Keeping cost effectively warm: the inclusion of thermal performance in the New Zealand Building Code

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ABSTRACT: The 1990s saw change from the (nominally) prescriptive NZS1900 to the performance-based New Zealand Building Code (NZBC). Although there had been thermal insulation requirements for new houses since 1 April 1978, the change provided the opportunity to develop a performance-based requirement. It also provided the opportunity to include non-residential buildings, notably including for the first-time office and retail buildings. While around two thirds of energy use in houses is for space conditioning (heating) and water heating, in commercial buildings the main energy uses are space conditioning (heating and cooling) and lighting. Extensive background research developed a set of proposed documents, which were then refined using the Committee structure of Standards New Zealand. The three standards (NZS 4218 *Energy Efficiency: Housing and Small Building Envelope*, NZS 4243 *Energy Efficiency: Large Buildings* and NZS 4305: *Energy efficiency: Domestic type hot water systems*) provided an integrated series of standards. The paper will explore the background research, the use of Standards Committees, and the political issues that played a crucial role in delaying the implementation.

Introduction

New Zealand's interest in the use of thermal insulation to reduce mould, improve comfort, and/or reduce energy costs was first researched in the 1940s. However, it was not until the 1970s when a combination of the OPEC-created "oil shock" and poor rainfall leading to low-hydroelectric lake levels creating an "electricity shortage" that action was taken to mandate increased dwelling thermal performance.[1]

Thermal insulation was made mandatory in new houses from 1 April 1978,[2] although, since 1974/75, government energy conservation measures included the Housing Corporation's "Rental Housing Tender Prices Index" including: thermal insulation,[3] a home insulation interest-free loan scheme, and the reintroduction of daylight saving.[4] NZS4218P:1977 could be used to demonstrate compliance, either through the selection of a permitted R-value combination, or Clause 3 "Specific Thermal Design" (SPD). For example, SPD in a commissioned report showed compliance for foil lined board (lower wall R-value) when combined with higher ceiling R-value.[5]

These thermal performance requirements continued unchanged through the 1980s. Questions about the presence of thermal insulation were asked only in the 1976 and 1981 censuses.[6] The number of New Zealand houses with roof and/or wall insulation rose from 240,345 to 388,080, an increase of 147,735 or 61%, compared to just a 13% increase in the total number of new houses subject to the mandatory requirements.[7] Research exploring the achieved R-values found that after five years of the requirement about 40% were achieving the mandated minimum levels, about 40% were close but 20% failed.[8] In August 1982, commercial buildings were provided with their own code of practice, NZS4220:1982, providing guidance and energy consumption targets for new and

[1] Isaacs *Thermal Efficiency in New Zealand Buildings* p 4.

[2] Isaacs "The 1978 Mandatory Requirement for Thermal Insulation in Housing" pp 32-38.

[3] NZDS *New Zealand Official Yearbook* (1978) p 479.

[4] NZDS *New Zealand Official Yearbook* (1982) p 511.

[5] Beca Carter Hollings and Ferner *Winstone Limited: Report on Thermal Insulation Investigation*.

[6] NZDS *New Zealand Census of Population and Dwellings 1981* pp 120-121.

[7] NZDS *New Zealand Official Yearbook* (1978) p 475; NZDS *New Zealand Official Yearbook* (1982) p 502.

[8] Isaacs & Trethowen "But We Have to Insulate" pp 1057-1063.

existing buildings.[9] The 1980s also saw the standards for low pressure storage electric domestic hot water (DHW) systems (NZS4602:1988 and NZS4603:1985) revised for the first time since 1976. This paper is based on notes and background papers from the author being involved in the work leading to the 2000 Clause H1.

