REPORT ON

THERMAL PERFORMANCE

OF

INSULATED WALLS

FOR

AUSTECH EXTERNAL BUILDING PRODUCTS PTY LTD

December, 1993

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1 AIM

To determine the overall thermal resistances of typical wall constructions incorporating *DURATUFF F2000*.

The client for these calculations is the manufacturer, Austech External Building Products Pty Ltd, PO Box 208, Marayong NSW 2148.

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2 CALCULATIONS

Calculations are for the winter condition of 12°C outside air temperature. The winter inside air temperature has been taken as 18°C per AS2627–1983 Appendix B.

The following calculations are based upon the Australian Institute of Refrigeration Air-conditioning & Heating (AIRAH) Design Data, Section 3–1 Thermal Properties, Heat Transfer Data.

In general, the overall thermal resistance comprises the combined effect of two heat paths:

- through frames
- through air spaces and insulation

The resulting overall R is calculated by the reciprocal of the weighted mean of the conductances.

Because of the sensitivity of the thermal resistance of reflective air spaces to surface temperatures, it was also necessary to perform calculations based upon the U.S.A. Division of Housing Research Paper 32 (HR32) equations (1)––(5), and Figure 8.

Calculation of the total thermal resistance through reflective spaces involved an iterative procedure. The air space mean temperature and temperature drop was estimated; then the resistance of the air space was determined by the Robinson and Powlitch method. This enabled improved estimation of the air space mean temperature and temperature drop, and further calculations.

For the sake of brevity, only the final converged calculations are presented. Because of normal variations in building materials, the report resistance values for plasterboard and timber have an estimated error of 10%.

All calculations were done by:

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PAPERS PUBLISHED:
Low Energy Housing Design, UNESCO conference, Alice Springs 1990 (coauthor with Angelo Delsante, CSIRO)
Calculation of Energy Targets, ASHRAE Journal, Oct 87.

3 RESULTS

ITEM (5c) Wall with Gyprock, Stud frame, Weatherboard, Duratuff (Winter)

(12°C outside air temperature. 18°C inside air temperature.)

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED CAVITY BETWEEN STUDS

Result after converging iterations:

For air space,	Tmean =	16.37	°C = 61.5 °F => hrsi =	5.52	W/(m².K) (ref pg1 HR32)
e1= 0.87	e2= 0.87		=>E=1/(1/e1+1/e2-1)=	0.77	
dT= 1.15	°C <=>	2.07	°F		
L= 90	mm <=>	3.54	inch		
	dTxL³ =	92.0	°F.inch³		
From HR32 Fig.8, (hcL)50=		**0.514**	BTU.inch/h.ft².°F		
	hc50=	0.145	BTU/h.ft².°F		
	=> hc=	0.143	BTU/h.ft².°F		
	<=> hc=	0.814	W/m².K		
Space conductance C=Ehr+hc=		5.068	W/m².K		
=> Space resistance R=1/C =		0.197	m².K/W (unventilated cavity)		

Wall Space (90%)	m².K/W	Note	Tout	Tin	Tmean	dT °C
Outdoor air film:	0.030	1	**12.00**	12.17	12.09	-0.17
Duratuff:	0.505	2	12.17	15.12	13.65	-2.94
Unventilated cavity:	0.030	3	15.12	15.29	15.20	-0.17
Weatherboard:	0.086	5	15.29	15.79	15.54	-0.50
Unventilated Cavity:	0.197	3a	15.79	16.94	16.37	-1.15
10mm Gyprock:	0.062	4	16.94	17.30	17.12	-0.36
Indoor air film:	0.120	1	17.30	**18.00**	17.65	-0.70
Total R:	1.03					

Wall Frame (10%)	m².K/W	Note
Outdoor air film:	0.030	1
Duratuff:	0.505	2
Unventilated cavity:	0.030	5
Weatherboard:	0.086	5
90mm stud:	0.900	5
10mm Gyprock:	0.062	4
Indoor air film:	0.120	1
Total R:	1.73	
WEIGHTED MEAN R =	**1.1**	6

NOTES:

Calc: 8-Aug-94 4:59 PM

Calculations for Winter conditions.
12°C outside air temperature. 18°C inside air temperature.

