In 2006, R-values were introduced into Section J of the Building Code of Australia to set a minimum standard for thermal insulation of duct and pipe for energy efficiency in commercial buildings. As Sean McGowan reports, because insulation thickness can challenge the space that's available, compliance is proving to be increasingly difficult.

PUTTING THE SQUEEZE ON R-VALUES

For a variety of reasons, Section J of the Building Code of Australia (BCA) Volume One has long challenged parts of the industry.

This may be because some sectors are still coming to terms with energy efficiency applying to all aspects of HVAC design. Alternatively, it could be that BCA requirements are forcing current practice to advance at a pace that's too fast for some to easily adjust.

Whatever the case, Section J is for many what the Bathurst 1000 is for its competitors – while ultimately rewarding, the journey is rarely an easy one.

A good example of this is compliance with R-values (resistance values) that first appeared in Section J of the BCA in 2005, relating to the minimum standard for thermal insulation for energy efficiency in the wall/floor/roof values of residential buildings. In 2006, both the wall/floor/roof values and the pipe and duct values for commercial buildings were written into the BCA.

The values vary according to the location of the pipe or duct within a particular building, as well as the system capacities and climate zone where a building is located. The resultant R-values are used to determine the thickness of insulation to be applied to a particular section of pipe or duct.

Overnight, their introduction made the pipe or duct location important in determining the required R-value, and increased the thickness of insulation beyond what had to that time been accepted industry practice.

It also resulted in a fundamental change to the way insulation was specified, with the R-value replacing insulation thickness (in millimetres) as the compliance measure for thermal performance.

According to Kevin O'Reilly, M.AIRAH, director of Adelaide-based System Solutions Engineering, these early values represented best practice. He says it was not particularly difficult to meet the nominated values until things started to become more stringent around 2009.

Duct clashing with other services.

"For some reason, the insulation values were doubled," says O'Reilly, a member of AIRAH's South Australian Division committee. "Previously duct work located within a ceiling space that had an R-value of, say, R0.6 suddenly became R1.2 and resulted in 25mm of mineral wool fibre insulation, for example, needing to be 75mm in thickness.

"Combined with the further complication that the R-value of the insulation alone can only be used – not the collective R-value of the sheet metal plus insulation – this effectively made it over twice as difficult to achieve the prescriptive values."

Of course, the ABCB had its reasons – it had been directed by COAG, under the NSEE, to up the stringency of minimum building energy efficiency. This move was agreed by the State, Federal and Territory governments. Increasing the R-values was one of the areas targeted by the ABCB as a result of energy modelling.

In practical terms, this resulted in contractors needing more space for services that, in an environment where cost per square metre is king, has become increasingly difficult to come by.

COAG, NSEE, AIRAH and AMCA

COAG has updated NSEE in 2010 and it appears likely that the trend of increasing minimum energy efficiency standards through the BCA will continue.

Both AIRAH and AMCA have made submissions to the ABCB and the BCC regarding this matter, but all proposals for change for the BCA are now required to meet a "neutral stringency test", so that any change will not reduce the energy efficiency outcome.

The draft "National Building Energy Standard-Setting Assessment and Rating Framework" issued by the DCCEE shows the government's intention to continue increasing energy efficiency standards through the BCA.

Furthermore, the tightening of the BCA's energy efficiency standards also had an effect on pipe and duct sizes, which are generally forced to be larger in order to limit fan and pump sizes and motor power use. The combined size increase of the larger ducts plus thicker insulation can have a significant impact on available space, which was not considered in the original modelling.

According to Shane Durkin, M.AIRAH, engineering services manager for A.G.Coombs in New South Wales, space for services such as duct and pipe are generally minimised by architects in order to minimise building costs and free up space for other building elements.

"This naturally opposes energy-efficiency outcomes achieved with low-loss duct and pipe sizing, and increased insulation thicknesses that require more space," he says.

"There appears to be limited acceptance from designers that the introduction of Section J R-values requires increasing services zones. When architects and designers do not coordinate sufficient space for compliant R-values to be installed, this will ultimately compromise the contractor's ability to meet Section J requirements."

A NEED FOR UNDERSTANDING

Common problem areas for installation contractors are ceiling space heights and riser shaft dimensions, as these are typically the first focus of designers looking for reductions in building costs. Others include costly transition sections to pass under beams or local restrictions.

Durkin says there are also numerous other installation difficulties that contractors need to overcome as a result of the Section J R-values, including duct and pipe systems that need to be adjusted for commissioning, and maintained in operation.

"The R-values equate to insulation thicknesses that make accessing these elements more difficult, or require use of non-standard components," Durkin says. "Ultimately, something may need to give, and a non-compliant installation may result."

