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Energy efficiency of buildings (domestic hot water and commercial heating, ventilating and air-conditioning systems)

Submission to the Department of Building and Housing
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Background to IPENZ

The Institution of Professional Engineers New Zealand (IPENZ) is the lead national professional body representing the engineering profession in New Zealand. It has approximately 10,000 Members, including a cross-section of the engineering community from students to senior Fellows in management or governance positions in important design or construction organisations. IPENZ is non-aligned and seeks to contribute to the community in matters of national interest giving a learned view on important issues, independent of any commercial interest.

In making these comments IPENZ has drawn particularly on the knowledge of its Members who work in building services engineering, or are otherwise aware of the issues.

Executive Summary

IPENZ thanks the Department of Building and Housing (DBH) for the opportunity to comment on the "Energy efficiency of buildings (domestic hot water and commercial heating, ventilating and air-conditioning systems)" consultation paper. We note DBH's intention that the proposed changes to clause H1 of the Building Code will lower electricity and gas bills and limit the environmental impact of new buildings in the future.

Having studied the consultation document in detail, IPENZ strongly supports the thrust of the proposed amendments to clause H1 of the Building Code.

This submission deals principally with matters relating to domestic hot water. We understand that the Association of Consulting Engineers New Zealand (ACENZ) and the National Committee of the International Institute of Refrigeration Engineers, both of whom have Members in common with IPENZ, are making submissions that concentrate on the HVAC matters.

Recommendations

- In general we consider that DBH has been too modest with its proposals. IPENZ has previously publicly advocated minimum energy consumption standards that are more rigorous than those currently in place, and consequently we recommend a requirement more ambitious than a score of 1 in the rating tool.
- IPENZ recommends that a cost-benefit analysis is undertaken to determine the economic viability of introducing a requirement for a time limit for delivered water to reach operating temperature.
- We recommend that the rationale for a single CO_2 emission factor for electricity be clarified in the rating tool.
- We recommend that a note be added to H1, and repeated in the rating tool, drawing the attention of designers to the importance of temperature and stating that clause G12 gives the compliance requirements.
- In respect of solar water heater design, we recommend that an authority such as BRANZ accredits the various systems available using a quality mark.
- IPENZ recommends that DBH consults IPENZ and ACENZ to determine the form of LBP certification, and to determine how the risk is to be shared between the building services LBP and the site lead.

Suggestions

- IPENZ suggests a new requirement that specifies the maximum time for water to run hot.
- We suggest a requirement that the rating tool be used before alterations requiring consent are carried out, and that the "score" be required to exceed 1.
- To help the rating tool users, IPENZ suggests that a comment be added to H1 and repeated in the rating tool, emphasising the importance of not only reducing input energy but also recognising that some sources of energy impose more difficult waste product disposal problems.
- We suggest that DBH reconsiders the requirement to insulate all hot water pipes with materials preformed to the shape of the pipe.

There are concepts that could be clarified or better explained (these are discussed in more detail in this submission):

- The rationale for the energy to CO_2 calculation.
- The rationale for a single CO_2 emission factor for electricity.
- The temperatures to be reached by hot water system.
- The correct way of accounting for solar water heaters in a dwelling with multiple hot water systems.
- The appropriate LBP for certifying the performances of the specified systems.

Submission

Previous IPENZ submission

On 29 September 2006 IPENZ made a submission to the Energy Efficiency and Conservation Authority entitled "Increasing the Uptake of Solar Water Heating". In that submission, we stated that solar water heating was only one of a number of possible solutions to the problem of reducing the energy used for residential hot water heating in New Zealand.

We advocated:

- establishing minimum standards and a rating scheme whereby technologies can be evaluated and ratings published
- providing free of charge easy-to-use calculators to help consumers make informed choices about hot water heating options
- allowing consumers to choose the technology most suited to their circumstances

We recognised the following technologies as offering reductions in energy use:

- solar water heating
- water heating using a heat pump with a coefficient of performance of 3 to 3.5
- instant hot water heating using gas
- improved insulation options for electric or gas-fired storage systems
- woodburners with wetbacks

We suggested that the performance requirements be related to the number of bedrooms or the residential floor area.

We are delighted to see that DBH has picked up every one of these suggestions. We note that the DBH proposal uses both the number of bedrooms and the residential floor area, including integral garage space.

Modest versus ambitious requirements

In our energy policy document *Engineering a National Energy Strategy* we stated that "the Building Code should include minimum energy standards that are much higher than today's for the thermal performance of... building services, including water heating and air conditioning plant". The context shows that the energy required should be less for the same thermal performance.

This contrasts with the DBH discussion document's section 5.8.2 which states that "the [HVAC] proposal sets up a baseline that is below present industry best practice, and possibly even [below] good practice". At section 5.3 the discussion document states that "the proposed changes are intended to remove any existing worst practice activity".

