INTERNATIONAL FIRE CONSULTANTS LIMITED

PRIVATE & CONFIDENTIAL

IFC ENGINEERING ASSESSMENT REPORT

Engineering Assessment of Biotecture Living Wall System With Respect to Reaction to Fire Classification

Reaction to Fire Classification Standard: BS EN 13501-1:2007 +A1:2009

IFC Report PAR/16691/01

Prepared on behalf of:

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NOTE: This report should not be manipulated, abridged or otherwise presented without the written consent of International Fire Consultants Ltd

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ISSUE AND AMENDMENT RECORD

Rev	Date	Author	Review	Section	Amendments
Draft	June 2017	RA	CH	-	-
-	June 2017	RA	CH	-	-

CONTENTS

1. INTRODUCTION

This report has been produced by International Fire Consultants Ltd (IFC) as an Engineering Assessment of the likely reaction to fire performance of the Biotecture Living Wall System. IFC have performed the evaluations/analysis, and preparation of the Assessment report, on the instruction of Biotecture Ltd.

This assessment is based upon the constructional information supplied to IFC (detailed in Section 2 and Appendix A) and upon the reaction to fire test evidence for the Living Wall System (detailed in Section 0 and Appendix C). The analysis of the likely reaction to fire performance of the Living Wall System is summarised in Section 4.

Living Wall Systems are a relatively new type of wall covering within construction, and as such, existing testing standards associated with reaction to fire testing do not include provisions to test such a product. A judgement is therefore required in terms of the reaction to fire performance of a Living Wall System, based upon test evidence that is available for the product. This judgement is sometimes made by the approving authority.

Where the approving authority does not feel technically able to make such judgements, or, does not wish to take responsibility for them, then a third party expert opinion is often sought. Such an opinion is often expressed in the form of an assessment of the performance, which may be supported by numerical/quantifiable methods or may be purely an expert judgement.

Where Building Regulations guidance requires that Fire Safety Information is given to the 'Responsible Person' [as defined under the Regulatory Reform (Fire Safety) Order 2005] for a building or project, an Assessment is used to provide essential information upon the design, construction and performance of relevant fire resisting assemblies.

2. PROPOSAL

It is proposed that this Engineering Assessment Report shall establish the likely reaction to fire classification that would have been achieved, could the Biotecture Living Wall System be tested fully in accordance with the relevant testing standards required to classify the system using BS EN 13501-1:2007 +A1:2009. Part of the testing was conducted on an ad-hoc basis, for reasons detailed in Section 3 of this report, and is therefore why IFC are being employed by Biotecture to make this judgement.

The construction and details of the assessed Living Wall System are summarised in Section 2.1, below, based upon drawings which have been issued by Biotecture Ltd, for use in the evaluation by IFC. These drawings can be found in Appendix A, and shall be read in conjunction with this report for full interpretation. Anyone using this report shall verify that copies of construction documents in their possession match those copies which are kept on file by IFC and in Appendix A. Refer to Section 6 for recommendations with respect to audit and verification of the manufactured / installed assemblies.

2.1 Description of the Biotecture Living Wall System

- The Biotecture Living Wall System is formed using Biotiles, each nominally 600mm wide x 450mm high x 62mm thick constructed from Polypropylene.
- The polypropylene framework is filled with 4no. stone mineral fibre core strips each nominally 55mm deep x 100mm high x 596mm long with a nominal dry density of 16.8Kg/m^3. The mineral fibre is manufactured by Grodan. Between each strip of mineral fibre, orientated horizontally, is a Terram drainage layer, created from a high density polyethylene (HDPE) core with a polypropylene geotextile filter layer. The drainage layer is overall 4.5mm thick and is also present to the back edge of the Biotile.
- The front face of the Polypropylene Biotile has only a nominally 10mm wide grid section remaining, exposing the stone mineral fibre core in order to facilitate planting. Each stone mineral fibre strip has 50mm diameter holes, for the plant roots to be bedded into. Each Biotile has 16no. holes in total. When plants are not fitted, the holes are filled with cylinders of the stone mineral fibre material.
- The Biotiles are secured to a backing board constructed from nominally 8mm thick Rockpanel 'Durable' with a nominal density of 1050±150Kg/m^3.
- The irrigation system between the Biotiles is created from a drip line by DuraDrip, and is made from polyethylene with the cover strip made from PVC. The drip line is held in place using an aluminium profile screw fixed to the Rockpanel backing board.

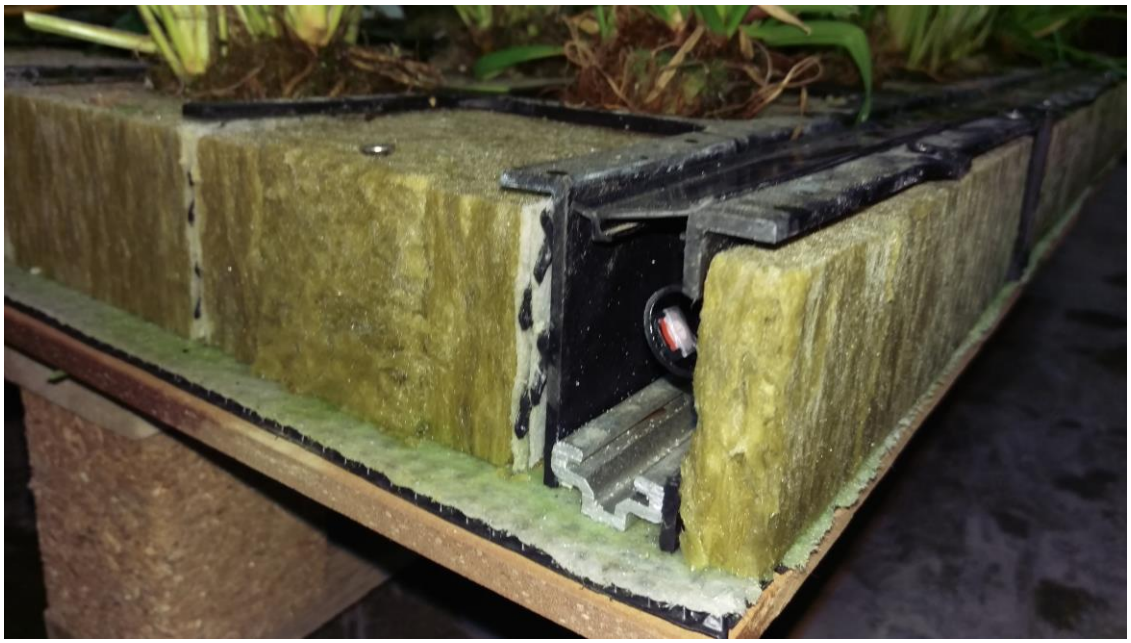

Photo 1 – Cross sections of Biotiles including irrigation system, backing board and Terram drainage layer.

3. TEST EVIDENCE

The anticipated reaction to fire performance of the Biotecture Living Wall System using BS EN 13501-1:2007 +A1:2009 was between Class B and Class D, therefore testing using the following 2no. reaction to fire standards was required:

EN ISO 11925-2 Reaction to fire tests – Ignitability of Building Products Subject to Direct Impingement of Flame – Part 2: Single Flame Source

Sometimes referred to as Single Flame Ignitability (SFI), the purpose of this test is to subject the surface of a construction material to the continuous exposure of a single flame source, for a pre-determined time period.

The test specimens are 250mm long by 90mm wide with maximum thickness 60mm. A minimum of 6 specimens are tested for each test condition.

For proposed class B products, the application of the small flame is for 30 seconds and there should be no flame spread in excess of 150mm vertically from the point of application within 60 seconds from the time of application.

EN 13823:2010 Reaction to fire tests - Building Products Excluding Floorings Exposed to the Thermal attack by a Single Burning Item

The single burning item test (SBI) evaluates the potential contribution of a product to the development of a fire. This is done by simulating a single burning item in a corner of a room near to the product being evaluated.

The test specimen is created by two wings at right angles. The short wing measures 495mm wide by 1500mm high and the long wing 1000mm wide by 1500mm high. A minimum of three specimens (one long wing and one short wing per specimen) are tested.

The test period is over 20 minutes and the measured parameters include heat production i.e. heat release rate (HRR) & total heat release (THR), fire growth rate (FIGRA), smoke production (SPR) and total smoke release (TSP) as well as smoke growth rate SMOGRA. The test also measures lateral flame spread and falling flaming droplets and particles.

Products classified B, C & D can also obtain additional classification based on the performance of smoke production (s1, s2 & s3) and flaming droplets and or particles (d0, d1 & d2).

3.1 Inability to Test Fully in Accordance with EN 13823:2010

The nature of the Biotecture Living Wall System means that in usual service, a number of the circular holes in the Biotiles are filled with live plants, which are fed using an automated irrigation system. The stone mineral fibre insulation used at the core of the system is therefore constantly saturated at a nominal 70% moisture content.

In order to achieve accurate reaction to fire results for the Living Wall System for its typical end use, it was deemed necessary to test in the form detailed above, where possible.

However, the requirement of EN 13823:2010 is that test specimens are conditioned in line with the requirements of EN 13238:2001. Within this document the method of conditioning for a specimen is at 23±2°C and at a relative humidity of 50±5%, in order to achieve either a constant mass, or for a fixed time period.

Live plants will continue to grow, therefore conditioning to a constant mass is not possible, nor is the ability to achieve 50±5% relative humidity, as the fluctuation would be too great, due to the constant saturation of the stone mineral fibre core of the Biotile, in order to feed the plants.

Furthermore, EN 13823:2010 requires that the specimen is no greater than 200mm thick, and is consisted of a flat or regularly corrugated surface. The Biotecture Living Wall System is constructed using a mix of plant material fitted in random combinations and in random spaces within the Biotiles. Therefore the requirements of the standard cannot be satisfied in this regard either.

The testing referenced in Section 3.3, conducted using EN 13823:2010, therefore followed the test standard in so far as possible, although has been reported by the laboratory on an ad-hoc basis.

3.2 Ability to Test in Accordance with EN ISO 11925-2

The nature of the testing method detailed in EN ISO 11925-2 means that it is a requirement for one of the exposure conditions of the single flame source to be in direct contact with the polypropylene of the Biotile and for the flame spread to be measured across this material. For this reason, it was deemed unnecessary to test the panel planted, and with the stone mineral fibre core saturated, as the flame spread along the polypropylene is independent of the plants or core stone mineral fibre material. Furthermore, the apparatus used to hold the specimen for testing requires the specimen to be no larger than 250mm long x 90mm wide x maximum 60mm thick; smaller than the specimen size had it been planted.

The specimens used for the EN ISO 11925-2 testing were therefore conditioned in complete alignment with the requirements of EN 13238:2001, meaning that the testing was conducted fully in accordance with the standard, and has been reported as such.

3.3 Testing Summary for the Biotecture Living Wall System

3.3.1 Ad-hoc SBI testing to the principles of EN 13823:2010 – Planted Living Wall System

BRE Test Report reference: BIO-FT-001. Tested 17/03/17

Summary of tested specimens:

Test	Condition	FIGRA ($FIGRA_{0.2\,MJ}$) W/s	THR_{600s} MJ	SMOGRA m^2/s^2	TSP_{600s} M^2	Result
1	Planted material remained untrimmed, except at burner zone at base of specimen.	**64.3**	**1.72**	**105.4**	**320.7**	**B s3 d2**
2	Planted material in area of vertical impingement area cut back to 80mm thick	**77.1**	**1.97**	**42.0**	**168.1**	**B s2 d2**
3	All planted material cut back to 80mm thick beyond the face of the panel	**57.5**	**2.24**	**43.5**	**110.8**	**B s2 d0**

In tests 1 and 2, burning droplets (detached plant material) fell to the floor of the apparatus, and continued to burn in excess of 10 seconds. In test 3, no burning droplets fell to the floor.

