwood and grey ironbark could only be sourced in limited quantity and are unlikely to be commonly used in the future due to their limited supply.

A number of other species were also tested to increase the variety although they are not used for decking. These include myrtle-beech, blackwood and tasmanian oak.

### 2.2 Species Identification

Samples of spotted gum, blackbutt, jarrah, grey ironbark and mountain ash were sent to the Ensis laboratories for species identification. Other species where identification could be reasonably assumed by appearance and industry labelling were merbau, treated radiata pine, radiata pine, redgum and cypress pine.

### 2.3 Weathering

The requirements in the Draft AS 3959 Appendix D calls for the timber to be subjected to an accelerated weathering regime prior to testing. The purpose of this is to check if the properties

of the fire retardant is effected by weathering. While no fire retardants were used in the timbers tested a subset of the timbers were subjected to the accelerated weathering regime given in ASTM D 2898-94 Method B [1] to determine if the weathering had any effect on the combustion of the timbers. Due to time limits only the easiest to source species could be subjected to the accelerated weathering. These were jarrah, cypress pine, redgum, merbau and two wrongly labelled timbers identified as spotted gum and blackbutt and which have been labelled as ?spotted gum and ?blackbutt in the results given later. The accelerated weather regime took 1000 hours or approximately 1.5 months complete.

## **2.4 Conditioning**

All specimens were conditioned to equilibrium moisture content (EMC). In addition to the standard conditioning at 23° C and 50% RH, some specimens were condition at 45° C and 18% RH to determine the effect of bushfire type conditions. Specimens which had been exposed to the accelerated weathering regime were condition at 23° C and 50% RH prior to testing. Samples of each species were oven dried to determine the typical EMC for each species (see Appendix B).

## 3. Test Method

### 3.1 General

In general the testing was performed in accordance with the requirements of the Draft AS 3959 Appendix D. However some conditions were varied to determine their influence.

In summary the requirements are:

- Samples to be subjected to accelerated weathering regime given in ASTM D 2898. Since the specimens hadn't been treated by fire retardant this was only undertaken for a subset of the specimens to gauge if accelerated weathering had any affect.
- Samples were conditioned at 23° C and 50% RH. Some specimens were conditioned differently to gauge the influence of the conditioning on the result.
- Samples were tested to AS/NZS 3837 Method of Test for Heat and Smoke Release Rates for Materials and Products using an Oxygen Consumption Calorimeter [2] (see Figure 3.1). The following requirements were checked:
  - No ignition after 10 minutes at a irradiance level of 10 kW/m<sup>2</sup>. Both radiata pine and mountain ash were tested and found to pass. Since these were known to be the easiest to ignite, the other species were not tested but were assumed to have passed.
  - Maximum heat release less than 100 kW/m<sup>2</sup> and average heat release over the 10 minutes following ignition is less than 60 kW/m<sup>2</sup> when exposed to a irradiance level of 25 kW/m<sup>2</sup>



Figure 3.1 Cone Calorimeter



## 4. Results

### 4.1 Peak and Average Heat Release

Only 4 specimens passed the fire retarded timber requirement given in the Draft AS 3959 Appendix D, two merbau and two treated pine. However there were other specimens of these species which did not pass. As a result it was concluded that none of the timber species passed the requirement.