1 Table 3.3 AIRAH Design Data.
Air surface film, Winter, exterior, R=0.03 m².K/W.
Air surface film, still air, interior, R=0.12 m².K/W.
2 From ETRS test data 12.11.92 report no. WC92-659.
3 Unventilated partial cavity between Duratuff and weatherboard. 3a Non-reflective, unventilated cavity.
4 CSR Gyprock test data.
5 Table 3.1 AIRAH Design Data.
6 Reciprocal of weighted mean of conductances.

CONCLUSION:

For a wall with 10mm Gyprock, 90mm stud frame, Weatherboard, and non-reflective Duratuff, the overall R value is 1.1 m².K/W (winter conditions).

3 RESULTS

ITEM (1) Wall with Gyprock, Stud frame, Duratuff F2000 insulated panelling with RFL (Winter)

(12°C outside air temperature. 18°C inside air temperature.)

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED CAVITY WITHIN WALL

Result after converging iterations:

For air space,	Tmean =	15.74	°C = 60.3	°F => hrsi =	5.49 W/(m².K) (ref pg1 HR32)
e1= 0.05	e2= 0.87		=>E=1/(1/e1+1/e2-1)=	0.05	
dT= 2.99	°C <=>	5.38	°F		
L= 90	mm <=>	3.54	inch		
	dTxL³ =	239.4	°F.inch³		
From HR32 Fig.8, (hcL)50=		**0.714**	BTU.inch/h.ft².°F		
	hc50=	0.201	BTU/h.ft².°F		
	=> hc=	0.199	BTU/h.ft².°F		
	<=> hc=	1.132	W/m².K		
Space conductance C=Ehr+hc=		1.404	W/m².K		
=> Space resistance R=1/C =		0.712	m².K/W (unventilated cavity)		

Wall Space (90%)	m².K/W	Note	Tout	Tin	Tmean	dT °C
Outdoor air film:	0.030	1	**12.00**	12.13	12.06	-0.13
Duratuff F2000:	0.505	2	12.13	14.25	13.19	-2.12
Unventilated Cavity:	0.712	3	14.25	17.24	15.74	-2.99
10mm Gyprock:	0.062	4	17.24	17.50	17.37	-0.26
Indoor air film:	0.120	1	17.50	**18.00**	17.75	-0.50
Total R:	1.43					

Wall Frame (10%)	m².K/W	Note
Outdoor air film:	0.030	1
Duratuff F2000:	0.505	2
90mm stud:	0.900	5
10mm Gyprock:	0.062	4
Indoor air film:	0.120	1
Total R:	1.62	
WEIGHTED MEAN R =	**1.4**	6

NOTES: Calculations for Winter conditions.

Calc: 21-Dec-93 1:55 PM 12°C outside air temperature. 18°C inside air temperature.

1 Table 3.3 AIRAH Design Data.
Air surface film, Winter, exterior, R=0.03 m².K/W.
Air surface film, still air, interior, R=0.12 m².K/W.
2 From ETRS test data 12.11.92 report no. WC92-659. Duratuff F2000 has RFL facing cavity.
3 Reflective, unventilated cavity.
4 CSR Gyprock test data.
5 Table 3.1 AIRAH Design Data.
6 Reciprocal of weighted mean of conductances.

CONCLUSION:

For a wall with 10mm Gyprock, 90mm stud frame and Duratuff F2000 insulated panelling with RFL facing cavity, the overall R value is 1.4 m².K/W (winter conditions).

3 RESULTS

ITEM (2) Wall with Gyprock, Stud frame, RFL, 3-Ply bracing, Duratuff F2000 (Winter)

(12°C outside air temperature. 18°C inside air temperature.)

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED CAVITY WITHIN WALL

Result after converging iterations:

For air space,	Tmean =	15.79	°C = 60.4 °F => hrsi =	5.49	W/(m².K) (ref pg1 HR32)
e1= 0.05	e2=	0.87	=>E=1/(1/e1+1/e2-1)=	0.05	
dT= 2.92	°C <=>	5.26	°F		
L= 90	mm <=>	3.54	inch		
	dTxL³ =	234.0	°F.inch³		
From HR32 Fig.8, (hcL)50=		**0.710**	BTU.inch/h.ft².°F		
	hc50=	0.200	BTU/h.ft².°F		
	=> hc=	0.198	BTU/h.ft².°F		
	<=> hc=	1.126	W/m².K		
Space conductance C=Ehr+hc=		1.398	W/m².K		
=> Space resistance R=1/C =		0.715	m².K/W (unventilated cavity)		