Photo 2 – Living Wall System before test 1 of BIO-FT-001 – Note the planted material cut back at flame impingement area.

3.3.2 Ad-hoc SBI testing to the principles of EN 13823:2010 – Unplanted Living Wall System (Biotiles saturated to the same level as for planted testing)

BRE Test Report reference: BIO-STD. Tested 10/04/17

Summary of tested specimens:

Test	Condition	FIGRA ($FIGRA_{0.2\,MJ}$) W/s	THR_{600s} MJ	SMOGRA m^2/s^2	TSP_{600s} M^2	Result
1	Unplanted, exposing front face of Biotile which was saturated to nominal 70% moisture content	**61.7**	**3.12**	**7.9**	**59.0**	**B s2 d0**
2	Unplanted, exposing front face of Biotile which was saturated to nominal 70% moisture content	**35.6**	**0.87**	**10.5**	**68.7**	**B s2 d0**
3	Unplanted, exposing front face of Biotile which was saturated to nominal 70% moisture content	**38.6**	**2.59**	**9.1**	**72.3**	**B s2 d0**

No flaming droplets were witnessed in any of the 3no. tests.

Overall average result for the Unplanted Living Wall System: **B s2 d0**

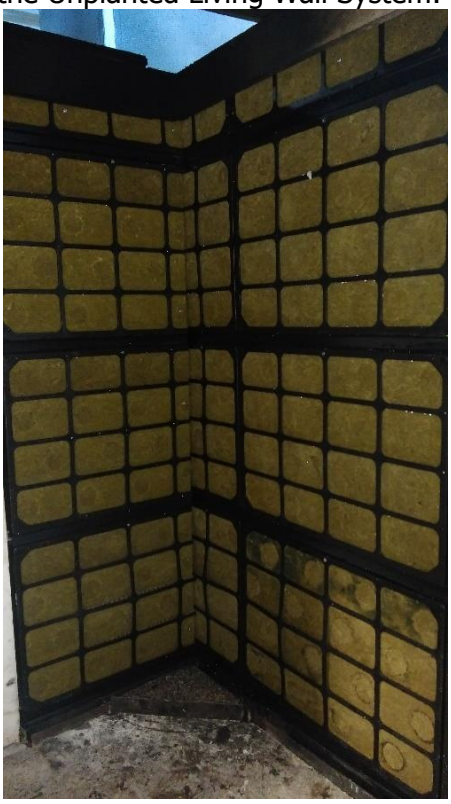

Photo 3 – Unplanted Wall System before test 1 of BIO-STD

3.3.3 SFI testing in accordance with EN ISO 11925-2

BRE Test Report reference BIO-FT-004

Test condition	Ignition (Y/N)	Time to ignition (sec)	Duration of flaming (sec)	Flame spread of 150mm (Y/N)	Time to reach 150mm (sec)	Maximum flame spread (mm)	Ignition of filter paper (Y/N)
Surface – stone wool	No	N/A	N/A	No	N/A	0	No
Edge – plastic	Yes	24	9	No	N/A	25	No
Edge 90° to face – plastic	Yes	24	9	No	N/A	25	No

Result: No flame spread in excess of 150mm noted. Therefore the requirements were met for Class B.

4. ANALYSIS

Evaluation of the likely reaction to fire performance of the Biotecture Living Wall System, will address the factors that influence the overall reaction to fire performance of system with respect to the requirements of BS EN 13501-1:2007 +A1:2009.

4.1 Analysis of SBI Testing for Planted Living Wall System (Testing Summarised in Section 3.3.1)

The planted Living Wall System tested and noted in Section 3.3.1 is the most representative of the end use application. The plants had bedded into the stone mineral fibre core material at the Biotecture Nursery over a period of 2 months prior to delivery of the specimens at the laboratory of BRE, and the moisture content was nominally 70% within the stone mineral fibre core.

As noted in Section 3, the EN 13823:2010 testing standard requires 3no. of a specimen type to be tested. However, at the request of IFC, and in order to gain more comprehensive data, the 3no. planted and saturated specimens were tested with differing levels of plant 'cut back', for reasons detailed below.

In the first test of BIO-FT-001, the plant material was only cut back at the area of the flame impingement zone. This therefore meant that the maximum mass of planted material remained on the specimen, and enabled the maximum potential smoke/steam production as the plants burnt, and also more likelihood of flaming droplets as burning plant material fell to the floor of the test apparatus. Smoke production (s) and burning droplet (d) results as close to the end use application were therefore able to be generated. **s3** & **d2** were the results that were achieved from this test.

It was noted in this test, that the shrouding of the flame impingement zone, by the plant material (see photo 2), caused the flame from the test apparatus to burn inefficiently. A positive characteristic for the end use, as fire propagation would likely be inhibited, but this potentially caused the test to be less onerous other than in relation to the smoke production (s) and the flaming droplet (d) result.

In order to achieve more efficient burning from the apparatus, test two of BIO-FT-001, was conducted with the planted area from the flame impingement zone up to the top of the specimen 'cut back' so that the plants only protruded approximately 80mm from the face of the stone mineral fibre core of the Biotile. A more efficient flame was recorded from the test apparatus, although, due to the cut back of the planted material a less representative, of end use, result in terms of smoke production (s) and flaming droplets (d) was noted.

Test three of BIO-FT-001, was conducted with the entire planted area 'cut back' so that the plants only protruded approximately 80mm from the face of the stone mineral fibre core of the Biotile. This further improved the efficiency of the burning of the flame from the test apparatus, as there was no shrouding to the flame impingement area at all, and therefore meant the test was most akin to the full requirements of the test standard other than, again, in terms of smoke production (s) and flaming droplets (d).

It is the opinion of IFC that for the series of 3no. tests of the planted Biotecture Living Wall System, detailed above, although variable levels of planted material were tested, this allowed for the most comprehensive set of results to be generated for all 3no. criteria; the overall class, the smoke production and flaming droplets. If 3no. tests identical to test 1 of BIO-FT-001, had been conducted, the results in terms of smoke production (s) and flaming droplets (d) would have been representative of the end use, but not the overall class.

4.2 Analysis of SBI Testing for Unplanted Living Wall System (Testing Summarised in Section 3.3.2)

The SBI testing described in Section 4.1, of the planted Biotecture Living Wall System, provided results most relevant to the end use of the product. For the reasons detailed in Section 3.1, the testing was conducted on an ad-hoc basis, and in the first test, there was inefficient flaming noted from the test apparatus due to the shrouding of the flame impingement zone, by the planted material.

It was therefore decided, that for more comprehensive results, three further tests would be conducted on an unplanted, but saturated Living Wall System as noted in section 3.3.2. This meant that 3 sets of results with the required flame efficiency from the test apparatus would be achieved, as the test specimen would be a more uniform flat surface (see photo 3), and therefore in accordance with the test standard EN 13823:2010. Due to the saturation of the Biotiles, in order to provide a more realistic end-use state, conditioning was again not possible and therefore the testing was conducted on an ad-hoc basis.

This series of 3no tests were considered more onerous in terms of the criteria for the general class, as lateral flame spread was more likely, due to the polypropylene of the Biotile and irrigation pipework being fully exposed, and not shrouded by the planted material. The testing provided results for the general class that were the same as for the planted Living Wall System. However, better results were achieved in terms of the smoke production (s) and flaming droplets (d) criteria. Namely due to the lack of planted material able to provide smoke/steam production, and fall to the ground as loose burning elements.

4.3 Analysis of SFI Testing for Biotile (Testing Summarised in Section 3.3.3)

The SFI testing was conducted in accordance with the requirements of EN ISO 11925-2, for the reasons already noted in Section 3.2. The testing was conducted on 3 different edge conditions, on a minimum of 3no. specimens per edge condition, as is the requirement of the standard. The results achieved were within the tolerances required for class B.

4.4 Irrigation/Maintenance of the Living Wall System

The SBI testing conducted and described in Section 3 was using Biotiles with a stone mineral fibre core saturated to 70% moisture content. Biotecture Ltd have confirmed that in 'normal' service conditions, the system would be constantly irrigated and monitored to achieve the 70% moisture content documented in testing.

Residual moisture content within the core of the Biotile is going to aid with the overall likely reaction to fire performance of the Living Wall System.

Therefore it is a requirement of this Engineering Assessment, that the Living Wall System, when in service, is constantly monitored, and irrigated where necessary, to achieve a nominal moisture content within the stone mineral fibre core of the Biotile, of 70±5%.

The testing described in Section 3 has proven, that the Living Wall System can have planted material removed, and still achieve the same performance of a fully planted system. Therefore, if required, the planted material can be removed/replaced during the service life of the Living Wall System, on the condition that the Biotiles remain fully irrigated, ensuring minimum moisture content levels as stated above.

4.5 Mixed Plant Materials

The SBI testing conducted and described in Section 3.3.1 was performed on a Living Wall System consisting of the following plant mix:

- Carex Morrowii
- Convolvulus Cneorum
- Hedera helix 'Wonder'
- Pachysandra Terminalis
- Various Mosses growing directly onto the Grodan mineral fibre core.

In so far as possible, an equal amount of each plant was used across the test specimens (excluding the mosses).

When the SBI testing was conducted on the planted Living Wall System, with the plant material trimmed back only at the flame impingement zone; the lowest performing class in terms of smoke production (**s3**) and flaming droplets (**d2**) were recorded.

If the type of planted material fitted to the Living Wall System were to change, the likely classification achieved for smoke production and flaming droplets could not reduce, and would therefore only be comparative, or improved. However, due to the lack of testing on alternative planted materials, IFC are only able to provide an opinion based upon the lowest smoke production and flaming droplets results achieved, as has been reflected in the conclusion to this document.

An area for further consideration is the effect of density of the planted material on the result in relation to the general classification criteria. For the planted Living Wall testing described in Section 3, the density of plant material used for testing was 60 plants per square metre. The testing demonstrated that there was no effect on the general classification between the planted Living Wall System, and when the Living Wall System was unplanted. There is the potential that having a greater density of planted material, and therefore more mass present to burn, could produce worse figures in terms of FIGRA and THR, (the value which decide the general classification level). It was noted though, in the tests of the planted Living Wall System, that the flame from the apparatus, was burning inefficiently, due to the amount of planted material. It could therefore also be argued that increasing the density of the planted material may actually inhibit fire propagation across the Living Wall System. However, because of the lack of test data of more densely planted Living Wall Systems, it is a requirement of this Assessment, that the maximum level of planted material is 60 plants per square metre, although less planted material is considered acceptable.

In end use, Biotecture Ltd have confirmed that a varying number of different species of plants are likely to be planted as part of the Living Wall Systems. The Biotecture Plant Database can be found in Appendix B, and is the complete list of plants that usually form a Living Wall System. As it is a requirement of this Assessment that the Living Wall System is constantly irrigated to ensure that the plants remain alive, it is the opinion of IFC that 'similar' plants can be fitted, as an alternative to those listed in the database. Alternatives must not include any plants with a higher calorific content or that are liable to produce dry foliage, dry stems or dry seeds as part of their natural growth cycle than those given in the database, nor to include 'dry' material such as pine cones or other decorations, as this may adversely affect the likely reaction to fire performance.