Review of Building Controls

Most important for the building industry was the 1984 "Review of Planning and Building Controls," the foundation for the development of the Building Act 1991 and 1992 New Zealand Building Code (NZBC). The reviewers, Jack Searle (retired Secretary of Internal Affairs) and Peter Scoular (retired Christchurch City Council City Engineer), were appointed mid-1982 under the Third National Government. Their 1983 first discussion document considered a wide range of topics including the "real purpose of planning and building controls."[10] They noted that while health and safety may have been prime considerations, their exact meaning had changed over time to include comfort, convenience, workmanship, durability, appearance and protection of property, as well as people. They noted that "thermal insulation is more than a matter of energy conservation."[11]

Following the government decisions from the first document, their 1984 second document provided an analysis of the submissions, a review of planning controls, a cost benefit analysis and a proposed National Building Code for residential buildings which would include "noise insulation, energy conservation."[12]

On 4 February 1986, the Minister of Internal Affairs of the Fourth Labour Government, announced not only the preparation of a simplified, performance-oriented, national uniform building code but that it would be binding on the Crown.[13] A five-member Building Industry Commission (BIC) would be appointed to draft the code and means of compliance over the next two years. The BIC was established in July 1987, and in 1988 released a series of "Working Papers." The first dealt with the philosophy of building controls, stating:

> For objectives such as conservation of property, energy, or other resource management objectives, to be included in the national building control system, it must first be agreed that these are issues of public and national interest.[14]

The second Working Paper explored the definition of building controls, putting forward the view:

> During the 1970s, as technology advanced on all fronts, policy makers in many countries set new objectives for building control beyond the traditional goals of safety, health and welfare - energy conservation and economic management of other resources, fostering of trade and the needs of special user groups. Building control systems around the world began collapsing under the weight of all the specific requirements and technical information about what and how to build to achieve them.[15]

This philosophy continued until the BIC's final 1990 report explicitly excluded energy conservation:

> 3.10 Matters of national interest, such as conservation of

[9] SANZ *NZS 4220:1982 Code of Practice for Energy Conservation in Non-Residential Buildings* p 9.
[10] Searle & Scoular *Review of Planning and Building Controls* (1983) p 16.
[11] Searle & Scoular *Review of Planning and Building Controls* (1983) p 16.
[12] Searle & Scoular *Review of Planning and Building Controls* (1984) p 100.
[13] Tapsell "New Zealand Building Code and Terms of Reference for the Building Industry Commission"
[14] BIC *Philosophy of Building Control* p 3.
[15] BIC *Defining Building Controls* p 3.

energy and other resources, or matters affecting the national economy may be appropriate for inclusion in the Code. However, there are usually more direct and effective ways of achieving national objectives than by reliance on building controls. Since these normally apply only to new buildings and do not affect the existing building stock, new measures will take a very long time to have a significant overall effect.[16]

Apparently, in parallel with the preparation of the Building Bill, the BIC was directed by the Minister of Internal Affairs:

to develop, and in due course, include performance oriented residential and commercial building energy efficiency standards in the New Zealand Building Code.[17]

Energy efficiency was not included in the Building Bill introduced to Parliament on 4 September 1990 by Hon. Margaret Austin, Minister of Internal Affairs in the Fourth Labour Government. The Bill supported the making of performance-based regulations to be called "the building code" and the creation of documents to establish compliance.[18] The Purposes of the Act were to provide for:

(a) Such controls relating to building work and the occupation of buildings as are necessary for the effective and efficient provision of safety and health for building users; and
(b) The co-ordination of those controls with other controls relating to building use and the management of natural and physical resources.[19]

The Principles, which must be read with the Purposes, were:

(a) Safeguarding people from possible injury, illness, or loss of amenity; and
(b) Protecting neighbouring property from physical damage (including fire); and
(c) Protecting household units (whether or not on land held under the same title) from physical damage (including fire); and
(d) Providing access to and facilities for use by people with disabilities within buildings to which section 25 of the Disabled Persons Community Welfare Act 1975 applies; and
(e) Assessing, in relation to the application of controls relating to building work and the occupation of buildings, the potential costs and benefits of those controls.

When the Building Act 1991 was passed by the Fourth National Government, apart from formal changes to the Purposes and Principles, two major changes were added. The first, in response to the New Zealand Fire Service, added the safeguarding of "reasonable expectations of any person who is authorised by law to enter the building for the purpose of rescue operations and fire fighting in response to fire,"[20] and the second was for energy efficiency:

(f) Facilitate the efficient use of energy, in the case of new buildings, during the intended life of those buildings.[21]

While in general there was support for the inclusion of energy conservation, an example of the opposing arguments came from a previous Minister of Internal Affairs, Hon. Peter Tapsell (Labour, Eastern Maori), who did not believe in the inclusion of "natural resources subject to market requirements [that] are well protected by statue; … they are better protected by the simple market function."[22] The then Minister of Internal Affairs, Hon. Graeme Lee, commented that zoning "will enable local climatic conditions to be taken into account,"[23] rather than one requirement for all New Zealand. The Bill was passed, under urgency, on 17 December