Wall Space (90%)	m².K/W	Note	Tout	Tin	Tmean	dT °C
Outdoor air film:	0.030	1	**12.00**	12.12	12.06	-0.12
Duratuff F2000 & 3-ply:	0.541	2	12.12	14.33	13.23	-2.21
RFL:	0.000	5	14.33	14.33	14.33	0.00
Unventilated Cavity:	0.715	3	14.33	17.26	15.79	-2.92
10mm Gyprock:	0.062	4	17.26	17.51	17.38	-0.25
Indoor air film:	0.120	1	17.51	**18.00**	17.75	-0.49
Total R:	1.47					

Wall Frame (10%)	m².K/W	Note
Outdoor air film:	0.030	1
Duratuff F2000 & 3-ply:	0.541	2
RFL:	0.000	5
90mm stud:	0.900	5
10mm Gyprock:	0.062	4
Indoor air film:	0.120	1
Total R:	1.65	
WEIGHTED MEAN R =	**1.5**	6

NOTES: Calculations for Winter conditions.

Calc: 21-Dec-93 1:55 PM 12°C outside air temperature. 18°C inside air temperature.

1 Table 3.3 AIRAH Design Data.
Air surface film, Winter, exterior, R=0.03 m².K/W.
Air surface film, still air, interior, R=0.12 m².K/W.
2 From ETRS test data 12.11.92 report no. WC92-659 R=.505 + 3-ply R=.036
RFL on Duratuff F2000 ineffective as it touches 3-ply.
3 Reflective, unventilated cavity.
4 CSR Gyprock test data.
5 Additional RFL between studs and 3-ply faces cavity. Table 3.1 AIRAH Design Data.
6 Reciprocal of weighted mean of conductances.

CONCLUSION:

For a wall with 10mm Gyprock, 90mm stud frame, RFL facing cavity, 3-ply bracing, and Duratuff F2000, the overall R value is 1.5 m².K/W (winter conditions).

3 RESULTS

ITEM (3) Wall with Gyprock, Stud frame, RFL, Weatherboard, Duratuff F2000 (Winter)

(12°C outside air temperature. 18°C inside air temperature.)

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED CAVITY BETWEEN STUDS

Result after converging iterations:

For air space,	Tmean =	16.01	°C = 60.8	°F => hrsi =	5.50 W/(m².K) (ref pg1 HR32)
e1= 0.05	e2= 0.87		=>E=1/(1/e1+1/e2-1)=	0.05	
dT= 2.66	°C <=>	4.79	°F		
L= 90	mm <=>	3.54	inch		
	dTxL³ =	212.9	°F.inch³		
From HR32 Fig.8, (hcL)50=		**0.694**	BTU.inch/h.ft².°F		
	hc50=	0.196	BTU/h.ft².°F		
	=> hc=	0.194	BTU/h.ft².°F		
	<=> hc=	1.100	W/m².K		
Space conductance C=Ehr+hc=		1.373	W/m².K		
=> Space resistance R=1/C =		0.728	m².K/W	(unventilated cavity)	

Wall Space (90%)	m².K/W	Note	Tout	Tin	Tmean	dT °C
Outdoor air film:	0.030	1	**12.00**	12.11	12.05	-0.11
Duratuff F2000:	0.505	2	12.11	13.95	13.03	-1.84
Unventilated partial cavity:	0.112	3	13.95	14.36	14.16	-0.41
Weatherboard:	0.086	5	14.36	14.68	14.52	-0.31
RFL:	0.000	5	14.68	14.68	14.68	0.00
Unventilated Cavity:	0.728	3	14.68	17.34	16.01	-2.66
10mm Gyprock:	0.062	4	17.34	17.56	17.45	-0.23
Indoor air film:	0.120	1	17.56	**18.00**	17.78	-0.44
Total R:	1.64					

Wall Frame (10%)	m².K/W	Note	
Outdoor air film:	0.030	1	
Duratuff F2000:	0.505	2	
Unventilated partial cavity:	0.112	3	<Estimated for gap between weatherboad and Duratuff F2000.
Weatherboard:	0.086	5	
RFL:	0.000	5	
90mm stud:	0.900	5	
10mm Gyprock:	0.062	4	
Indoor air film:	0.120	1	
Total R:	1.81		
WEIGHTED MEAN R =	**1.7**	6	

NOTES: Calculations for Winter conditions.

Calc: 21-Dec-93 1:54 PM 12°C outside air temperature. 18°C inside air temperature.

