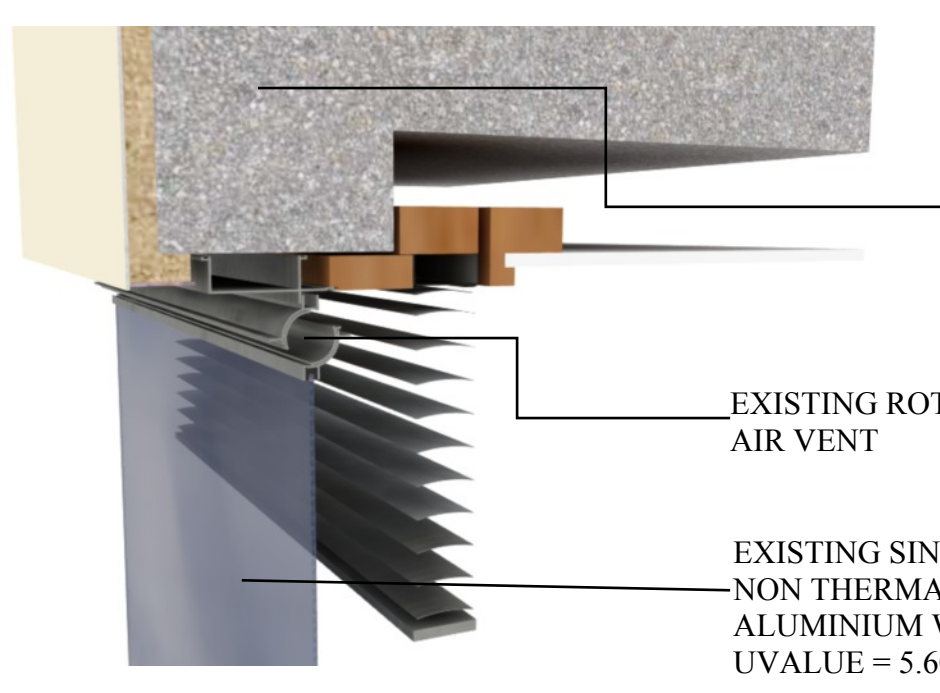
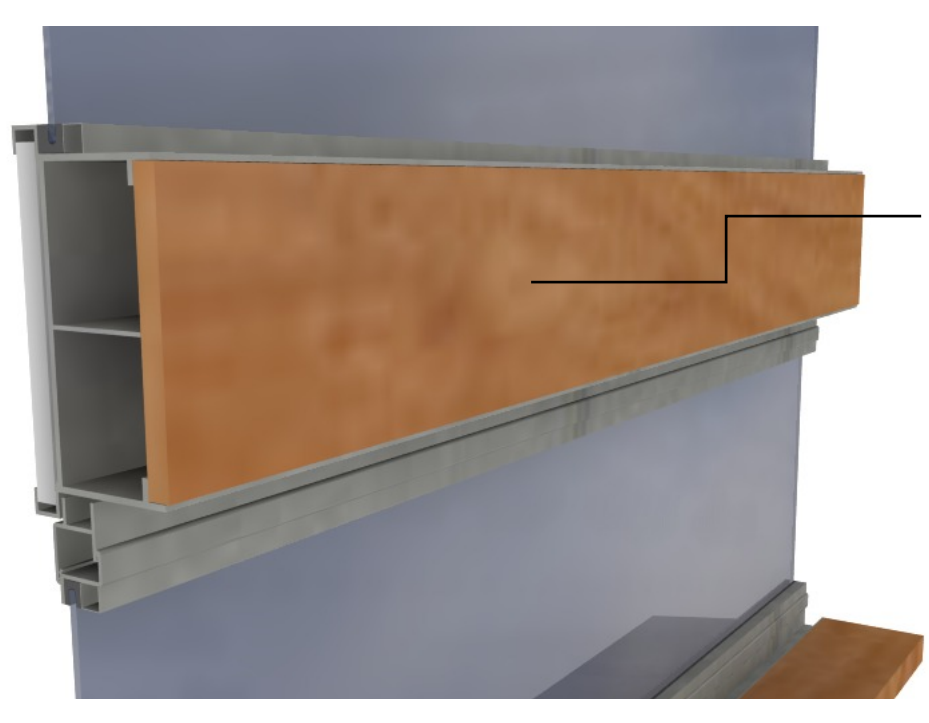
DUBLIN SCHOOL OF ARCHITECTURE
POSTGRADUATE DIPLOMA IN DIGITAL ANALYSIS AND ENERGY RETROFIT - DT774A
ARCH 2080 OFFICE RETROFIT - LIBERTY HALL


EXISTING EXTERNAL CONCRETE UP STAND WALL WITH MOSAIC TILE FINISH UVALUE = 3.33 W/(M2)

EXISTING ROTARY AIR VENT

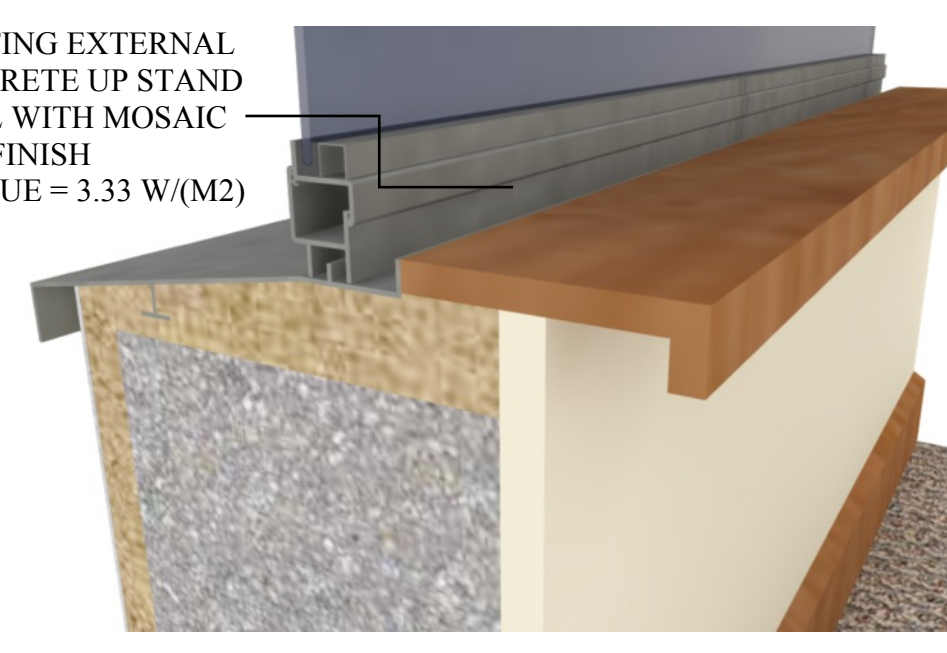
EXISTING SINGLE GLAZED NON THERMALLY BROKEN ALUMINIUM WINDOW UVALUE = 5.60 W/(M2)

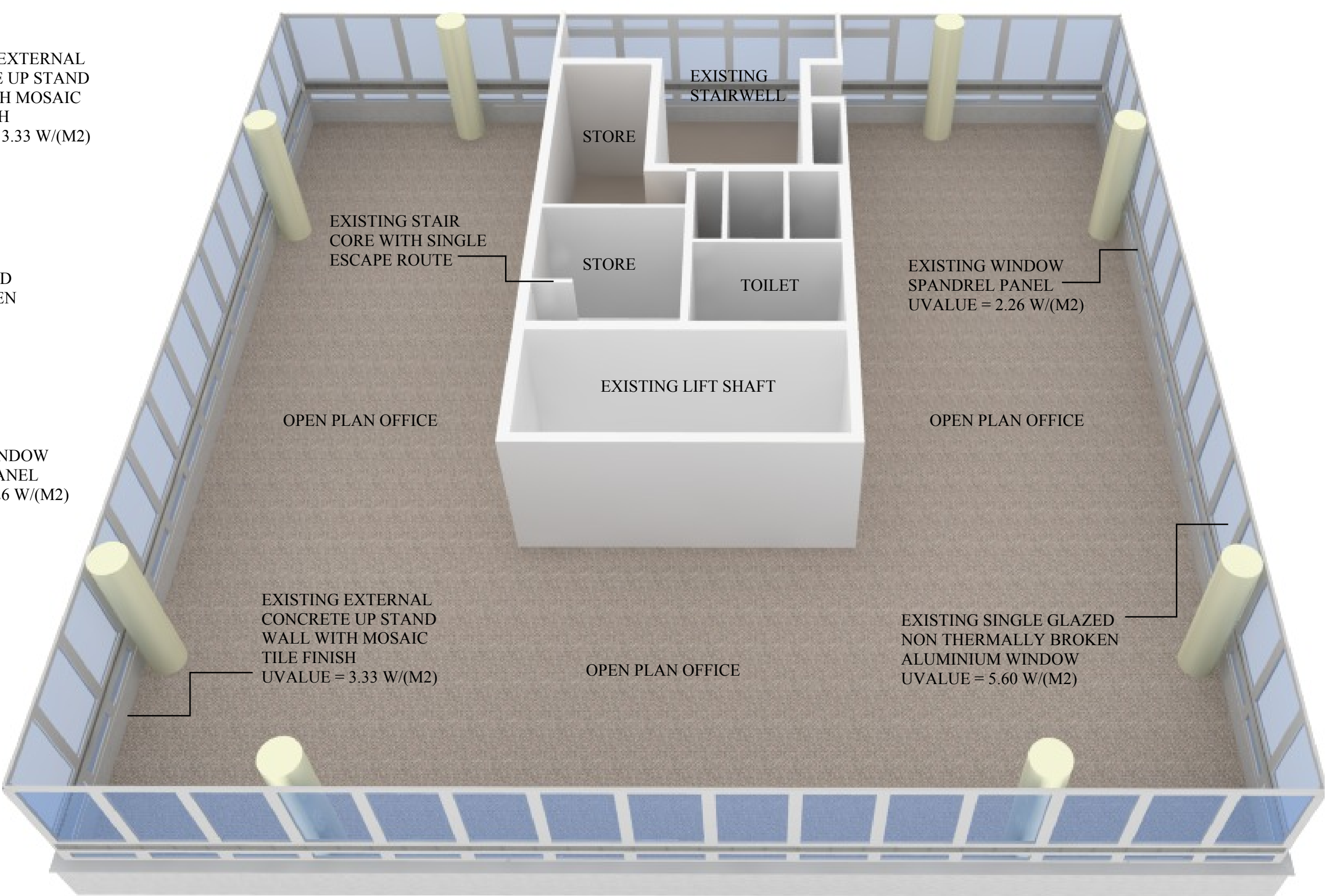
BASELINE WINDOW HEAD


EXISTING WINDOW SPANDREL PANEL UVALUE = 2.26 W/(M2)

BASELINE SPANDREL PANEL

EXISTING EXTERNAL CONCRETE UP STAND WALL WITH MOSAIC TILE FINISH UVALUE = 3.33 W/(M2)

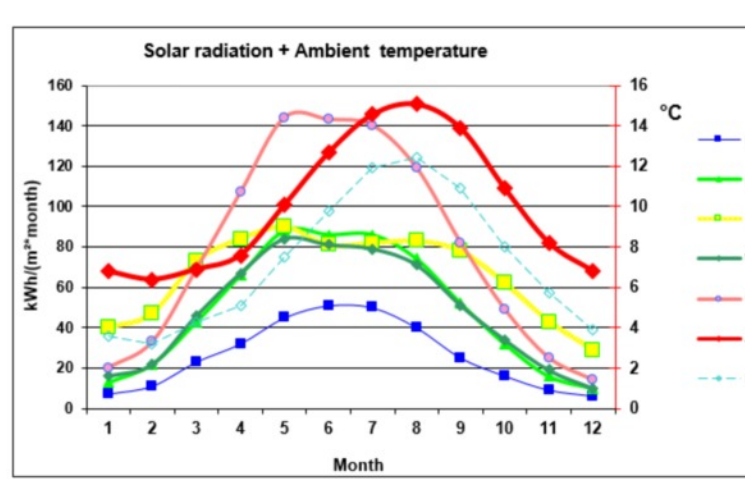

BASELINE WINDOW CILL



BASELINE FLOOR PLAN

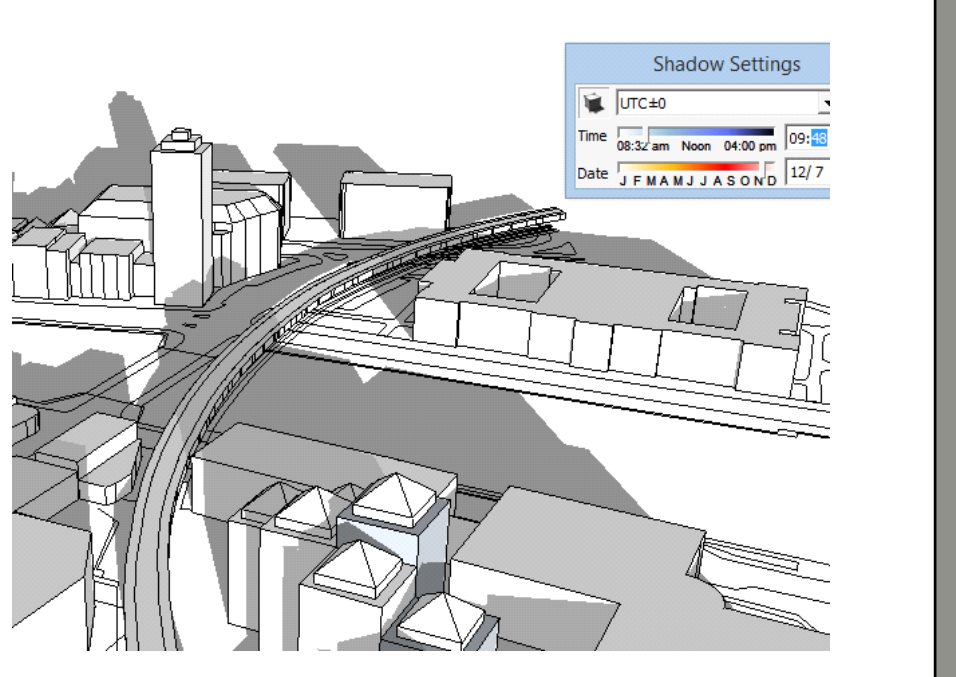
Façade Baseline		
Heat Distribution During Occupancy Hours (3032 Hrs)		
Zone	Hours Above 25°c	Hours Above 28°c
South Office	21	0
East Office	29	0
West Office	34	0
Target Hours	5% = 151.60 Hours	1% = 30.32 Hours