4.6 Installation and Supporting Construction

The installation of the Biotecture Living Wall System needs to be as per manufacturers specification, and therefore as tested. A brief description of the required installation detail for the Living Wall System is given below.

The backing board is secured to the main wall structure with stainless steel self-drilling screws at nominal 600mm centres, with the aluminium rails screw fixed to the backing board also with stainless steel screws at 600mm centres. The Biotiles are secured by nylon cams fitted to the back edge of the Biotile, which locate into the aluminium rails. In addition, there is a single 4.5 x 85mm stainless steel screw fixing, into the backing board, at the top-centre of each panel. The screw fixing is through the plastic carrier tray and through the Grodan mineral fibre core. The irrigation drip line and cover plate are then push fit secured into the channels between the Biotiles.

5. CONCLUSION

For the reasons detailed in Section 2 of this report, IFC were employed by Biotecture Ltd, to consider the **likely** reaction to fire performance of their Living Wall System had it been able to be tested fully in accordance with the relevant testing standards required to classify the system using BS EN 13501-1:2007 +A1:2009. Based upon the reaction to fire testing conducted and described in Section 3, it is the opinion of International Fire Consultants Ltd that, if the Biotecture Ltd Living Wall System, was manufactured, installed and maintained in accordance with the requirements of this engineering Assessment Report, then the following reaction to fire performance would likely be achieved:

Reaction to fire performance of Biotecture Living Wall System:

B-s3, d2

6. LIMITATIONS

This Engineering Assessment Report, which is only valid for the Biotecture Living Wall System, addresses itself solely to the likely ability of the system described to satisfy the criteria of BS EN 13501-1:2007 +A1:2009. It does not imply any suitability for use with respect to other unspecified criteria.

This document only considers the Living Wall System described, herein, and assumes that the surrounding construction will provide no less restraint than the tested assembly, and that it will remain in place and be substantially intact for the same period of time as the testing described herein.

The analysis and conclusions within this report are based upon the likely reaction to fire performance of complete assemblies that are manufactured and installed in accordance with this document, and offered for reaction to fire testing in 'perfect' condition. In practice, management procedures must be in place in the building where the system is installed, to ensure that no parts are damaged or faulty. Further, a maintenance regime as described in Section 4.4 must be in place. Any shortfalls in respect to the condition of the Biotecture Living Wall System will invalidate the approval by IFC, and may seriously affect the ability of the system to provide the required level of reaction to fire performance. Determination of what constitutes wear or damage, and any corrective actions in order to return the assemblies to the required condition, shall only be carried out following consultation with the manufacturer and IFC.

Where the assessed Living Wall System has not been subject to an on-site audit by International Fire Consultants Ltd, it is the responsibility of anyone using this report to confirm that all aspects of the System fully comply with the descriptions and limitations, herein.

Where the constructional information in this report is taken from details provided to International Fire Consultants Ltd (IFC) and/or from reaction to fire test reports referenced herein, it is, therefore, limited to the information given in those documents. It is necessarily dependent upon the accuracy and completeness of that information. Where constructional or manufacturing details are not specified, or discussed herein, it shall not, therefore, be taken to infer approval of variation in such details from those tested or otherwise approved.

Any materials specified in this report have been selected and judged primarily on their likely reaction to fire performance. IFC do not claim expertise in areas other than fire safety. Whilst observing all possible care in the specification of solutions, we would draw the reader's attention to the fact that during the construction and procurement process, the materials used shall be subjected to more general examination regarding the wider Health and Safety, and CoSHH Regulations.

This Report is provided to the sponsor on the basis that it is a professional independent engineering opinion as to what the fire performance of the construction/system would be shall it to be tested to the named standard. It is IFC's experience that such an opinion is normally acceptable in support of an application for building approvals, certainly throughout the UK and in many parts of Europe and the rest of the world.

However, unless IFC have been commissioned to liaise with the Authorities that have jurisdiction for the building in question for the purpose of obtaining the necessary approvals, IFC cannot assure that the document will satisfy the requirements of the particular building regulations for any building being constructed.

It is, therefore, the responsibility of the sponsor to establish whether this evidence is appropriate for the application for which it is being supplied and IFC cannot take responsibility for any costs incurred as a result of any rejection of the document for reasons outside of our control. Early submittal of the Report to the Authorities will minimise any risks in this respect.

Prepared by:

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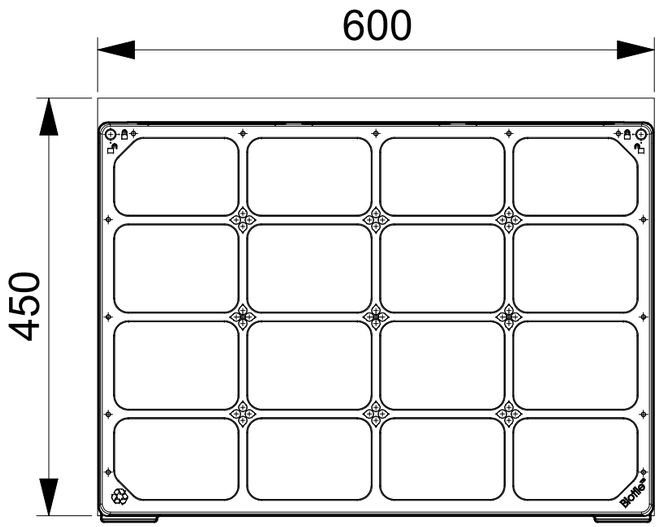
Senior Fire Safety Engineer
International Fire Consultants Ltd. (IFC)

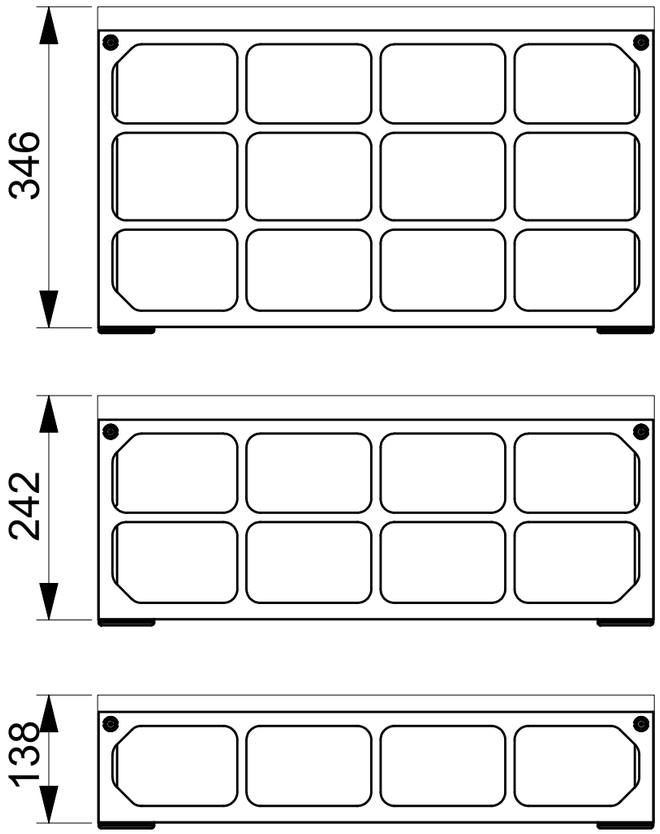
APPENDIX A

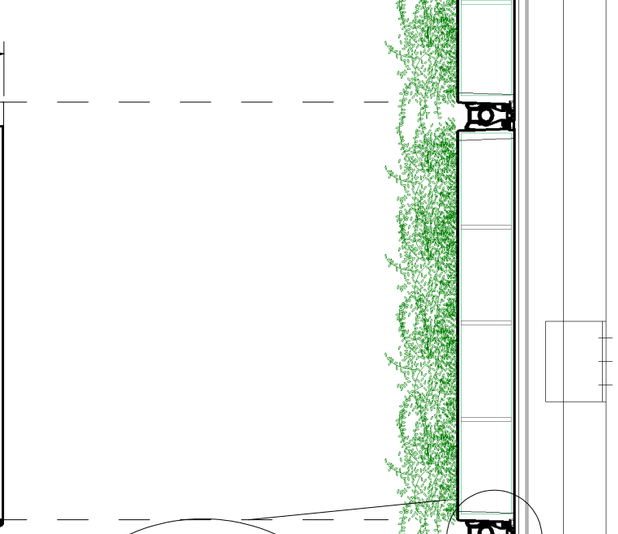
Drawings Supplied by Biotecture Ltd

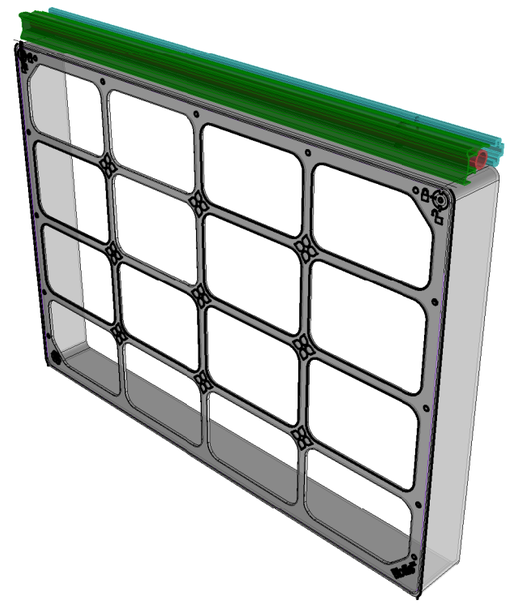
'Biotile Standard Panel Sizes' Rev A, 'Irrigation Layout Schematic' xxxx-IS-001 and 'Standard Section' dated 15/04/15

The figures in this Appendix are not included in the sequential page numbering of this report









NOTES:

REVISIONS:

KEY:

GA - General Assembly
PL - Panel Layout
BS- Backing Board Layout
IS - Irrigation System

biotecture
sustainable living walls

Client:
BIOTECTURE

Project:

Title:
BIOTILE
STANDARD
PANEL SIZES

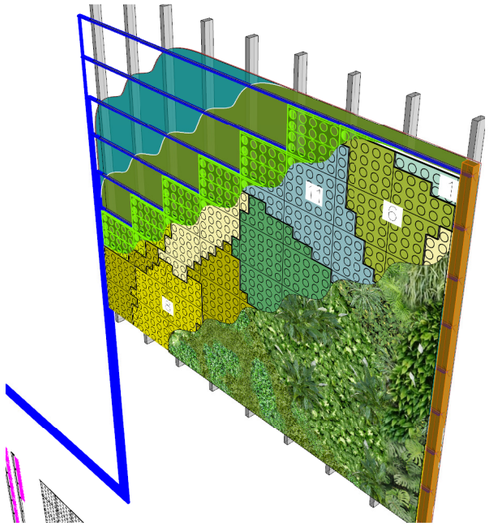
Date:
21/04/15

Drawn: SB

Checked:

