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BORAL MULTIFRAME™ WALL AND FLOOR SYSTEMS

ACOUSTIC OPINIONS

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1 INTRODUCTION

Renzo Tonin & Associates was commissioned to review the proposed Boral Multiframe™ Wall and Floor Systems which include internal and external wall systems, timber joist floor systems and provide opinions on the acoustic performances of these systems. The predicted acoustic ratings are to be published in the Boral Multiframe™ Wall and Floor Systems brochure as a guideline for designers and engineers.

The acoustic ratings shown in this report are opinions and are not laboratory test results. The acoustic ratings of the partitions were based on both laboratory test results of similar constructions and calculations using predictive models. The expected tolerance of the opinions is ±2dB for R_w and $L_{n,w}$ and ±3dB $L_{n,w}+C_I$ and Rw + C_{tr}. This allows for variation in the test method, the difference between laboratories and the accuracy of the estimating techniques. The ratings obtained on a building site may differ from laboratory result. The opinions stated in this report assume the partitions is of good construction with perimeter of the wall sealed acoustically with mastic and no penetrations though the partition.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

2 WALL SYSTEMS

2.1 Predicted Airborne Acoustic Ratings

Renzo Tonin & Associates have reviewed the proposed Boral Multiframe™ Wall Systems utilising Boral plasterboard and proprietary insulation and have predicted the airborne sound insulation ratings of each wall system. Table 1 below outlines the various wall systems and their respective acoustic performances.

Table 1 - Airborne Sound Insulation of Timber Stud Wall Systems

System Reference & Description	Nominal Width (mm)	Stud Size (mm)	Plaster-board Surface Density (kg/m^2)	Predicted Acoustic Ratings		
				Insulation	R_w (C_{tr})	$R_w + C_{tr}$
Party Walls						
TT1616F - 1x16mm Boral Firestop plasterboard - insulation - timber stud at 450mm centres - 20mm gap - timber stud at 450mm centres - insulation - 1x16mm Boral Firestop plasterboard	192	70	26.0	70mm glass wool min 11kg/m^3 in each stud cavity	58 (-8)	50
	232	90	26.0	70mm glass wool min 11kg/m^3 in each stud cavity	59 (-9)	50
TT16F10 - 1x10mm Boral Regular plasterboard - 1x16mm Boral Firestop plasterboard - insulation - timber stud at 450mm centres - 20mm gap - timber stud at 450mm centres - 1x16mm Boral Firestop plasterboard	202	70	32.8	50mm glass wool min 11kg/m^3 in one stud cavity only	59 (-9)	50
	242	90	32.8	50mm glass wool min 11kg/m^3 in one stud cavity only	59 (-8)	51
	242	90	32.8	50mm glass wool min 14kg/m^3 in each stud cavity	63 (-8)	55
TT16F1016F10 - 1x10mm Boral Regular plasterboard - 1x16mm Boral Firestop plasterboard - insulation - timber stud at 450mm centres - 20mm gap - timber stud at 450mm centres - 1x16mm Boral Firestop plasterboard - 1x10mm Boral Regular plasterboard	212	70	39.6	50mm glass wool min 11kg/m^3 in one stud cavity only	61 (-9)	52
	252	90	39.6	50mm glass wool min 11kg/m^3 in one stud cavity only	62 (-8)	54
	252	90	39.6	90mm glass wool min 11kg/m^3 in one stud cavity only	64 (-9)	55