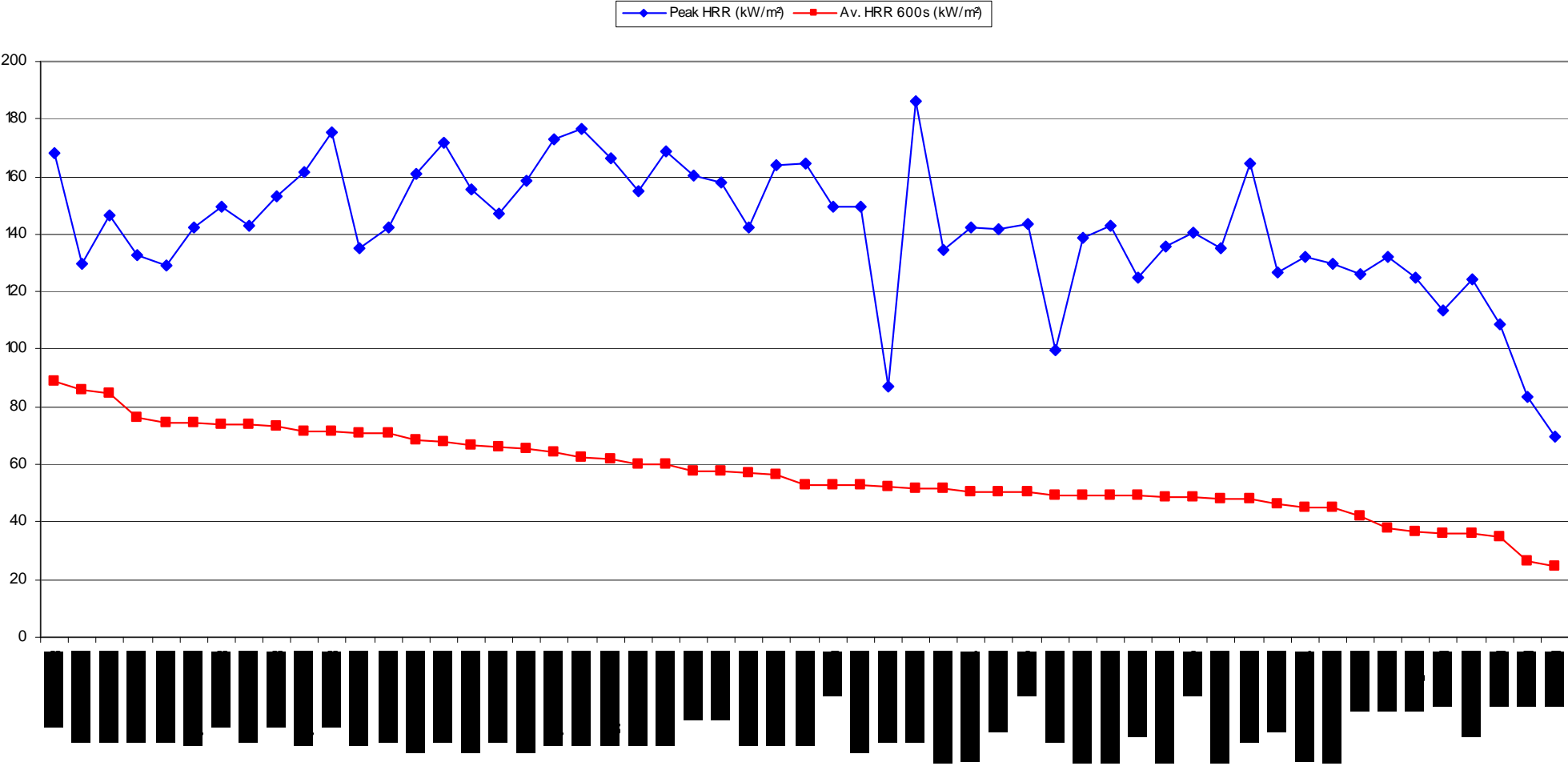
A plot of the peak heat release and the average heat release over 10 minutes following ignition is presented in Figure 4.1 for specimens tested in accordance with the Draft AS 3959 Appendix D. The requirement for accelerated weathering was assumed to be not applicable and hence was not undertaken.

A full plot of all tests performed is given in Appendix A.

The range in peak heat release was approximately 60 - 200 kW/m<sup>2</sup>. The majority being over 120 kW/m<sup>2</sup>. The range in average 10 minute heat release was approximately 20 - 90 kW/m<sup>2</sup>.

The best performing species in terms of low average heat release were merbau, redgum and tasmanian oak. The worst in terms of high average heat release were radiata pine, brushbox and spotted gum.

