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## Building Fabric Design : Thermal Performance Standards

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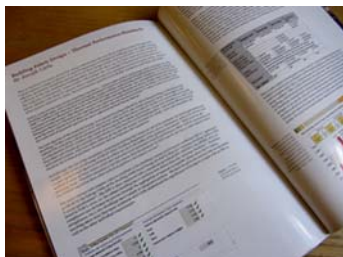
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# Bui l di ng Fabri c Desi gn

## Thermal Performance Standards



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FIGURE 1

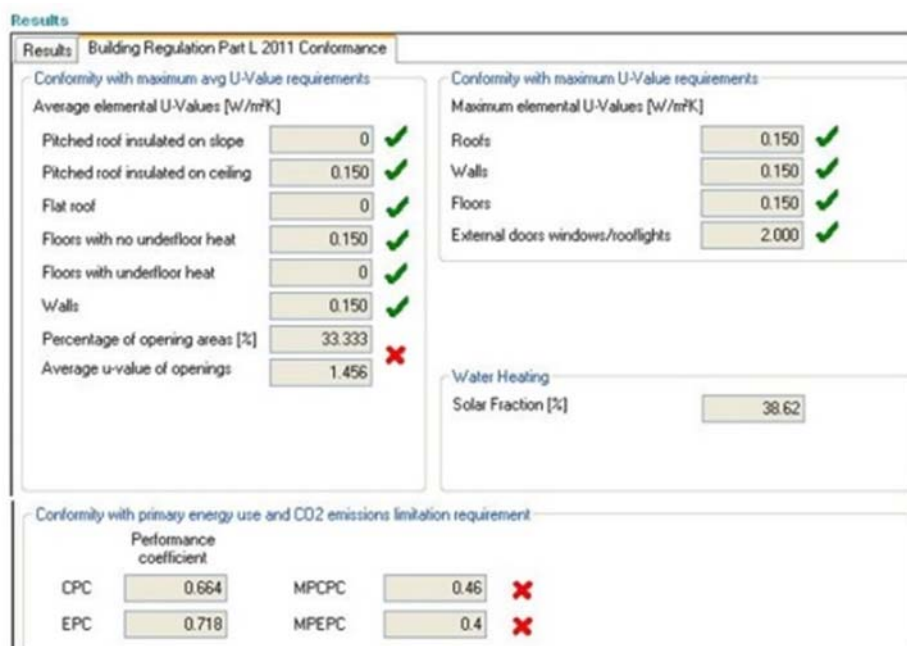
Results excerpted from a DEAP  
assessment

This is the first of a series of articles using content from the new *RIAI Building Fabric Design CPD* which explores a range of themes of central importance to designing buildings that are highly energy efficient, genuinely compliant and perform to their design intent and specification. As the articles are short and the themes are often complex, they can be at best a short introduction to the issues raised. In this article we will look at the new minimum building fabric standards: these are far more onerous than much of the Industry understands. In later articles we will critique

the Acceptable Construction Details (and show better details with their psi-values);

show compliant and non-compliant forms of construction; discuss what causes, and how to close, the performance gap between design standards and what gets built; and explore the impact compliant glazing ratios and U-values could have on aesthetics and natural lighting. The course goes into greater detail.

TGD L-2005 was the last version of guidance for Part L - Conservation of Fuel and Energy which a designer of a new dwelling could



open, select a maximum average elemental U-value for an element of building fabric from the relevant table<sup>1</sup>, and *know* that that element would thereby comply. 0.27 W/m<sup>2</sup>K, the maximum average elemental U-value for walls built through much of the Boom, was consequently burned into many an architect’s brain and may still influence notional wall widths and specifications at scheme design stage to this day. The Elemental Heat Loss Method as this approach was called was considered best practice. Developers of multiple units used the more relaxed Overall Heat Loss Method (which allowed maximum average U-values as poor as 0.37 W/m<sup>2</sup>K for walls) and all generally ignored the more sophisticated Heat Energy Rating<sup>2</sup>.

area (kWh/m<sup>2</sup>.yr) by that of a reference dwelling. The reference dwelling has performance characteristics typical of a dwelling of the same design that complied with TGD L-2005 under the Elemental Heat Loss Method<sup>5</sup>. The EPC is then compared with a maximum permitted EPC (MPEPC). An MPEPC of 0.4, which proves compliance under TGD L-2011, means that the subject dwelling has to perform 60% better than the reference dwelling.