System Reference & Description	Nominal Width (mm)	Stud Size (mm)	Plaster-board Surface Density (kg/m^2)	Predicted Acoustic Ratings		
				Insulation	R_w (C_{tr})	$R_w + C_{tr}$
TT2626F - 2x13mm Boral Firestop plasterboard - insulation - timber stud at 450mm centres - 20mm gap - timber stud at 450mm centres - 2x13mm Boral Firestop plasterboard	212	70	42.0	50mm glass wool min 11kg/m^3 in one stud cavity only	64 (-9)	55
	252	90	42.0	50mm glass wool min 11kg/m^3 in one stud cavity only	65 (-9)	56
Corridor Walls						
TT1616F - 1x16mm Boral Firestop plasterboard - insulation - timber stud at 450mm centres - 20mm gap - timber stud at 450mm centres - 1x16mm Boral Firestop plasterboard	192	70	26.0	50mm glass wool min 11kg/m^3 in one stud cavity only	54 (-8)	46
	232	90	26.0	50mm glass wool min 11kg/m^3 in one stud cavity only	55 (-7)	48
TF1616F - 1x16mm Boral Firestop plasterboard - insulation - timber stud at 450mm centres - 28mm steel furring channel on furring channel clips - 1x16mm Boral Firestop plasterboard	130	70	26.0	90mm glass wool min 14kg/m^3	50 (-8)	42
	150	90	26.0	70mm glass wool min 14kg/m^3	50 (-8)	42
TT2626F - 2x13mm Boral Firestop plasterboard - timber stud at 450mm centres - 20mm gap - timber stud at 450mm centres - 2x13mm Boral Firestop plasterboard	212	70	42.0	Nil	50 (-8)	42
	252	90	42.0	Nil	52 (-9)	43
TF2626F - 2x13mm Boral Firestop plasterboard - insulation - timber stud at 450mm centres - 28mm steel furring channel on furring channel clips - 2x13mm Boral Firestop plasterboard	150	70	42.0	Nil	47 (-7)	40
	150	70	42.0	50mm glass wool min 11kg/m^3	54 (-6)	48
	170	90	42.0	50mm glass wool min 11kg/m^3	55 (-6)	49
Internal Walls						
T1616F - 1x16mm Boral Firestop plasterboard - timber stud at 450mm centres - 1x16mm Boral Firestop plasterboard	122	90	26.0	Nil	39 (-8)	31
T2626F - 2x13mm Boral Firestop plasterboard - timber stud at 450mm centres - 2x13mm Boral Firestop plasterboard	142	90	42.0	Nil	45 (-8)	37

System Reference & Description	Nominal Width (mm)	Stud Size (mm)	Plaster-board Surface Density (kg/m^2)	Predicted Acoustic Ratings		
				Insulation	R_w (C_{tr})	$R_w + C_{tr}$
External Walls – Lightweight Cladding (Boral OutRwall)						
OW10 - Cladding - insulation - timber stud at 450mm centres - 1x10mm Regular plasterboard	10 + frame + cladding system	90	6.8	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	28 (-3)	25
OW13WF13F - Cladding, battens & Tyvek HomeWrap membrane - 1x13mm Wet Area Firestop plasterboard - insulation - timber stud at 450mm centres - 1x13mm Firestop plasterboard	26 + frame + cladding system	90	21.0	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	40 (-9)	31
OW16WF16F - Cladding, battens & Tyvek HomeWrap membrane - 1x16mm Wet Area Firestop plasterboard - insulation - timber stud at 450mm centres - 1x16mm Firestop plasterboard	32 + frame + cladding system	90	26.0	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	41 (-4)	37
OW26WF26F - Cladding, battens & Tyvek HomeWrap membrane - 2x13mm Wet Area Firestop plasterboard - timber stud at 450mm centres - 2x13mm Firestop plasterboard	52 + frame + cladding system	90	42.0	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	48 (-6)	42
OW32WF16F - Cladding, battens & Tyvek HomeWrap membrane - 2x16mm Wet Area Firestop plasterboard - insulation - timber stud at 450mm centres - 1x16mm Firestop plasterboard	48 + frame + cladding system	90	39.0	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	45 (-5)	40
OW32WF10 - Cladding, battens & Tyvek HomeWrap membrane - 2x16mm Wet Area Firestop plasterboard - insulation - timber stud at 450mm centres - 1x10mm Regular plasterboard	42 + frame + cladding system	90	32.8	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	45 (-8)	37

System Reference & Description	Nominal Width (mm)	Stud Size (mm)	Plaster-board Surface Density (kg/m^2)	Predicted Acoustic Ratings		
				Insulation	R_w (C_{tr})	$R_w + C_{tr}$
External Walls – Brick Veneer						
TBV(0)10 - 110mm non-fire rated brick - 50mm cavity - insulation - timber stud at 450mm centres - 1x10mm Regular plasterboard	10 + frame + cavity + veneer	90	6.8	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	59 (-7)	52
TBV(30)13F - 110mm FRL 30/30/30 brick - 50mm cavity - insulation - timber stud at 450mm centres - 1x13mm Firestop plasterboard	13 + frame + cavity + veneer	90	10.5	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	59 (-6)	53
TBV(60)16F - 110mm FRL 60/60/60 brick - 50mm cavity - insulation - timber stud at 450mm centres - 1x16mm Firestop plasterboard	16 + frame + cavity + veneer	90	13.0	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	59 (-6)	53
TBV(90)26F - 110mm FRL 90/90/90 brick veneer - 50mm cavity - insulation - timber stud at 450mm centres - 2x13mm Firestop plasterboard	26 + frame + cavity + veneer	90	21.0	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	60 (-5)	55
TBV(90)16F - 110mm FRL 90/90/90 brick veneer - 50mm cavity - insulation - timber stud at 450mm centres - 1x16mm Firestop plasterboard	16 + frame + cavity + veneer	90	13.0	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	59 (-6)	53
TBV(90)10 - 110mm FRL 90/90/90 brick veneer - 50mm cavity - insulation - timber stud at 450mm centres - 1x10mm Regular plasterboard	10 + frame + cavity + veneer	90	6.8	90mm glass wool min 16kg/m^3 (R2.5 glass wool batt or equivalent)	59 (-7)	52