Drawing No: BIO-PL-01

Revision: A



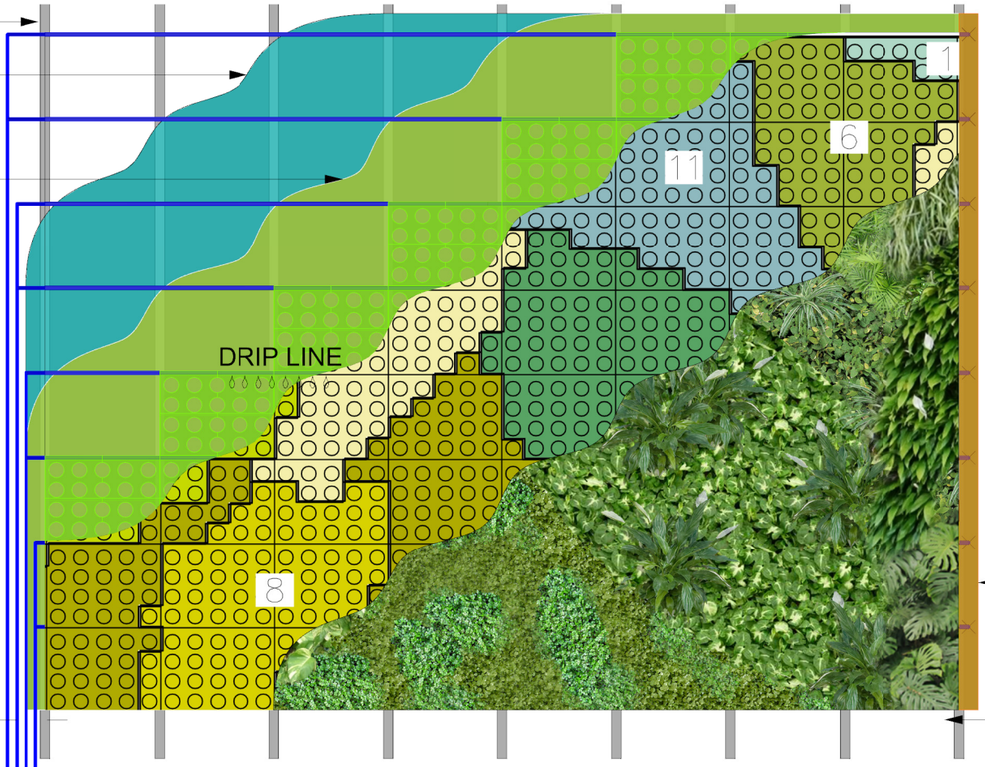
STRUCTURE (BY OTHERS)

BACKING BOARD

VOID FORMER

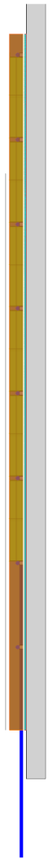
IRRIGATION ARRAY

IRRIGATION RISER



ACCESSIBLE & REMOVABLE RISER COVER (BY OTHERS)

DRAINAGE DETAIL AT BASE OF WALL (BY OTHERS)



LIVING WALL PANELS

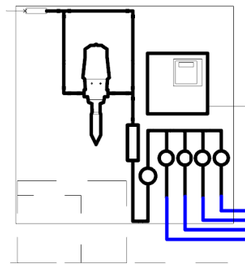
ONE CLEAN RUN OF PIPE FROM LIVING WALL TO PLANT ROOM REQUIRED WITH SWEEPING BENDS (NO JOINS)

ARIEL
3G SIGNAL STRENGTH (NOT GSM) REQUIRED FOR COMMUNICATION
LOCATION OF ARIEL NEEDS TO BE AGREED IN ADVANCE.
IF NO SIGNAL IN PLANT ROOM - ARIEL WILL NEED ROUTING TO SUITABLE LOCATION TO GET SIGNAL.

SIGNAL STENGTH IN PLANT ROOM LOCATION NEEDS CHECKNG IN ADVANCE OF INSTALLTION

PLANT ROOM TO BE LOCATED AS CLOSE TO BASE OF LIVING WALL AS PRACTICAL, WITHIN 30m IMPORTANT

PLANT ROOM
LOCATION OF IRRIGATION RIG



ARIEL

IRRIGATION PIPE ROUTE TO LIVING WALL

NUMBER OF IRRIGATION PIPES BASED ON NUMBER OF ZONES PART OF DETAILED DESIGN

GULLEY ADVISABLE IN PLANT ROOM.
DEALS WITH LEAKS, WASH DOWN OF FILTERS & SPILLS

DESIGN FOR MAINTENACE:

ACCESS FOR MAINTENACE OF LIVING WALL TO BE CONSIDERED.
CLEAR ACCESS METHOD REQUIRED.
CLEAR AND LEVEL SURFACE AT GROUND LEVEL IN FRONT OF WALL RECOMMENDED

examples to be considered...
Anchor points for scaffold tower,
no large areas soft landscaping at base of wall

biotecture
sustainable living walls

Client: xxx
Project: xxx
Title: IRRIGATION LAYOUT SCHEMATIC

Scale: NOT TO SCALE
Date: 22/09/16
Drawn: SB Checked:
Drawing Number: xxxx-IS-001 Revision:

KEY:
GA - General Assembly/Overview
PL - Panel Layout
BB - Backing Board Layout
IS - Irrigation System
PD - Plant Design

REVISIONS:

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COPING OR PLANTED TOP BOX

MAIN STRUCTURE

HELPING HAND BRACKETS (HILTI OR SIMILAR)

CLADDING RAILS

WATERPROOF BACKING BOARD

4.5mm GEOTEXTILE DRAINAGE LAYER

BIOTILE

16mm DIAMETER PRESSURE COMPENSATED DRIP-LINE

GROWING MEDIUM (GRODAN)

GEOTEXTILE CAPILARY BREAK

INFILL STRIP

62mm thick Biotecture panels c/w grodan growing medium & capillary breaks @ max 100mm centres

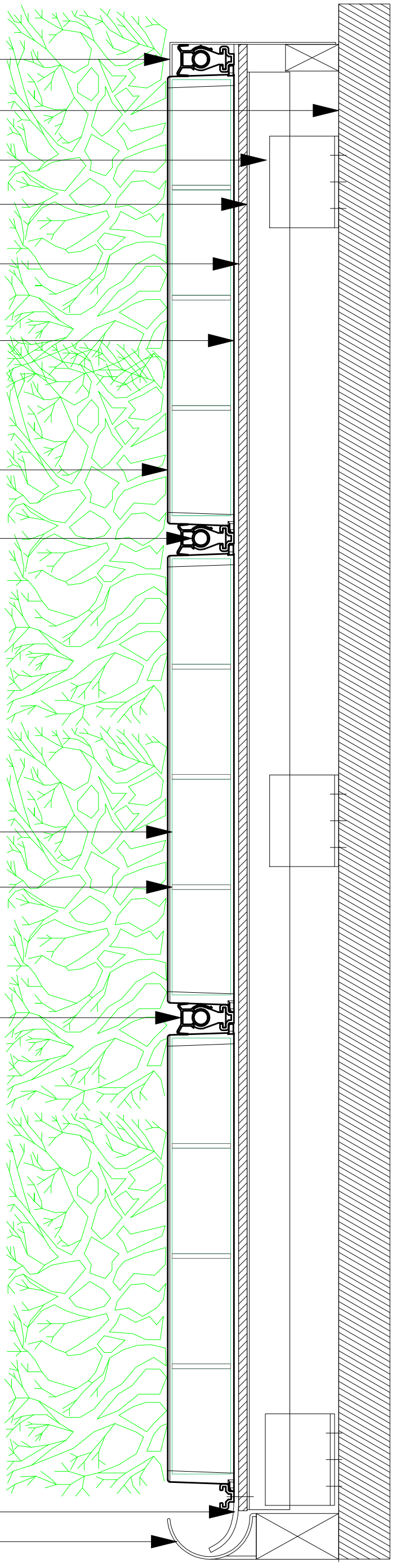
Plant choice as selected by design team & Biotecture to suit location and client requirements

Cladding rails nominally 50mm to 200mm either timber or aluminium c/w cavity zone for rigid board insulation (if required)

New or existing building or free standing structure

DRAINAGE FROM THIS ZONE ONLY

MINILINE GUTTER (or similar)



biotecture
sustainable living walls

Client:

Project:

Title: STANDARD SECTION

Scale: NOT TO SCALE

Date: 15/04/15

Drawn: SB

Checked: JD

Drawing Number:

Revision:

REVISIONS:

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APPENDIX B

Biotecture Ltd Plant Database

The figures in this Appendix are not included in the sequential page numbering of this report

Plant Name	Rating	Type e = exterior i = interior	N= Native W=Wildlife Friendly	Availability	Single Species	Aspect	Plant Image
Acorus gramineus 'Ogon'	1	e	W	All year	Y	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Armeria maritima	2	e	NW	All year	N	sunny	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Asplenium scolopendrium (SYN. Phyllitis scolopendrium)	1	e	N	All year	Y	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Bergenia 'Baby Doll'	2	e	W	All year	Y	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Bergenia cordifolia 'Winterglow'	2	e	W	All year	Y	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Bergenia purpurascens	2	e	W	All year	Y	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Carex 'Ice Dance'	2	e	W	All year	N	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Carex morrowii 'Irish Green'	2	e	W	All year	N	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Convolvulus cneorum	3	e	W	March to November	Y	full shade partial shade full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Erysimum 'Bowls' Mauve'	1	e	W	March to November		full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Euonymus fortunei 'Dart's Blanket'	1	e		March to November	Y	full sun partial shade full shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Euonymus fortunei 'Emerald Gaiety'	1	e		All year	Y	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Euonymus fortunei 'Emerald n' Gold'	1	e		All year	Y	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Euonymus fortunei 'Minimus'	1	e		All year	Y	full sun partial shade full shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Euphorbia amygdaloides	1	e	W	All year	Y	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Euphorbia amygdaloides var. robbiae	2	e	W	All year	Y	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Euphorbia myrsinites	3	e	W	All year	Y	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Euphorbia 'Tiny Tim'	3	e	W	All year	Y	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Geranium macrorrhizum 'Album'	2	e	NW	March to November	N	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Geranium macrorrhizum 'White-Ness'	2	e	NW	April to October	N	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Geranium sanguineum ' Max Frei'	3	e	NW	March to November	N	full shade full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Hebe pinguifolia 'Pagei'	2	e	W	All year	Y	full shade full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Hedera helix 'Wonder'	1	e	W	All year	Y	full shade full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx

Heuchera americana 'Dale's Strain'	2	e	W	March to November	N	full shade full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera americana 'Green Spice'	2	e	W	March to November	N	full shade full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera americana 'Plum Pudding'	2	e	W	March to November	N	full shade full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Amethyst Mist'	2	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Beauty Colour'	2	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Fire Chief'	2	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Georgia Peach'	2	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Ginger Ale'	2	e	W	March to November	N	full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Key Lime'	2	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Licorice'	2	e	W	March to November	N	full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Marmalade'	2	e	W	March to November	N	full sun full dry shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera micrantha 'Palace Purple'	2	e	W	March to November	N	full sun full dry shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Paris'	2	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Peach Flambe'	3	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Stoplight'	2	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Stormy Seas'	2	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Strawberry Candy'	2	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Sugar Frosting'	2	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Heuchera 'Sugar Plum'	2	e	W	March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Hypericum spp	2	e	NW	March to November	Y	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Iris foetidissima	2	e	NW	March to November	Y	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Lavandula angustifolia 'Hidcote Blue'	2	e	W	All year	Y	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Lavandula angustifolia 'Munstead'	2	e	W	All year	Y	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Liriope 'Big Blue'	1	e	W	All year	Y	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx

Liriope 'Monro White'	1	e	W	All year	Y	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Lonicera 'May Green' (syn. L. 'Mai Grun')	1	e	W	All year	Y	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Pachysandra variegata	1	e	W	All year	Y	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Phlox douglasii 'Lilac Cloud'	2	e	W	All year	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Polypodium vulgare	1	e	N	All year	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Polystichum aculeatum	1	e		March to November	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Polystichum braunii	2	e		March to November	N	partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Polystichum polyblepharum	1	e		March to November	N	full shade partial shade sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Polystichum setiferum	1	e		March to November	N	full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Polystichum tsussimense	2	e		March to November	N	full shade partial shade sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Sarcococca hookeriana var. digyna	1	e	W	All year	Y	partial shade sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Sarcococca humilis	1	e	W	All year	Y	full shade partial shade sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Soleirolia soleirolii	2	e		All year	Y	full shade partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Vinca minor	2	e	W	All year	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Vinca minor 'Atropurpurea'	2	e	W	All year	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Vinca minor 'Bowles' Variety'	2	e	W	All year	N	full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Vinca minor f. alba	2	e	W	All year	N	full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Vinca minor 'Gertrude Jekyll'	2	e	W	All year	N	full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Vinca minor 'La Grave'	2	e	W	All year	N	full sun partial sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Viola odorata	3	e	W	All year	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Waldsteinia ternata	3	e	W	All year	N	full sun partial shade	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Hedera helix 'Wonder'/Polypodium vulgare/Vinca spp mix	1	e	W	All year	N	Partial shade/Full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx

Hedera helix 'Wonder'/Pachysandra terminalis/Waldsteinia ternata	1	e	W	All year	N	Partial shade/Full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Matrices containing *Geranium spp.*				All year		Partial/Full sun	M:\Plant Info\Plant Images\PLANT IMAGES\OUTDOOR PLANTS.docx
Adiantum 'Fritz Luthi'	3	i		1	N		
Anthurium 'Red'	1	i		1	N		
Begonia 'Curley Fireflush'	1	i		1	Y		
Begonia 'Lime Swirl'	1	i		1	Y		
Begonia rex (red)	1	i		1	Y		
Blechnum spicant	5	i	N	1	N		
Chamaedorea elegans	2	i		1	Y		
Chlorophytum variegatum	1	i		1	Y		
Codiaeum 'Red Banana'	4	i		1	N		
Crassula ovata		i		1	N		
Dieffenbachia maculata		i		1	N		
Dracaena compacta	2	i		1	N		
Epipremnum aureum	1	i		1	Y		
Episcia dianthiflora		i		1			
Ficus pumila	1	i		1	Y		
Fittonia verschaffeltii	3	i		1	Y		
Hedera helix 'Wonder'	1	i		1	Y		
Nephrolepis cordifolia 'Duffi'	2	i		1	Y		
Nephrolepsis 'Green Fantasy'	2	i		1	Y		
Peperomia caperata 'Shumii'		i		1	Y		

Peperomia 'Green Valley Variegata'		i		1	Y		
Peperomia obtusifolia 'Green'	3	i		1	Y		
Peperomia 'Pixie'	3	i		1	Y		
Peperomia rotundifolia	3	i		1	Y		
Phlebodium aureum 'Blue Star'	2	i		1			
Pilea cadierei		i		1			
Pilea depressa 'Sao Paulo'	5	i		1			
Pilea 'Norfolk'		i		1			
Saxifraga stolonifera	2	i		1	N		
Spathiphyllum wallisii	1	i		1	Y		
Tradescantia 'Dark Green'	4	i		1	N		
Tradescantia 'Mini Joy'	3	i		1	N		
Tradescantia zebrina	4	i		1	N		

APPENDIX C

SBI Test Results

'BIO-FT-001' – Planted Living Wall System – Tested 17/03/17
'BIO-STD' – Unplanted Living Wall System – Tested 10/04/17

The figures in this Appendix are not included in the sequential page numbering of this report

TEST RESULTS SHEET

General Information

Product Identification	BIO-FT-001
Standard used	BS EN 13823
Date of test	17/03/17
Filename	s170307b.rw1
Report reference	s170307b

Laboratory

Laboratory name	BRE Global
Operator	Alan Turvey

Test Results

THR_{600}	1.72
$FIGRA_{0.2MJ}$	64.3
$FIGRA_{0.4MJ}$	64.3
TSP_{600}	320.7
SMOGRA	105.4

Comments

LFSedge {Y/N}	No
FDP (f =< 10s) {Y/N}	No
FDP (f > 10s) {Y/N}	No
Full test duration/performed {Y/N}	Yes
Smoke Correction Used	No

Product

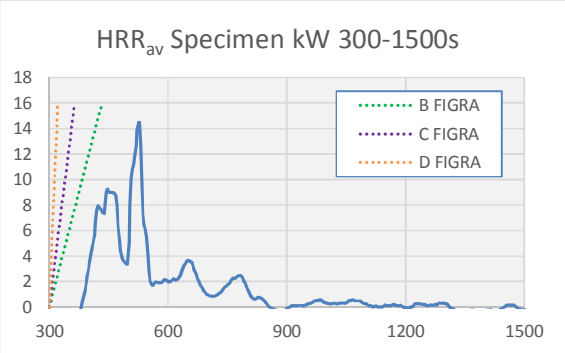
Sample number	1
Substrate	particleboard
Mounting	Direct mount
Joints	screws

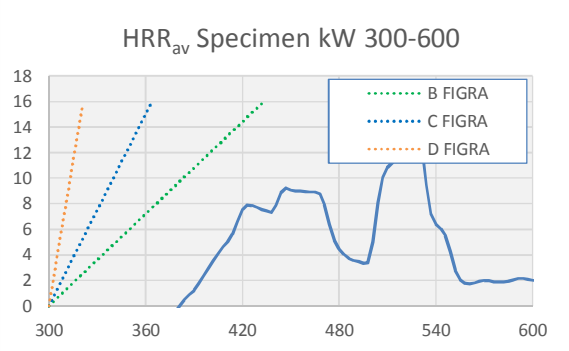
Conditioning

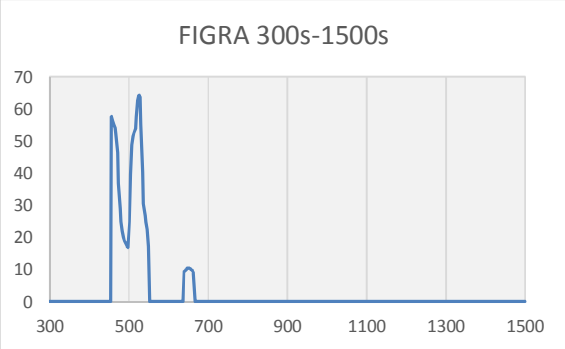
Conditioned	Yes
Time interval	Held on file
Weight 1 (g)	Held on file
Weight 2 (g)	Held on file

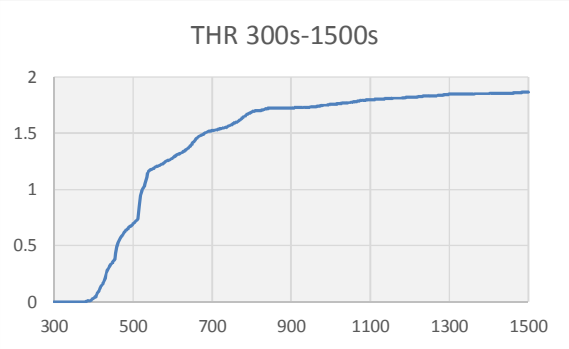
Additional Information

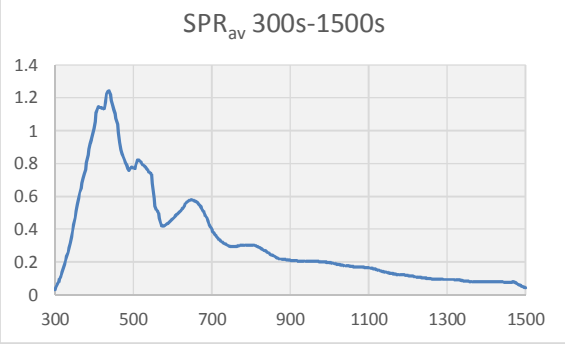
Time to $FIGRA_{0.2MJ}$ (s)	525
Time to $FIGRA_{0.4MJ}$ (s)	525
Time to SMOGRA (s)	405

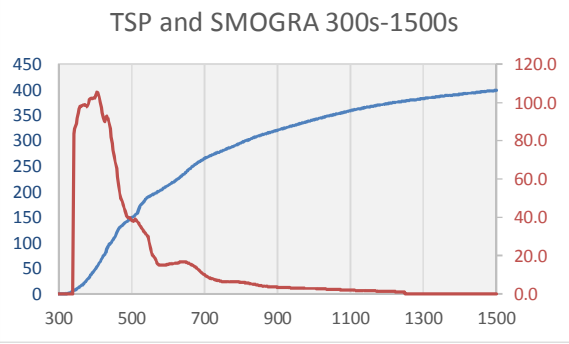












Signiture: _____ Name: _____ Date: _____

TEST RESULTS SHEET

General Information

Product Identification	BIO-FT-001
Standard used	BS EN 13823
Date of test	17/03/17
Filename	s170317c.rw1
Report reference	s170317c

Laboratory

Laboratory name	BRE Global
Operator	Alan Turvey

Test Results

THR_{600}	1.97
$FIGRA_{0.2MJ}$	77.1
$FIGRA_{0.4MJ}$	77.1
TSP_{600}	168.1
SMOGRA	42.0

Comments

LFSedge {Y/N}	No
FDP (f =< 10s) {Y/N}	No
FDP (f > 10s) {Y/N}	No
Full test duration/performed {Y/N}	Yes
Smoke Correction Used	No

Product

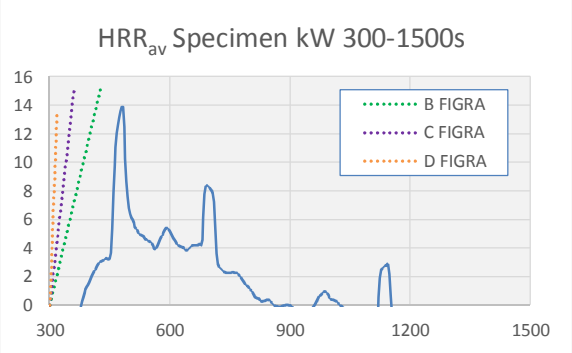
Sample number	1
Substrate	particleboard
Mounting	Direct mount
Joints	screws

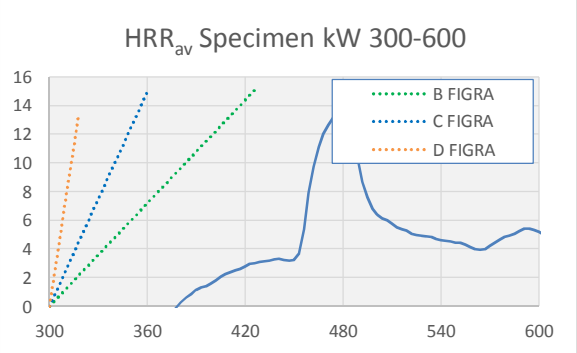
Conditioning

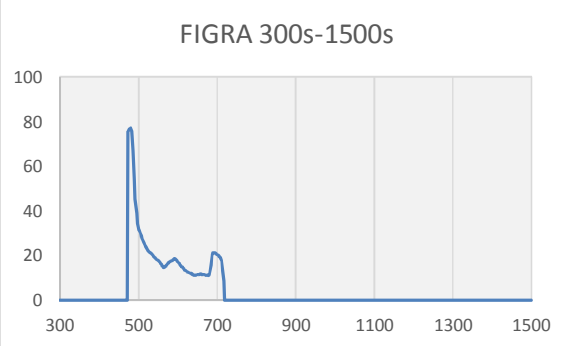
Conditioned	Yes
Time interval	Held on file
Weight 1 (g)	Held on file
Weight 2 (g)	Held on file