Figure 4.1 Peak and Average Heat Release Rate (kW/m<sup>2</sup>)



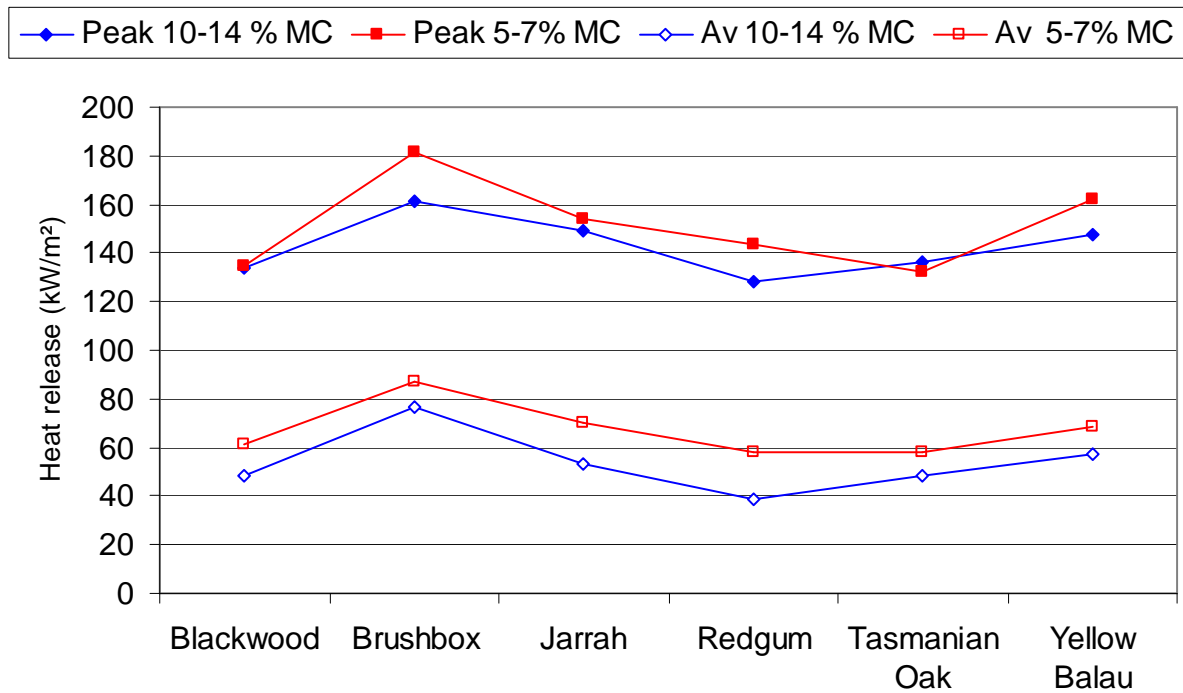
### 4.2 Effect of Moisture Content on Heat Release

Some specimens were conditioned at 45° C and 18% RH (conditioning room limit) prior to testing to determine what effect bushfire climatic conditions would have on the combustion. These specimens had EMCs in the range 4 – 7%. This contrasts with EMCs of 10 – 14 % for the specimens conditioned at the standard 23° C and 50% RH.

A table of EMCs is given in Appendix B.

Table 4.2 shows the effect of the specimens moisture content on the heat release and the average heat release over 10 minutes following ignition. Generally the bushfire conditioned specimen had the higher heat release. For example the average heat releases were 10 – 20 kW/m<sup>2</sup> higher for the bushfire conditioned specimens compared with the standard conditioned specimens.