[16] BIC *Reform of Building Controls* v 1, p 42.
[17] Anon. "Energy Efficiency" p 3.
[18] Building Bill 1990 Pt. VII.
[19] Building Bill 1990 Pt. II.
[20] Building Act 1991 s6(2)(a).
[21] Building Act 1991 Pt. II.
[22] Tapsell, Peter (Eastern Maori). Building Bill (Report of Internal Affairs and Local Government Committee) p 332.
[23] Lee, Graeme (Minister of Internal Affairs). Building Bill (Second Reading) p 549.

1991.[24]

1992 Creation of New Zealand Building Code (NZBC) Clause H1 – Energy Efficiency

The NZBC is regulations made under the Building Act 1991. The first NZBC was consented on 8 June 1992.[25] As no "Technical Working Group" had been organised by the BIC[26] to create an appropriate performance-based clause, the original 1992 Clause H1 (Table 1) largely continued the previous requirements turned into a performance goal (H1.3.1) for housing. Due to the lack of pre-existing legal requirements, only broad guidance was given for other buildings which required heating and/or cooling (H1.3.2). Other NZBC Clauses relevant to thermal performance were "E3 Internal Moisture" with respect to fungal growth in Housing and Communal Residential buildings, and "G5 Interior Environment" which was concerned with the temperature control in habitable spaces, bathrooms and recreation rooms of old people's homes and early childhood centres.[27]

Clause HI-ENERGY EFFICIENCY
Provisions
OBJECTIVE
H1.1 The objective of this provision is to facilitate efficient use of energy.
FUNCTIONAL REQUIREMENT
H1.2 *Buildings*, throughout their lives, shall have provision for ensuring efficient energy use in controlling indoor temperature when that energy is sourced from a public electricity supply, or any other depletable energy resource.
PERFORMANCE
H1.3.1 The *building* envelope shall be constructed to ensure that the *building performance index* shall not exceed 0.13 kWh.
H1.3.2 Where any space within a *building* is intended to have a controlled temperature, construction of building elements affecting energy use shall take account of:
(a) Thermal resistance to heat loss through the *building* envelope,
(b) Heat gains (including solar radiation) through the *building* envelope,
(c) Airtightness,
(d) The contribution to space heating of heat losses from *building services* (including hot water systems, and lighting),
(e) Control systems for heating and ventilating, and for other services, and
(f) Utilisation of waste heat from internal processes.
Limits on application
H1.3.1 applies only to *Housing*.
H1.3.2 shall not apply to *Housing*, *Outbuildings*, *Ancillary buildings*, or *buildings* with a floor area of less than 50 m^2

Table 1: NZBC 1992 Original Clause H1

The new "Building Performance Index" (BPI) (see Table 1), although a descendent of the NZS 4218P:1977 SPD heat loss method,[28] made use of the Building Research Association of New Zealand (BRANZ)-developed ALF (Annual Loss Factor) updated from the 1980 first edition.[29] ALF accounted for not only heat loss, but also solar and internal heat gains, and thermal mass. Industry made prompt use

[24] Building Bill (Third Reading) p 821.
[25] Building Regulations 1992 First Schedule, Clause H1, p 1141.
[26] BIC *Reform of Building Controls* pp 135-137 (Appendix 6).
[27] Isaacs "The Building Code & Improving Energy Efficiency" p 49.
[28] SANZ *NZS 4218P:1977 Minimum Thermal Insulation Requirements for Residential Buildings* Clause 3.
[29] Bassett *ALF Design Manual*; Bassett et al. *ALF Design Manual*.

of it, for example, updating a SPD analysis for an insulation product manufacturer.[30] For commercial and institutional buildings, the Centre for Building Performance Research (CBPR) at Victoria University of Wellington modified and computerised for IBM PC DOS the "Building Energy Performance Targets" tool (BETARG2) to assist with code compliance.[31]

