PROBLEMS WITH DESCRIPTIVE ENERGY EFFICIENCY STANDARDS (NZS4243:1996)

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ABSTRACT This paper presents a synopsis of the content of the New Zealand Standard for Energy Efficiency in Large Buildings. This new standard is purported to be 'descriptive'. The paper outlines the three permissible methods for demonstrating compliance with the Standard's requirements.

Disadvantages of this approach are stated and an alternative proposal is suggested.

1 Background

The New Zealand Building Act recognises Residential and Non-residential buildings as separate categories for the purposes of energy efficiency standards. It also defines a number of building types and circumstances that are exempt from the requirement, but these are unheated, or seasonally occupied.

Currently the Act cites both NZS 4218: Energy Efficiency for Residential buildings, and NZS 4220 Energy Efficiency for Commercial buildings. Both of these Standards have undergone review, and NZS 4243 – Energy Efficiency for Large Buildings has been produced as a "voluntary" standard, pending incorporation into the Building Act. It is intended that both the Residential and Large Building standards will be similar in structure.

Conceptually New Zealand buildings are distinguished into four categories, Large residential, Small residential, Large non-residential and Small non-residential. The distinction between large and small is that anything greater than 300m^2 and/or taller than three storeys is by definition – large (Isaacs 95). Generally speaking, any small buildings with common walls will be amalgamated to a large building for the purposes of the Act. Probably 70% of all New Zealand buildings would be defined as Small.

The standards are concerned only with electrical energy supplied from the grid. The Residential Energy Efficiency Standard is concerned with the building envelope and water heating. The Large Building Standard is concerned with the building envelope and electric lighting. In residential buildings space and water heating are the two largest energy consuming requirements: in large buildings it is both space heating and cooling. Electric lighting is a large consumer of electrical energy which is dissipated as heat into buildings, hence adding to the cooling load. Unlike the US and Canadian energy standards, the New Zealand codes contain no consideration of the energy efficiency of the actual heating and cooling plant itself.

The current legal requirements are said to be less rigorous than the new proposals, even though the new standards are arguably woefully low. The previous standards were **prescriptive** – in that it stipulated what designers were required to do to propose a compliant building. The new standards are **descriptive**: that is, they purport to tell the designer what has to be achieved, and it is up to the designer to decide how to achieve it. This paper deals with NZS 4243:1996 Energy Efficiency in Large Buildings.

2 The large building energy standard (NZS 4243:1996)

The New Zealand Building Act requires a building to be built to be "energy efficient". Commercial buildings in NZ are generally "Load Dominated" (Isaacs 95). This means that internal sources of heat generation are more significant than those caused by climate. This is because of electric lighting, increased technology in the buildings, occupant's metabolic heat etc. and deep floor plates. The Large Building energy standard was based on the lowest cost means of achieving a minimum level of energy efficiency rather than promoting 'good' thermal design, as is explained in its preamble.

The Standards recognise three climatic regions (but only two climate zones) and offer a selection of ways in which the designer can demonstrate compliance with the standard. These are:

a) The Schedule Method.

This is essential a prescription. It offers very simplistic limits that, if adhered to, mean that the building is deemed to meet the requirements of H1. In the Large Building standard, the limitation involves thermal resistances, glazing areas and lighting energy limits.

b) The Calculation Method

Should the building designer want to use a mix of different construction types for the building envelope, or glazing ratios beyond those set out in the Schedule Method, then the design has to be validated by calculation.This means that the building energy target is established by assuming that the proposed building will be designed to the limitations set in the Schedule Method. Provided the calculated Energy consumption of the intended design is no worse, then again, the design is deemed to satisfy the Act.

c) The Simulation Method

Where the proposed building's energy efficiency cannot be demonstrated by the preceding two methods, the standard allows for 'simulation' by computer models. It should be noted that any highly glazed, or atrium design will involve thermal simulation.

3 The schedule method – for large buildings

The Standard specifies both minimum thermal, and maximum lighting power limits, within which the proposed building is accepted as satisfying the requirements of the Building Act.

a. Thermal Envelope

Provided that a building design has more than 50% opaque wall, then the minimum permitted Thermal Resistance values for the following components are:

Building Thermal Envelope Component	North of the North Island	The rest of New Zealand
ROOF (including glazing)	R 1.9 m^2K/W	R 1.9 m^2K/W
WALL	R 0.3 m^2K/W	R 1.2 m^2K/W
FLOOR	No requirement	R 1.3 m^2K/W
GLAZING	No requirement	No requirement

NZS 4243:1996 demands that the overall wall R value for buildings with 50% or less of single glazing should not be less than 0.3 m^2K/W in Climate Zone 1, and 1.2 m^2K/W in Zones 2 & 3. This means that the maximum target heat loss (HL) per square meter to satisfy the standard is given by:

HL = 0.5 / Rwall + 0.5 / Rwindow (W/K) (1)

This gives a maximum heat loss value of 4.4 and 3.19 W/K in the respective climatic zones. In principle the wall and roof R values are supposed to have the effect of limiting the amount of glazing that can be placed in wall and roof.

b. Electric Lighting

Depending upon the usage of the space, the maximum electric lighting power density (in W/m^2) is as follows:

Building Activity	Maximum Lighting power density (W/m²)
Office Building	18
Primary and Secondary School	15
Other educational establishment	18
Communal non-residential (assembly)	11
Retail (including concourse)	23
Service Establishment (eg. Bank etc.)	20
Cafeteria and Restaurant	12
Car Park	6
Storage Facility	14
Hotel	12

Provided that the design satisfies these requirements it will be deemed to meet the requirements of the Standard. However, designers could argue that these constraints (particularly with respect to glazing area) are too restrictive. In anticipation of this building designers are offered the potential to opt for a calculation method.

