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**APPLICATION FOR BUILDING WARRANT
FOR ALTERATIONS TO DWELLING HOUSE**



11 BUCCLEUCH STREET, INNERLEITHEN
MR AND MRS TULLOCH

U-VALUE CALCULATIONS

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PITCHED ROOF WITH INSULATION BETWEEN AND OVER THE CEILING JOISTS (OWENS CORNING CROWN WOOL QUILT INSULATION)

Roof construction

12mm Scots slates

Felt

18mm sarking board

155mm timber rafter

Ceiling void.

125mm X 50mm timber ceiling ties at 450mm centres (conductivity 0.13 W/m K)

250mm (150mm between joists and 100mm laid over insulation and joists) Crown Wool quilt insulation by Owens Corning between joists (conductivity 0.040 W/m K)

12.5mm Gyproc plasterboard (conductivity 0.25 W/m K)

| Calculation of thermal resistance | | | | |
|-----------------------------------|------------------------------------|---------------|-------|--------------------|
| Layer | Material | Thickness (m) | W/m K | m ² K/W |
| | External surface | - | - | 0.040 |
| 1 | Roof construction (BS EN ISO 6946) | - | - | 0.300 |
| 2(a) | Timber ceiling joist | 0.155 | 0.13 | 1.154 |
| 2(b) | Quilt insulation over joist | 0.100 | 0.040 | 2.500 |
| 2(c) | Quilt insulation | 0.250 | 0.040 | 6.250 |
| 3 | Plasterboard | 0.013 | 0.25 | 0.052 |
| | Internal surface | - | - | 0.130 |

Resistance through section containing insulation

| | |
|-----------------------------|----------------------------|
| External surface resistance | = 0.040 |
| Resistance of roof | = 0.300 |
| Resistance of insulation | = 6.250 |
| Resistance of plasterboard | = 0.052 |
| Internal surface resistance | = <u>0.130</u> |
| Total (R1) | = 6.772 m ² K/W |

Fractional area (F1) = 0.935 (93.5%)

Resistance through section containing timber

| | |
|--------------------------------------|----------------------------|
| External surface resistance | = 0.040 |
| Resistance of roof | = 0.300 |
| Resistance of timber | = 1.154 |
| Resistance of insulation over timber | = 2.500 |
| Resistance of plasterboard | = 0.052 |
| Internal surface resistance | = <u>0.130</u> |
| Total (R2) | = 4.176 m ² K/W |

Fractional area (F2) = 0.065 (6.5%)

The upper limited of resistance (Ru)

$$R_u = 1/((F1/R1) + (F2/R2)) = 6.508 \text{ m}^2\text{K/W}$$

Lower resistance limit (Rv)

| | |
|-----------------------------|----------------------------|
| External surface resistance | = 0.040 |
| Resistance of roof | = 0.300 |
| Resistance of bridged layer | = 4.563 |
| Resistance of plasterboard | = 0.052 |
| Internal surface resistance | = <u>0.130</u> |
| Total (Rv) | = 6.085 m ² K/W |

Total resistance of wall (Rt)

$$R_t = (R_u + R_v)/2 = 6.296 \text{ m}^2\text{K/W}$$

U-value calculation

$$U\text{-value} = 1/R_t = 0.158 \text{ W/m}^2\text{K}$$

PITCHED ROOF WITH INSULATION BETWEEN THE RAFTERS (KINGSPAN KOOLTHERM K7 RIGID BOARD INSULATION)

Roof construction

12mm Scots slates

Felt

18mm sarking board

155mm X 50mm timber rafter 450mm centres (conductivity 0.13 W/m K)

100mm Kooltherm K7 Kingspan phenolic insulation slabs between rafters
(conductivity 0.018 W/m K).

12.5mm Gyproc plasterboard (conductivity 0.25 W/m K)

| Calculation of thermal resistance | | | | |
|-----------------------------------|------------------------------------|---------------|-------|--------------------|
| Layer | Material | Thickness (m) | W/m K | m ² K/W |
| | External surface | - | - | 0.040 |
| 1 | Roof construction (BS EN ISO 6946) | - | - | 0.300 |
| 2(a) | Timber rafter | 0.155 | 0.13 | 1.346 |
| 2(b) | Kooltherm K7 insulation | 0.100 | 0.018 | 5.555 |
| 3 | Plasterboard | 0.013 | 0.25 | 0.052 |
| | Internal surface | - | - | 0.130 |