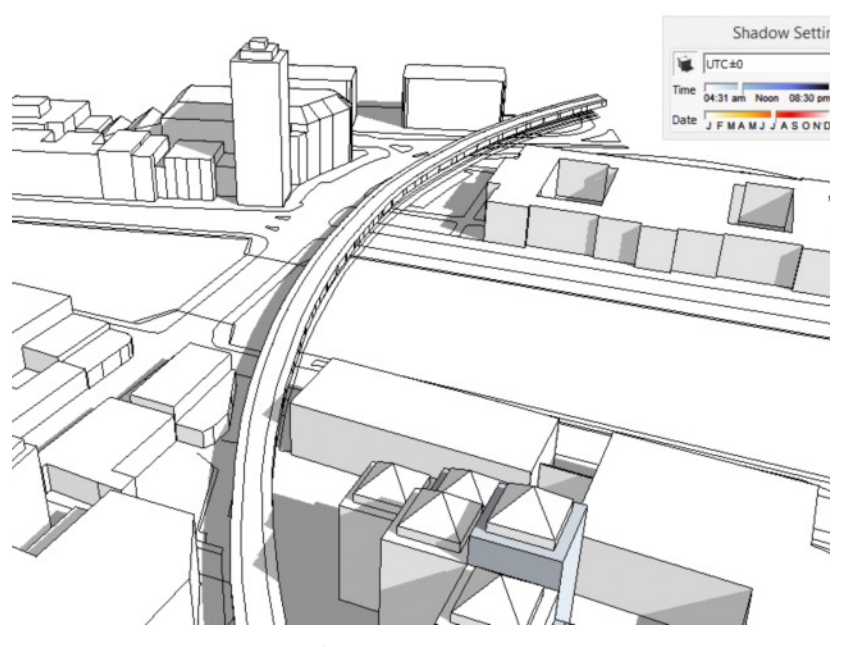
BASELINE HEAT DISTRIBUTION

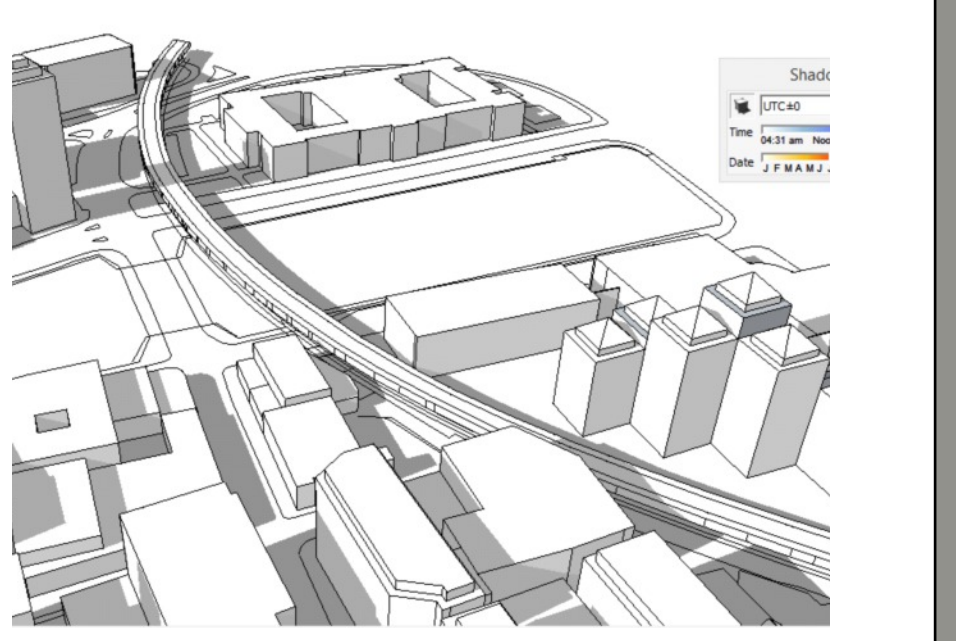


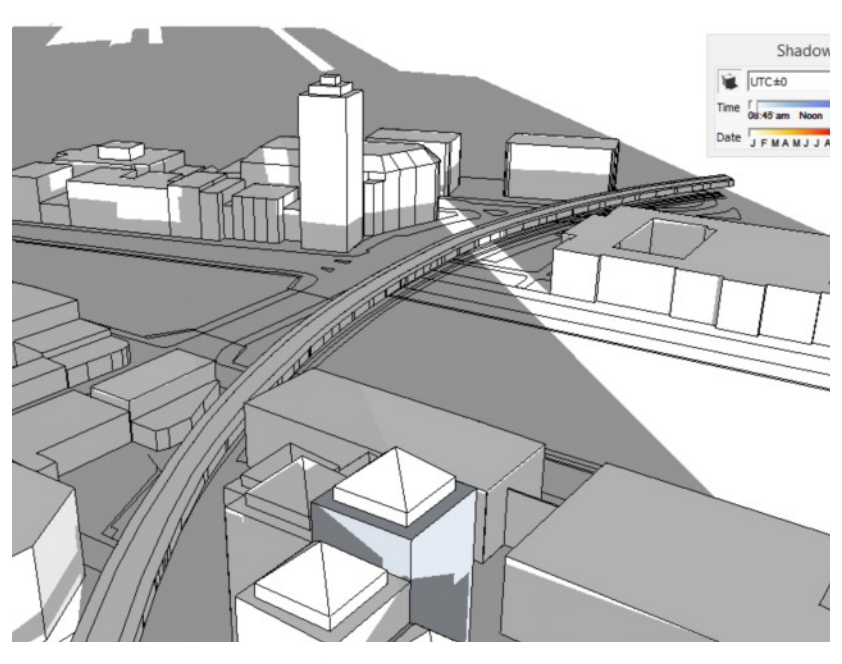
SOLAR RADIATION

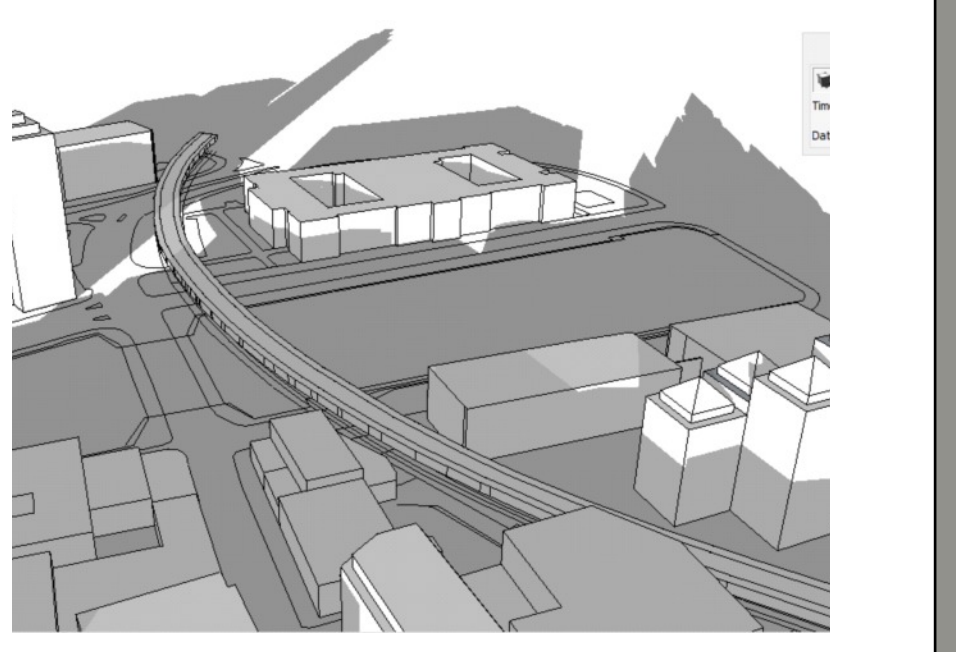

PHOTO VALIDATION OF SHADING - 12th Dec


VALIDATION MODEL - 12th Dec


21st July - 9.00am


21st July - 3.00pm


21st Dec- 9.00am


21st Dec - 3.00pm

BASELINE DETAILS

LIBERTY HALL - BASELINE

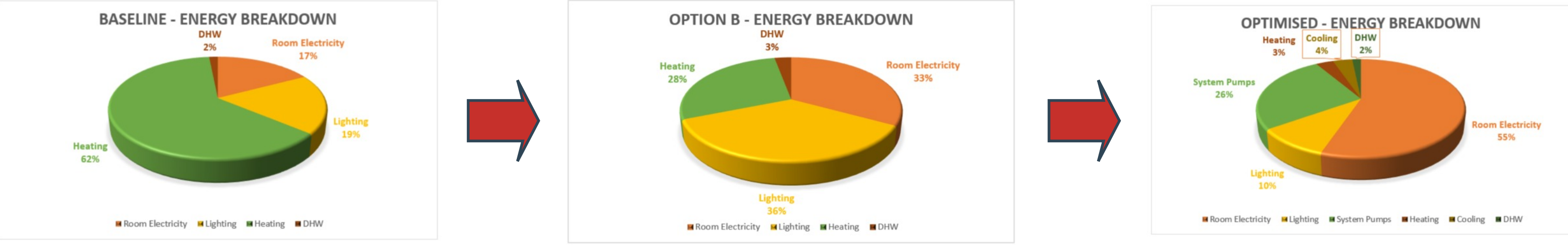
SUN SHADING STUDY

PRIMARY ENERGY SAVINGS		
TOTAL BASELINE ENERGY CONSUMPTION = 124,276 kWh		
Electricity	68,260 kWh x 0.19 Cent	€12,969
Oil	56,016 kWh x 0.06 Cent	€ 3,360
Energy Cost Per Floor = €16,329		
Total Energy Cost for Building (17 Floors) = €16,329 x 17 = **€277,593**		
TOTAL OPTIMISED SPECIFICATION ENERGY CONSUMPTION = 18,007 kWh		
Electricity	18,007 kWh x 0.19 Cent	€3,421
Energy Cost Per Floor = €3,421		
Total Energy Cost for Building (17 Floors) = €3,421 x 17 = **€58,157**		
REDUCTION IN ENERGY CONSUMPTION FROM BASELINE = 86%		
REDUCTION IN ENERGY COST FROM BASELINE = 80%		

PRIMARY ENERGY SAVINGS

	Delivered Energy (kWh)				Primary Energy (kWh)			
	Oil	Electrical	Total	Per m²	Oil	Electrical	Total	Per m²
Baseline	50,924	28,802	79,726	300.18	56,016	68,260	124,276	467.92
Option A	12,788	27,774	40,562	152.72	14,066	65,824	78,890	297.03
Option B	12,616	27,921	40,537	152.62	13,877	66,172	80,049	301.40
Option C	14,360	27,950	42,310	159.30	15,796	66,241	82,037	308.88