O'Reilly believes it is too easy for design engineers to only state the new R-values on a drawing. He compares current practice to that of the past, where the prescribed insulation thickness would typically be indicated by cross-hatching.

"Today, we just quote R-values with no mention of insulation thickness," he says.

An apparent disconnect in terminology between some consultants and contractors is further complicating matters, O'Reilly says, with confusion around internal air stream sizing and the external dimensions of duct.

It begs the question – is the effect of R-values on insulation thicknesses widely understood?

According to Neil Lindegreen, M.AIRAH, national sales and marketing manager for duct manufacturer Bradflo, an increase in R-value from R0.6 to R1.0, for example, results in polyester flexible duct increasing from 35mm to 60mm in thickness. An increase from R1.0 to R1.5 sees the thickness of glasswool increase from 40mm to 65mm.

He says along with having an effect on specifiers, designers and contractors, the increase in bulk insulation requirements has also forced manufacturers such as Bradflo to make tooling changes to accommodate thicker insulants.

"Compacting bulkier flexible duct has meant changes to wire diameters were necessary," he says.

Lindegreen says the Section J requirements will help weed out non-conforming suppliers in the industry. Yet he agrees there needs to be a wider understanding of the implication on available space for services.

"With air conditioning consuming the most significant amount of resources in a building, the more efficient the ductwork off the plant, the less power is required to condition the building," he says.

"What has not altered to reflect this, however, is the premium of lettable space for a developer. The more floors on a building, the greater return on investment. Hence, the available cavity spaces are reducing while the insulation is getting thicker.

"Manufacturers have an input into the BCA without giving consideration to the effects of the building designers, and vice versa," he says. "Greater consultation between manufacturers and building designers would be a start."

ONE STEP FORWARD, TWO STEPS BACK

There is a growing chorus across the industry for the Australian Building Codes Board (ABCB) to reverse its decision to double the R-values, and simply revert back to 2009 levels.

According to O'Reilly, despite the good intentions of the BCA, doubling the R-values in the belief that this results in a doubling of the efficiencies gained is misguided.

"From a thermodynamics perspective, you do not halve the heat gain – or loss – by doubling the insulation. It is therefore my belief that the current R-values represent a diminished return, and will never provide the energy savings to offset their embodied energy."

However, embodied energy did not form part of the original analysis conducted by the ABCB.

He says despite some manufacturers being able to offer high R-values with relatively thin material by using cutting-edge technologies, these are not yet commercially viable. They can attract enormous price penalties, as well as having potentially negative flow-on effects.

"I recall one project where we were struggling to design a ducted system to fit within the limited confines of the ceiling space, so we looked at alternative technologies such as the flat-board foil-face material," he says.

"While we did reduce the overall height and width by 75mm, the product offered no acoustic benefit. So we dug our heels in and made the builder give us 100mm more ceiling space."

Along with wanting R-values lowered in response to current industry feedback, Durkin would also like to see further work done to simplify the insulation rating scheme.

"The BCA has made significant steps in terms of clarifying the insulation requirements in terms of applicability of insulation schedules within the building," he says. "However, further work could be done to reduce the number of R-values in the tables to simplify the overall insulation rating scheme.

"In Sydney, for instance, there are two applicable rating schemes, and this adds complexity. The industry still tends to work with a limited number of insulation materials and thicknesses, and the standards need to align with industry standards and workflows."

In the meantime, there appears to be no easy solution other than to address the issue as early as possible.

"BCA compliance can be achieved using an alternative solution that acknowledges non-compliant insulation R-values early in a project," Durkin says. "But this process is costly and not viable for all projects."

Although honest contractors will take the battle to the designer, builder or developer in an effort to increase services space and comply with the prescribed R-values, others will deliver a non-compliant installation and hope it is never discovered.

"Look, I would love for there to be a simple answer such as, 'Use XYZ-type insulation – it's cheap and works well', but in reality, I'm dreaming," says O'Reilly.

"A case in point – have you ever seen a piece of flexible duct that has an R-value of R2.0? It's not what you would call flexible! Perhaps the ABCB could just take a breath, listen to the concerns of the industry and relax the laws back to 2009 levels?" ▲

More information

For more information to the BCA's Section J, visit www.abcb.gov.au

HVAC&R Nation's July 2008 issue featured the article The trouble with Section J – it can be accessed at www.airah.org.au by selecting the Publications tab, then the HVAC&R Nation and Past Issues tabs.

Additionally, AIRAH offers a one-day course in Section J energy efficiency and verification courses. For more information, contact lauren@airah.org.au