Table 4.2 Effect of Moisture Content on Heat Release Rates



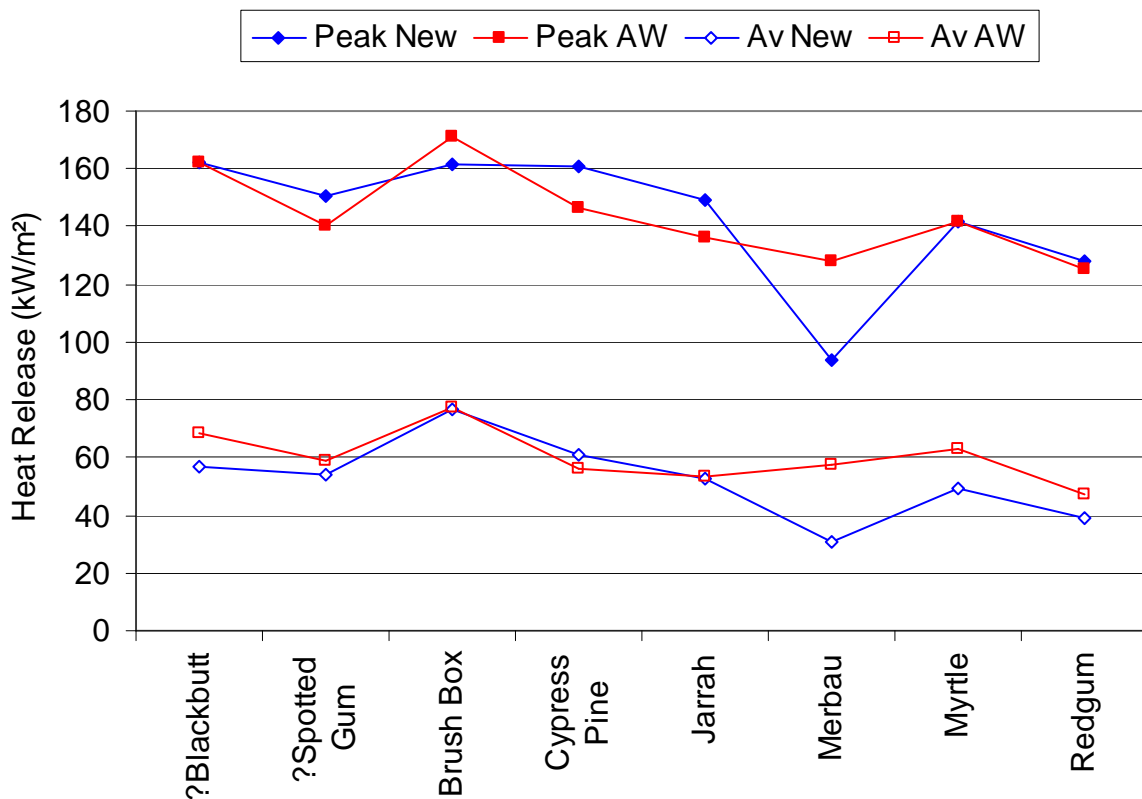
### 4.3 Effect of Accelerated Weathering on Heat Release

Some specimens were exposed to the accelerated weathering regime given in ASTM D 2898 prior to being conditioned at 23° C and 50% RH, to determine what effect weathering would have on the combustion. The accelerated weathering is conducted over 1000 hours (1.5 months) of wetting and drying.

The peak heat release and the average heat release over 10 minutes following ignition for the accelerated weathered (AW) and unweathered (New) specimens are shown in Table 4.3.

Except for the merbau specimens there was little difference. The two species labelled ?Blackbutt and ?Spotted Gum were found to have been misidentified by the supplier. While the actual species was not determined they still provide data on comparing weathered and unweathered timber.

Table 4.2 Effect of Accelerated Weathering on Heat Release Rates



## 5. References

1. American Society for Testing and Materials (1999) ASTM D 2898-94 – Standard Test Methods for Accelerating Weathering of Fire-Retardant-Treated Wood for Fire Testing. ASTM, Philadelphia, USA.
2. Standards Australia (1998) AS/NZS 3837:1998 – Method of Test for Heat and Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter. Standards Australia, Sydney.
3. Standards Australia (1999) AS 3959:1999 – Construction of Buildings in Bushfire-Prone Areas. Standards Australia, Sydney.

## APPENDIX A – Heat Release

The peak heat release and the average heat release over 10 minutes following ignition for all specimens tested are given in the 3 plots below. The plots and the specimens are in order of decreasing average heat release values.

The following abbreviations have been used in the species label:

(5D)	Conditioned at 45°C and 18% RH
(WET)	Wet sample
(AW)	Accelerated weathering
(NW)	Naturally weathered
(OD)	Oven dried before testing
(SAP)	Sapwood present

Where no abbreviations have been used the specimen was tested according to the

Draft AS 3959 except for the accelerated weathering which was assumed to be not applicable.