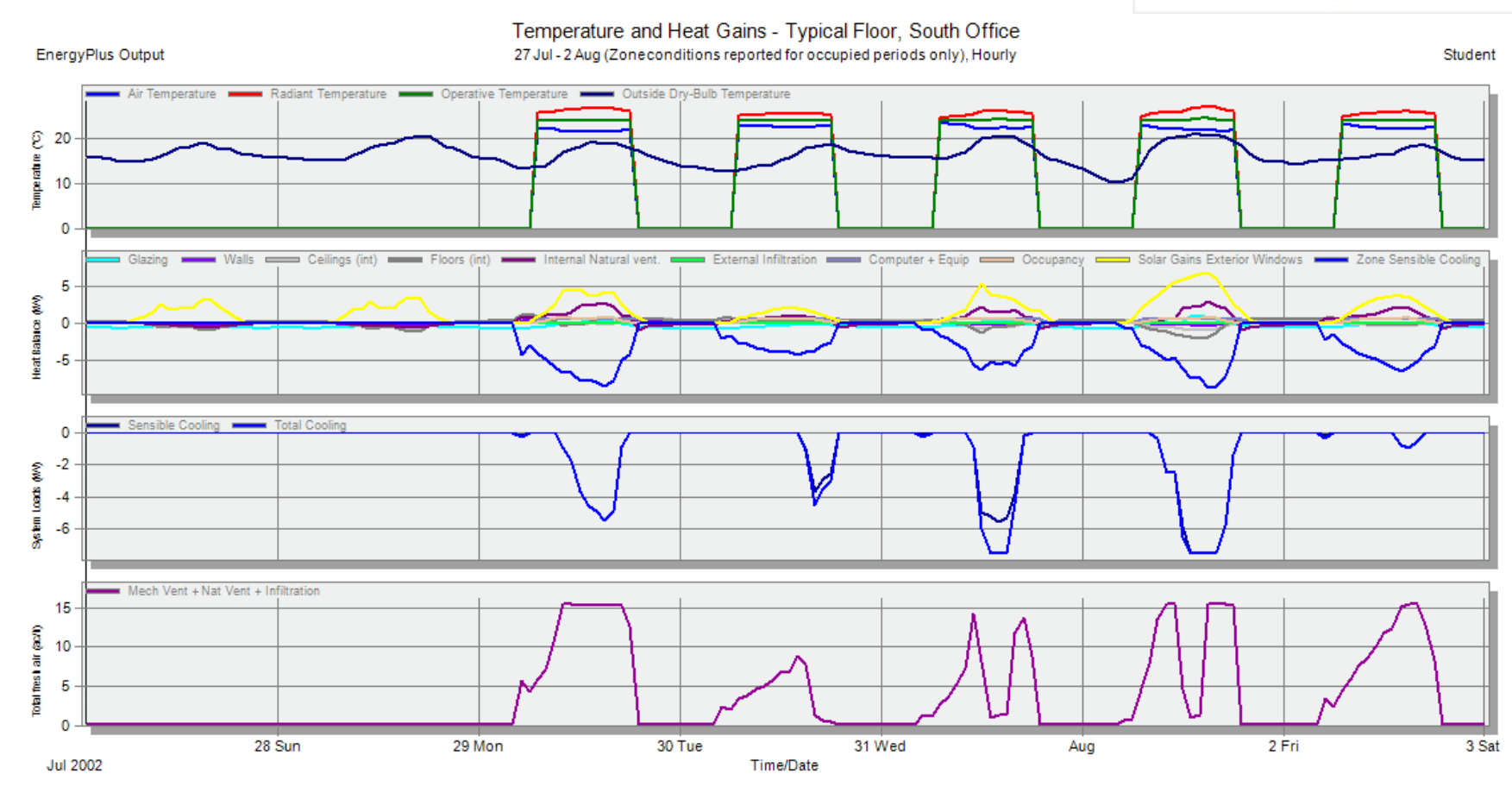
	Delivered Energy (kWh)				**Primary Energy (kWh)**			
	Oil	Electrical	Total	Per m²	Oil	Electrical	Total	Per m²
Baseline	50,924	28,802	79,726	**300.18**	56,016	68,260	124,276	**467.92**
Option A	12,788	27,774	40,562	152.72	14,066	65,824	78,890	297.03
Option B	12,616	27,921	40,537	152.62	13,877	66,172	80,049	301.40
Option C	14,360	27,950	42,310	159.30	15,796	66,241	82,037	308.88
Optimised	0	7,598	7,598	**28.60**	0	18,007	18,007	**67.80**



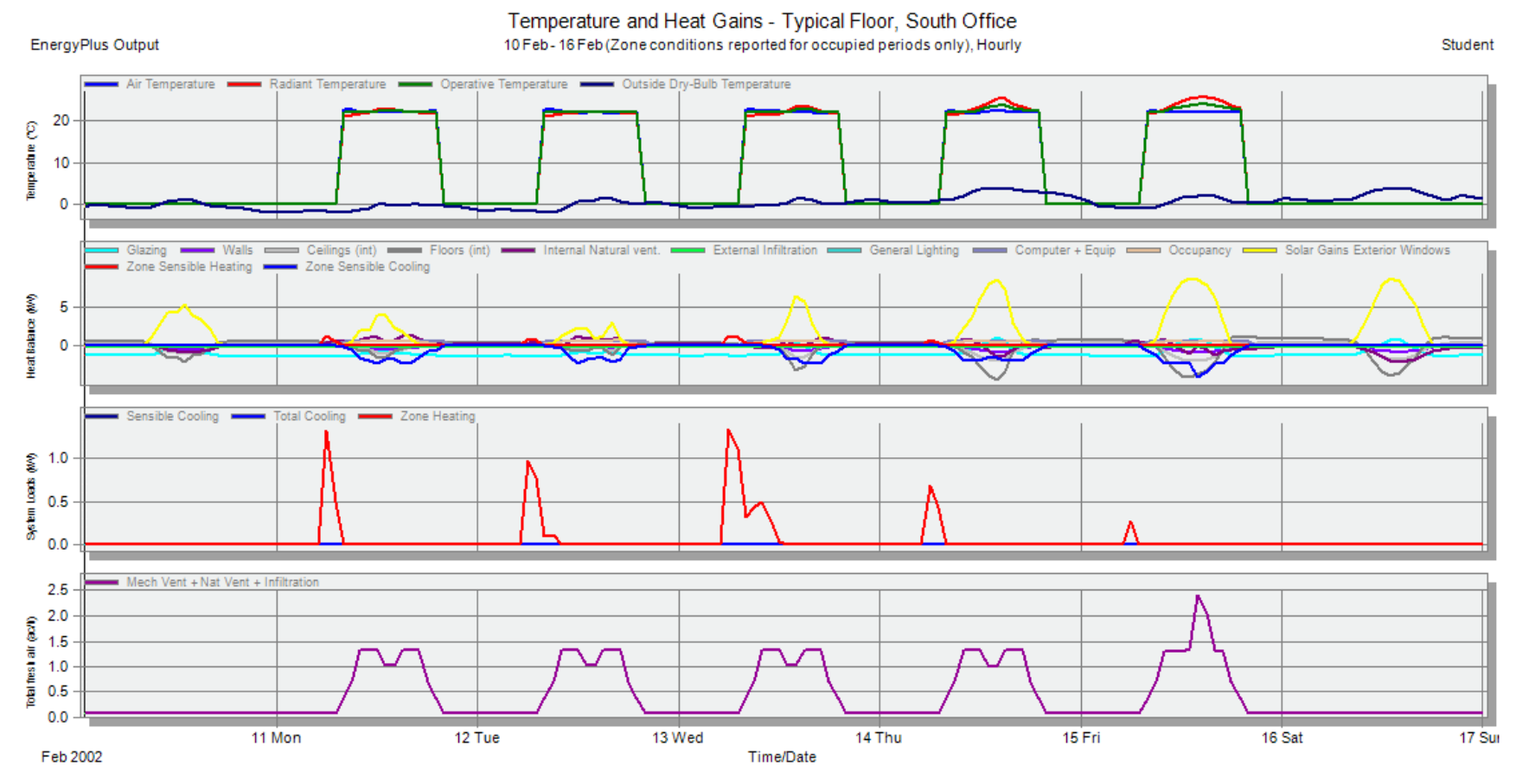
ENERGY BREAKDOWN

DELIVERED ENERGY SAVINGS		
TOTAL BASELINE ENERGY CONSUMPTION = 79,726 kWh		
Electricity	28,802 kWh x 0.19 Cent	€5,472
Oil	50,924 kWh x 0.06 Cent	€3,055
Energy Cost Per Floor = €8,527		
Total Energy Cost for Building (17 Floors) = €8,527 x 17 = **€144,959**		
TOTAL OPTIMISED SPECIFICATION ENERGY CONSUMPTION = 7,598 kWh		
Electricity	7,598 kWh x 0.19 Cent	€1,443
Energy Cost Per Floor = €1,443		
Total Energy Cost for Building (17 Floors) = €1,443 x 17 = **€24,531**		
REDUCTION IN ENERGY CONSUMPTION FROM BASELINE = 91%		
REDUCTION IN ENERGY COST FROM BASELINE = 84%		

DELIVERED ENERGY SAVINGS



SOUTH OFFICE - SUMMER DESIGN WEEK



SOUTH OFFICE - WINTER DESIGN WEEK

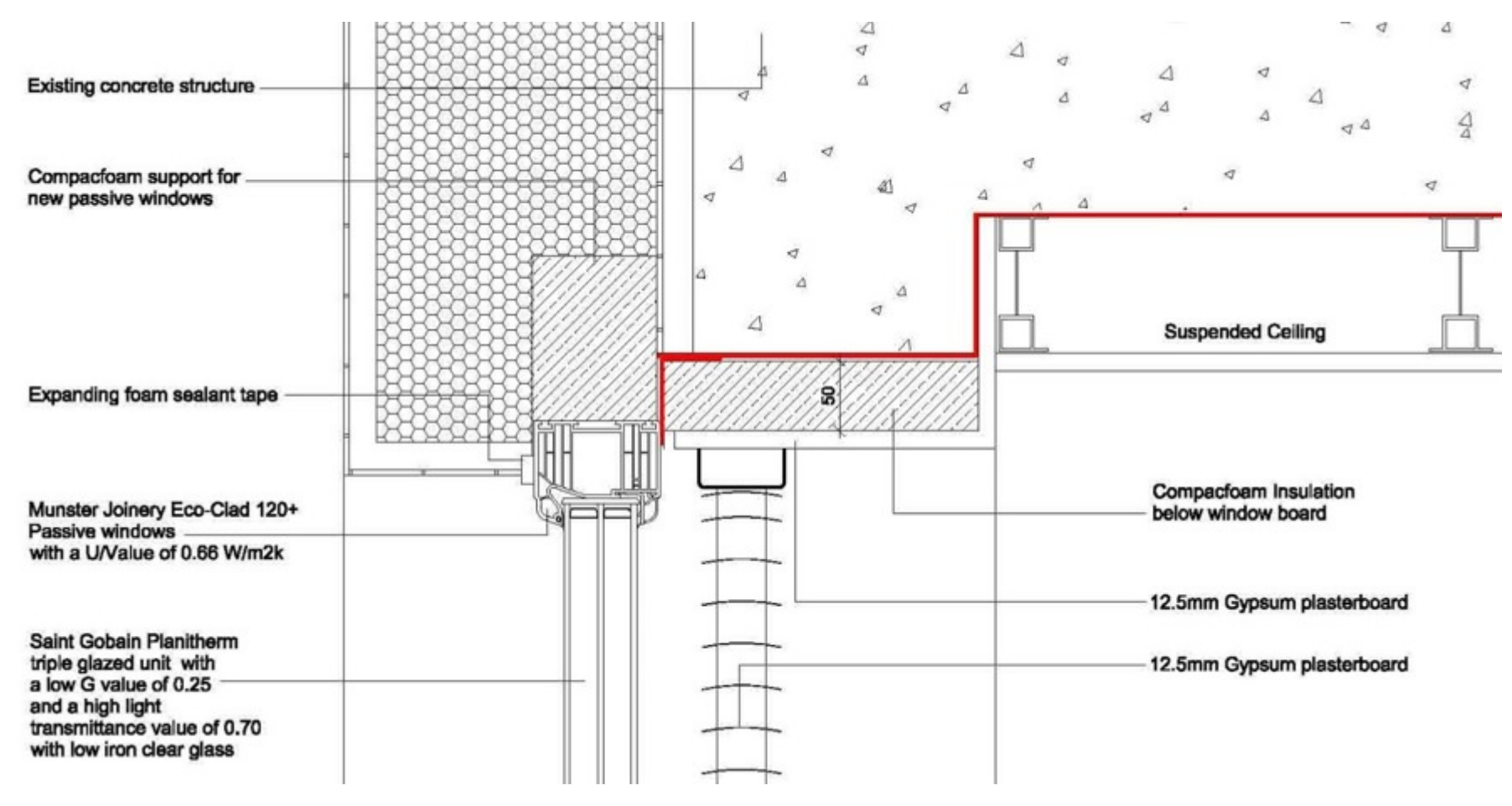
LOCATION OF NEW PV SOLAR ELECTRICAL PANELS

PROPOSED OPTIWIN 120+ PASSIVE WINDOWS UVALUE = 0.85 W/(M2)

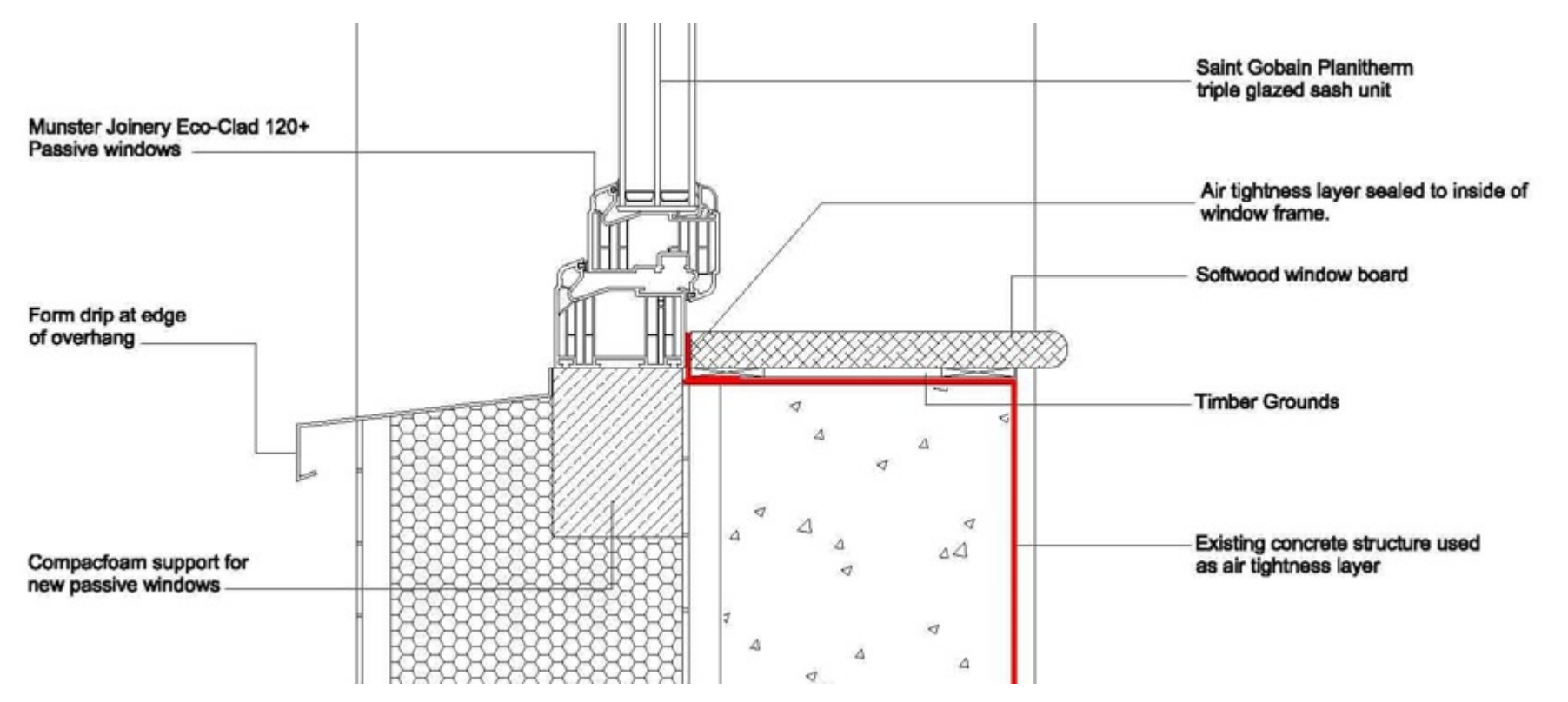
UPGRADED EXTERNAL UP STAND WALLS UVALUE = 0.14 W/(M2)