It can thus be seen, when designing new dwellings, that *not* using DEAP is contrary to the Regulations, not just the technical guidance. It follows from this that without doing a compliance check in DEAP (or assessing a BER certificate) one should not sign an Opinion of Compliance with Building

TABLE 1

Extract from DoEHLG’s ‘Regulatory Impact Analysis’ of July 2010. *Our additions are shown in italics*

RIA Dwelling ID	1	3	5	8
House type	<b>Bungalow small</b>	<b>Detached large</b>	<b>Semi-D medium</b>	<b>Apt small mid-mid</b>
<i>Area and geometry</i>	<i>Least efficient geometry</i>	<i>Largest dwelling</i>	<i>Average case</i>	<i>Smallest area &amp; most efficient geometry</i>
walls U-value	0.14			
floor U-value	0.15			
roof U-value	0.12			
Window U-value	1.1 (triple)	0.9 (triple)	1.3 (double)	0.9 (triple)
Y-value W/m <sup>2</sup> K	0.06	0.08	0.05	0.05
Heat & Power	100% low energy lighting, 91.3% efficient gas boiler with optimum responsiveness & heating controls, 100mm insulation on cylinder, 10% secondary heating from 80% efficient heater (all gas except dwelling 2)			
Renewables	4.3 m <sup>2</sup> SHW	6.5 m <sup>2</sup> SHW & wood pellet stove	5.5 m <sup>2</sup> SHW	3 m <sup>2</sup> SHW
<b>EPC = MPEPC</b>	<b>0.4</b>	<b>0.4</b>	<b>0.4</b>	<b>0.4</b>

The introduction of the Domestic Energy Assessment Procedure (DEAP) by SEAI changed things *radically* for new dwellings. Under L2 of S.I. 854 of 2007 and L3 of S.I. 259 of 2011 primary energy consumption and CO<sub>2</sub> emissions are considered satisfactorily limited when DEAP shows conformity with a number of requirements, and proves maximum values have not been exceeded<sup>3</sup>. The most complex value to establish is the dwelling’s ‘energy performance coefficient’ (EPC)<sup>4</sup>. The coefficient is created by dividing the primary energy consumption of the dwelling per unit

Regulations. We would advise architects to use DEAP from early in the sketch design process to assess the implications of wall widths, glazing ratios, perimeter-to-area ratios and costs.

Figure 1 shows a screen print of results from a DEAP assessment for a new 108m<sup>2</sup>, 2-storey detached house. It has a range of low energy features, compact shape, an airtightness of 7 m<sup>3</sup>/m<sup>2</sup>.hr, solar hot water, boiler interlock, factory-insulated cylinder etc. Junctions did not conform to the Acceptable Construction Details (therefore 0.15 W/m<sup>2</sup>K was used). Triple-glazed, argon-filled, windows were selected and all opaque elements exceed the maximum average elemental U-values (see green ticks and values of 0.15 W/m<sup>2</sup>K in Figure 1). Despite

<sup>1</sup> Table 1 of TGD L-2002, -2007, -2011 and Table 2 of TGD L-2005

<sup>2</sup> This was introduced in TGD L-1997, formed part of TGD L-2002 and was omitted in preparation for DEAP in TGD L-2005. It assessed compliance based on energy consumption

<sup>3</sup> These are the MPEPC, maximum average elemental U-values, maximum elemental U-values, permeability, boiler efficiency and renewable energy requirements

<sup>4</sup> See TGD L-2011, section 1.1.2

<sup>5</sup> See Table C1 of TGD L-2011. Note this means that it represented a more onerous standard than most housing estate houses of the time which complied with the less onerous Overall Heat Loss Method.

this the dwelling does not comply with the Building Regulations because (a) the percentage of windows, rooflights and doors in relation to floor area is too high for their average U-value<sup>6</sup> and (b) because the EPC greatly exceeds the maximum permitted EPC. The fact that this specification, including super-insulation values, fails to comply is striking proof of how onerous *minimum* compliance has now become. It is also clear the U-values of Table 1, TGD L-2011, are no guide to which values to use when starting to design a new dwelling.

