Non-Compliance with the Washington State Nonresidential Energy Code: Causes and Consequences

Introduction

This report illustrates the relevance of the compliance problems encountered with the implementation of the Washington State Nonresidential Energy Code (NREC), an ASHRAE Standard 90.1-1989 equivalent code. Numerous publications have been referenced to compile this report; all of the information contained herein can be found within other documents. The primary source of information for this report is *Energy Consequences of Non-Compliance with the 1994 Washington Nonresidential Energy Code* (Kennedy et al, 1997).

The targeted audience for this report is all code developing and implementing entities within the United States, who may benefit through the Washington State Energy Code experience.

Summary

Washington State began the implementation of an ASHRAE Standard 90.1-1989 equivalent code for non-residential structures in March 1994. The code and the implementation process resulted in an average annual electrical energy savings of 10.2 megawatts and an average annual increase in gas use of about 700,000 therms. As with all codes, there is a degree of non-compliance. Full compliance with the provisions of the code would result in additional energy savings of 1.93 average megawatts of electricity and average savings of 9,500 therms of gas per year.

A considerable portion of the consequences of non-compliance can be traced to a few code measures where the requirements are confusing, or where the building and enforcement communities disagree with the premise of a code feature. The major areas of non-compliance are:

- the semi-heated space heating system capacity limitations,
- the lighting power allowances for retail spaces, and
- the insulation requirements for on grade slabs.

Each of these major areas of non-compliance is inherently problematic; a high level of training effort has focused on these areas, yet they persist as significantly non-compliant.

Estimating the Cost of Non-Compliance

To estimate the cost of non-compliance and to appreciate its impact, a number of questions must be asked:

- How energy efficient were buildings before implementation of the 1994 NREC?
- How efficient are buildings today?

- How efficient would buildings be if they met every provision of the code?
- How many new and existing buildings are effected by the code?
- How many and what type of structures will be affected by the NREC in the future?

Several reports aided in the cost estimate of non-compliance. A Northwest Power Planning Council floor area forecast (Harris, 1997) was utilized to predict average annual floor area of new construction, additions and renovations. Another report, *Energy Code Compliance in Commercial Buildings in Washington and Oregon*, (Baylon et al., 1992) describes energy code compliance prior to the 1994 NREC. The document *Compliance with the 1994 Washington State Nonresidential Energy Code* (Baylon et al., 1997) provided critical compliance information based upon a study conducted two years after 1994 implementation. A complete breakdown of estimating procedures and non-compliance forecasts is contained in Kennedy et al., 1997.

The code and the implementation process resulted in average annual electrical energy savings of 10.2 megawatts and an average annual increase in gas use of 640,000 to 740,000 therms.

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Contrasting NREC with ASHRAE 90.1 – 1989

The NREC is based upon, and for the most part, equivalent to ASHRAE 90.1 – 1989. The scope of the NREC includes nonresidential additions, remodels and new construction, and includes requirements for envelope, lighting, and mechanical systems. Unlike 90.1, however, the NREC does not apply to high-rise residential structures. In Washington, high-rise residential structures must comply with separate residential energy code requirements.

The most striking differences between the ASHRAE Standard 90.1 and the NREC are the lighting requirements. The power allowances (W/ft^2) within the NREC are generally more stringent, and for certain commercial uses, like retail, the NREC power allowance is significantly lower than the 90.1 allowance. Of interest, but less importance, is the NREC Prescriptive Lighting Option. The Prescriptive Lighting Option allows the unlimited use of certain low wattage, electronically ballasted, one and two lamp fluorescent fixtures.

While the NREC language for mechanical requirements differs somewhat from 90.1, the codes are fundamentally similar with regard to energy consequences. Unique to the NREC is the division of mechanical system requirements based on whether the system is "simple" or "complex." Complex systems are subject to controls and heat recovery requirements that are not applied to simple systems. Also, unlike 90.1, the NREC contains no equipment sizing limitations for most uses.

The NREC envelope requirements include a provision for semi-heated spaces. The semi-heated option allows a structure to be exempt from envelope requirements, except for

ceiling insulation, if the heating system meets restrictive capacity requirements and is equipped with controls that allow a 44°F setpoint. Similar semi-heated provisions are proposed in the 90.1 – 1989R Public Review draft.

A Brief Description of the Major Implementation Efforts

A coalition of utilities, known collectively as the Utility Code Group, led the effort to implement the NREC. The implementation plan they developed and managed was comprehensive and innovative. Listed below are some of the most important of the NREC implementation tools.

Third Party Plans Examiner/Inspector Program - Also known as the Special Plans Examiner/Inspector Program (SPE/I), this effort is the centerpiece of the NREC implementation effort in Washington. Where a local jurisdiction may prefer not to conduct NREC enforcement, they can require the permit applicant to hire a third party certified SPE/I. A list of certified NREC inspectors and plans examiners and a standard fee schedule for SPE/I services are maintained by the Washington Association of Building Officials (WABO). Fees charged by SPE/Is are partially reimbursed by the local utilities. Compliance ratings were found to be significantly higher (90% compared to 60% overall) for buildings that were reviewed by an SPE/I (Baylon et al., 1997.)

Inspector certification - The SPE/I certification program is facilitated by WABO. The process includes certification exams and an official list of certified SPE/Is.

Training - Both formal and "brown bag" training sessions were provided to NREC users. Training sessions were offered in a variety of formats to attract the largest possible percentage of building professionals.

Technical Assistance Hotline - A centralized hotline service provided instant technical assistance to NREC users.

Circuit Rider trainers/technical assistance - Three "circuit riders" provided on site training and technical assistance throughout the state. Each of the circuit riders focused on a specific region of the state.