OPTIONAL PV PANELS FITTED VERTICALLY TO UP STAND WALLS

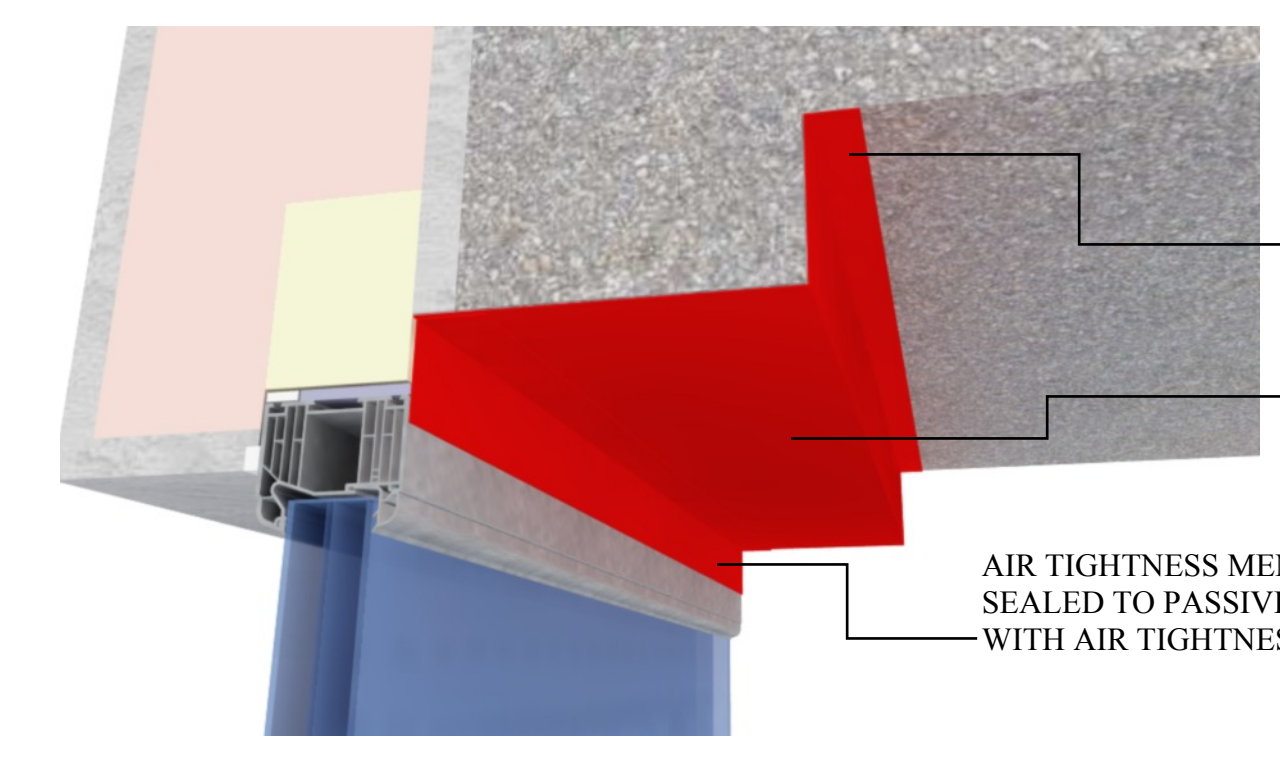

OPTIMISED ELEVATION



WINDOW HEAD DETAIL



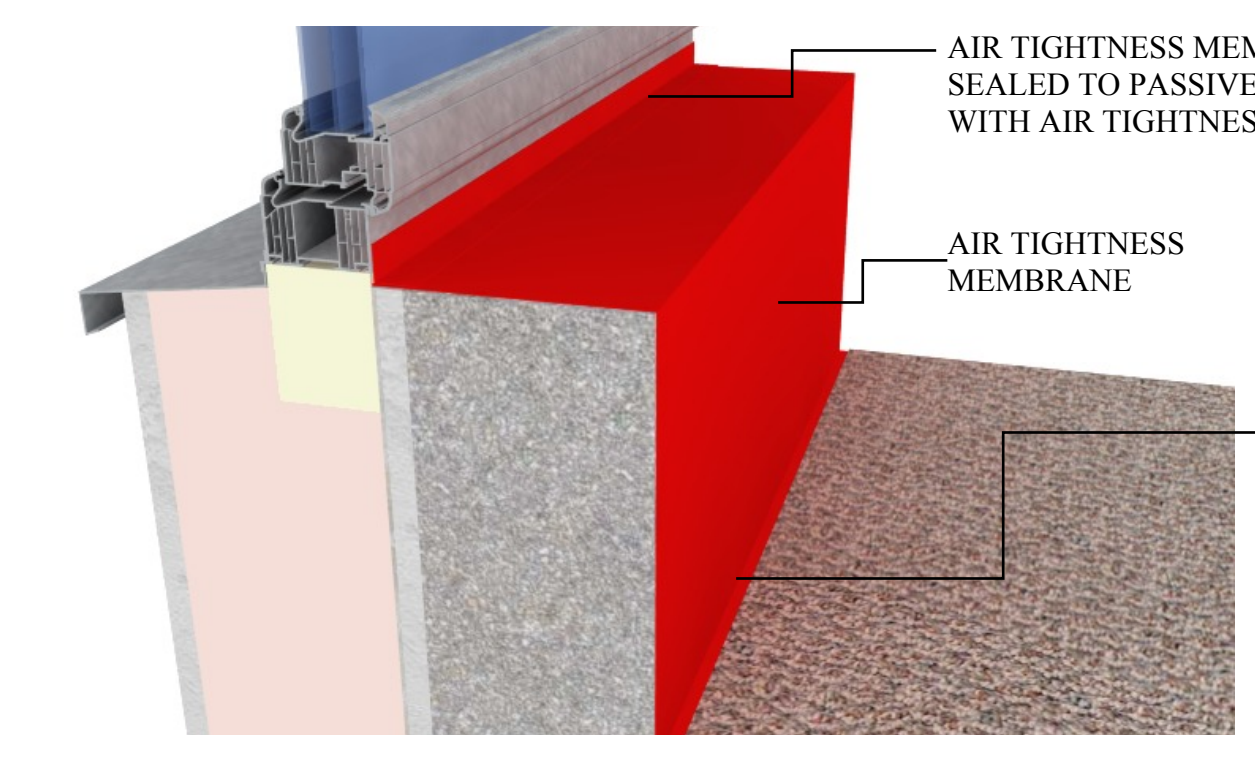
WINDOW CILL DETAIL


AIR TIGHTNESS MEMBRANE SEALED TO CONCRETE CEILING WITH AIR TIGHTNESS TAPE

AIR TIGHTNESS MEMBRANE

AIR TIGHTNESS MEMBRANE SEALED TO PASSIVE WINDOW WITH AIR TIGHTNESS TAPE

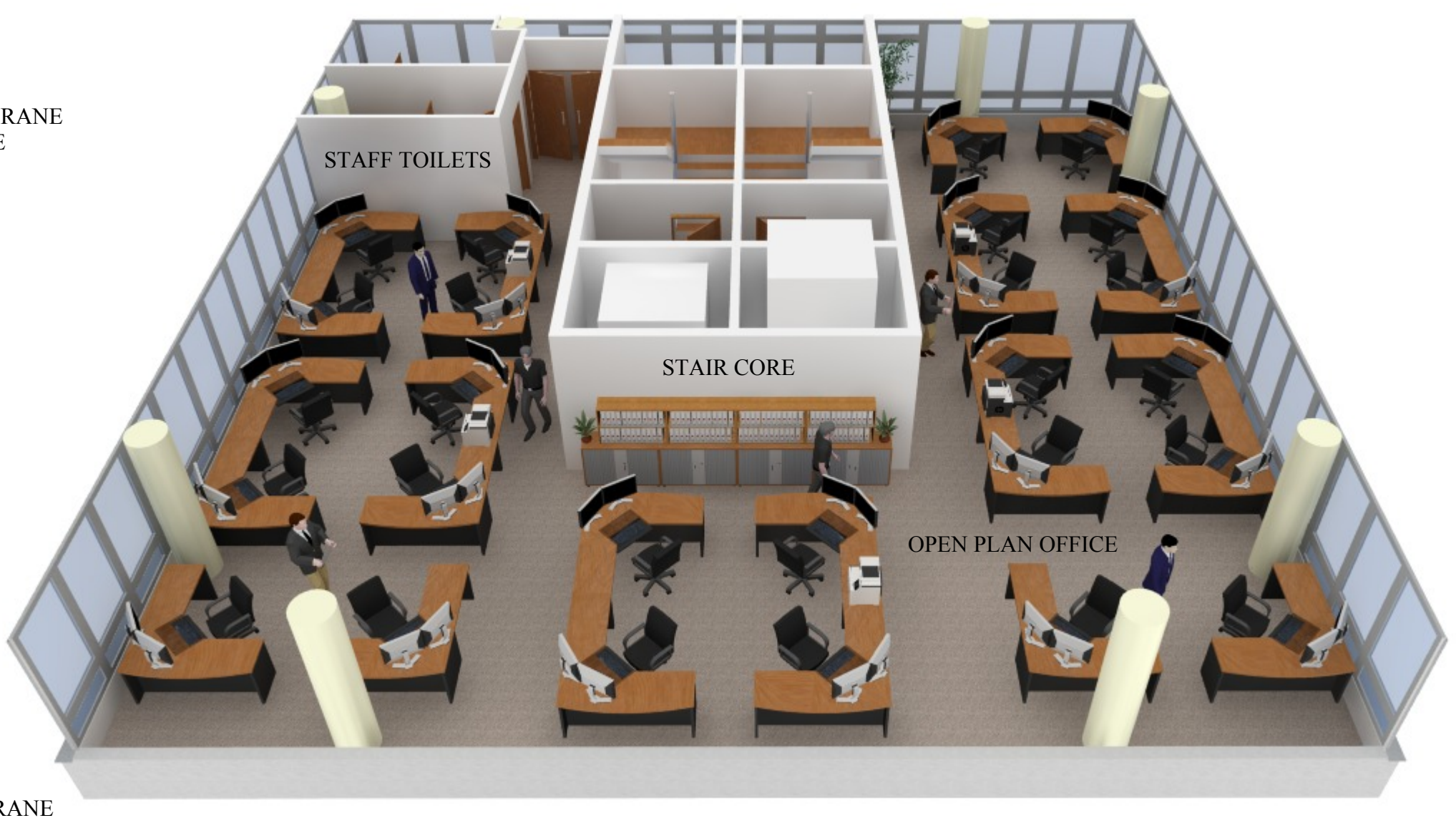
AIR TIGHTNESS DETAIL - WINDOW HEAD


AIR TIGHTNESS MEMBRANE SEALED TO PASSIVE WINDOW WITH AIR TIGHTNESS TAPE

AIR TIGHTNESS MEMBRANE

AIR TIGHTNESS MEMBRANE SEALED TO CONCRETE CEILING WITH AIR TIGHTNESS TAPE