Revising H1

Work on the revision of the original H1 soon followed, with the commissioning of a review of the historic aspects of energy efficiency in New Zealand buildings. This identified that no measured data on the energy use of New Zealand commercial buildings had been published since the early 1980s, but changes to energy use included: improved air handling controls; a shift from central, energy-intensive mainframe computers to desktop personal computers (the IBM PC was introduced in 1981); the use of higher efficiency fluorescent tubes and control gear; and the many low-first-cost commercial buildings built during the 1980s stock market boom.[32] As well as improvements in house envelope thermal performance, it was noted that there had been a steady improvement in the performance of electric DHW cylinders, with heat losses for a 180 litre cylinder decreasing from 3.3 kWh/day (NZS720:1949) to 3.2 kWh/day (NZS720:1975) to 1.6 kWh/day (NZS 4602:1988).[33]

Funding for the development of new performance-based residential and commercial building energy standards, along with an energy efficiency public-sector loans scheme, whiteware labelling and databases of energy use, was announced in June 1993 by the Ministry of Energy.[34] Clause H1 is unusual in that while the Building Industry Authority (BIA) was required to include energy efficiency in the NZBC, the Energy Efficiency and Conservation Authority (EECA), a Crown entity, was also active promoting increased energy efficiency. The BIA and EECA worked together in the development of the new H1, taking complementary and supporting roles. They set up an "Energy Efficiency Building Standards Project" Reference Group which was regularly used as a sounding board.

In March 1994 research was commissioned to underpin the revision of H1. It evaluated the significance of different NZ building types, evaluated the use of energy in these different building types and finally developed a range of possible taxonomies. This was completed with the February 1995 report "Energy Efficiency in the N.Z. Building Code: a New Structure." It recommended that the revision of NZBC Clause H1:

(a) have as few energy performance targets as possible;
(b) be divided into four groups based on a combination of floor area and use type (under 300 m² residential & non-residential; over 300 m² residential & non-residential);
(c) provide support tools either by New Zealand development or use of an overseas tool to provide Acceptable Solutions (AS) for all building uses and sizes, "simple" Verification Methods (VM) only for residential buildings under 300 m²; and "comprehensive" Verification Method(s) for all building uses and sizes;
(d) include commissioning of any aspect of energy efficiency which is required for

[30] Beca Carter Hollings and Ferner *Pilot Study: Economics of Home Insulation Prepared for New Zealand Fibreglass Ltd*.
[31] Isaacs et al. *BETARG 2 Manual* p 1.
[32] Isaacs *Thermal Efficiency in New Zealand Buildings* pp 1, 18.
[33] Isaacs *Thermal Efficiency in New Zealand Buildings* p 6; Isaacs et al. *Energy Use in New Zealand Households* p 236.
[34] Luxton "$2.5 Million Funding for Energy Efficiency Initiatives: Press Release 27 June 1993" pp 1-2.

compliance; and

(e) include energy efficiency in the Building Warrant of Fitness.[35]

Following discussion of the proposed options, contracts were let to develop a revised Clause H1 for initial selection and screening of possible code measures. This work was undertaken by CBPR, BRANZ and Energy Research Otago Ltd. The final 1996 report "A Sensible Step to Building Energy Efficiency" set out research-based proposals for AS for stand-alone houses under 300 m² (roof, floor, wall and glazing R-values, DHW heat loss) and offices over 300 m² (coverage as for houses but plus Window-to-wall ratio and lighting power density limits). A VM based on a "Building Energy Target" (BET) compared the proposed building to use no more energy than a same (size, use etc) building meeting the AS requirements.[36] As well as a first draft revision of Clause H1 and background papers on the proposed AS and VM, papers with background research and recommendations were prepared for use by the Standards Association of New Zealand (SANZ) committees.[37]

Traditionally standards committees either took an existing, out-of-date standard, or developed their own standard, taking as much time as was required. The approach used for these three standards was unusual but enabled the committees to work faster than would have normally been the case. From the first committee meetings to approval by the Standards Council, including the normal public consultation phase, took 12 months with a further two months for publication. Each building standard followed the same structure: "Schedule" (or "Deemed-to-satisfy") options; simplified "Calculation Method"; and a more complex "Modelling Method."