In respect of the domestic water heating proposals, we have written a spreadsheet based on the equations published in the discussion document and used this to test the equations on data provided by IPENZ staff and others. We did this because the rating tool hides the equations. The spreadsheet and the rating tool both show that many existing systems comply, but with little margin. This agrees with the statement in 4.11.1 that "the design maximum limit for CO_2 was

thus set so that a typical electric storage hot water system fitted with water efficient showers would nearly always comply". The notes attached to the rating tool indicate that a score of 1 complies, 2 is more satisfactory, and 3 indicates an energy-efficient system.

IPENZ agrees with DBH that the proposals are modest, and encourages DBH to be more ambitious and set a much higher standard.

Alterations to buildings

The Building Act s112(1)(b) requires that, after an alteration, the building will continue to comply with the code at least to the same extent as before the alteration.

This means that a homeowner replacing a corroded hot water cylinder or remodelling an old bathroom will not have to lag previously bare pipes, nor consider a more efficient system, nor use the rating tool, nor do any of the other things that the amendments to H1 propose. As the potential retro-fit market is bigger than the new-build market, we recommend that people doing renovations be encouraged to comply as much as possible with the thrust of the amendments.

We note that replacing a corroded hot water cylinder is maintenance, and therefore does not require building consent.

We note that in s7 the Act defines restricted building work as work that requires a building consent and relates to an element of a building that is critical to the health and safety of its occupants. Because of the problems of scalding and *Legionella*, we interpret s7 to mean that a domestic hot water system is critical to the health and safety of the occupants. Hence, remodelling a bathroom is restricted work, is an alteration, requires consent, and requires an LPB.

We suggest a requirement that the rating tool be used before alteration work requiring consent is carried out, and that the "score" be required to exceed 1.

Time for water to run hot

People have commented that their existing systems take a long time for the water to run hot, particularly for the first person to use the shower each morning. This observation may be understood if there is a long length of pipe between the heater and the shower, and the water cools in this overnight. The proposed new requirement to lag the entire length of the pipe will help subsequent users in the 15 to 45 minute period, but will not solve the first user's problem.

IPENZ suggests a new requirement that the shower and other outlets reach their operating temperatures (specified in clause G12) in a small number (to be established by further study) of seconds. This will force the heater(s) to be close to the outlets, thus reinforcing the proposal to give credit to multiple hot water systems.

We recognise that making this mandatory could penalise centralised gas-fired storage and heat pump systems. Some designers may specify recirculating systems (as used in commercial buildings) to satisfy a time–to-run-hot

requirement, and this may use more energy. Others may specify several small instantaneous heaters, each situated close to the fixture it serves.

IPENZ recommends that a cost-benefit analysis is undertaken to determine the economic viability of introducing a requirement for a time limit for the delivered water to reach operating temperature.

Rationale for the energy to CO_2 conversion process

In its draft policy document on CO_2 emissions, IPENZ advocated that "performance standards should be introduced for hot water heating systems in new residences, for example, stating in the Building Code that a residence must include a water heating system rated to use no more than a prescribed amount of energy per year". Clearly, IPENZ and DBH agree.

We did not advocate the further step of relating energy saved to reduced CO_2 emissions, but recognise that there are social and political reasons for doing so.

We expect that the people who will make most use of the rating tool will be plumbers, builders of "spec" houses, salespeople in bathroom showrooms, architectural draughters, and possibly their clients.

To help the rating tool users, IPENZ suggests that a comment be added to H1 and repeated in the rating tool, emphasising the importance of not only reducing input energy but also recognising that some sources of energy impose more difficult waste product disposal problems than others.

Rationale for a single CO_2 emission factor for electricity

At least one major electricity generating company in New Zealand claims to be "carbon neutral". This company also has a retail division, and invites its retail customers to claim zero emissions when they calculate their own "carbon footprints". If this is valid, then the single CO_2 emission factor for electricity, 103 kg CO_2/GJ, does not account for the carbon neutrality of the generation process.

We understand that all electricity retail companies buy their product on the spot market and cannot know what proportion was generated in a carbon-neutral manner. If this is the situation, the single CO_2 emission factor is justified.

IPENZ recommends that this point be clarified in the rating tool.

Specification of temperatures

Because clause H1 does not specify temperatures, a designer of limited experience who desires to achieve great energy efficiency may believe that temperatures are of little importance. This is far from the case, as clause G12 clearly shows.

One problem relates to the type of pneumonia known as Legionnaires' Disease or legionellosis. This is caused by the bacteria *Legionella* which thrive in warm water and some soils such as potting mix. The route of infection of legionellosis is largely, if not exclusively, through inhalation of *Legionella* contaminated aerosols, or perhaps very fine particles, as in the case of potting mix. According to the New South Wales Code of Practice for the Control of Legionnaires' Disease, *Legionella*

will remain dormant at temperatures up to 20°C, will multiply between 20 and 55°C, will die in time at temperatures up to 70°C (a few minutes at 60°C), and are destroyed almost immediately at temperatures above 70°C.

Showers are one of the recognised devices for producing a sufficiently fine aerosol.