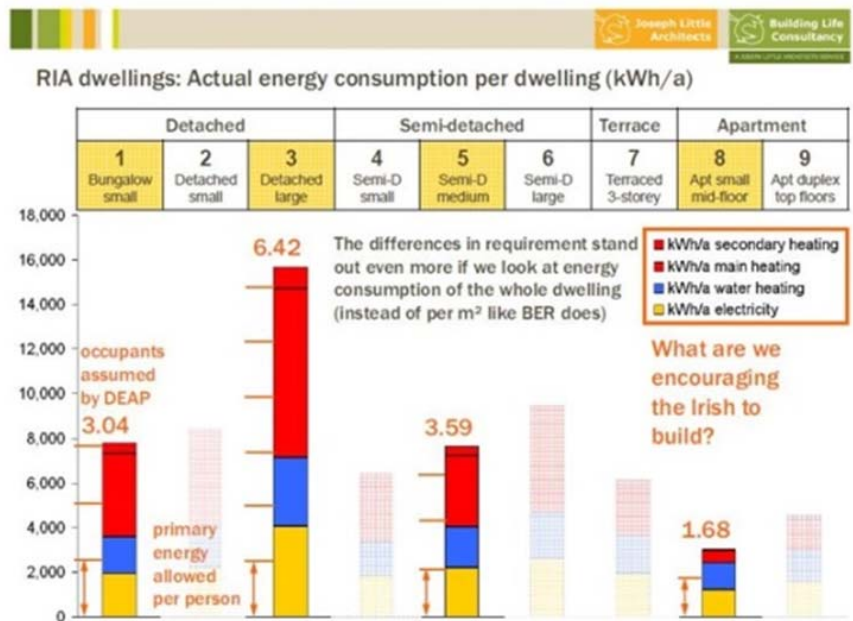
This is made explicit in the Regulatory Impact Analysis<sup>7</sup>, which the Building Regulations team in DoEHLG created to prove to themselves and the Minister that TGD L-2011 *could* be implemented. Table 2 of that document shows the measures necessary to make 9 dwelling types *barely compliant*. Table 1 of this article shows the performance values for key elements of four of these dwellings, selected due to their contrasting exposed areas and sizes. Maximum average U-values are at 'Passivhaus' standard levels, all glazing values shown are lower than those listed in DEAP (pushing designer to use specific values of very high-performing windows systems), the Y-value in most cases exceeds 0.08 W/m<sup>2</sup>K (which means many Acceptable Construction Details and related psi-values can't be used) and all dwellings feature a large amount of solar panels (exceeding the

traditional rule-of-thumb of 1m<sup>2</sup> per person). It is clear that the performance required of new dwellings is light years beyond that of the Boom.

Figure 2 looks at the same dwellings in relation to the energy each is permitted to use (kWh/a). There is an extraordinary disparity. From this it can be seen that the reference dwelling is skewed in favour of large dwellings of inefficient geometry: surely this is neither appropriate nor sustainable? This is because compliance is based on performing 60% better than a dwelling complying with TGD L-2005 which shares the same geometry and area as the subject dwelling. Comparing the detached large house with the mid-mid apartment, the large surface area of the former gives ample scope to reduce energy use by 60%, but as the mid-mid apartment built to TGD L-2005 specification lost proportionately little through its small external envelope, its ability to lose 60% more under TGD L-2011 is compromised, especially as DEAP expects all occupants to use the same amount of hot water. Contrasting the red, blue and yellow bars in Figure 2 makes this very clear. In our view the hot water generated by 3m<sup>2</sup> of solar panels will not be fully used – the renewables are being used to compensate for a reference dwelling that does not take account of the naturally sustainable, efficient form of the apartment.