1 Table 3.3 AIRAH Design Data.
Air surface film, Winter, exterior, R=0.03 m².K/W.
Air surface film, still air, interior, R=0.12 m².K/W.
2 From ETRS test data 12.11.92 report no. WC92-659 R=.505
3 Reflective, unventilated cavity.
4 CSR Gyprock test data.
5 Additional RFL between studs and weatherboard faces cavity. Table 3.1 AIRAH Design Data.
6 Reciprocal of weighted mean of conductances.

CONCLUSION:

For a wall with 10mm Gyprock, 90mm stud frame, RFL, Weatherboard, and Duratuff F2000, the overall R value is 1.7 m².K/W (winter conditions).

3 RESULTS

ITEM (6) Wall with Gyprock, Stud frame, Fibro-cement, 12mm Battens, Duratuff F2000 (Winter)

(12°C outside air temperature. 18°C inside air temperature.)

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED OUTER CAVITY

Result after converging iterations:

For air space,	Tmean =	15.29	°C =	59.5	°F => hrsi =	5.46 W/(m².K) (ref pg1 HR32)
e1= 0.05	e2= 0.87		=>E=1/(1/e1+1/e2-1)=	0.05		
dT= 1.87	°C <=>	3.36	°F			
L= 12	mm <=>	0.47	inch			
	dTxL³ =	0.35	°F.inch³			
From HR32 Fig.8, (hcL)50=		**0.176**	BTU.inch/h.ft².°F			
	hc50=	0.373	BTU/h.ft².°F			
	=> hc=	0.369	BTU/h.ft².°F			
	<=> hc=	2.095	W/m².K			
Space conductance C=Ehr+hc=		2.366	W/m².K			
=> Space resistance R=1/C =		0.423	m².K/W (unventilated cavity)			

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED CAVITY BETWEEN STUDS

Result after converging iterations:

For air space,	Tmean =	16.76	°C = 62.2	°F => hrsi =	5.55 W/(m².K) (ref pg1 HR32)	
e1= 0.87	e2= 0.87		=>E=1/(1/e1+1/e2-1)=	0.77		
dT= 0.88	°C <=>	1.59	°F			
L= 90	mm <=>	3.54	inch			
	dTxL³ =	70.6	°F.inch³			
From HR32 Fig.8, (hcL)50=		**0.466**	BTU.inch/h.ft².°F			
	hc50=	0.132	BTU/h.ft².°F			
	=> hc=	0.130	BTU/h.ft².°F			
	<=> hc=	0.738	W/m².K			
Space conductance C=Ehr+hc=		5.009	W/m².K			
=> Space resistance R=1/C =		0.200	m².K/W (unventilated cavity)			

Wall Space (90%)		m².K/W	Note	Tout	Tin	Tmean	dT °C
Outdoor air film:		0.030	1	**12.00**	12.13	12.07	-0.13
Duratuff F2000:		0.505	2	12.13	14.36	13.25	-2.23
Unventilated cavity:		0.423	3	14.36	16.23	15.29	-1.87
Fibro-cement:		0.020	5	16.23	16.32	16.27	-0.09
Unventilated Cavity:		0.200	3a	16.32	17.20	16.76	-0.88
10mm Gyprock:		0.062	4	17.20	17.47	17.33	-0.27
Indoor air film:		0.120	1	17.47	**18.00**	17.74	-0.53
	Total R:	1.36					

Wall Frame (10%)		m².K/W	Note
Outdoor air film:		0.030	1
Duratuff F2000:		0.505	2
12mm Battens:		0.140	5
Fibro-cement:		0.020	5
90mm stud:		0.900	5
10mm Gyprock:		0.062	4
Indoor air film:		0.120	1
	Total R:	1.78	
WEIGHTED MEAN R =		**1.4**	6

NOTES: Calculations for Winter conditions.

Calc: 21-Dec-93 1:53 PM 12°C outside air temperature. 18°C inside air temperature.

1 Table 3.3 AIRAH Design Data.
Air surface film, Winter, exterior, R=0.03 m².K/W.
Air surface film, still air, interior, R=0.12 m².K/W.
2 From ETRS test data 12.11.92 report no. WC92-659 R=.505
3 Reflective, unventilated cavity. 3a Non-reflective, unventilated cavity.
4 CSR Gyprock test data.
5 Table 3.1 AIRAH Design Data.
6 Reciprocal of weighted mean of conductances.