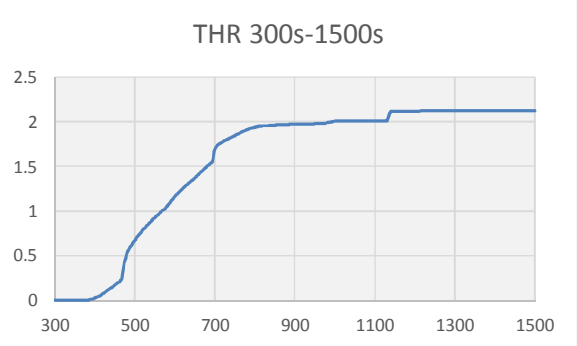
Additional Information

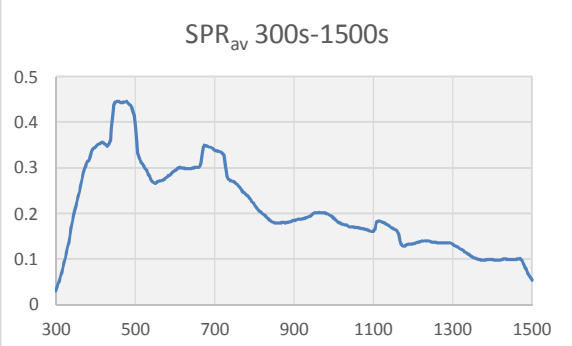
Time to $FIGRA_{0.2MJ}$ (s)	480
Time to $FIGRA_{0.4MJ}$ (s)	480
Time to SMOGRA (s)	354

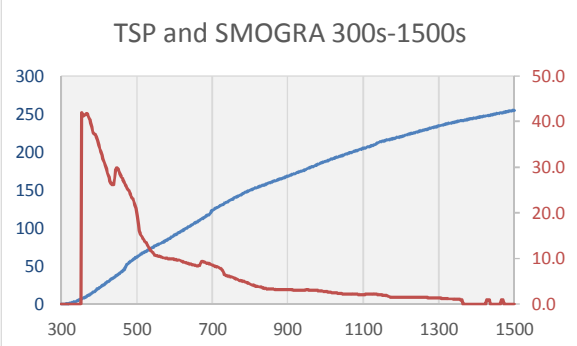












Signiture: _____ Name: _____ Date: _____

TEST RESULTS SHEET

General Information

Product Identification	BIO-FT-001
Standard used	BS EN 13823
Date of test	17/03/17
Filename	s170317d.rw1
Report reference	s170317d

Laboratory

Laboratory name	BRE Global
Operator	Alan Turvey

Test Results

THR_{600}	2.24
$FIGRA_{0.2MJ}$	57.5
$FIGRA_{0.4MJ}$	52.6
TSP_{600}	110.8
SMOGRA	43.5

Comments

LFSedge {Y/N}	No
FDP (f =< 10s) {Y/N}	No
FDP (f > 10s) {Y/N}	No
Full test duration/performed {Y/N}	Yes
Smoke Correction Used	No

Product

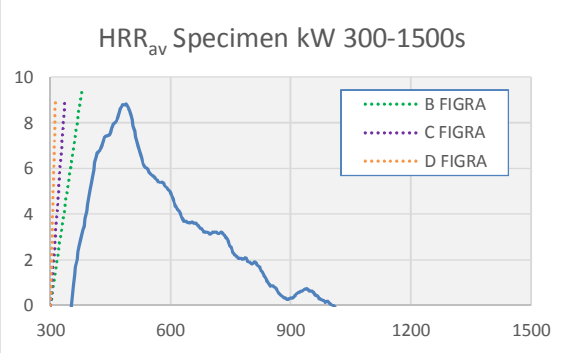
Sample number	1
Substrate	particleboard
Mounting	Direct mount no substrate
Joints	Staple

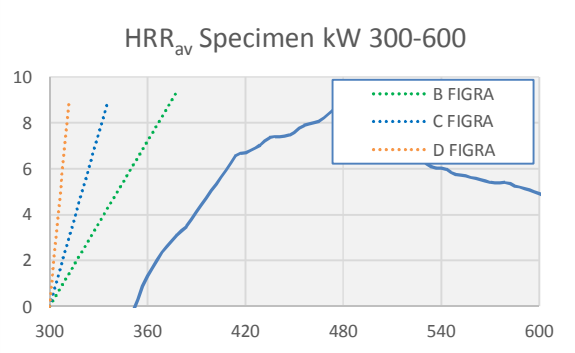
Conditioning

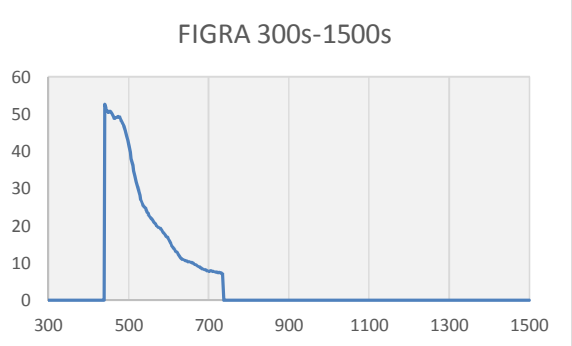
Conditioned	Yes
Time interval	Held on file
Weight 1 (g)	Held on file
Weight 2 (g)	Held on file

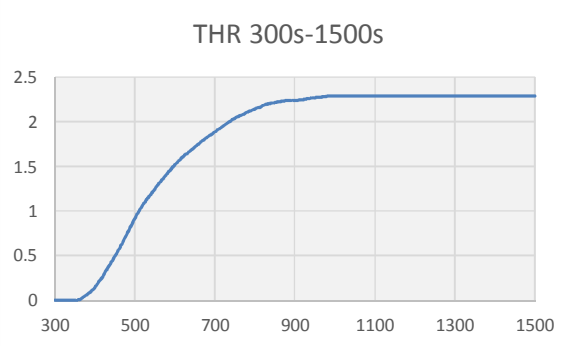
Additional Information

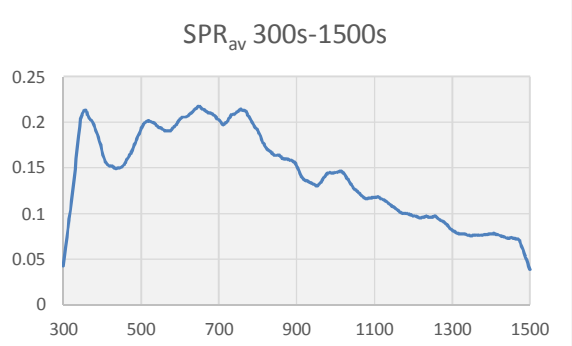
Time to $FIGRA_{0.2MJ}$ (s)	414
Time to $FIGRA_{0.4MJ}$ (s)	441
Time to SMOGRA (s)	348

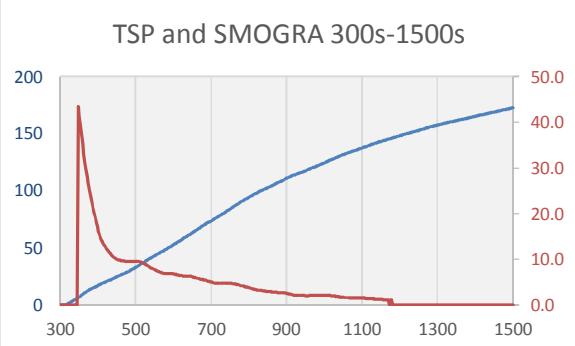












Signiture: _____ Name: _____ Date: _____

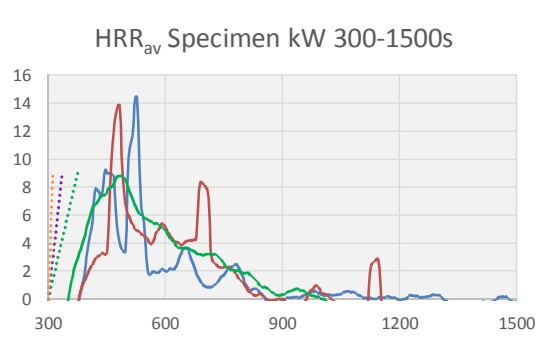
TEST RESULTS SHEET COMBINED

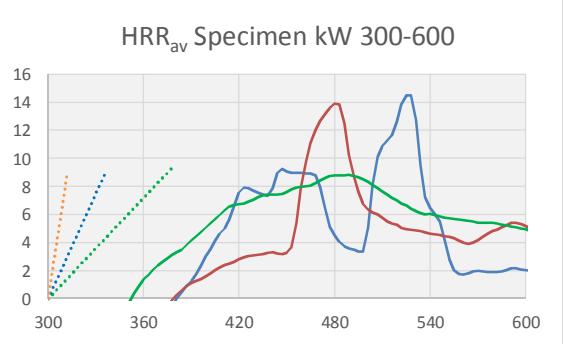
Product Identification	BIO-FT-001	BIO-FT-001	BIO-FT-001
Specimen number	1	1	1
Operator	Alan Turvey	Alan Turvey	Alan Turvey
Date of test	17/03/17	17/03/17	17/03/17
Filename	s170307b.rw1	s170317c.rw1	s170317d.rw1
THR_{600}	**1.72**	**1.97**	**2.24**
$FIGRA_{0.2MJ}$	**64.3**	**77.1**	**57.5**
$FIGRA_{0.4MJ}$	**64.3**	**77.1**	**52.6**
TSP_{600}	**320.7**	**168.1**	**110.8**
SMOGRA	**105.4**	**42.0**	**43.5**
Time of $FIGRA_{0.2MJ}$ (s)	525	480	414
Time of $FIGRA_{0.4MJ}$ (s)	525	480	441
LFSedge {Y/N}	N	N	N
FDP (f =< 10s) {Y/N}	N	N	N
FDP (f > 10s) {Y/N}	N	N	N
Smoke Correction Used	No	No	No

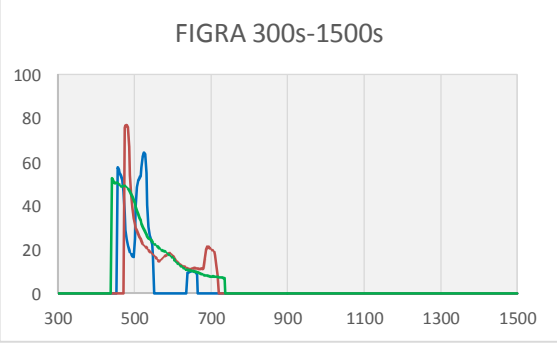
Chart Legend

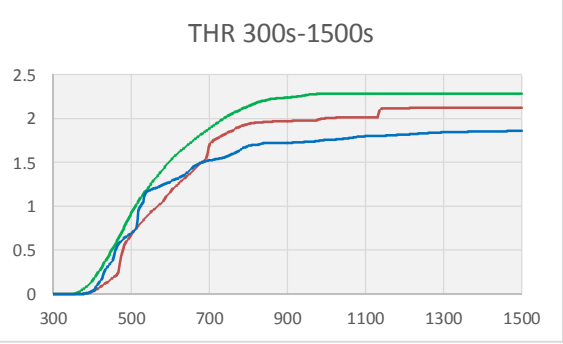
BIO-FT-001
BIO-FT-001
BIO-FT-001
B FIGRA Threshold
C FIGRA Threshold
D FIGRA Threshold