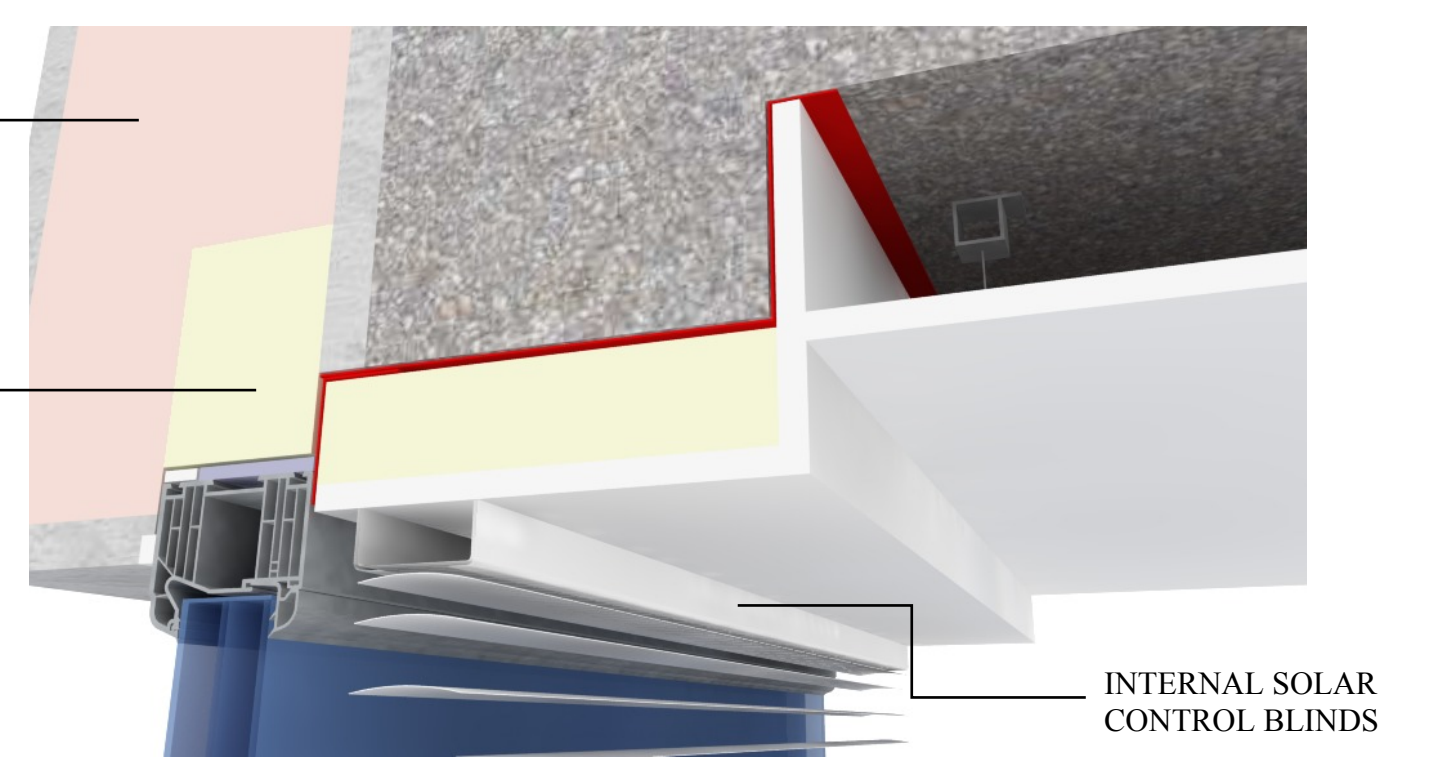
AIR TIGHTNESS DETAIL - WINDOW CILL



OPTIMISED FLOOR LAYOUT

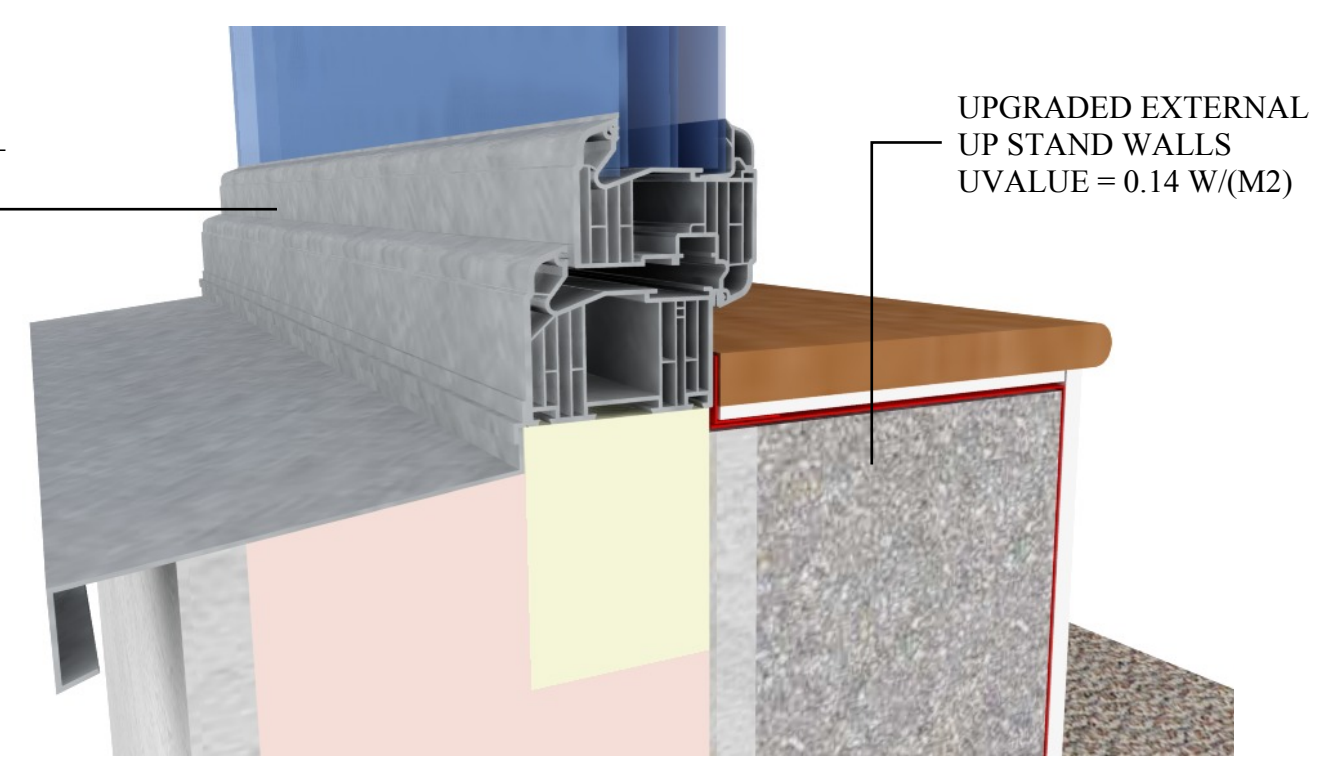
PHENOLIC FOAM INSULATION 0.025 W/M2

COMPACT FOAM INSULATION 0.04 W/M2

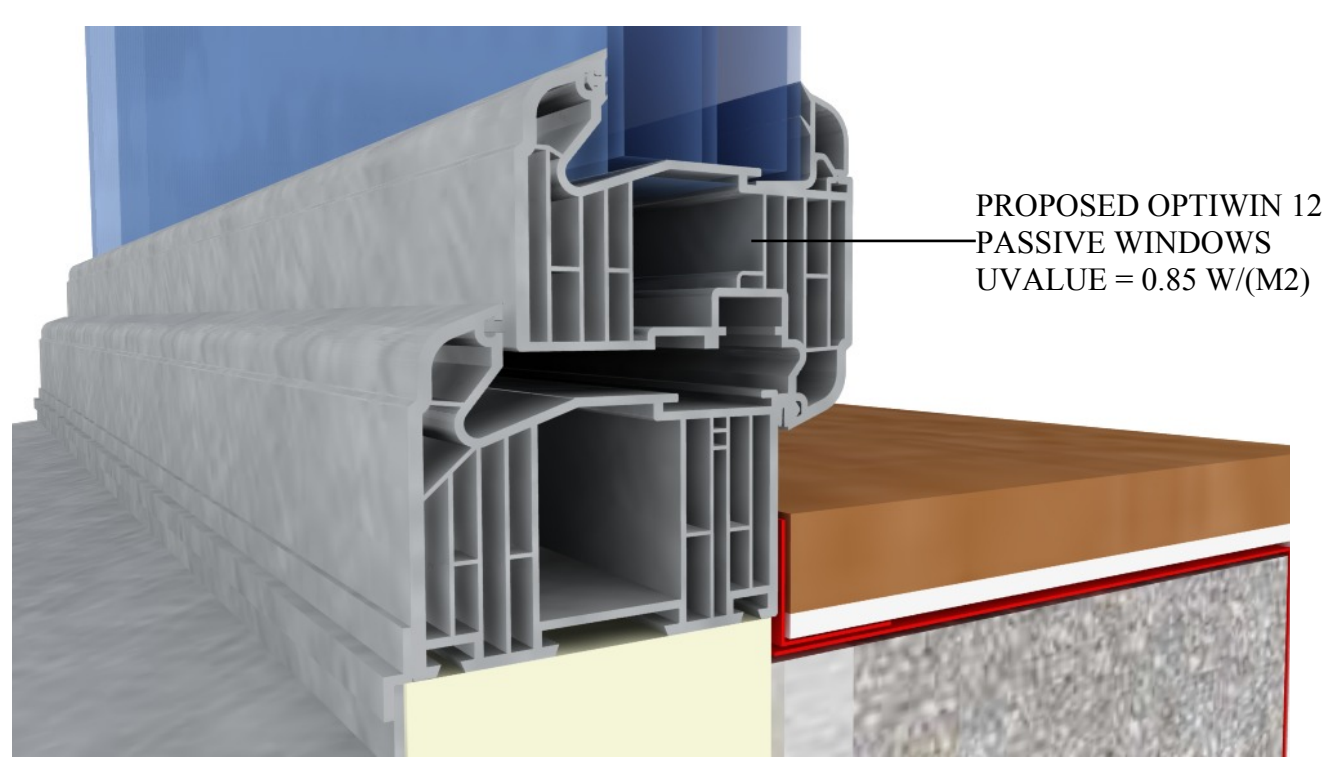

INTERNAL SOLAR CONTROL BLINDS

OPTIMISED WINDOW HEAD DETAIL

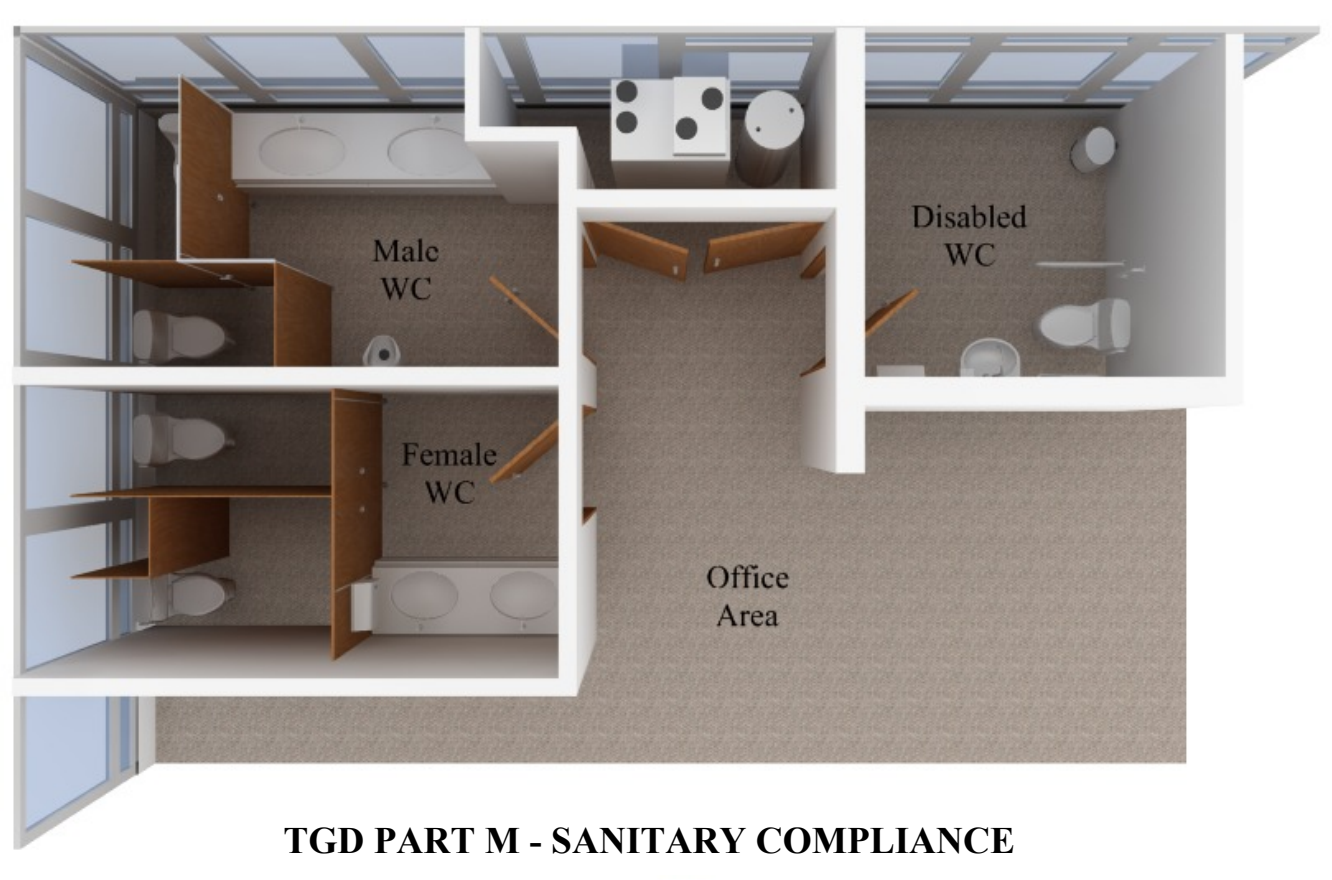
PROPOSED OPTIWIN 120+ PASSIVE WINDOWS UVALUE = 0.85 W/(M2)


UPGRADED EXTERNAL UP STAND WALLS UVALUE = 0.14 W/(M2)

OPTIMISED WINDOW CILL DETAIL


PROPOSED OPTIWIN 120+ PASSIVE WINDOWS UVALUE = 0.85 W/(M2)