A comparison of the research recommendations and the draft standards found reasonably close agreement. Key differences for houses were: the establishment of the South Island as single climate zone due to the suppliers' concerns as to the extra cost of maintaining a range of insulation products in the limited market; the continuation of the difference between conventional framed and solid timber construction; the removal of floor coverings from the floor R-value calculation as they are often unknown at the time of permit application; the removal of an upper glazing limit (proposed at 30%). The BIA requirement for the inclusion of the BPI in Clause H1 meant additional work to ensure consistency with the modelling method. For large buildings, the consultants' proposals were supplemented with considerable additional Committee work on lighting. The two building committees also worked to ensure consistency between the two standards. The DHW standard continued the existing "Grade A" thermal performance, but, as this was to be the minimum under the NZBC, lower performance cylinders were excluded. Insulating the pipe from the DHW cylinder to the kitchen sink (the most used hot water demand) was included.[38] R-value evaluation changed, away from "one-side-to-the-other-side" to "inside-to-outside" in order to include the subfloor perimeter wall e.g. floor changed from R-0.9 in NZS4218P:1977 to R-1.3 $m^2{}^oC/W$ in NZS 4218:1996.[39] This change followed research that found although R-0.9 was

[35] Isaacs et al. *Energy Efficiency in the N.Z. Building Code* p v.

[36] Isaacs et al. *A Sensible Step to Building Energy Efficiency* pp 1-4.

[37] Isaacs et al. *A Sensible Step to Building Energy Efficiency* pp 5-6.

[38] Isaacs & Lee "Clause H1: Energy Efficiency" pp 1-5.

[39] Isaacs "Changes in Floor Insulation Requirements?" pp 41-42.

achieved in floors with a perimeter foundation, it was not achieved for exposed (e.g. pole-house) floors.[40]

The three energy efficiency standards – NZS4218:1996 for houses and other buildings under 300 m² ("small buildings"),[41] NZS4243:1996 for other commercial buildings,[42] and NZS4305:1996 for electric DHW cylinders[43] – were able to be used in the revised Clause H1, which had been completed on 9 April 1996.[44]

However, implementation took extra time as there were two "major objections."[45] For the first, the Treasury argued the case for regulating energy efficiency had not been sufficiently made. An independent review found "good grounds for government involvement in setting home building insulation standards for reasons of health, comfort, protection of future residents and energy efficiency."[46] The second related to the industry response.

Industry Response

Not all of the construction industry was happy with the proposals. In February 1996, the Chief Executive of the New Zealand Master Builders Federation (NZMBF) wrote about

> double glazed toilets and bathrooms – that's the level of inanity of the joint BIA and EECA plan to require new homes whose exterior envelope exceeds 30 per cent glazing to double glaze the amount over that threshold.[47]

Even though, he acknowledged, the requirement might only impact on 5% of new homes it would have the effect of widening the gap between the cost of an existing home and a new home. The reason was that "[c]learly, EECA, the government agency charged with devising new ways to save energy, had a brainwave that the building industry would be an ideal target."[48] Even at the time, commentators were noting that the building sector did not have a strong track record in voluntarily exceeding minimum mandatory standards, and wondering if the response was merely a way to delay change.[49]

An insulation industry participant provided their own review of current insulation calculation and installation practices, concluding the calculated thermal bridging due to timber framing was as much as twice as much (30% vs. 15%) as used in the standard insulation guides (with a consequential reduction in the achieved component R-value) and that insulation installation was treated by the industry "more as a commodity than a material requiring technical competence."[50] They also recommended manufacturers and suppliers provide adequate design data.[51]

After the standards process, the NZMBF were reportedly happy with NZS4218 even though it "was initially feared the new standard

[40] Isaacs & Trethowen "But We Have to Insulate: A Survey of Insulation Levels in New Zealand" p 1060.
[41] SNZ *NZS 4218 Energy Efficiency: Housing and Small Building Envelope*.
[42] SNZ *NZS 4243 Energy Efficiency: Large Buildings*.
[43] SNZ *NZS 4305: Energy Efficiency: Domestic Type Hot Water Systems*.
[44] BIA "Draft for Comment: Approved Document H1: Energy Efficiency"
[45] Internal Affairs and Local Government Committee "1997/98 Financial Review of the Building Industry Authority" p 3.
[46] Internal Affairs and Local Government Committee "1997/98 Financial Review of the Building Industry Authority" p 3.
[47] Allsebrook "From the Chief Executive's Desk" p 8.
[48] Allsebrook "From the Chief Executive's Desk" p 8.
[49] Wood "Letter to the Editor" p 11.
[50] Patterson *Report on: Energy Efficiency Clause H1 Housing Insulation Review* pp 3-5.
[51] Patterson *Report on: Energy Efficiency Clause H1 Housing Insulation Review* pp 3-5.