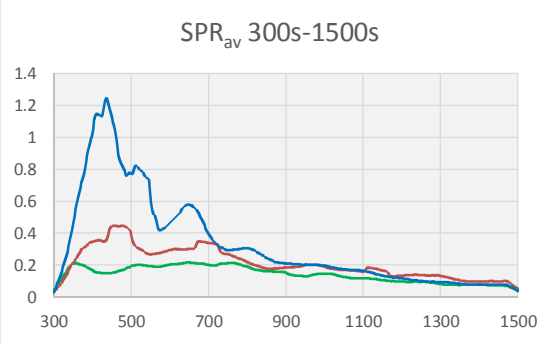
Test Averages	
THR_{600}	1.98
$FIGRA_{0.2MJ}$	66.29
$FIGRA_{0.4MJ}$	64.64
TSP_{600}	199.85
SMOGRA	63.59
LFSedge {Y/N}	N

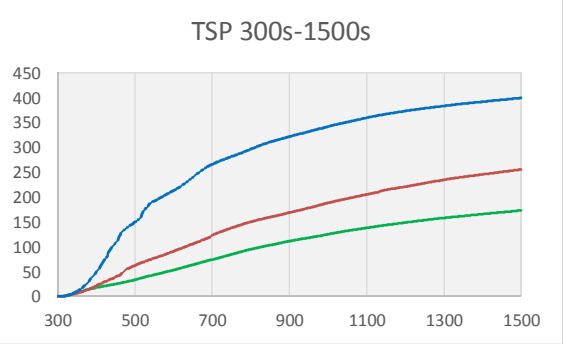












Signiture: _____ Name: _____ Date: _____

SBI HRR rate Calculation Sheet Ver: 1 / Issue Date: 10Mar17 / Author: P.Howard

TEST RESULTS SHEET

General Information

Product Identification	BIO STD. Unplanted/Irrigated
Standard used	BS EN 13823
Date of test	10/04/2017
Filename	s100417c.rw1
Report reference	s100417c

Laboratory

Laboratory name	BRE Global
Operator	Alan Turvey

Product

Sample number	1
Substrate	Gypsum Fibreboard
Mounting	Direct mount
Joints	screws

Conditioning

Conditioned	Yes
Time interval	Held on file
Weight 1 (g)	Held on file
Weight 2 (g)	Held on file

Test Results

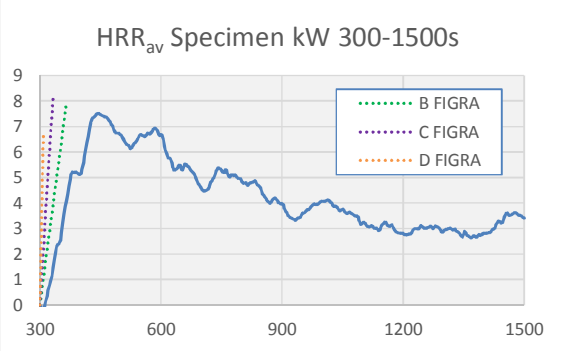
THR_{600}	3.12
$FIGRA_{0.2MJ}$	61.7
$FIGRA_{0.4MJ}$	56.8
TSP_{600}	59.0
SMOGRA	7.9

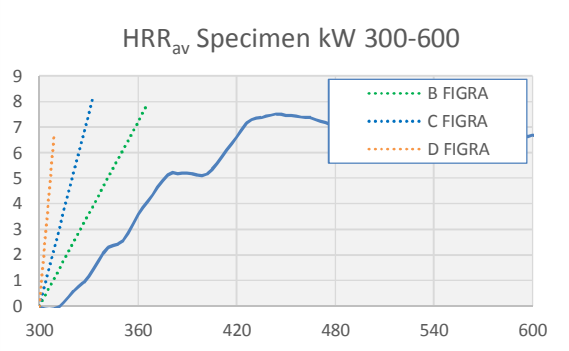
Additional Information

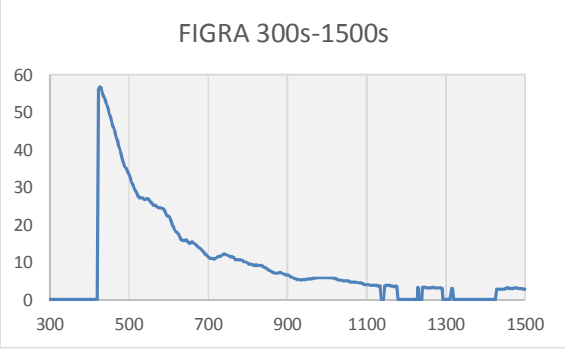
Time to $FIGRA_{0.2MJ}$ (s)	384
Time to $FIGRA_{0.4MJ}$ (s)	426
Time to SMOGRA (s)	516

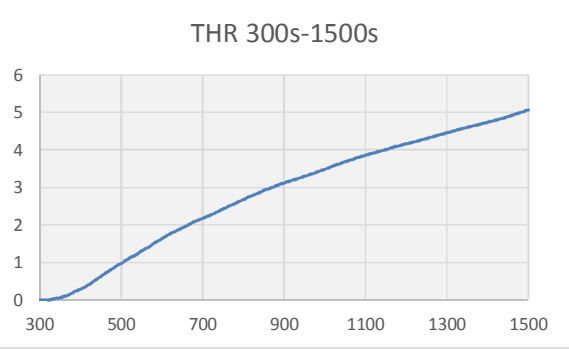
Comments

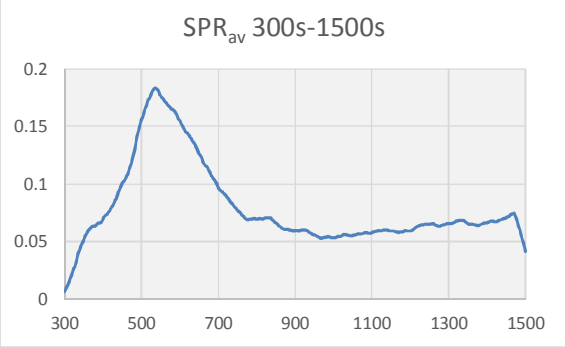
LFSedge {Y/N}	No
FDP (f =< 10s) {Y/N}	No
FDP (f > 10s) {Y/N}	No
Full test duration/performed {Y/N}	Yes
Smoke Correction Used	No

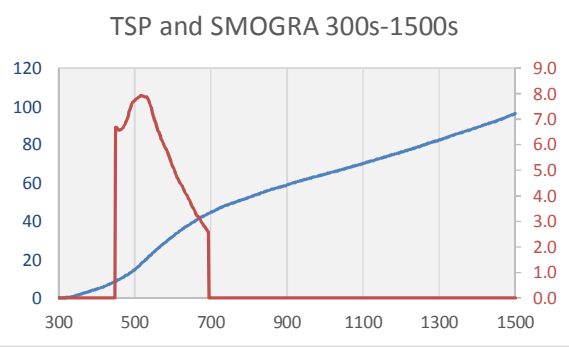












Signiture: _____ Name: _____ Date: _____

TEST RESULTS SHEET

General Information

Product Identification	BIO STD. Unplanted/Irrigated
Standard used	BS EN 13823
Date of test	10/04/2017
Filename	s100417d.rw1
Report reference	s100417d

Laboratory

Laboratory name	BRE Global
Operator	Alan Turvey

Test Results

THR_{600}	0.87
$FIGRA_{0.2MJ}$	35.6
$FIGRA_{0.4MJ}$	22.8
TSP_{600}	68.7
SMOGRA	10.5

Comments

LFSedge {Y/N}	No
FDP (f =< 10s) {Y/N}	No
FDP (f > 10s) {Y/N}	No
Full test duration/performed {Y/N}	Yes
Smoke Correction Used	No

Product

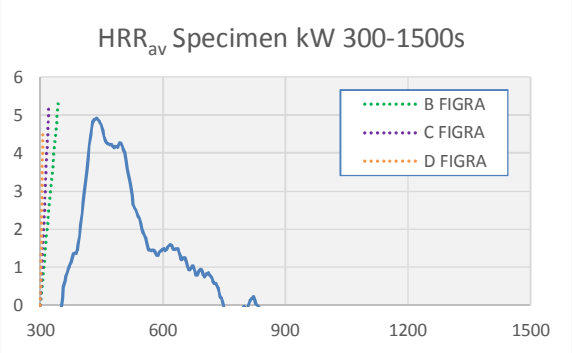
Sample number	1
Substrate	Gypsum Fibreboard
Mounting	Direct mount
Joints	screws

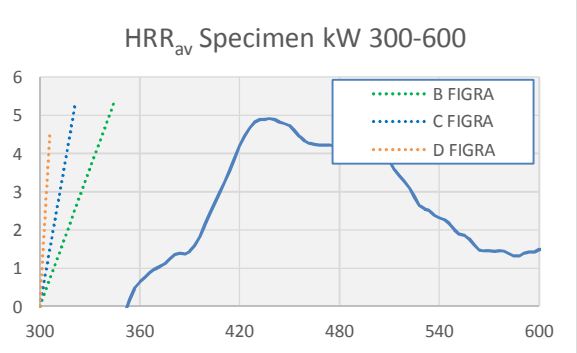
Conditioning

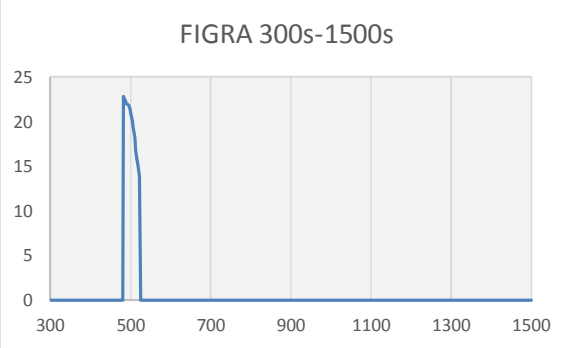
Conditioned	Yes
Time interval	Held on file
Weight 1 (g)	Held on file
Weight 2 (g)	Held on file

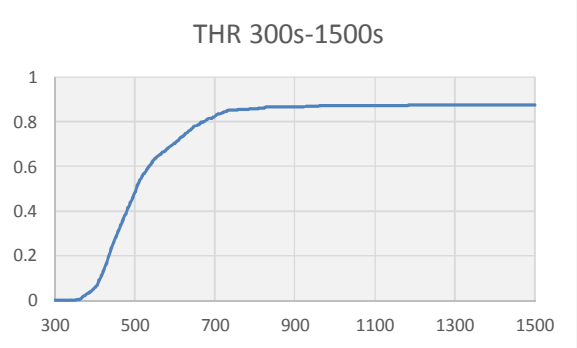
Additional Information

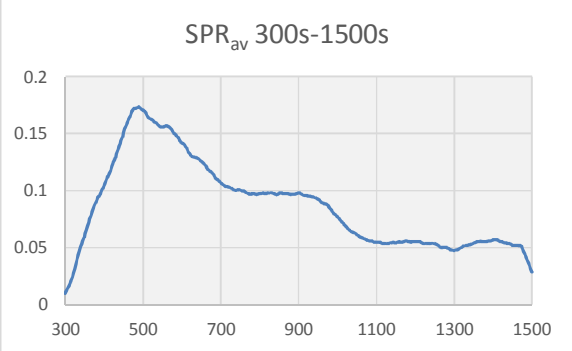
Time to $FIGRA_{0.2MJ}$ (s)	438
Time to $FIGRA_{0.4MJ}$ (s)	483
Time to SMOGRA (s)	399