FIGURE 2

Analysis of primary energy use per year and population for four RIA dwellings when each are *equally* compliant with an EPC of 0.4



<sup>6</sup> As set-out in 1.3.2.4 and Table 2 of TGD L-2011

<sup>7</sup> Downloadable from [www.environ.ie](http://www.environ.ie) > Legislation > Development and Housing > Building Standards

In contrast to new build, conformity for extensions and retrofit is proven through meeting or exceeding maximum values: neither the EPC nor the regulatory requirement to use DEAP applies. A new extension can therefore be built to a far less onerous standard than a new dwelling. Nonetheless DEAP is still a valuable tool in these cases because it shows the integrated performance of the retrofitted or extended dwelling and makes compliance with maximum values clear. DEAP is particularly useful in showing the impact of heating systems and controls, an area architects have often regarded as ‘dark arts’!

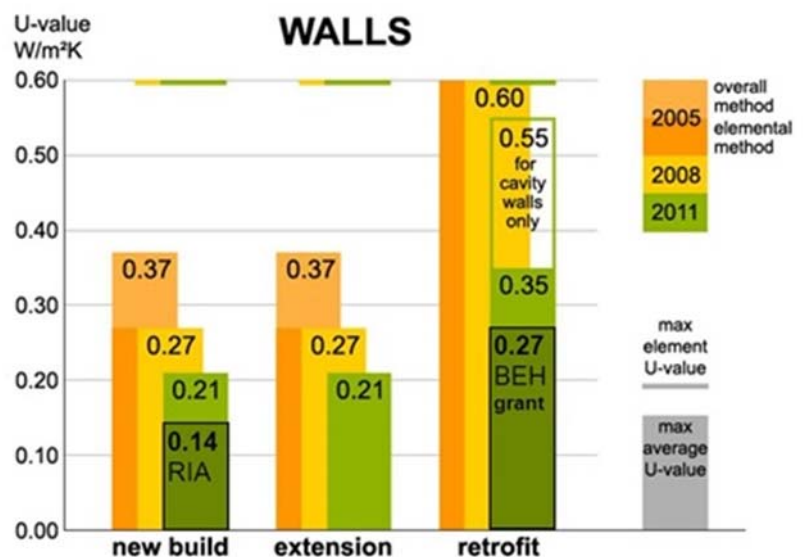
Tables 1 and 5 of TGD L-2011 set out the relevant maximum average U-values for extensions, and for material alterations and changes of use. Permeability standards are greatly relaxed for both<sup>8</sup>. In relation to thermal bridging Diagram 2 is still considered compliant for retrofit and sadly reference is still made to 15mm of insulation (now of 0.033 W/mK) being adequate to resolve any thermal bridge at the window of a retrofitted dwelling (ref: TGD L-2011, section 2.1.3.3)<sup>9</sup>. Sensibly Table 5 allows a relaxation for the insulating of houses with cavity walls, but sets the same target for is appallingly poor guidance, and can result in increases of surface condensation in certain cases.

internal and external insulation which have very different hygrothermal risks. As we know grants currently drive building fabric standards of domestic retrofit projects: the Better Energy Homes scheme which serves the private sector requires the elemental values listed in Table 1 of TGD L-2007. In our view this is generally reasonable for external wall insulation (where appropriate) but once again inappropriate for internal insulation. The range of values for walls discussed in this article can be reviewed at one go in Figure 3.

In terms of sustainability it is good that standards have become more onerous but a review does seem necessary to ensure that they are also genuinely environmentally sustainable, and fully integrated

FIGURE 3

Changes in average elemental U-values from 2005 – 2011. Bars without outline are from Table 1, TGD L for new build and retrofit, and from Table 5 for retrofit



<sup>8</sup> The focus is on limitation and careful practice on site rather than achieving a provable standard, such as an airtightness test would allow. Following the Acceptable Construction Details is cited as ‘reasonable provision’. We would argue that in relation to extensions air permeability standards should be the same as for new build.

<sup>9</sup> This guidance makes no differentiation between internal insulation, cavity or external nor of the U-values in question: it is appallingly poor guidance, and can result in increases of surface condensation in certain cases.