Objective

H1.1 The objective of this provision is to facilitate efficient use of energy.

Functional requirement

Hl.2 *Buildings* must be constructed to achieve an adequate degree of energy efficiency when that energy is used for-

(a) modifying temperature or humidity, or both; or

(b) providing hot water to sanitary fixtures or sanitary appliances, or both; or

(c) providing artificial lighting

Performance

H1.3.1 The building envelope enclosing spaces where the temperature or humidity (or both) are modified must be constructed to-

(a) provide adequate thermal resistance; and

(b) limit uncontrollable airflow.

H1.3.2 Buildings must be constructed to ensure that the building performance index does not exceed:

(a) 0.13 kWh in a warm location; and

(b) 0.12 kWh in a cool location.

Provisions

H1.3.3 Account must be taken of physical conditions likely to affect energy performance of buildings, including-

(a) the thermal mass of building elements; and

(b) the building orientation and shape; and

(c) the airtightness of the building envelope; and

(d) the heat gains from services, processes and occupants; and

(e) the local climate; and

(f) heat gains from solar radiation.

H1.3.4 Systems for the heating, storage, or distribution of hot water to sanitary fixtures or sanitary appliances must, having regard to the energy source used,-

(a) limit the energy lost in the heating process; and

(b) be constructed to limit heat losses from storage vessels. and from distribution systems connected to storage vessels.

H.1.3.5 Artificial lighting fixtures must-

(a) be located and sized to limit energy use, consistent with the intended use of space; and

(b) be fitted with a means to enable light intensities to be reduced. consistent with reduced activity in the space.

Limits on application

Objective H 1.1 applies only when the energy is sourced from a *network utility operator* or a depletable energy resource.

Requirement H 1.2(a) does not apply to *assembly service buildings*, *industrial buildings*, *outbuildings*, or *ancillary buildings*, or to plant and equipment provided to modify temperature, humidity, or both.

Requirement H 1.2(c) applies only to *commercial buildings* and *communal non-residential buildings* whose floor area is greater than 300 m".

Performance H 1.3.2 applies only to *housing*.

Performance H 1.3.4(b) applies only where individual storage vessels are 700 litres or less in capacity.

Performance Hl.3.S does not apply to lighting provided solely to meet the requirements of clause F6.

Table 2: NZBC 200 Revised Clause H1

would be tantamount to mandatory double-glazing of homes in the South Island and, potentially, a forerunner to similar requirements in the North Island"[52] as the increased requirements could be achieved across the ceilings, walls, floors and/or glazing. The new Standard also provided compliance methods from the simple schedule which would be used by "80 to 90% of builders"[53] for the calculation and modelling methods "as an energy efficiency designer would want in designing a home to specific requirements."[54]

Year	Government	Source & Date	Roof $m^2.^oC.W^{-1}$	Wall $m^2.^oC.W^{-1}$	Floor $m^2.^oC.W^{-1}$	Glazing $m^2.^oC.W^{-1}$
1978	**National 3rd (75-84)**	**NZS4218P:1977**	**1.9**	**1.5**	**0.9**	**-**
1987	Labour 4th (84-90)	DZ4218 (review draft)	2.6	2.0	0.9	-
1990	Labour 4th (84-90)	DZ4218 (draft)	3.0	2.0	0.9	-
1992	**National 4th (90-99)**	**NZBC Clause H1 – AS1**	**1.9**	**1.5**	**0.9**	**-**
1996	National 4th (90-99)	NZS4218:1996 *	1.9	1.5	1.3	-
2000	**Labour 5th (99-08)**	**NZBC Clause H1 – AS1**	**1.9**	**1.5**	**1.3**	**-**
2004	Labour 5th (99-08)	NZS4218:2004	1.9	1.5	1.3	0.15
2007	**Labour 5th (99-08)**	**NZBC Clause H1 – AS1**	**2.9**	**1.9**	**1.3**	**0.26**