CONCLUSION:

For a wall with 10mm Gyprock, 90mm stud frame, Fibro-cement, 12mm Battens, and Duratuff F2000, the overall R value is 1.4 m².K/W (winter conditions).

3 RESULTS

ITEM (5) Wall with Gyprock, Stud frame, Weatherboard, 12mm Battens, Duratuff F2000 (Winter)

(12°C outside air temperature. 18°C inside air temperature.)

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED OUTER CAVITY

Result after converging iterations:

For air space,	Tmean =	15.13	°C =	59.2	°F => hrsi =	5.45 W/(m².K) (ref pg1 HR32)
e1= 0.05	e2= 0.87		=>E=1/(1/e1+1/e2-1)=	0.05		
dT= 2.11	°C <=>	3.79	°F			
L= 16	mm <=>	0.63	inch			
	dTxL³ =	0.95	°F.inch³			
From HR32 Fig.8, (hcL)50=		**0.176**	BTU.inch/h.ft².°F			
	hc50=	0.279	BTU/h.ft².°F			
	=> hc=	0.277	BTU/h.ft².°F			
	<=> hc=	1.572	W/m².K			
Space conductance C=Ehr+hc=		1.843	W/m².K			
=> Space resistance = 1/C =		0.543	m².K/W	(esitmated for varying gap between weatherboard and Duratuff F2000)		

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED CAVITY BETWEEN STUDS

Result after converging iterations:

For air space,	Tmean =	16.90	°C = 62.4	°F => hrsi =	5.56 W/(m².K) (ref pg1 HR32)	
e1= 0.87	e2= 0.87		=>E=1/(1/e1+1/e2-1)=	0.77		
dT= 0.78	°C <=>	1.40	°F			
L= 90	mm <=>	3.54	inch			
	dTxL³ =	62.3	°F.inch³			
From HR32 Fig.8, (hcL)50=		**0.446**	BTU.inch/h.ft².°F			
	hc50=	0.126	BTU/h.ft².°F			
	=> hc=	0.124	BTU/h.ft².°F			
	<=> hc=	0.706	W/m².K			
Space conductance C=Ehr+hc=		4.983	W/m².K			
=> Space resistance R=1/C =		0.201	m².K/W	(unventilated cavity)		

Wall Space (90%)		m².K/W	Note	Tout	Tin	Tmean	dT °C
Outdoor air film:		0.030	1	**12.00**	12.12	12.06	-0.12
Duratuff F2000:		0.505	2	12.12	14.08	13.10	-1.96
Unventilated cavity:		0.543	3	14.08	16.18	15.13	-2.11
Weatherboard:		0.086	5	16.18	16.52	16.35	-0.33
Unventilated Cavity:		0.201	3a	16.52	17.29	16.90	-0.78
10mm Gyprock:		0.062	4	17.29	17.53	17.41	-0.24
Indoor air film:		0.120	1	17.53	**18.00**	17.77	-0.47
	Total R:	1.55					

Wall Frame (10%)		m².K/W	Note
Outdoor air film:		0.030	1
Duratuff F2000:		0.505	2
12mm Battens:		0.140	5
Weatherboard:		0.086	5
90mm stud:		0.900	5
10mm Gyprock:		0.062	4
Indoor air film:		0.120	1
	Total R:	1.84	
WEIGHTED MEAN R =		**1.6**	6

NOTES: Calculations for Winter conditions.

Calc: 21-Dec-93 1:48 PM 12°C outside air temperature. 18°C inside air temperature.

1 Table 3.3 AIRAH Design Data.
Air surface film, Winter, exterior, R=0.03 m².K/W.
Air surface film, still air, interior, R=0.12 m².K/W.
2 From ETRS test data 12.11.92 report no. WC92-659 R=.505
3 Reflective, unventilated cavity. 3a Non-reflective, unventilated cavity.
4 CSR Gyprock test data.
5 Table 3.1 AIRAH Design Data.
6 Reciprocal of weighted mean of conductances.

CONCLUSION:

For a wall with 10mm Gyprock, 90mm stud frame, Weatherboard, 12mm Battens, and Duratuff F2000, the overall R value is 1.6 m².K/W (winter conditions).

3 RESULTS

ITEM (5A) Wall with Gyprock, Stud frame, Weatherboard, 18mm Battens, Duratuff F2000 (Winter)

(12°C outside air temperature. 18°C inside air temperature.)