OPTIWIN 120+ PASSIVE WINDOW DETAIL

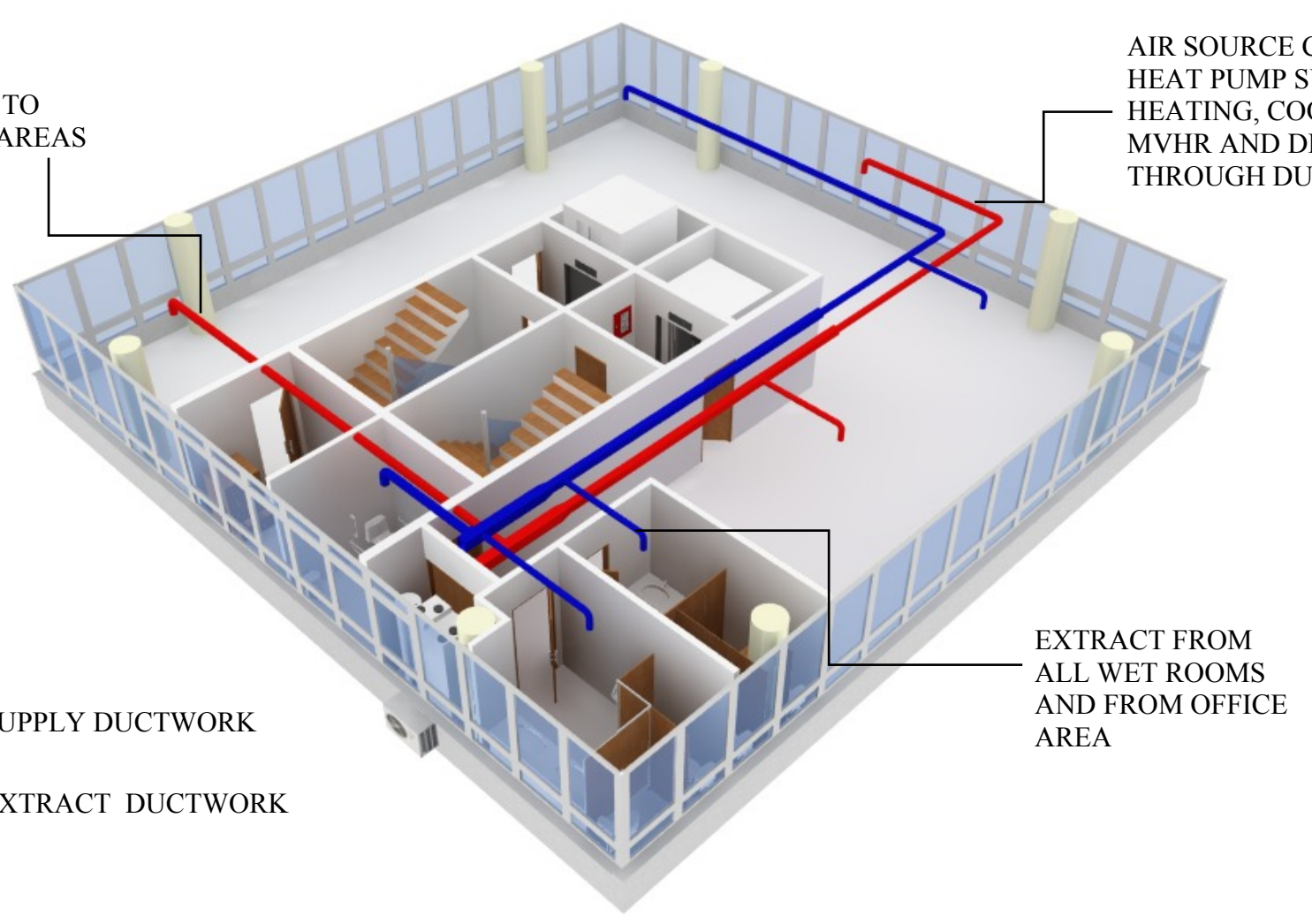


TGD PART M - SANITARY COMPLIANCE

OPTIMISED SECTION AA

SUPPLY TO OFFICE AREAS

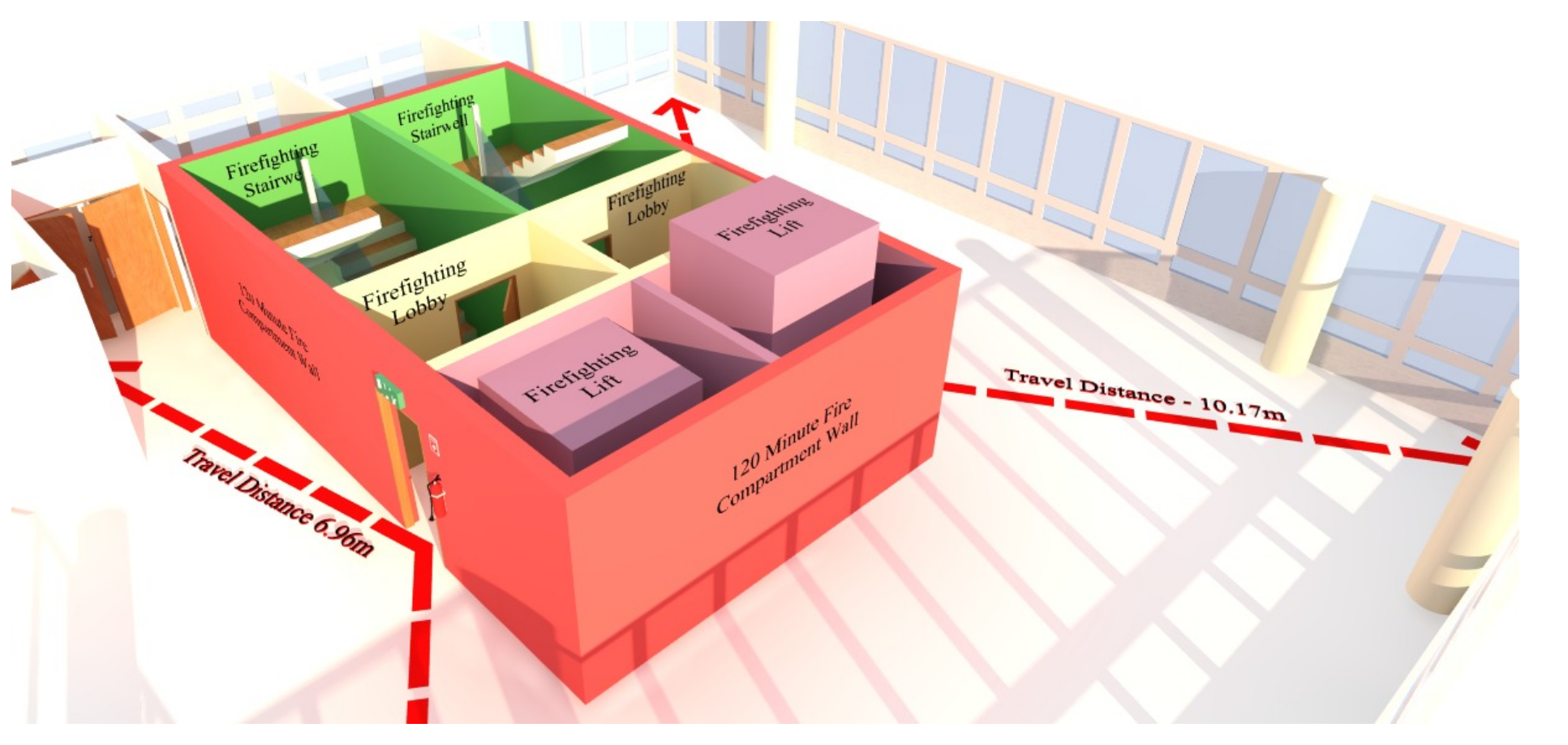
AIR SOURCE COMPACT HEAT PUMP SUPPLIES HEATING, COOLING, MVHR AND DHW ALL THROUGH DUCTWORK


EXTRACT FROM ALL WET ROOMS AND FROM OFFICE AREA

🟥 = SUPPLY DUCTWORK

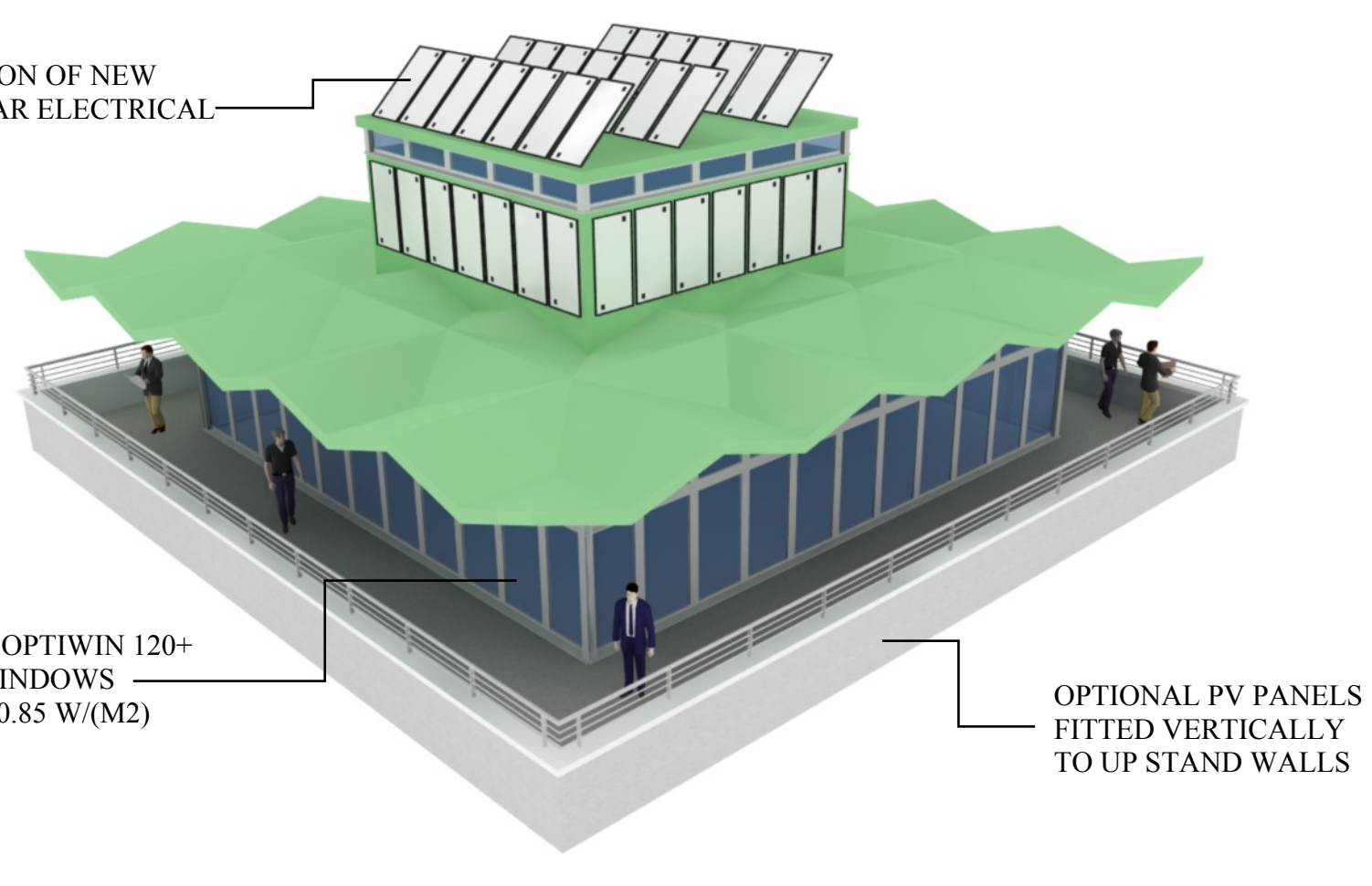
🟦 = EXTRACT DUCTWORK

MECHANICAL DUCTWORK LAYOUT



TGD PART B - FIRE REGULATION COMPLIANCE

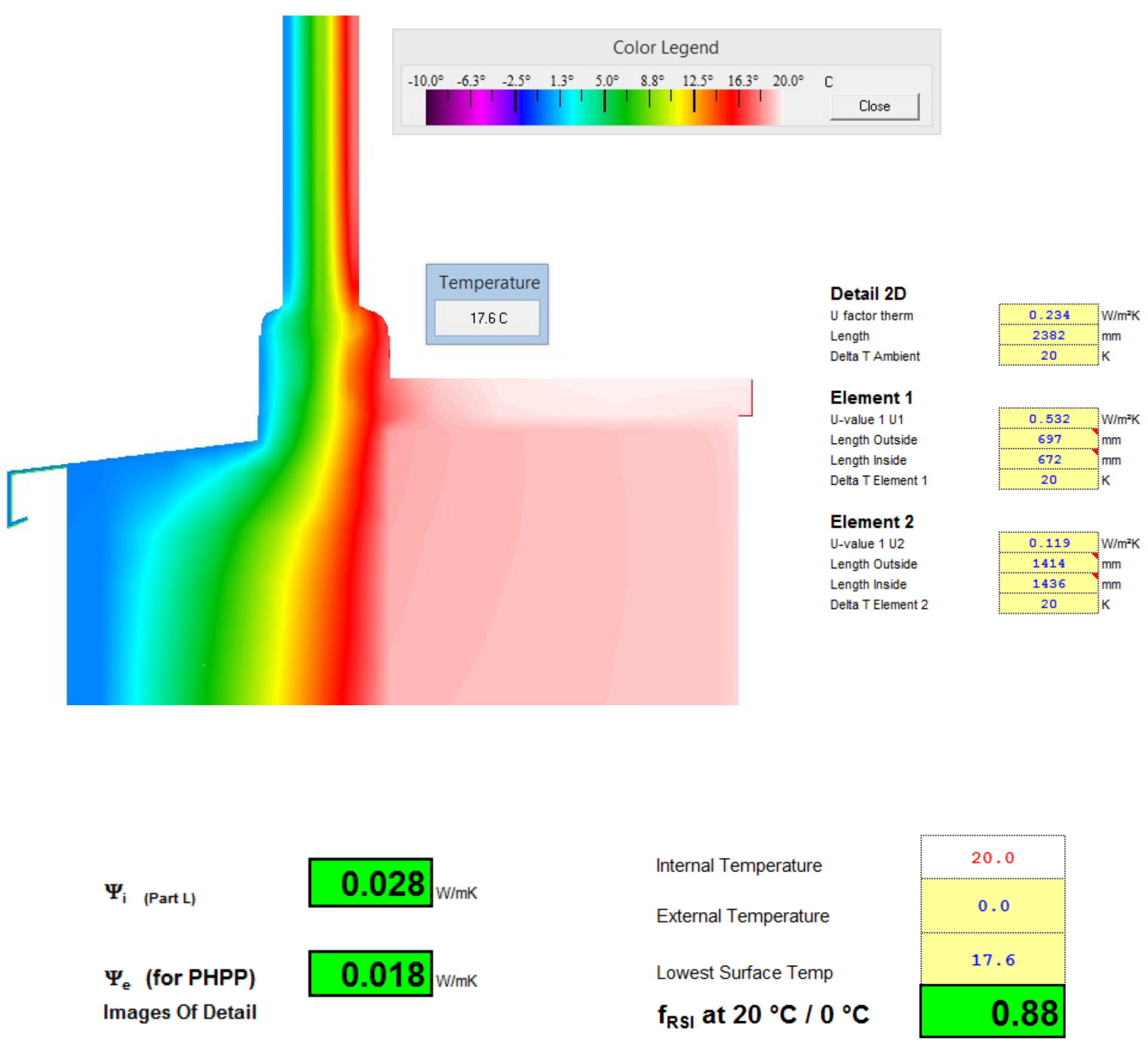
LOCATION OF NEW PV SOLAR ELECTRICAL PANELS