Table 3: Schedule Method Component Thermal Performance 1978 – 2015 (Mandatory in bold)[1] (Note: Floor R-value calculation changed in 1996. Based on Wellington (Climate Zone 2))

La Grouw Corporation made the most critical industry objection on the grounds even with the continuation of the solid timber concession, the new Clause H1 would disadvantage its Lockwood solid-wood wall. They funded reports from the New Zealand Forest Research Institute (now Scion)[55] and undertook extensive lobbying.[56] This resulted in the Department of Internal Affairs reporting to their minister on the submissions made on the draft H1 by La Grouw Corporation and the Business Roundtable. The Department was concerned of the possibility of either (1) a "declaratory judgement on what is meant by energy efficiency" to clarify whether the meaning of "during the intended life of those buildings" (see Building Act 1992 above) included embodied energy or (2) a judicial review. They suggested that legal advice should be obtained, and the BIA and EECA provide evidence of considering each point in the submissions.[57] An independent review concluded that the "solid wall product produced by the La Grouw Corporation had been taken fully into consideration in the formulation of the Standard."[58]

Nevertheless, it was not until the Fifth Labour Government, that the revised NZBC Clause H1 (**Table 2**) was published 29 June 2000, coming into effect six months later on 29 December 2000, some four years after the completion of the standards.

[52] "Revised S4218 "Very Acceptable"" p 5.
[53] "Revised S4218 "Very Acceptable"" p 5.
[54] "Revised S4218 "Very Acceptable"" p 5.
[55] Clark. memo to Isaacs: "FRI Reports to Lockwood."
[56] Dunne "Revisions to the Energy Efficiency Provisions of the Building Code"
[57] Secretary for Internal Affairs "Preliminary Assessment of Objections"
[58] Williamson *Energy Efficiency in Domestic Dwellings* pp 5, 28-32.

Political Implementation

Originally it was intended that the NZBC should in "clear, simple and plain English" provide either "measurable performance requirements" or "expanded descriptions of the features of a building that will meet the requirements."[59] It is notable in the performance clauses given in the 1990 sample Building Code, numerical values were for a specific measurements (e.g. acceptable electricity voltage (G9) or maximum safe hot water temperatures (G12)[60]), but none required complex calculations. The consequence of the inclusion of the calculated BPI in the Performance Statement – part of the regulations made under the Building Act 1994 – was that any future change required political approval and passage through the regulations process.

Practical Implementation

In 1993 BRANZ undertook a national seminar series to educate the industry in the energy efficiency aspects of the NZBC,[61] but not until the 1996 revisions had been incorporated could EECA undertake a new campaign, working with BRANZ on a national seminar series.[62] However, EECA had already published a leaflet promoting the three new energy efficiency standards[63] and other publicity was provided.[64]

Assistance for designers, specifiers, cost consultants and builders required R-value publications which included thermal bridging. In the late 1970s BRANZ had published two editions of the black and white *A Construction Guide to Home Insulation*,[65] but in 1995 the first edition of the *BRANZ House Insulation Guide* provided both a commentary and detailed colour images for a range of roof, wall, floor and window constructions.[66]

Changes in Mandatory R-values

Table 3 provides a summary of the thermal insulation requirements over time, with mandatory requirements shown in bold. The next improvement in thermal performance was initiated by the Fifth Labour-led government in early 2006 leading, amongst other things, to the housing schedule method requiring double glazing in most of New Zealand.[67] It is worth noting that depending on the government's attitude to energy efficiency, H1 has either been developed (1978, 1992, 2000 and 2007) or often left unchanged as was the case from 2008 to 2017 under the Fifth National-led government.

Australia

It is also worth briefly reviewing Australia, which had a house thermal insulation standard since 1983,[68] and a 1993 revised edition.[69] Unlike the NZ Standards, AS 2627.1:1993 excluded floor insulation. The requirements were provided as

> the recommended thermal resistance (R_I) to be added to the roof/ceiling space over the heated or heating and cooled area, and to the walls of dwellings which are heated or heated and cooling for substantial periods of the year.