NREC manuals and other materials - A builders field guide and a technical reference manual were developed and sold to NREC users. Calculation and compliance documentation forms were made available in both hard copy and electronic versions.

Newsletters - Announcements and newsletters flooded the commercial structure industry to notify readers of test certification dates, training schedules, and to provide technical and programmatic assistance.

Non-compliance Problems

There are least two ways to measure non-compliance. One way is to measure the total amount of energy not conserved due to non-compliance. In Washington, approximately 80% of the codes potential to save energy is being realized (Baylon, 1997).

Another measure of non-compliance is the percentage of buildings in a given sample that are determined to be non-compliant. Kennedy et al, 1997, determined a code compliance

rate of about 60% in a sample of 88 non-residential structures*. Some common compliance problems have a major impact on energy savings while some, though common, have little impact on energy savings. Listed below are three commonly non-compliant measures. The first two, semi-heated spaces capacity requirements, and retail lighting, have fairly significant energy consequences. The third, on-grade slab insulation requirements, is only significant for its high degree of non-compliance.

Semi-heated spaces - At least 23% of the surveyed sample exceeded the maximum heating system capacity requirements of the NREC. Strict adherence to the capacity requirements of the semi-heated spaces could result in a net 9,500 therms of natural gas average annual savings, compared to a net increase of 10,000 therms predicted based upon sampled compliance levels. The capacity provisions of the NREC are difficult to enforce, in part because some heating equipment is not labeled with capacity information. (The survey assumed unlabeled equipment was compliant.) More importantly, the code may encourage cheating. While the intent of the semi-heated option was to facilitate freeze protection, the code specifications are frequently inadequate to prevent freezing. The lack of a more aggressive space heating control requirement for semi-heated spaces exacerbates the energy consequences: the code merely requires that the thermostat be capable of being set at 44^{o}F. In other words, it can be set at a much higher temperature. The key factors determining the energy consequences of non-compliance to the semi-heated provisions are the installed capacity of the heating system and the thermostat setpoint.

The non-compliance consequences of the semi-heated capacity provisions are significant because:

- the affected buildings tend to be large,
- the control requirements are ineffective, and
- "semi-heated" buildings, by definition, are poorly insulated.

A potential solution to the problem is to require a permanent thermostat setpoint of 44^{o}F, and increase the allowed heating system capacity to ensure freeze protection.

The proposed ASHRAE 90.1 – 1989R Public Review draft includes proposed requirements for semi-heated spaces. The proposed language appears incomplete at this time. Currently, ASHRAE 90.1 does not have semi-heated space language.

Lighting systems in retail and grocery stores - The difference between full compliance with the NREC and current practice is 1.93 average megawatts of electricity. Of that, 1.78 average megawatts is lost due to non-compliance to the NREC lighting provisions. In most commercial structures, however, compliance to the lighting provisions is quite good, with an overall compliance rate of 81%.

Retail and grocery stores stand out as exceptions, where compliance is poor. In the sampled retail sector, the NREC's required lighting power allowance (LPA) was

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* Structures were not considered compliant if they used at least 5% more energy than a fully compliant structure in any of three broad categories: envelope, mechanical systems, or lighting systems (this is a simplified definition.)

exceeded by an average of 33%. The code language regulating retail uses may be the problem. The code allows the retail sector a choice of two separate paths for meeting compliance. In contrast, other commercial uses are offered only one path.

The "Retail A" path allows for an LPA of 1.0 W/ft^2 plus unlimited ceiling mounted adjustable tungsten halogen and HID merchandise display lighting. The "Retail B" path allows an LPA of 1.5 W/ft^2 but requires all general and permanently mounted display lighting to be included in the LPA calculation. Confusion about these two paths has resulted in a great deal of non-compliance.

ASHRAE 90.1 – 1989 LPAs for retail range between 3.3 W/ft^2 for small retail, and 2.1 W/ft^2 for large retail. The 90.1 allowance does not distinguish between general and display lighting.

On-Grade Slab Insulation - Based on a review of construction plans, about 50% of the sample set was not in compliance for slab insulation. About 30% had no indication of any slab insulation and the other 20% were significantly deficient in some manner. The NREC prescriptive code requires the slab to be thermally broken and insulated for 24 inches, as required by ASHRAE 90.1. This requirement is contrary to common structural detailing for large concrete slabs, and many architects and structural engineers are not complying with this feature of the code (Baylon, et al, 1997).

Lessons Learned

To achieve a high degree of compliance, building codes must be understood from a technical standpoint and agreed upon from a policy perspective. In Washington State, a high level of effort went into implementation, creating well trained building officials, architects, engineers, and general contractors. The implementation effort paid off. The code is reaping 80% of the potential energy savings.

A considerable portion of the consequences of non-compliance can be traced to a few code measures where the requirements are confusing, or where the building and enforcement communities disagree on the sagacity of a code feature:

- The reason for a low compliance rate with the retail lighting power allowance is probably the complex code language. The provisions are needlessly confusing and therefore misapplied by designers and inconsistently enforced by code officials.
- Two other requirements with relatively low compliance, the semi-heated heating system capacity requirements, and the on grade slab insulation requirements, are written in explicit, simple language in the code. However, HVAC engineers believe the semi-heated provisions do not provide adequate freeze protection. Likewise, many architects disagree with the slab insulation requirements which, they believe are at odds with standard architectural practices for large structures.

Each of these three areas of non-compliance is inherently problematic; a high level of training effort has focused on these issues, yet they persist as significantly non-compliant. The remedy to each, hopefully, will be found in a future edition of the Washington State Nonresidential Energy Code.

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