Clause G12 AS1 section 6.14.3 aims to minimise this problem by requiring the hot water system to be capable of reaching 60°C, and 6.14.4 goes further by requiring the water temperatures within flow and return circulating systems to be maintained at not less than 60°C.

Clause G12 AS1 section 6.15.1 notes that the plumbing and drainage standard AS/NZS 3500 Part 4 2003 provides an Acceptable Solution for the installation of solar water heaters provided they can maintain an average daily temperature of 60°C.

The second problem relates to the risk of scalding. To minimise this risk, clause G12 AS1 section 6.14.1 requires that the water be reduced in temperature to 45°C where small children or infirm adults are users, and 55°C in other buildings. Valves that mix hot and cold water are the obvious way of achieving this reduction in temperature.

We do not suggest that these temperatures be repeated in clause H1. We recommend that a note be added to H1, and repeated in the rating tool, drawing the attention of designers to the importance of temperature and stating that clause G12 gives the compliance requirements.

Insulation of pipes

NZS 4305 section 3.8 specifies the performance of pipe insulation and gives examples of satisfactory types. These include closed cell foam polymers and preformed fibreglass 12 mm thick.

We note that some hot water pipes are run in wall cavities that are insulated with fibreglass batts. There will be a temptation to ignore the “preformed” requirement and claim that the existing fibreglass provides the required insulation.

One manufacturer is investigating a cross-linked polyethylene pipe rated at 90°C to take water at 60°C from the cylinder to a kitchen appliance. This pipe is to have an ID of 6 mm and an OD of 10 mm. This is too small to satisfy the pipe size requirement in G12, and so will be part of the appliance rather than part of the hot water supply. Our calculations show that 12 mm of insulation over a 10 mm OD pipe has a beneficial effect, and we note that split preforms could be fitted between the wall studs. The calculations also show that the cost of the lost energy amounts to only a few cents per metre each year, and that it is unlikely that preformed insulation can be installed for a sufficiently low price.

We note that insulating very small diameter pipes does not reduce heat losses, but this problem does not occur with pipes of compliant sizes and materials, nor with the 10 mm polyethylene.

We suggest that DBH reconsiders the requirement to insulate all hot water pipes with materials preformed to the shape of the pipe. We note that batts made from glass or hollow plastic fibres could be cut to fit sufficiently snugly around the pipe, would satisfy reasonable insulation requirements, and would be cheap to install.

Number of occupants

In calculating the number of occupants N_A and N_B, it is possible to obtain fractional numbers. We ask if this is intended, or is it intended that the values be rounded up to the nearest whole number?

As the values are used only as inputs to other equations, and are never meant to represent real people, we suggest that they be left as fractional numbers.

Number of solar water heaters

Some dwellings may be fitted with a solar water heater that supplies one of several hot water systems. It should be clarified whether the solar water heater is to be counted only for the system it supplies, or is to be counted for each system.

Design of solar water heater systems

An IPENZ Member working in this field reports that he has come across several cases where the solar heaters were not working well because the installations were not thought out properly. He cites a thermosyphoning system with insufficient height difference, a hot water tank that mixes too much hot and cold, and a booster element that is left on during the day. He also notes that some householders are not aware that their collector panels need to be cleaned.

He suggests that the performance specification in 5.3.1(iv) will be too difficult for many installers who are also designers to achieve, and that a prescriptive compliance document that gives acceptable design solutions would be an improvement. Because some companies have already developed their own solutions which may fall outside the range of acceptable solutions, we recommend that an authority such as BRANZ accredits the various systems available using a quality mark that is easily visible to purchasers and installers.

Licensed Building Practitioner

In respect of commercial HVAC systems, IPENZ supports the provision (in sections 5.7 and 6.4) that "a Licensed Building Practitioner (LBP) would have to certify that all specified systems in the building could perform to the performance standards set out in the building consent."

We note that DBH has already proposed 13 different classes of LBP licence. Not all LBPs would be capable of making this certification, so it will be necessary to ensure that only an appropriately-qualified LBP does so.

The form of the certification is not specified. IPENZ is aware that an engineer who signs a producer statement – construction review (PS4) may have to rely on the LBP's certificate. We note that s88(4)(a) of the Act does not create any liability on the part of the LBP issuing the certificate, and so the engineer may doubt the reliability of the certificate.

IPENZ recommends that DBH consults IPENZ and ACENZ to determine the form of LBP certification, and to determine how the risk is to be shared between the building services LBP and the PS4 writer.

Conclusion

IPENZ strongly supports the general thrust of DBH's proposals to amend clause H1 of the Building Code. We have already publicly advocated measures similar in intent but more ambitious in reach, and encourage DBH to do more than simply eliminate the worst of present practice.

The notion of using CO_2 emissions as a proxy for energy efficiency is an interesting one. We neither support nor oppose it. We recognise that a great deal of work will have to be done to persuade suppliers and consumers of water heating equipment that the CO_2 released at a power station is related to the hot water in a shower.