[59] BIC *Reform of Building Controls* v 1, pp 34, 45.
[60] BIC *Reform of Building Controls* v 2, pp 85-129.
[61] Isaacs & Bassett "Residential and Commercial Buildings"; Isaacs & Donn "The Building Act and Energy Efficiency"
[62] Isaacs &. ten Broke "H1, Insulation & Energy Efficiency"
[63] EECA "New Energy Efficiency Standards"
[64] Isaacs "New Energy Efficiency Standards Available" p 43; Isaacs and Cogan "Revision of H1" pp 41-42.
[65] BRANZ *A Construction Guide to Home Insulation* (1977); BRANZ *A Construction Guide to Home Insulation* (1978).
[66] BRANZ *BRANZ House Insulation Guide*.
[67] Isaacs & Donn *NZBC Clause H1: Short Term Opportunities*.
[68] SA *AS 2627.1-1983 Thermal Insulation of Dwellings: Design Guide*.
[69] SA *AS 2627.1-1993 Thermal Insulation of Dwellings - Part 1*.

This meant the Australian Standard was limited to certain types of construction where the cost of installation was independent of the installed insulation levels. To permit its use with skillion-type roofs an "arbitrary upper limit" of R_I of 4.0 for roof/ceiling, while Type A walls (brick veneer or weatherboard) had a limit of R_I 2 and Type B walls (cavity brick) of R_I 1.5. Foil insulation was not included.[70]

Foil Insulation

The dangers of accidentally connecting with live electricity cables when retrofitting underfloor foil insulation were recognised in the 1990s.[71] Guidance was issued in 2007 but it was not until July 2016 this use of foil insulation was banned, primarily due to the new requirement under the Residential Tenancy Regulations to require the retrofitting of underfloor insulation.[72] From 2005-2008 there were five foil insulation-related deaths.

Conclusions

This paper set out to document the background to the development and implement of NZBC Clause H1: Energy Efficiency during the 1990s. Although the original 1983 and 1984 reports reviewing planning and building controls included thermal insulation, it was excluded in the Building Industry Commission's implementation. The BIC considered that this was one of the many specific requirements whose weight was leading to the collapse of building control systems around the world. Finally, a government directive was given, so when the Building Act 1992 was passed it included energy efficiency in its purposes.

As the BIC had not appointed a "Technical Working Group" to develop the compliance document, the 1992 H1 implementation was limited in its scope. It continued the requirements (established as from 1 April 1978) for houses albeit with a new Performance statement and provided guidance for other building types.

The revision of Clause H1 started in 1993 with a review of historic aspects of energy efficiency in New Zealand buildings. The specialist Energy Efficiency and Conservation Authority (EECA) worked with the building-focused Building Industry Authority to establish a suitable work programme. Research projects developed new H1 requirements within the Building Act 1992, firstly with building use (residential and non-residential) and size (under and over 300 m^2). These developed into a series of documents for consideration by Standards New Zealand committees, which in turn supported the preparation of three energy efficiency standards – NZS4218:1996, NZS4243:1996 and NZS4305:1996 – a process taking just 12 months for completion.

Although the reports had been through extensive reviews of the economic analysis and the standards, through the normal public consultation process, the Treasury required an additional review and a building manufacturer concerned with the potential impact on their product raised the issue of a legal challenge. Although the necessary evidence was soon provided, it was not until the next change of government that the new Clause H1 could be gazetted, and six months later come into force on 29 December 2000.

The inclusion of a calculated numerical value in the Performance Statement was a decision made by the BIA. This had the impact of requiring any change to H1 to be handled

[70] Standards Australia, *Thermal Insulation of Dwellings* pp 9-12.

[71] Isaacs "WARNING: Don't Kill Yourself Retro-Fitting Underfloor Insulation" p 63.

[72] Building Systems Performance, MBIE "Ban 2016/01" pp 1-4.

through the Regulations process, effectively changing it from being a technical clause and turning it into a political clause. The consequence of this has been a lack of regular updating of Clause H1, with any change dependent on the viewpoint of the government of the day.

A comparison with the contemporaneous Australian Standard revealed a different basis for calculation – New Zealand calculated the thermal performance of the overall building component while in Australia the only concern was with the additional amount of insulation. The Australian standard excluded foil insulation, although New Zealand permitted its use, albeit principally in sub-floor insulation. This use stopped in new construction due to increased R-value requirements and in existing houses in 2016 due to the danger of electrocution.

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