System Reference & Description	Nominal Width (mm)	Stud Size (mm)	Plaster-board Surface Density (kg/m^2)	Predicted Acoustic Ratings		
				Insulation	R_w (C_{tr})	$R_w + C_{tr}$

NOTES:

1. Where a wall system has not been tested in the laboratory for its sound insulation performance, an acoustic opinion has been provided. This acoustic opinion is not a laboratory test result.

2. The acoustic rating of the wall was based on both laboratory test results of similar constructions and calculations using predictive models. The expected tolerance of the opinions is ±2dB for Rw, Ln,w and ±3dB Ln,w + CI and Rw + Ctr. This allows for variation in the test method, the difference between laboratories and the accuracy of the estimating techniques. The rating obtained on a building site may differ from laboratory result. The opinion stated above assumes the wall is of good construction with the perimeter of the wall sealed acoustically with mastic and no penetrations though the wall.

3. The Rw (Weight Sound Reduction Index) is a single number index used to rate the sound isolation of a partition which does not have significant low frequency component. The R_w is single number descriptor for quantifying the attenuating performance of partitions for typical intrusive noises produced inside residences. The higher the rating, the greater the isolation provided by the partition.

4. Spectrum adaptation factors are commonly used to compensate for the fact that certain kinds of sounds are more readily transmitted through insulating materials than others insulate. The adaptation factor C_{tr} has now been introduced for most building elements which require an airborne sound insulation rating.

5. C and Ctr are adaption terms which when applied to the Rw value result in a single number index which provides a more reliable indicator of the ability of the partition to isolate against certain types of noise. In particular, the Rw combined with the Ctr value gives a more reliable indicator of the ability of the partition to isolate against noise containing low frequency components and has been chosen in large part, in recognition of the problem of the high bass frequency outputs of modern home theatre systems and music reproduction equipment.

3 TIMBER JOIST FLOOR SYSTEMS

3.1 Predicted Airborne and Impact Acoustic Ratings

Renzo Tonin & Associates have reviewed the proposed Boral Multiframe™Floor Systems utilising Boral plasterboard and other proprietary products (such as floorboards, acoustic underlay, resilient ceiling mounts, and insulation) and have predicted the airborne and impact sound insulation ratings of each floor system. Table 2 below outlines the various floor systems and their respective acoustic performances.

Table 2 - Airborne and Impact Sound Insulation of Hardwood Timber Floor Systems

System Reference & Description	Plasterboard Surface Density (kg/m^2)	Predicted Acoustic Ratings			
		Airborne		Impact	
		R_w (C_{tr})	$R_w + C_{tr}$	$L_{n,w}$ (C_I)	$L_{n,w} + C_I$
Hardwood Timber Floors					
HCF26F - Boral 15mm & 18mm thick Silkwood Engineered Flooring, 18mm thick Parquetry, or 10mm & 13mm thick Overlay Solid Strip Flooring ($8.5kg/m^2$) - Boral 4mm thick Rv-4 Impact Sound Acoustic Underlay ($1.7kg/m^2$) - Minimum 19mm particleboard flooring ($12.8kg/m^2$) - 190mm to 240mm deep joists - min 115mm glass wool, min $11kg/m^3$ (R2.5 glass wool ceiling batts or equivalent) - 28mm furring channel at 600mm centres housed in a direct fixing clip arrangement - 2x13mm Boral Firestop plasterboard	21.0	58 (-8)	50	51 (+1)	52
HCF29F - Boral 15mm & 18mm thick Silkwood Engineered Flooring, 18mm thick Parquetry, or 10mm & 13mm thick Overlay Solid Strip Flooring ($8.5kg/m^2$) - Boral 4mm thick Rv-4 Impact Sound Acoustic Underlay ($1.7kg/m^2$) - Minimum 19mm particleboard flooring ($12.8kg/m^2$) - 190mm to 240mm deep joists - min 115mm glass wool, min $11kg/m^3$ (R2.5 glass wool ceiling batts or equivalent) - 28mm furring channel at 600mm centres housed in a direct fixing clip arrangement - 1x13mm Boral Firestop plasterboard - 1x16mm Boral Firestop plasterboard	23.5	60 (-8)	52	51 (+1)	52