4 Calculation method – for large buildings

The intention here was to allow designers to use any construction types and glazing ratios they wished, provided that the energy requirement of the proposed design was no greater than would be the case if it were designed to the schedule method. However, this is not quite what is actually drafted into the Standard. The standard allows the designer to trade-off glazing area for Thermal Resistance and vice versa; however, this is restricted to walls only (Clause 4.4.2). Nor does the standard allow thermal energy to be traded off against lighting energy.

There is some scope however to manipulate these standards when the proposed glazing ratio is greater than 50%. When exceeding 50% glazing, the Standard introduces a second concept that requires that solar penetration does not exceed that which would occur with 50% single glazing. This is achieved by decreasing the solar shading coefficient of the glazing system. Since it is possible to obtain standard glazing units with shading coefficient values of 0.38, compared with the standards assumed single glazing coefficient of 1.0, 50% glazing is not a limitation.

5 Simulation method

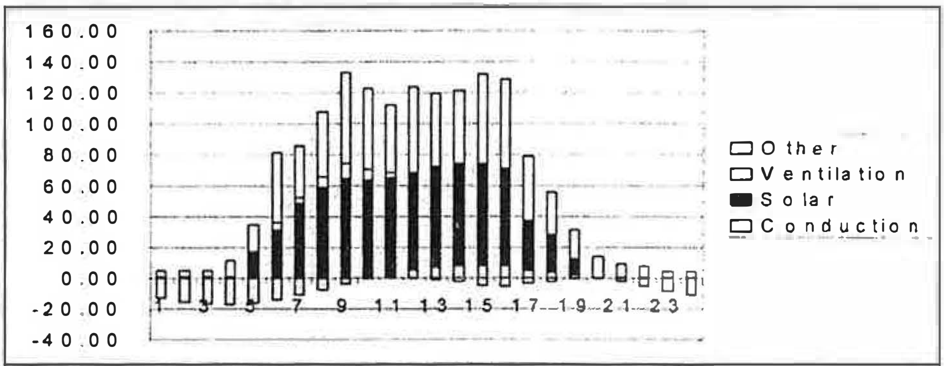
Thermal simulations are very complex and time consuming. The amount of detail required for simulation is only available at the detail design stage of a project. Consequently, any changes that have to be made are likely to be cosmetic, as by the stage the results are available it will be too late to make any fundamental alterations to the design.

The Standard does not prescribe particular thermal simulation computer programs, but demands only that they perform "satisfactorily" against a comparison procedure known as BESTEST (1995). No definition of 'satisfactorily' is given. Thermal simulators will be registered with the authorities. All of this will add to the cost and time in designing buildings. BESTEST is a procedure in which sets of data are used to model particular thermal features. The predicted results of the simulations are compared to those produced by a number of respected thermal models. The most 'credible' program is one produced by the Solar Energy Research Institute (SERI) – DOE.2. The complexities involved in using this program are discussed below.
The Energy Efficiency Standard requires the simulator to compare the performance of the proposed building design with the same envelope built to the Schedule limitations.

6 Discussion

Significantly the new standard has not yet become law. It is based upon historical methods of designing. The efficiency standards have been set low, and experience shows that nearly all buildings can be dealt with under the schedule considerations. Few buildings have more than 50% external glazing. It is still possible to design fully glazed buildings under the new code. Calculations for various building designs carried out by the writer shows that conduction losses and gains are relatively small when compared with solar gain, and internal heat loads. This is illustrated by a 24 hour plot for a 'typical' NZ office building as shown in Fig.1 below. The standard does not distinguish glazing orientation. However orientation can make an enormous difference between glazing acting as a heat sink or source.

The new standard is not easily understood. The Territorial Authorities whose job it is to police the standard will find it difficult and are likely to send building applications to consultants for verification, thus adding to the time and cost of obtaining building approvals. In particular, thermal simulation will be discouraged due to its cost.



Conduction	Solar	Ventilation	Other
-96.93	736.34	22.52	705.55

7 Proposal

A better approach to ensuring energy efficiency in commercial buildings would be to regulate energy supply rather than demand. This could be achieved by placing maximum energy consumption limits per square or cubic meter of building. This would make allowance for the usage and climatic location.

A fusible link in the incoming electricity supply of the appropriate rating could then be installed, making policing of the regulation very simple. If buildings require more energy than the link allows, then building designers can make up the shortfall with renewable and local energy generation sources such as solar water heaters, photovoltaic or wind generation etc. This would encourage investment in benign and dispersed energy infrastructure, reducing reliance on central electricity supply.
Building designers would then be able to propose whatever solution they think fit and is acceptable to their clients.

8 References

NZS 4243:1996 Energy Efficiency in Large Buildings.

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