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED OUTER CAVITY

Result after converging iterations:

For air space, Tmean = 15.12 °C = 59.2 °F => hrsi = 5.45 W/(m².K) (ref pg1 HR32)
e1= 0.05 e2= 0.87 =>E=1/(1/e1+1/e2-1)= 0.05
dT= 2.46 °C <=> 4.43 °F
L= 22 mm <=> 0.87 inch
dTxL³ = 2.88 °F.inch³
From HR32 Fig.8, (hcL)50= **0.179** BTU.inch/h.ft².°F
hc50= 0.206 BTU/h.ft².°F
=> hc= 0.204 BTU/h.ft².°F
<=> hc= 1.160 W/m².K
Space conductance C=Ehr+hc= 1.430 W/m².K
=> Space resistance = 1/C = 0.699 m².K/W (esitmated for varying gap between weatherboard and Duratuff F2000)

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED CAVITY BETWEEN STUDS

Result after converging iterations:

For air space, Tmean = 17.00 °C = 62.6 °F => hrsi = 5.56 W/(m².K) (ref pg1 HR32)
e1= 0.87 e2= 0.87 =>E=1/(1/e1+1/e2-1)= 0.77
dT= 0.71 °C <=> 1.28 °F
L= 90 mm <=> 3.54 inch
dTxL³ = 56.8 °F.inch³
From HR32 Fig.8, (hcL)50= **0.430** BTU.inch/h.ft².°F
hc50= 0.121 BTU/h.ft².°F
=> hc= 0.120 BTU/h.ft².°F
<=> hc= 0.681 W/m².K
Space conductance C=Ehr+hc= 4.963 W/m².K
=> Space resistance R=1/C = 0.201 m².K/W (unventilated cavity)

Wall Space (90%)	m².K/W	Note	Tout	Tin	Tmean	dT °C
Outdoor air film:	0.030	1	**12.00**	12.11	12.05	-0.11
Duratuff F2000:	0.505	2	12.11	13.88	12.99	-1.78
Unventilated cavity:	0.699	3	13.88	16.35	15.12	-2.46
Weatherboard:	0.086	5	16.35	16.65	16.50	-0.30
Unventilated Cavity:	0.201	3a	16.65	17.36	17.00	-0.71
10mm Gyprock:	0.062	4	17.36	17.58	17.47	-0.22
Indoor air film:	0.120	1	17.58	**18.00**	17.79	-0.42
Total R:	1.70					

Wall Frame (10%)	m².K/W	Note
Outdoor air film:	0.030	1
Duratuff F2000:	0.505	2
18mm Battens:	0.200	5
Weatherboard:	0.086	5
90mm stud:	0.900	5
10mm Gyprock:	0.062	4
Indoor air film:	0.120	1
Total R:	1.90	
WEIGHTED MEAN R =	**1.7**	6

NOTES: Calculations for Winter conditions.
Calc: 21-Dec-93 2:01 PM 12°C outside air temperature. 18°C inside air temperature.

1 Table 3.3 AIRAH Design Data.
Air surface film, Winter, exterior, R=0.03 m².K/W.
Air surface film, still air, interior, R=0.12 m².K/W.
2 From ETRS test data 12.11.92 report no. WC92-659 R=.505
3 Reflective, unventilated cavity. 3a Non-reflective, unventilated cavity.
4 CSR Gyprock test data.
5 Table 3.1 AIRAH Design Data.
6 Reciprocal of weighted mean of conductances.

CONCLUSION:

For a wall with 10mm Gyprock, 90mm stud frame, Weatherboard, 18mm Battens, and Duratuff F2000, the overall R value is 1.7 m².K/W (winter conditions).

3 RESULTS

ITEM (5b) Wall with Gyprock, Stud frame, Weatherboard, Alcan Thermalside (Winter)

(12°C outside air temperature. 18°C inside air temperature.)