System Reference & Description	Plasterboard Surface Density (kg/m^2)	Predicted Acoustic Ratings			
		Airborne		Impact	
		R_w (C_{tr})	$R_w + C_{tr}$	$L_{n,w}$ (C_I)	$L_{n,w} + C_I$
HCF32F - Boral 15mm & 18mm thick Silkwood Engineered Flooring, 18mm thick Parquetry, or 10mm & 13mm thick Overlay Solid Strip Flooring ($8.5kg/m^2$) - Boral 4mm thick Rv-4 Impact Sound Acoustic Underlay ($1.7kg/m^2$) - Minimum 19mm particleboard flooring ($12.8kg/m^2$) - 190mm to 240mm deep joists - min 115mm glass wool, min $11kg/m^3$ (R2.5 glass wool ceiling batts or equivalent) - 28mm furring channel at 600mm centres housed in a direct fixing clip arrangement - 2x16mm Boral Firestop plasterboard	26.0	61 (-9)	52	51 (+1)	52
HCFA26F - Boral 15mm & 18mm thick Silkwood Engineered Flooring, 18mm thick Parquetry, or 10mm & 13mm thick Overlay Solid Strip Flooring ($8.5kg/m^2$) - Minimum 19mm particleboard flooring ($12.8kg/m^2$) - 190mm to 240mm deep joists - min 115mm glass wool, min $11kg/m^3$ (R2.5 glass wool ceiling batts or equivalent) - Boral Acoustic Ceiling mounts or Embelton Ceiling Isolation Hangers - 28mm furring channel at 600mm centres - 2x13mm Boral Firestop plasterboard	21.0	58 (-6)	52	56 (+1)	57
HCFA29F - Boral 15mm & 18mm thick Silkwood Engineered Flooring, 18mm thick Parquetry, or 10mm & 13mm thick Overlay Solid Strip Flooring ($8.5kg/m^2$) - Minimum 19mm particleboard flooring ($12.8kg/m^2$) - 190mm to 240mm deep joists - min 115mm glass wool, min $11kg/m^3$ (R2.5 glass wool ceiling batts or equivalent) - Boral Acoustic Ceiling mounts or Embelton Ceiling Isolation Hangers - 28mm furring channel at 600mm centres - 1x13mm Boral Firestop plasterboard - 1x16mm Boral Firestop plasterboard	23.5	60 (-6)	54	56 (+1)	57
HCFA32F - Boral 15mm & 18mm thick Silkwood Engineered Flooring, 18mm thick Parquetry, or 10mm & 13mm thick Overlay Solid Strip Flooring ($8.5kg/m^2$) - Minimum 19mm particleboard flooring ($12.8kg/m^2$) - 190mm to 240mm deep joists - min 115mm glass wool, min $11kg/m^3$ (R2.5 glass wool ceiling batts or equivalent) - Boral Acoustic Ceiling mounts or Embelton Ceiling Isolation Hangers - 28mm furring channel at 600mm centres - 2x16mm Boral Firestop plasterboard	26.0	60 (-5)	55	56 (+1)	57