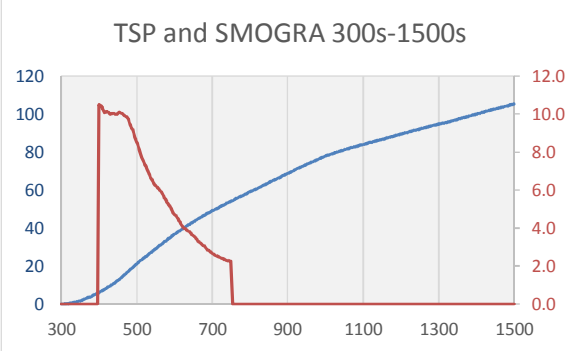












Signiture: _____ Name: _____ Date: _____

TEST RESULTS SHEET

General Information

Product Identification	BIO STD. Unplanted/Irrigated
Standard used	BS EN 13823
Date of test	11/04/2017
Filename	s110417a.rw2
Report reference	s110417a

Laboratory

Laboratory name	BRE Global
Operator	Alan Turvey

Test Results

THR_{600}	2.59
$FIGRA_{0.2MJ}$	38.6
$FIGRA_{0.4MJ}$	32.3
TSP_{600}	72.3
SMOGRA	9.1

Comments

LFSedge {Y/N}	No
FDP (f =< 10s) {Y/N}	No
FDP (f > 10s) {Y/N}	No
Full test duration/performed {Y/N}	Yes
Smoke Correction Used	No

Product

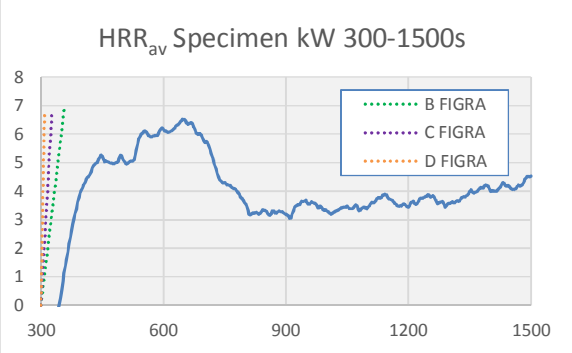
Sample number	2
Substrate	Gypsum Fibreboard
Mounting	Direct mount no substrate
Joints	Staple

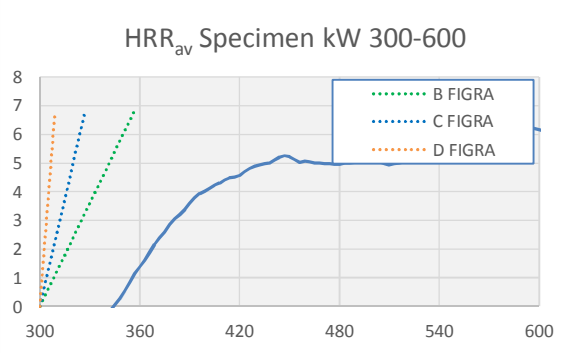
Conditioning

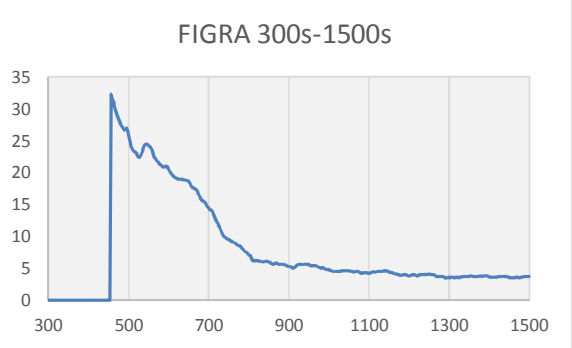
Conditioned	Yes
Time interval	Held on file
Weight 1 (g)	Held on file
Weight 2 (g)	Held on file

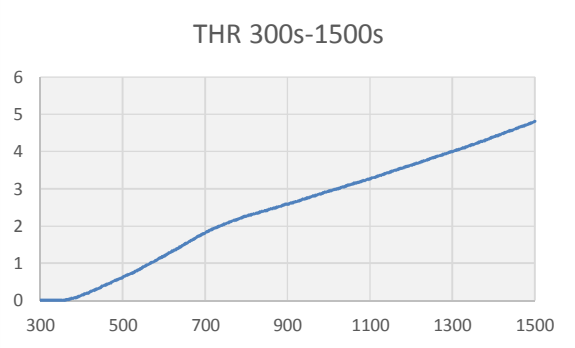
Additional Information

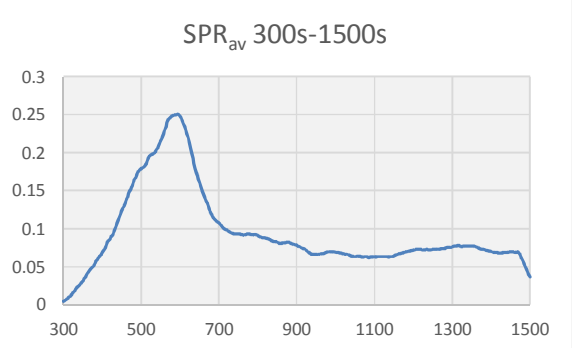
Time to $FIGRA_{0.2MJ}$ (s)	417
Time to $FIGRA_{0.4MJ}$ (s)	456
Time to SMOGRA (s)	492

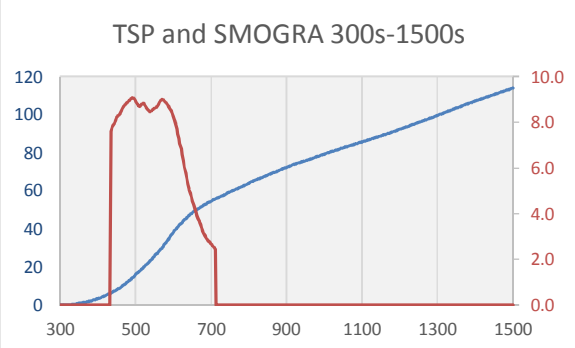












Signiture: _____ Name: _____ Date: _____

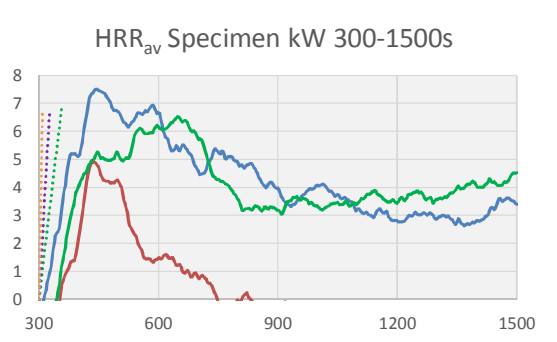
TEST RESULTS SHEET COMBINED

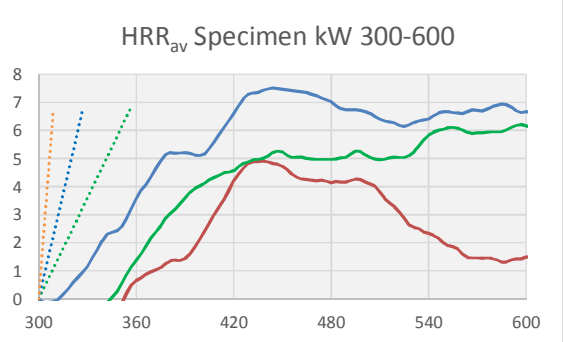
Product Identification	BIO STD. Unplanted/Irrigated	BIO STD. Unplanted/Irrigated	BIO STD. Unplanted/Irrigated
Specimen number	1	1	2
Operator	Alan Turvey	Alan Turvey	Alan Turvey
Date of test	10-Apr-17	10-Apr-17	11-Apr-17
Filename	s100417c.rw1	s100417d.rw1	s110417a.rw2
THR_{600}	**3.12**	**0.87**	**2.59**
$FIGRA_{0.2MJ}$	**61.7**	**35.6**	**38.6**
$FIGRA_{0.4MJ}$	**56.8**	**22.8**	**32.3**
TSP_{600}	**59.0**	**68.7**	**72.3**
SMOGRA	**7.9**	**10.5**	**9.1**
Time of $FIGRA_{0.2MJ}$ (s)	384	438	417
Time of $FIGRA_{0.4MJ}$ (s)	426	483	456
LFSedge {Y/N}	N	N	N
FDP (f =< 10s) {Y/N}	N	N	N
FDP (f > 10s) {Y/N}	N	N	N
Smoke Correction Used	No	No	No

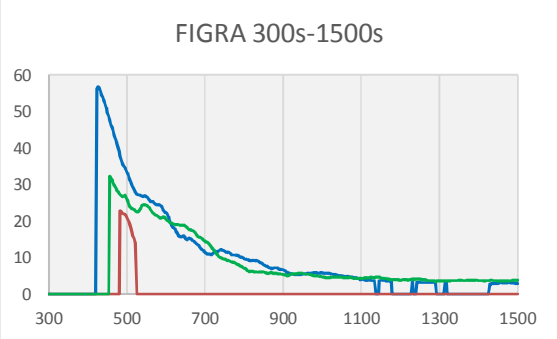
Chart Legend

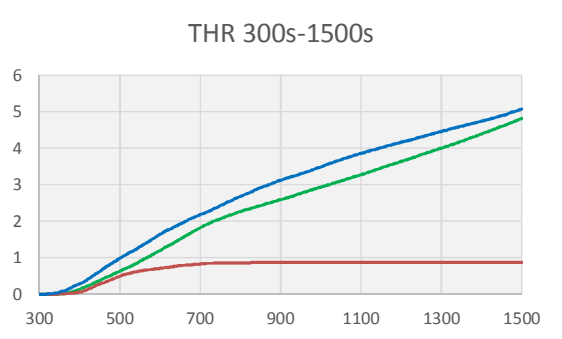
BIO STD. Unplanted/Irrigated
BIO STD. Unplanted/Irrigated
BIO STD. Unplanted/Irrigated
B FIGRA Threshold
C FIGRA Threshold
D FIGRA Threshold

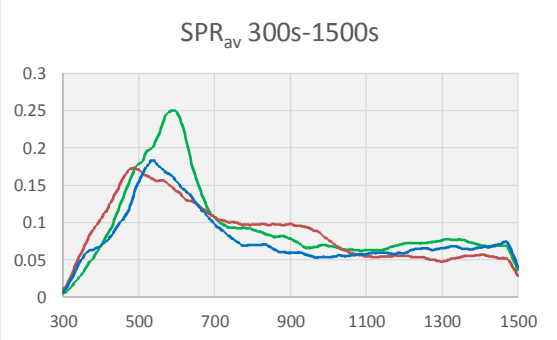
Test Averages	
THR_{600}	2.19
$FIGRA_{0.2MJ}$	45.31
$FIGRA_{0.4MJ}$	37.27
TSP_{600}	66.66
SMOGRA	9.16
LFSedge {Y/N}	N

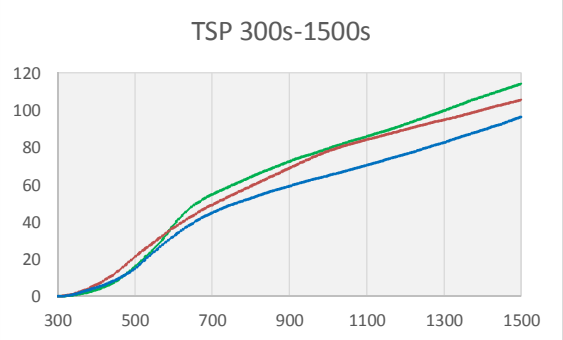












Signiture: _____ Name: _____ Date: _____

SBI HRR rate Calculation Sheet Ver: 1 / Issue Date: 10Mar17 / Author: P.Howard