PROPOSED OPTIWIN 120+ PASSIVE WINDOWS UVALUE = 0.85 W/(M2)

OPTIONAL PV PANELS FITTED VERTICALLY TO UP STAND WALLS

LAYOUT OF PV RENEWABLE ENERGY PANELS

LIBERTY HALL - OPTIMAL SPECIFICATION



Detail 2D
U factor therm 0.234 W/m²K
Length 2382 mm
Delta T Ambient 20 K

Element 1
U-value 1 U1 0.532 W/m²K
Length Outside 697 mm
Length Inside 672 mm
Delta T Element 1 20 K

Element 2
U-value 1 U2 0.119 W/m²K
Length Outside 1414 mm
Length Inside 1436 mm
Delta T Element 2 20 K

Ψ_i (Part L) 0.028 W/mK

Ψ_e (for PHPP) 0.018 W/mK

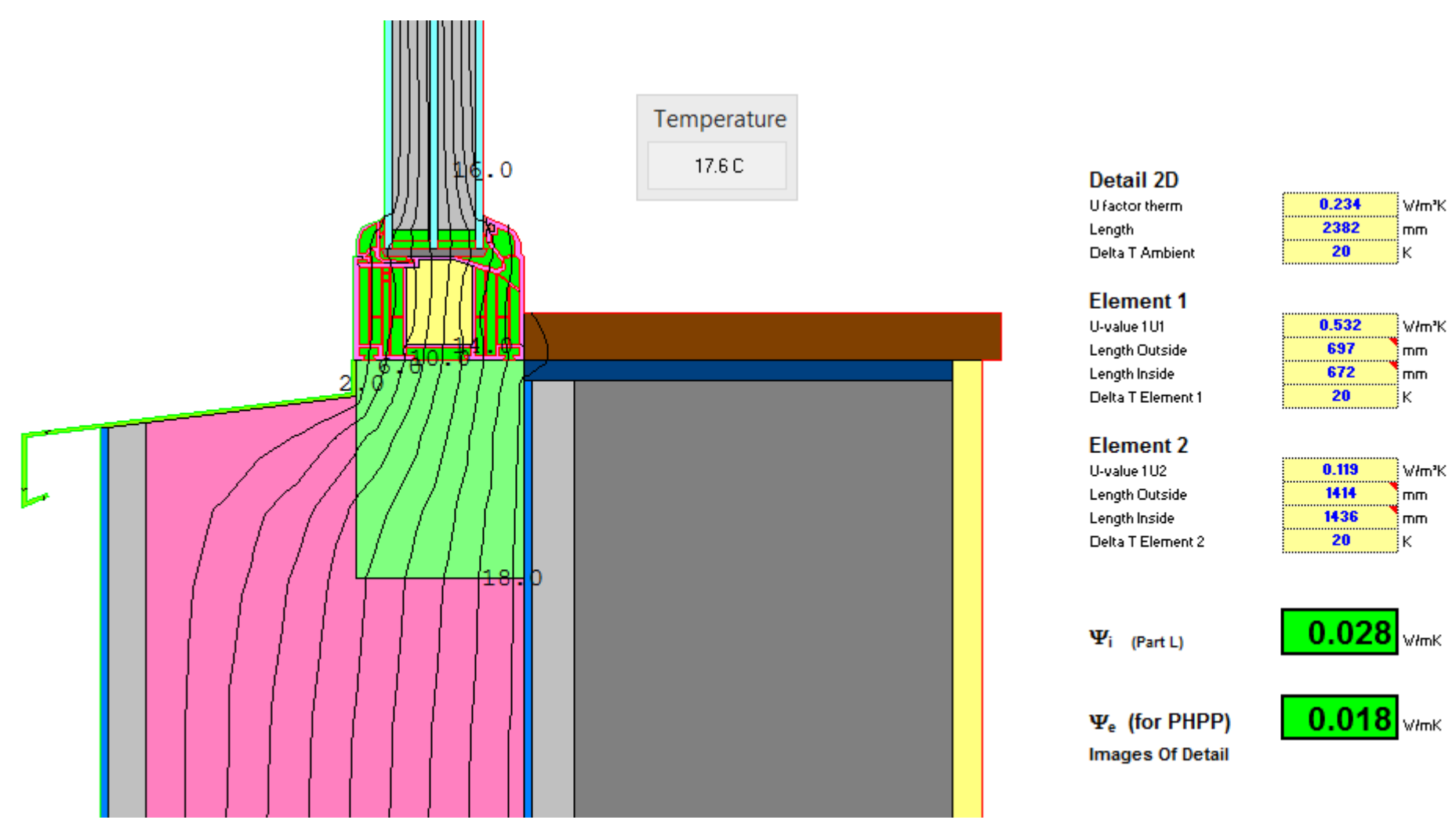
Images Of Detail

Internal Temperature 20.0

External Temperature 0.0

Lowest Surface Temp 17.6

f_{RSI} at 20 °C / 0 °C 0.88



Detail 2D
U factor therm 0.234 W/m²K
Length 2382 mm
Delta T Ambient 20 K

Element 1
U-value 1 U1 0.532 W/m²K
Length Outside 697 mm
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Delta T Element 1 20 K

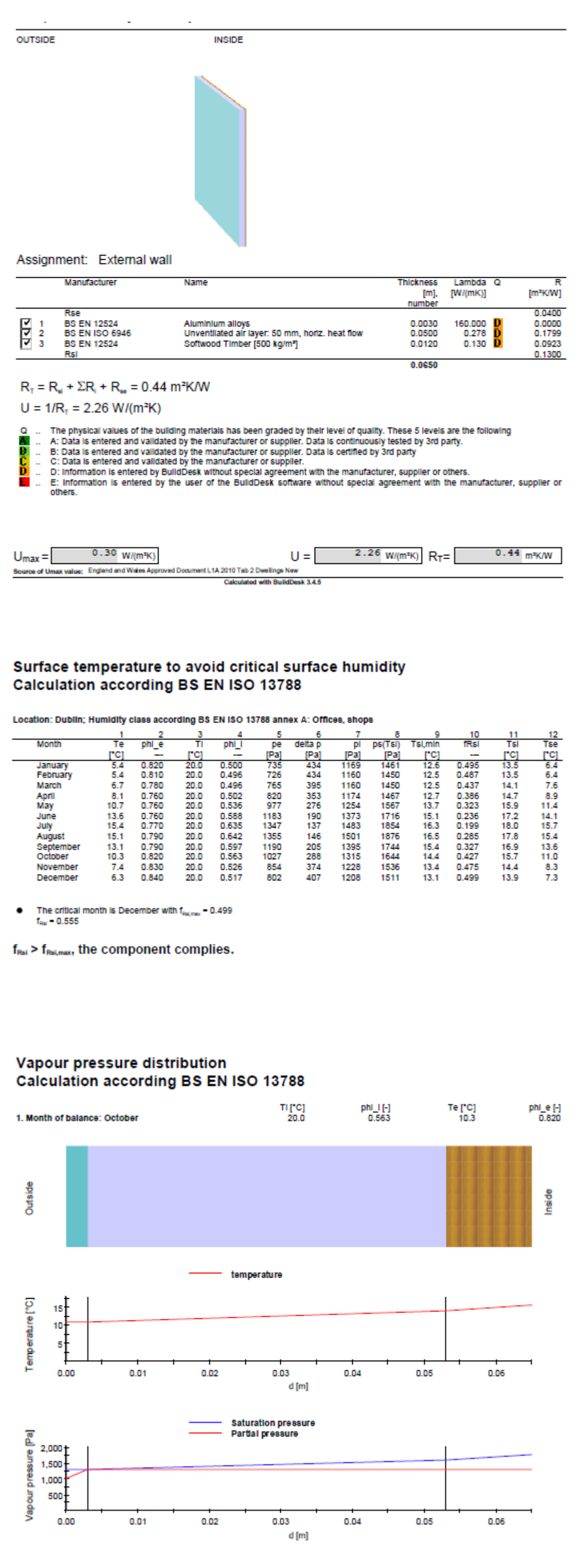
Element 2
U-value 1 U2 0.119 W/m²K
Length Outside 1414 mm
Length Inside 1436 mm
Delta T Element 2 20 K

Ψ_i (Part L) 0.028 W/mK

Ψ_e (for PHPP) 0.018 W/mK

Images Of Detail

OPTIMISED WINDOW CILL LINEAR THERMAL BRIDGE



Assignment: External wall

		Manufacturer	Name	Thickness [m], number	Lambda [W/(mK)]	Q	R [m²K/W]
		Rse					0.0400
☑	1	BS EN 12524	Aluminium alloys	0.0030	160.000	D	0.0000
☑	2	BS EN ISO 6946	Unventilated air layer: 50 mm, horiz. heat flow	0.0500	0.278	D	0.1799
☑	3	BS EN 12524	Softwood Timber [500 kg/m³]	0.0120	0.130	D	0.0923
		Rsi					0.1300
				0.0650			

$R_T = R_{si} + \Sigma R_i + R_{se} = 0.44$ m²K/W

$U = 1/R_T = 2.26$ W/(m²K)

Q .. The physical values of the building materials has been graded by their level of quality. These 5 levels are the following
A .. A: Data is entered and validated by the manufacturer or supplier. Data is continuously tested by 3rd party.
B .. B: Data is entered and validated by the manufacturer or supplier. Data is certified by 3rd party
C .. C: Data is entered and validated by the manufacturer or supplier.
D .. D: Information is entered by BuildDesk without special agreement with the manufacturer, supplier or others.
E .. E: Information is entered by the user of the BuildDesk software without special agreement with the manufacturer, supplier or others.

U_{max} = 0.30 W/(m²K) U = 2.26 W/(m²K) R_T = 0.44 m²K/W

Source of Umax value: England and Wales Approved Document L1A 2010 Tab 2 Dwellings New

Calculated with BuildDesk 3.4.5

Surface temperature to avoid critical surface humidity
Calculation according BS EN ISO 13788

Location: Dublin; Humidity class according BS EN ISO 13788 annex A: Offices, shops

	1	2	3	4	5	6	7	8	9	10	11	12
Month	Te [°C]	phi_e ---	Ti [°C]	phi_i ---	pe [Pa]	delta p [Pa]	pi [Pa]	ps(Tsi) [Pa]	Tsi,min [°C]	fRsi ---	Tsi [°C]	Tse [°C]
January	5.4	0.820	20.0	0.500	735	434	1169	1461	12.6	0.495	13.5	6.4
February	5.4	0.810	20.0	0.496	726	434	1160	1450	12.5	0.487	13.5	6.4
March	6.7	0.780	20.0	0.496	765	395	1160	1450	12.5	0.437	14.1	7.6
April	8.1	0.760	20.0	0.502	820	353	1174	1467	12.7	0.386	14.7	8.9
May	10.7	0.760	20.0	0.536	977	276	1254	1567	13.7	0.323	15.9	11.4
June	13.6	0.760	20.0	0.588	1183	190	1373	1716	15.1	0.236	17.2	14.1
July	15.4	0.770	20.0	0.635	1347	137	1483	1854	16.3	0.199	18.0	15.7
August	15.1	0.790	20.0	0.642	1355	146	1501	1876	16.5	0.285	17.8	15.4
September	13.1	0.790	20.0	0.597	1190	205	1395	1744	15.4	0.327	16.9	13.6
October	10.3	0.820	20.0	0.563	1027	288	1315	1644	14.4	0.427	15.7	11.0
November	7.4	0.830	20.0	0.526	854	374	1228	1536	13.4	0.475	14.4	8.3
December	6.3	0.840	20.0	0.517	802	407	1208	1511	13.1	0.499	13.9	7.3