Figure A.1 Peak and Average Heat Release Rate (kW/m<sup>2</sup>) – Plot 1/3

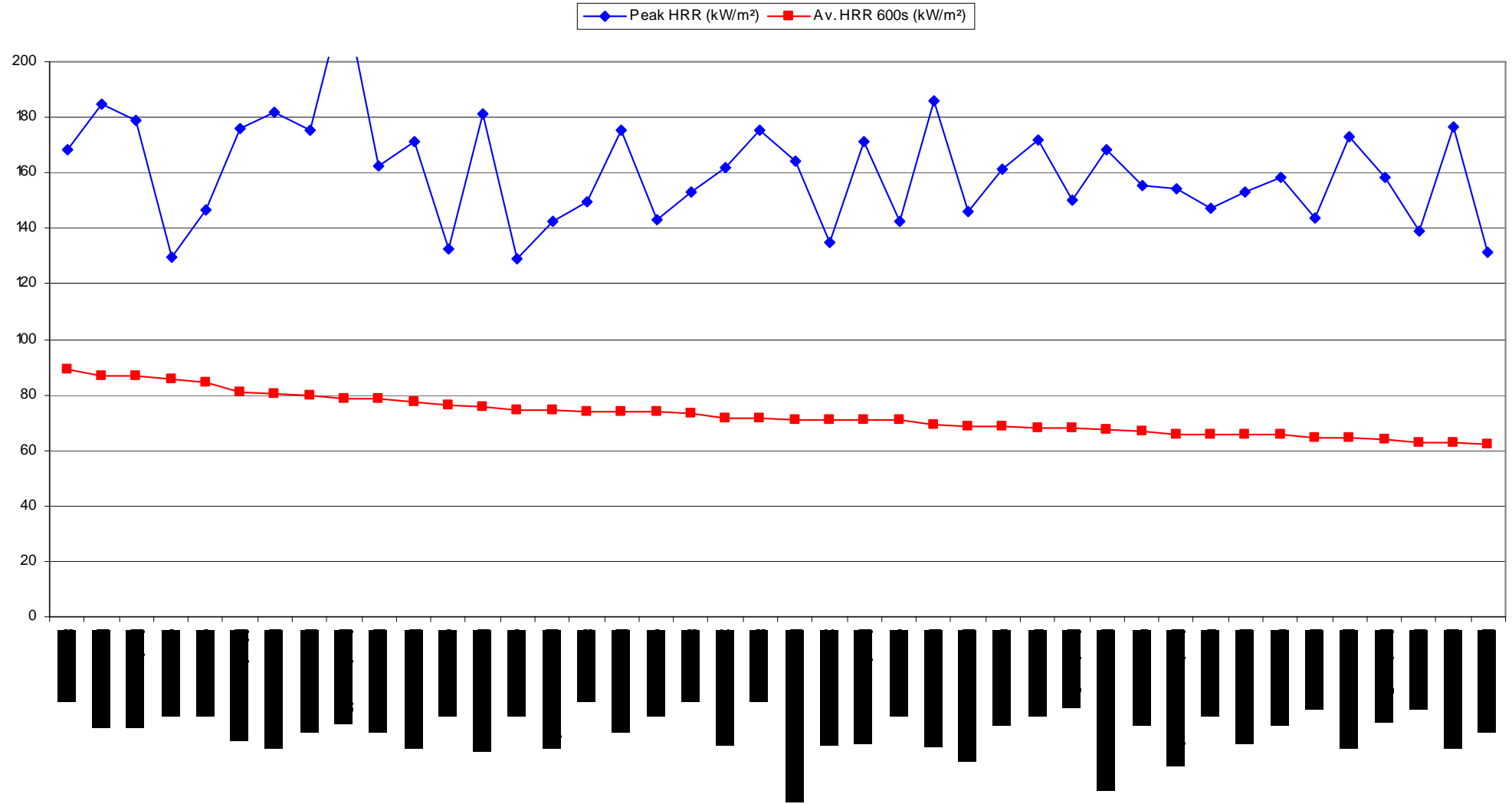




