Underfloor Heating with Carpets and Underlay

Background

- Carpets and carpet underlays have been developed over many years to provide high levels of thermal insulation so that, when they are used in a room that has a convective form of heating, the combination of carpet and underlay helps minimise the loss of heat downwards into the floor structure.
- As the use of underfloor heating increases, there has been concern in the carpet industry that the high thermal resistance of carpets and underlays could impede the transfer of energy between the floor and the room, and that this might diminish carpet sales.
- Performance output calculations that are based on EN1264 using the published Tog values of certain carpets and underlay predict that the thermal output may be diminished. As a consequence, general guidance provided to users, by professional underfloor heating suppliers, is that the combined resistance of carpet and underlay should be limited to 1.5Tog.
- Practical experience gained over many years has shown however that the rate of thermal transfer through some combinations of underlay and carpet appears higher than calculations based on EN1264 predict, even when the published resistance exceeds the recommended maximum 1.5Tog.
- In order to clear up the consequent confusion, both the carpet retail industry and underfloor heating system designers required definitive guidance about which combinations of underlay and carpet work satisfactorily with underfloor heating.

Tests Undertaken at BSRIA

During the period 17 June to 30 August 2005, thermal performance tests were carried out at BSRIA, which is an independent and internationally-recognised test laboratory in Bracknell.
A set of 13 different combinations of carpet and underlay were set over a section of low pressure warm water underfloor heating in the BSRIA test chamber and tested in accordance with procedures contained in BS EN 442-2:1997.
The work was undertaken as BSRIA Contract 19323/1 on behalf of the Underfloor Heating Manufacturer's Association (UHMA) and with the active cooperation of The Carpet Foundation.

Applying the detailed mathematical formulae incorporated within EN1264, calculations were made of the expected thermal power output when the test floor was covered by the tested combinations of carpet and underlay, using in the formulae the published Tog resistances of both. These outputs were then compared with the actual thermal outputs as measured by the Test Chamber computer. In every case, the measured output was greater than the calculated output. **A corrected value for Tog resistance was then used within the formulae, to bring the calculated thermal output into agreement with the measured output**. A comparison was then be made between the Published Tog and the Effective Tog, which is the resistance figure that would be used when a heating system designer wishes to predict the output of an underfloor heating system when it is covered by the tested combination of carpet and underlay.

In order to provide a basis for further comparison of the actual thermal output figures with the outputs from other known floor coverings, the actual output from the bare floor was measured as was the actual output when the bare floor was covered with 9mm plywood and with 18mm chipboard. These actual output figures were compared with the predicted outputs calculated using the same formulae from EN1264, using the known Tog resistances of plywood and chipboard.

Carpets and Underlay Tested

Five different types of carpet were each tested -

Make	Form	Pile	Construction	Tuft Density	Tog
Brintons	Axminster	80/20 wool/nylon	cut pile velvet	762	2.16
Abingdon	Tufted	100 wool	loop pile	895	1.97
Abingdon	Tufted	100 polypropylene	loop pile	1291	1.81
Cavalier	Tufted	80/10/10 wool/nylon/poly	cut pile hard twist	1115	1.90
Victoria	Tufted	100 polypropylene	cut pile hard twist	1472	1.60

Each was tested over two different forms of underlay -

Step 80	Sheet	underlay	waffle	1.27
Treadmore	Sheet	underlay	rubber crumb	1.03

Cavalier Tufted was tested over -

Cloud 9	Sheet	underlay	0.80

Brintons Axminster and Victoria Tufted were each tested over -

Roma	Sheet	underlay	0.90

Test Results

Combination	Actual Output (W/m2)	Published Tog	Effective Tog	Difference
Step 80 + Brintons Axminster	52	3.43	2.20	-1.23
Step 80 + Abingdon Tufted 895	55	3.24	1.90	-1.34
Step 80 + Victoria Tufted	55	2.87	1.90	-0.97
Step 80 + Abingdon Tufted 1291	54	3.04	2.00	-1.04
Step 80 + Cavalier Tufted	55	3.17	1.90	-1.27
Treadmore + Cavalier Tufted	56	2.93	1.80	-1.13
Treadmore + Brintons Axminster	53	3.19	2.10	-1.09
Treadmore + Abingdon Tufted 1291	56	2.84	1.80	-1.04
Treadmore + Abingdon Tufted 895	57	3.00	1.70	-1.30
Treadmore + Victoria Tufted	58	2.63	1.60	-1.03
Cloud 9 + Cavalier Tufted	56	2.70	2.10	-0.60
Roma + Brintons Axminster	55	U+2.16	1.90	
Roma + Victoria Tufted	60	U+1.60	1.40	

Assessment of Results

With the exception of Cloud 9 + Cavalier Tufted, it can be seen that the tested combinations of carpet and underlay provided thermal outputs that indicate an Effective Tog, when used over underfloor heating, more than 1.0Tog less than the Published Tog. In two cases, the reduction could be 1.3Tog.

The results also indicate that the Actual Output figures vary only slightly between the different tested combinations. If, at the Design Condition, the calculated heat losses of the space to be heated are below 50W/m2, then any of the tested carpet and underlay combinations could be used. A design heat loss of about 50W/m2 is a typical average found to be needed to heat most new-build housing.

There are three reasons why the Difference figures might be conservative -

Firstly, practical experience shows that the thermal output through a carpet increases over time perhaps as a consequence of manufacturing fluff being vacuumed out from within the pile. The tests were all undertaken on new carpet. If the Actual Output figures increase, the Effective Tog would decrease.

Secondly, for reasons of expediency, with the exception of the last test - Roma + Victoria Tufted - the underlays and carpets were all loose-laid within the test chamber. In a real home, they are often fixed to the floor and to each other either using double-sided adhesive tape or special glues. This would improve the connectivity between the heated floor surface, the underlay and the carpet, and it is expected that this would also increase the Actual Output and consequently reduce the Effective Tog.

Thirdly, the section of test flooring was necessarily a lightweight, dry construction and the Test Chamber represented a room that was completely bare of furniture. In a real room, there would be furniture whose weight would press together the sections of the floor construction, and the effect of this is expected to improve their physical connection, which would also result in the Actual Output being increased.

These test results should NOT be interpreted as indicating that the published Tog for any combination of carpet and underlay can be reduced by 1.0Tog when used over underfloor heating. The test results only apply to the tested combinations or to products having the same type of construction as the tested samples.