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED CAVITY BETWEEN STUDS

Result after converging iterations:

For air space,	Tmean =	16.40	°C = 61.5	°F => hrsi =	5.53 W/(m².K) (ref pg1 HR32)
e1= 0.87	e2= 0.87		=>E=1/(1/e1+1/e2-1)=	0.77	
dT= 1.13	°C <=>	2.03	°F		
L= 90	mm <=>	3.54	inch		
	dTxL³ =	90.3	°F.inch³		
From HR32 Fig.8, (hcL)50=		**0.511**	BTU.inch/h.ft².°F		
	hc50=	0.144	BTU/h.ft².°F		
	=> hc=	0.142	BTU/h.ft².°F		
	<=> hc=	0.809	W/m².K		
Space conductance C=Ehr+hc=		5.064	W/m².K		
=> Space resistance R=1/C =		0.197	m².K/W	(unventilated cavity)	

Wall Space (90%)	m².K/W	Note	Tout	Tin	Tmean	dT °C
Outdoor air film:	0.030	1	**12.00**	12.17	12.09	-0.17
Alcan Thermalside:	0.505	2	12.17	15.06	13.61	-2.88
Unventilated cavity:	0.050	3	15.06	15.34	15.20	-0.29
Weatherboard:	0.086	5	15.34	15.83	15.59	-0.49
Unventilated Cavity:	0.197	3a	15.83	16.96	16.40	-1.13
10mm Gyprock:	0.062	4	16.96	17.31	17.14	-0.35
Indoor air film:	0.120	1	17.31	**18.00**	17.66	-0.69
Total R:	1.05					

Wall Frame (10%)	m².K/W	Note
Outdoor air film:	0.030	1
Alcan Thermalside:	0.505	2
Unventilated cavity:	0.050	5
Weatherboard:	0.086	5
90mm stud:	0.900	5
10mm Gyprock:	0.062	4
Indoor air film:	0.120	1
Total R:	1.75	
WEIGHTED MEAN R =	**1.1**	6

NOTES: Calculations for Winter conditions.

Calc: 8-Aug-94 4:50 PM 12°C outside air temperature. 18°C inside air temperature.

1 Table 3.3 AIRAH Design Data.
Air surface film, Winter, exterior, R=0.03 m².K/W.
Air surface film, still air, interior, R=0.12 m².K/W.

2 From ETRS test data 12.11.92 report no. WC92-659. Duratuff F2000 has RFL facing cavity.
Duratuff F2000 is also called Alcan Thermalside (ref. fax from Austech 27.7.94)

3 Unventilated partial cavity between Thermalside and weatherboard. 3a Non-reflective, unventilated cavity.

4 CSR Gyprock test data.

5 Table 3.1 AIRAH Design Data.

6 Reciprocal of weighted mean of conductances.

CONCLUSION:

For a wall with 10mm Gyprock, 90mm stud frame, Weatherboard, and Alcan Thermalside, the overall R value is 1.1 m².K/W (winter conditions)

3 RESULTS

ITEM (4) Wall with Gyprock, Stud frame, RFL, Fibro-cement, Duratuff F2000 (Winter)

(12°C outside air temperature. 18°C inside air temperature.)

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED CAVITY WITHIN WALL

Result after converging iterations:

For air space,	Tmean =	15.77	°C = 60.4	°F => hrsi =	5.49 W/(m².K) (ref pg1 HR32)
e1= 0.05	e2= 0.87		=>E=1/(1/e1+1/e2-1)=	0.05	
dT= 2.95	°C <=>	5.31	°F		
L= 90	mm <=>	3.54	inch		
	dTxL³ =	236.4	°F.inch³		
From HR32 Fig.8, (hcL)50=		**0.711**	BTU.inch/h.ft².°F		
	hc50=	0.201	BTU/h.ft².°F		
	=> hc=	0.199	BTU/h.ft².°F		
	<=> hc=	1.128	W/m².K		
Space conductance C=Ehr+hc=		1.401	W/m².K		
=> Space resistance R=1/C =		0.714	m².K/W	(unventilated cavity)	

Wall Space (90%)	m².K/W	Note	Tout	Tin	Tmean	dT °C
Outdoor air film:	0.030	1	**12.00**	12.12	12.06	-0.12
Duratuff F2000 & Fibro-cement:	0.525	2	12.12	14.30	13.21	-2.17
RFL:	0.000	5	14.30	14.30	14.30	0.00
Unventilated Cavity:	0.714	3	14.30	17.25	15.77	-2.95
10mm Gyprock:	0.062	4	17.25	17.50	17.38	-0.26
Indoor air film:	0.120	1	17.50	**18.00**	17.75	-0.50
Total R:	1.45					

Wall Frame (10%)	m².K/W	Note
Outdoor air film:	0.030	1
Duratuff F2000 & Fibro-cement:	0.525	2
RFL:	0.000	5
90mm stud:	0.900	5
10mm Gyprock:	0.062	4
Indoor air film:	0.120	1
Total R:	1.64	
WEIGHTED MEAN R =	**1.5**	6

NOTES: Calculations for Winter conditions.