Figure A.2 Peak and Average Heat Release Rate (kW/m<sup>2</sup>) – Plot 2/3

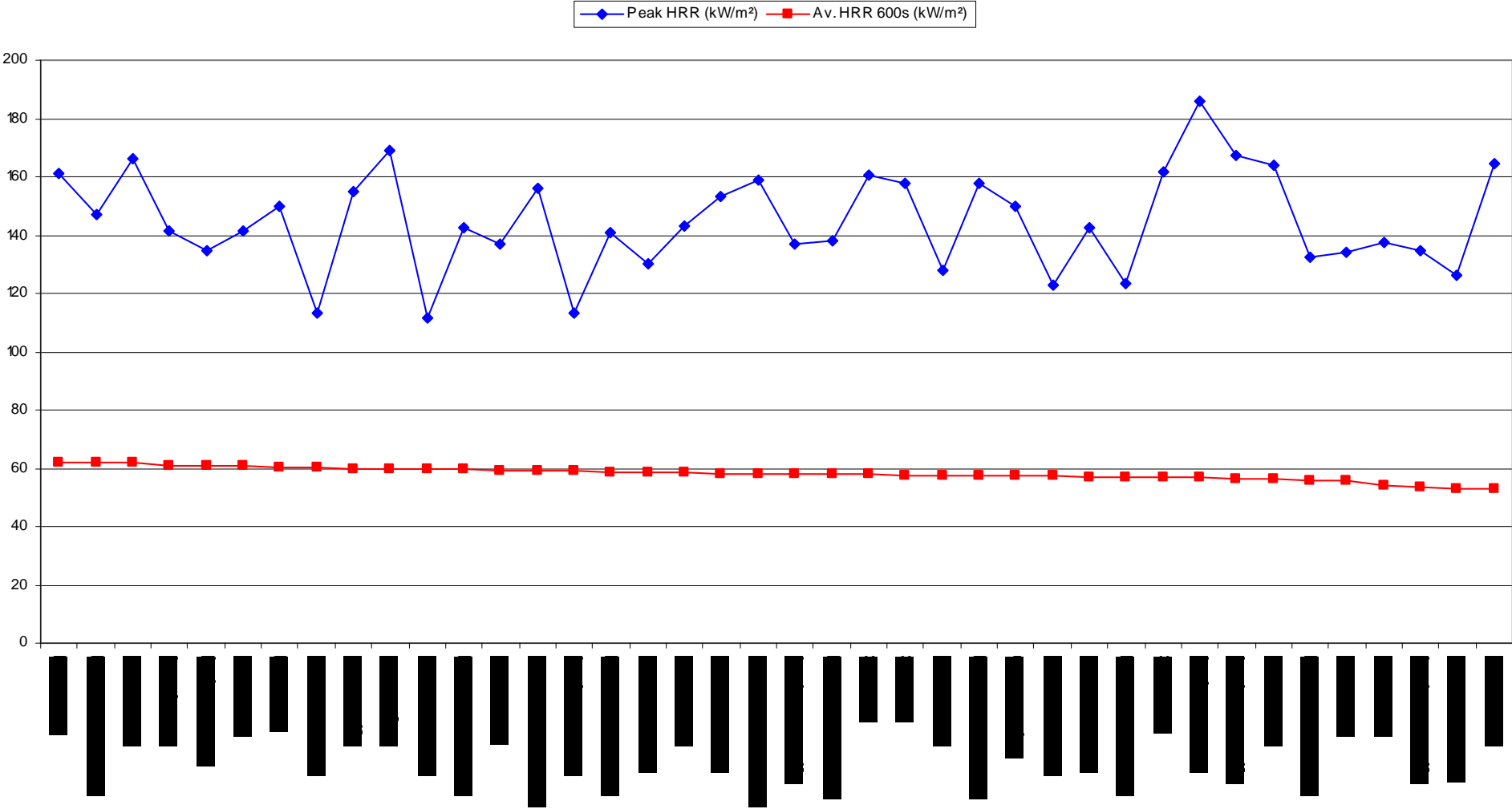
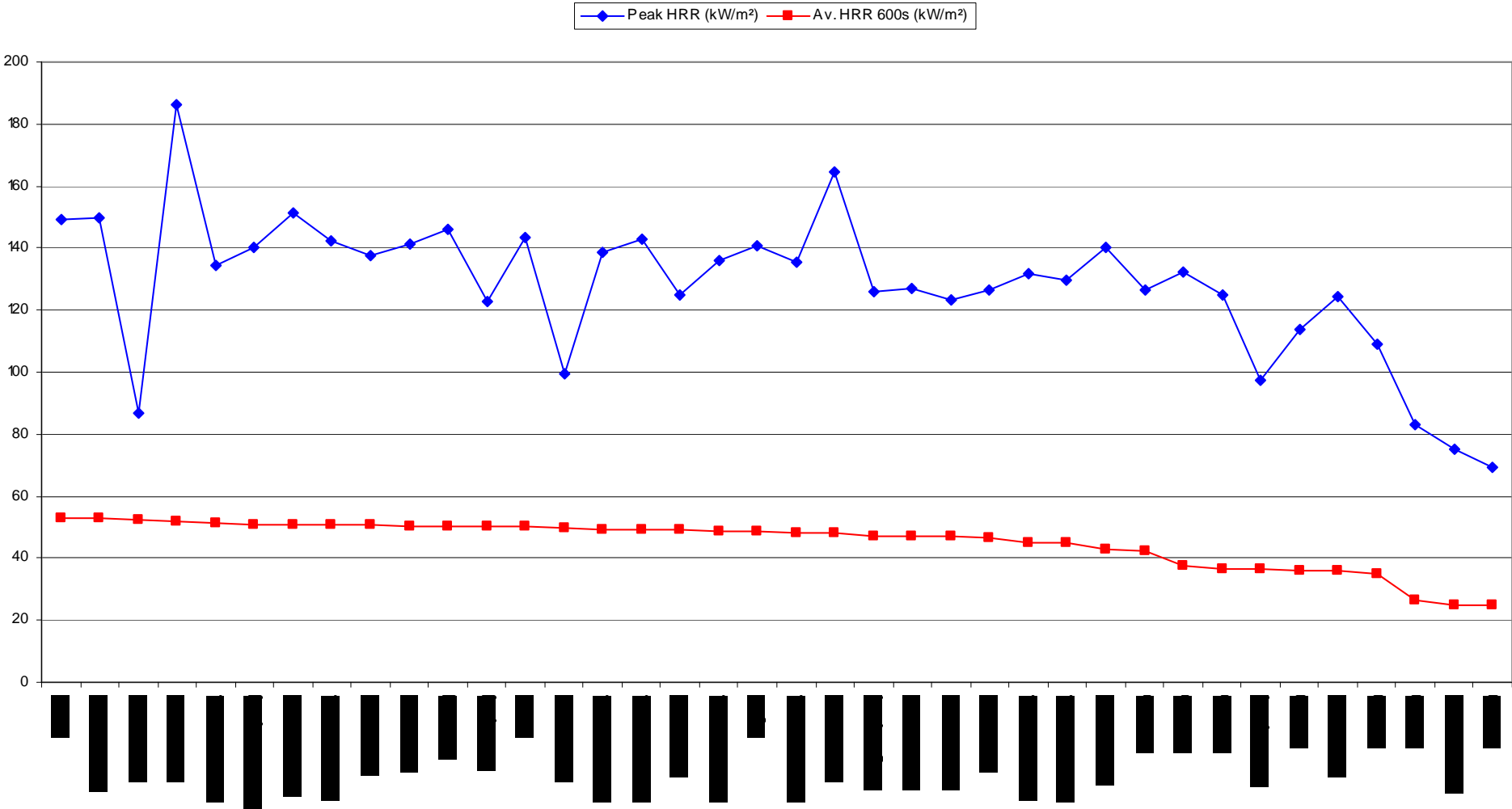