Resistance through section containing insulation

| | |
|-----------------------------|----------------------------|
| External surface resistance | = 0.040 |
| Resistance of roof | = 0.300 |
| Resistance of insulation | = 5.555 |
| Resistance of plasterboard | = 0.052 |
| Internal surface resistance | = <u>0.130</u> |
| Total (R1) | = 6.077 m ² K/W |

$$\text{Fractional area (F1)} = 0.935 \text{ (93.5\%)}$$

Resistance through section containing timber

| | |
|-----------------------------|----------------------------|
| External surface resistance | = 0.040 |
| Resistance of roof | = 0.300 |
| Resistance of timber | = 1.346 |
| Resistance of plasterboard | = 0.052 |
| Internal surface resistance | = <u>0.130</u> |
| Total (R2) | = 1.868 m ² K/W |

$$\text{Fractional area (F2)} = 0.065 \text{ (6.5\%)}$$

The upper limited of resistance (Ru)

$$R_u = 1 / ((F1/R1) + (F2/R2)) = 5.301 \text{ m}^2\text{K/W}$$

Lower resistance limit (Rv)

| | |
|-----------------------------|----------------------------|
| External surface resistance | = 0.040 |
| Resistance of roof | = 0.300 |
| Resistance of bridged layer | = 4.617 |
| Resistance of plasterboard | = 0.052 |
| Internal surface resistance | = <u>0.130</u> |
| Total (Rv) | = 5.139 m ² K/W |

Total resistance of roof (Rt)

$$R_t = (R_u + R_v)/2 = 5.220 \text{ m}^2\text{K/W}$$

U-value calculation

$$U\text{-value} = 1/R_t = 0.191 \text{ W/m}^2\text{K}$$

EXTERNAL WALLS FORMING DORMERS (KINGSPAN KOOLTHERM K7 RIGID BOARD INSULATION)

Wall construction

18mm dry-dash (conductivity 0.51 W/m K)
 18mm plywood sheeting (conductivity 0.13 W/m K)
 100mm X 50mm timber studs at 400mm centres (conductivity 0.13 W/m K)
 100mm Kooltherm K7 rigid insulation boards by Kingspan between studs
 (conductivity 0.018 W/m K)
 12.5mm Gyproc plasterboard (conductivity 0.25 W/m K)

| Calculation of thermal resistance | | | | |
|-----------------------------------|-------------------------|---------------|-------|--------------------|
| Layer | Material | Thickness (m) | W/m K | m ² K/W |
| | External surface | - | - | 0.040 |
| 1 | 18mm dry-dash | 0.018 | 0.51 | 0.035 |
| 3 | Plywood sheeting | 0.018 | 0.13 | 0.138 |
| 4(a) | Kooltherm K7 insulation | 0.100 | 0.018 | 5.555 |
| 4(b) | Timber studs | 0.100 | 0.13 | 0.769 |
| 5 | Plasterboard | 0.013 | 0.25 | 0.052 |
| | Internal surface | - | - | 0.130 |

Resistance through section containing insulation

External surface resistance = 0.040
 Resistance of Dry-dash = 0.035
 Resistance of plywood sheeting = 0.138
 Resistance of insulation = 5.555
 Resistance of plasterboard = 0.052
 Internal surface resistance = 0.130
 Total (R1) = 5.950 m²K/W

Fractional area (F1) = 0.935 (93.5%)

Resistance through section containing timber

External surface resistance = 0.040
 Resistance of UPVC lining = 0.035
 Resistance of plywood sheeting = 0.138
 Resistance of timber stud = 0.769
 Resistance of plasterboard = 0.052
 Internal surface resistance = 0.130
 Total (R2) = 1.164 m²K/W

Fractional area (F2) = 0.065 (6.5%)

The upper limited of resistance (Ru)

$$R_u = 1/((F1/R1) + (F2/R2)) = 4.695 \text{ m}^2\text{K/W}$$

Lower resistance limit (Rv)

| | |
|--------------------------------|----------------------------|
| External surface resistance | = 0.040 |
| Resistance of dry-dash | = 0.035 |
| Resistance of plywood sheeting | = 0.138 |
| Resistance of bridged layer | = 3.955 |
| Resistance of plasterboard | = 0.052 |
| Internal surface resistance | = <u>0.130</u> |
| Total (Rv) | = 4.350 m ² K/W |

Total resistance of wall (Rt)

$$R_t = (R_u + R_v)/2 = 4.523 \text{ m}^2\text{K/W}$$

U-value calculation

$$U\text{-value} = 1/R_t = 0.221 \text{ W/m}^2\text{K}$$