Calc: 21-Dec-93 1:53 PM 12°C outside air temperature. 18°C inside air temperature.

1 Table 3.3 AIRAH Design Data.
Air surface film, Winter, exterior, R=0.03 m².K/W.
Air surface film, still air, interior, R=0.12 m².K/W.
2 From ETRS test data 12.11.92 report no. WC92-659 R=.505 + Fibro-cement R=.02
RFL on Duratuff F2000 ineffective as it touches Fibro-cement.
3 Reflective, unventilated cavity.
4 CSR Gyprock test data.
5 Additional RFL between studs and fibro-cement faces cavity. Table 3.1 AIRAH Design Data.
6 Reciprocal of weighted mean of conductances.

CONCLUSION:

For a wall with 10mm Gyprock, 90mm stud frame, RFL facing cavity, fibro-cement, and Duratuff F2000, the overall R value is 1.5 m².K/W (winter conditions).

3 RESULTS

ITEM (1a) Wall with Gyprock, Stud frame, and Alcan Thermalside (Winter)

(12°C outside air temperature. 18°C inside air temperature.)

ROBINSON POWLITCH CALCULATIONS FOR UNVENTILATED CAVITY WITHIN WALL

Result after converging iterations:

For air space,	Tmean =	15.74	°C = 60.3	°F => hrsi =	5.49 W/(m².K) (ref pg HR32)
e1= 0.05	e2= 0.87		=>E=1/(1/e1+1/e2-1)=	0.05	
dT= 2.99	°C <=>	5.38	°F		
L= 90	mm <=>	3.54	inch		
	dTxL³ =	239.4	°F.inch³		
From HR32 Fig.8, (hcL)50=		**0.714**	BTU.inch/h.ft².°F		
	hc50=	0.201	BTU/h.ft².°F		
	=> hc=	0.199	BTU/h.ft².°F		
	<=> hc=	1.132	W/m².K		
Space conductance C=Ehr+hc=		1.404	W/m².K		
=> Space resistance R=1/C =		0.712	m².K/W	(unventilated cavity)	

Wall Space (90%)	m².K/W	Note	Tout	Tin	Tmean	dT °C
Outdoor air film:	0.030	1	**12.00**	12.13	12.06	-0.13
Alcan Thermalside:	0.505	2	12.13	14.25	13.19	-2.12
Unventilated Cavity:	0.712	3	14.25	17.24	15.74	-2.99
10mm Gyprock:	0.062	4	17.24	17.50	17.37	-0.26
Indoor air film:	0.120	1	17.50	**18.00**	17.75	-0.50
Total R:	1.43					

Wall Frame (10%)	m².K/W	Note
Outdoor air film:	0.030	1
Alcan Thermalside:	0.505	2
90mm stud:	0.900	5
10mm Gyprock:	0.062	4
Indoor air film:	0.120	1
Total R:	1.62	
WEIGHTED MEAN R =	**1.4**	6

NOTES: Calculations for Winter conditions.

Calc: 8-Aug-94 4:39 PM 12°C outside air temperature. 18°C inside air temperature.

1 Table 3.3 AIRAH Design Data.
Air surface film, Winter, exterior, R=0.03 m².K/W.
Air surface film, still air, interior, R=0.12 m².K/W.
2 From ETRS test data 12.11.92 report no. WC92-659. Duratuff F2000 has RFL facing cavity.
Duratuff F2000 is also called Alcan Thermalside (ref. fax from Austech 27.7.94)
3 Reflective, unventilated cavity.
4 CSR Gyprock test data.
5 Table 3.1 AIRAH Design Data.
6 Reciprocal of weighted mean of conductances.

CONCLUSION:

For a wall with 10mm Gyprock, 90mm stud frame and Alcan Thermalside panelling with RFL facing cavity, the overall R value is 1.4 m².K/W (winter conditions).

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Section 2
Elemental Approach

Provision of thermal insulatio

2.1 This requirement will be met if relevant elements of construction have an overall R value not less than that shown in Table 1 for either all of option A or all of option B.

Table 1
Minimum overall R values ($m^2.K/W$)

	Option A	Option B
Roof or Ceiling	2.2	2.2
External Walls	1.3	1.7
Ground Floor	1.0	1.4
	Slab on ground, or Timber floor with RFL, or Timber floor with R0.6 insulation.	Uninsulated Timber Floor