System Reference & Description	Plasterboard Surface Density (kg/m^2)	Predicted Acoustic Ratings			
		Airborne		Impact	
		R_w (C_{tr})	$R_w + C_{tr}$	$L_{n,w}$ (C_I)	$L_{n,w} + C_I$
Carpeted Timber Floors					
CCF26F - Carpet and underlay (underlay minimum density 1.1kg/m^2) - Minimum 19mm particleboard flooring (12.8kg/m^2) - 190mm to 240mm deep joists - min 215mm glass wool, min 11kg/m^3 (R5 glass wool ceiling batts or equivalent) - 28mm furring channel at 600mm centres housed in a direct fixing clip arrangement - 2x13mm Boral Firestop plasterboard	21.0	56 (-6)	50	35 (+3)	38
CCF29F - Carpet and underlay (minimum carpet underlay density 1.1kg/m^2) - Minimum 19mm particleboard flooring (12.8kg/m^2) - 190mm to 240mm deep joists - min 160mm glass wool, min 11kg/m^3 (R3.5 glass wool ceiling batts or equivalent) - 28mm furring channel at 600mm centres housed in a direct fixing clip arrangement - 1x13mm Boral Firestop plasterboard - 1x16mm Boral Firestop plasterboard	23.5	56 (-6)	50	35 (+3)	38
CCF32F - Carpet and underlay (minimum carpet underlay density 1.1kg/m^2) - Minimum 19mm particleboard flooring (12.8kg/m^2) - 190mm to 240mm deep joists - min 160mm glass wool, min 11kg/m^3 (R3.5 glass wool ceiling batts or equivalent) - 28mm furring channel at 600mm centres housed in a direct fixing clip arrangement - 2x16mm Boral Firestop plasterboard	26.0	57 (-7)	50	35 (+3)	38
Tiled Timber Floors					
TCFA26F - 6mm ceramic floor on 6mm thick fibre cement sheeting (total nominal mass 15kg/m^2) - Minimum 19mm particleboard flooring (12.8kg/m^2) - 190mm to 240mm deep joists - min 115mm glass wool, min 11kg/m^3 (R2.5 glass wool ceiling batts or equivalent) - Boral Acoustic Ceiling mounts or Embelton Ceiling Isolation Hangers - 28mm furring channel at 600mm centres - 2x13mm Boral Firestop plasterboard	21.0	58 (-8)	50	59 (-1)	58

System Reference & Description	Plasterboard Surface Density (kg/m^2)	Predicted Acoustic Ratings			
		Airborne		Impact	
		R_w (C_{tr})	$R_w + C_{tr}$	$L_{n,w}$ (C_I)	$L_{n,w} + C_I$
TCFA29F - 6mm ceramic floor on 6mm thick fibre cement sheeting (total nominal mass $15kg/m^2$) - Minimum 19mm particleboard flooring ($12.8kg/m^2$) - 190mm to 240mm deep joists - min 115mm glass wool, min $11kg/m^3$ (R2.5 glass wool ceiling batts or equivalent) - Boral Acoustic Ceiling mounts or Embelton Ceiling Isolation Hangers - 28mm furring channel at 600mm centres - 1x13mm Boral Firestop plasterboard - 1x16mm Boral Firestop plasterboard	23.5	60 (-8)	52	59 (-1)	58
TCFA32F - 6mm ceramic floor on 6mm thick fibre cement sheeting (total nominal mass $15kg/m^2$) - Minimum 19mm particleboard flooring ($12.8kg/m^2$) - 190mm to 240mm deep joists - min 115mm glass wool, min $11kg/m^3$ (R2.5 glass wool ceiling batts or equivalent) - Boral Acoustic Ceiling mounts or Embelton Ceiling Isolation Hangers - 28mm furring channel at 600mm centres - 2x16mm Boral Firestop plasterboard	26.0	61 (-8)	53	59 (-1)	58

NOTES:

1. Where a floor or wall system has not been tested in the laboratory for its sound insulation performance, an acoustic opinion has been provided. This acoustic opinion is not a laboratory test result.

2. The acoustic rating of the wall was based on both laboratory test results of similar constructions and calculations using predictive models. The expected tolerance of the opinions is ±2dB for Rw, Ln.w and ±3dB Ln,w + CI and Rw + Ctr. This allows for variation in the test method, the difference between laboratories and the accuracy of the estimating techniques. The rating obtained on a building site may differ from laboratory result. The opinion stated above assumes the wall is of good construction with the perimeter of the wall sealed acoustically with mastic and no penetrations though the wall.

3. The Rw (Weight Sound Reduction Index) is a single number index used to rate the sound isolation of a partition which does not have significant low frequency component. The R_w is single number descriptor for quantifying the attenuating performance of partitions for typical intrusive noises produced inside residences. The higher the rating, the greater the isolation provided by the partition.

4. Spectrum adaptation factors are commonly used to compensate for the fact that certain kinds of sounds are more readily transmitted through insulating materials than others insulate. The adaptation factor C_{tr} has now been introduced for most building elements which require an airborne sound insulation rating.

5. C and Ctr are adaption terms which when applied to the Rw value result in a single number index which provides a more reliable indicator of the ability of the partition to isolate against certain types of noise. In particular, the Rw combined with the Ctr value gives a more reliable indicator of the ability of the partition to isolate against noise containing low frequency components and has been chosen in large part, in recognition of the problem of the high bass frequency outputs of modern home theatre systems and music reproduction equipment.