Figure A.1 Peak and Average Heat Release Rate (kW/m<sup>2</sup>) – Plot 3/3



## APPENDIX B – Material Properties

Table B.1 Typical Properties of Specimens Conditioned to  
EMC at 23° C and 50% RH

Species	Density (kg/m <sup>3</sup> )	MC (%)
blackbutt	850	14
blackwood	600	10
brushbox	950	10
cypress pine	650	11
grey ironbark	1200	14
jarrah	950	11
losp m ash	650	11
merbau	950	12-14*
mountain ash	600	11
myrtle	800	11
radiata pine	550	13
red gum	1000	14
spotted gum	1050	12-14*
tasmanian oak	750	13
treated pine	550	14
tallowwood	950	12
yellow balau	900	14
?blackbutt	700	10
?spotted gum	950	12

\* material from a number of sources.

? material incorrectly labelled, species unknown

Table B.2 Typical Properties of Specimens Conditioned to  
EMC at 45° C and 18% RH

<b>Species</b>	<b>MC (%)</b>
blackbutt	6.0
blackwood	4.0
brushbox	4.0
cypress	5.0
grey ironbark	7.0
jarrah	5.0
merbau	5.5
mountain ash	4.5
myrtle	5.0
radiata pine	4.5
redgum	6.0
spotted gum	6.0
tasmanian oak	5.5
yellow balau	7.0
?blackbutt	4.0

? material incorrectly labelled, species unknown