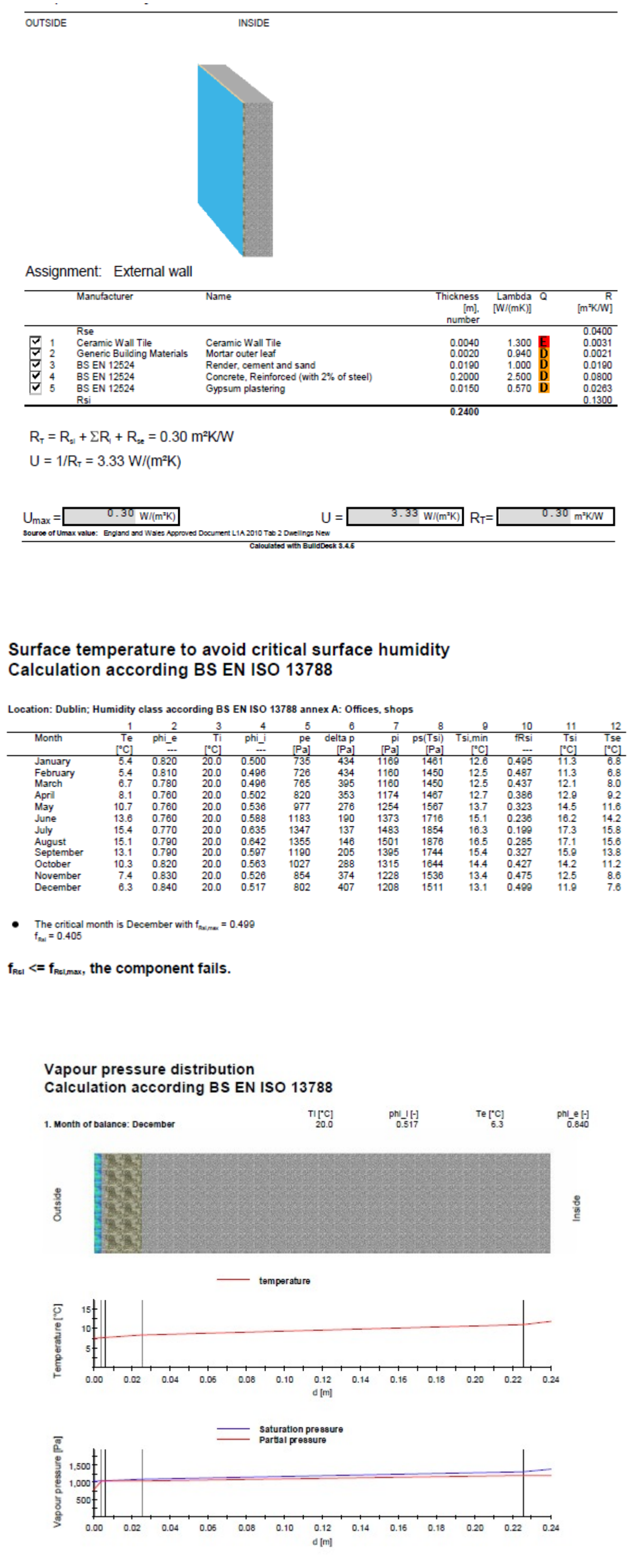
- The critical month is December with $f_{Rsi,max}$ = 0.499
  f_{Rsi} = 0.555

$f_{Rsi} > f_{Rsi,max}$, the component complies.

Vapour pressure distribution
Calculation according BS EN ISO 13788

1. Month of balance: October Ti [°C] 20.0 phi_i [-] 0.563 Te [°C] 10.3 phi_e [-] 0.820

BASELINE SPANDREL PANEL UVALUE AND HYGROTHERMAL ANALYSIS



Assignment: External wall

		Manufacturer	Name	Thickness [m], number	Lambda [W/(mK)]	Q	R [m²K/W]
		Rse					0.0400
☑	1	Ceramic Wall Tile	Ceramic Wall Tile	0.0040	1.300	E	0.0031
☑	2	Generic Building Materials	Mortar outer leaf	0.0020	0.940	D	0.0021
☑	3	BS EN 12524	Render, cement and sand	0.0190	1.000	D	0.0190
☑	4	BS EN 12524	Concrete, Reinforced (with 2% of steel)	0.2000	2.500	D	0.0800
☑	5	BS EN 12524	Gypsum plastering	0.0150	0.570	D	0.0263
		Rsi					0.1300
				0.2400			

$R_T = R_{si} + \Sigma R_i + R_{se} = 0.30$ m²K/W

$U = 1/R_T = 3.33$ W/(m²K)

U_{max} = 0.30 W/(m²K) U = 3.33 W/(m²K) R_T = 0.30 m²K/W

Source of Umax value: England and Wales Approved Document L1A 2010 Tab 2 Dwellings New

Calculated with BuildDesk 3.4.5

Surface temperature to avoid critical surface humidity
Calculation according BS EN ISO 13788

Location: Dublin; Humidity class according BS EN ISO 13788 annex A: Offices, shops

	1	2	3	4	5	6	7	8	9	10	11	12
Month	Te [°C]	phi_e ---	Ti [°C]	phi_i ---	pe [Pa]	delta p [Pa]	pi [Pa]	ps(Tsi) [Pa]	Tsi,min [°C]	fRsi ---	Tsi [°C]	Tse [°C]
January	5.4	0.820	20.0	0.500	735	434	1169	1461	12.6	0.495	11.3	6.8
February	5.4	0.810	20.0	0.496	726	434	1160	1450	12.5	0.487	11.3	6.8
March	6.7	0.780	20.0	0.496	765	395	1160	1450	12.5	0.437	12.1	8.0
April	8.1	0.760	20.0	0.502	820	353	1174	1467	12.7	0.386	12.9	9.2
May	10.7	0.760	20.0	0.536	977	276	1254	1567	13.7	0.323	14.5	11.6
June	13.6	0.760	20.0	0.588	1183	190	1373	1716	15.1	0.236	16.2	14.2
July	15.4	0.770	20.0	0.635	1347	137	1483	1854	16.3	0.199	17.3	15.8
August	15.1	0.790	20.0	0.642	1355	146	1501	1876	16.5	0.285	17.1	15.6
September	13.1	0.790	20.0	0.597	1190	205	1395	1744	15.4	0.327	15.9	13.8
October	10.3	0.820	20.0	0.563	1027	288	1315	1644	14.4	0.427	14.2	11.2
November	7.4	0.830	20.0	0.526	854	374	1228	1536	13.4	0.475	12.5	8.6
December	6.3	0.840	20.0	0.517	802	407	1208	1511	13.1	0.499	11.9	7.6

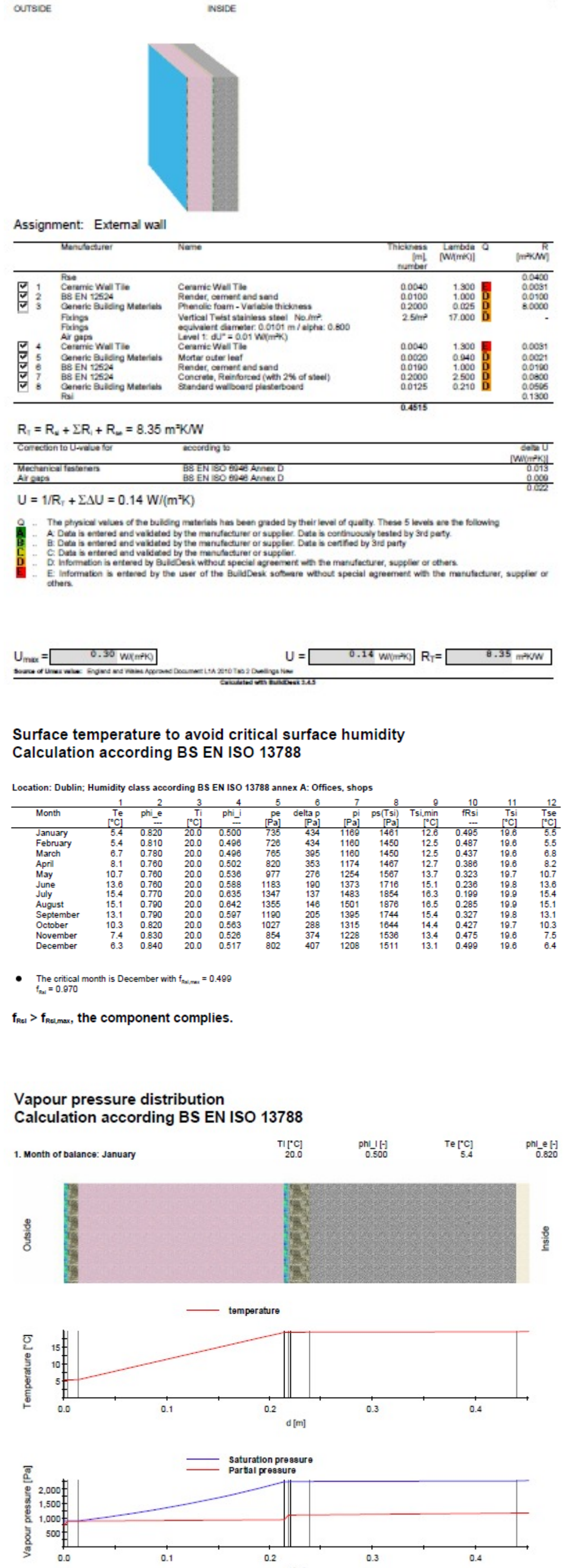
- The critical month is December with $f_{Rsi,max}$ = 0.499
  f_{Rsi} = 0.405

$f_{Rsi} <= f_{Rsi,max}$, the component fails.

Vapour pressure distribution
Calculation according BS EN ISO 13788

1. Month of balance: December Ti [°C] 20.0 phi_i [-] 0.517 Te [°C] 6.3 phi_e [-] 0.840

BASELINE EXTERNAL WALL UVALUE AND HYGROTHERMAL ANALYSIS



Assignment: External wall

		Manufacturer	Name	Thickness [m], number	Lambda [W/(mK)]	Q	R [m²K/W]
		Rse					0.0400
☑	1	Ceramic Wall Tile	Ceramic Wall Tile	0.0040	1.300	E	0.0031
☑	2	BS EN 12524	Render, cement and sand	0.0100	1.000	D	0.0100
☑	3	Generic Building Materials	Phenolic foam - Variable thickness	0.2000	0.025	D	8.0000
		Fixings	Vertical Twist stainless steel No./m²: equivalent diameter: 0.0101 m / alpha: 0.800	2.5/m²	17.000	D	-
		Fixings					
		Air gaps	Level 1: dU" = 0.01 W/(m²K)				
☑	4	Ceramic Wall Tile	Ceramic Wall Tile	0.0040	1.300	E	0.0031
☑	5	Generic Building Materials	Mortar outer leaf	0.0020	0.940	D	0.0021
☑	6	BS EN 12524	Render, cement and sand	0.0190	1.000	D	0.0190
☑	7	BS EN 12524	Concrete, Reinforced (with 2% of steel)	0.2000	2.500	D	0.0800
☑	8	Generic Building Materials	Standard wallboard plasterboard	0.0125	0.210	D	0.0595
		Rsi					0.1300
				0.4515			

$R_T = R_{si} + \Sigma R_i + R_{se} = 8.35$ m²K/W

Correction to U-value for	according to	delta U [W/(m²K)]
Mechanical fasteners	BS EN ISO 6946 Annex D	0.013
Air gaps	BS EN ISO 6946 Annex D	0.009
		0.022

$U = 1/R_T + \Sigma\Delta U = 0.14$ W/(m²K)

U_{max} = 0.30 W/(m²K) U = 0.14 W/(m²K) R_T = 8.35 m²K/W

Source of Umax value: England and Wales Approved Document L1A 2010 Tab 2 Dwellings New

Calculated with BuildDesk 3.4.5

Surface temperature to avoid critical surface humidity
Calculation according BS EN ISO 13788

Location: Dublin; Humidity class according BS EN ISO 13788 annex A: Offices, shops

	1	2	3	4	5	6	7	8	9	10	11	12
Month	Te [°C]	phi_e ---	Ti [°C]	phi_i ---	pe [Pa]	delta p [Pa]	pi [Pa]	ps(Tsi) [Pa]	Tsi,min [°C]	fRsi ---	Tsi [°C]	Tse [°C]
January	5.4	0.820	20.0	0.500	735	434	1169	1461	12.6	0.495	19.6	5.5
February	5.4	0.810	20.0	0.496	726	434	1160	1450	12.5	0.487	19.6	5.5
March	6.7	0.780	20.0	0.496	765	395	1160	1450	12.5	0.437	19.6	6.8
April	8.1	0.760	20.0	0.502	820	353	1174	1467	12.7	0.386	19.6	8.2
May	10.7	0.760	20.0	0.536	977	276	1254	1567	13.7	0.323	19.7	10.7
June	13.6	0.760	20.0	0.588	1183	190	1373	1716	15.1	0.236	19.8	13.6
July	15.4	0.770	20.0	0.635	1347	137	1483	1854	16.3	0.199	19.9	15.4
August	15.1	0.790	20.0	0.642	1355	146	1501	1876	16.5	0.285	19.9	15.1
September	13.1	0.790	20.0	0.597	1190	205	1395	1744	15.4	0.327	19.8	13.1
October	10.3	0.820	20.0	0.563	1027	288	1315	1644	14.4	0.427	19.7	10.3
November	7.4	0.830	20.0	0.526	854	374	1228	1536	13.4	0.475	19.6	7.5
December	6.3	0.840	20.0	0.517	802	407	1208	1511	13.1	0.499	19.6	6.4

- The critical month is December with $f_{Rsi,max}$ = 0.499
  f_{Rsi} = 0.970

$f_{Rsi} > f_{Rsi,max}$, the component complies.

Vapour pressure distribution
Calculation according BS EN ISO 13788

1. Month of balance: January Ti [°C] 20.0 phi_i [-] 0.500 Te [°C] 5.4 phi_e [-] 0.820

OPTIMAL EXTERNAL WALL UVALUE AND HYGROTHERMAL ANALYSIS

THERMAL BRIDGE ANALYSIS

UVALUE CALCULATION WITH HYGROTHERMAL ANALYSIS

ALAN CARR D13124789 - FINAL DESIGN SUBMISSION - SUPERVISED BY PATRICK DALY