Survey of Commercial New Construction

Activities in New Hampshire

Final Report
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Provided to:

The New Hampshire Commercial Construction Study Group

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EXECUTIVE SUMMARY

This report presents results from a study conducted by GDS Associates, Inc. and Entech Engineering (the "GDS Team") to assess the level of energy efficiency in current commercial new construction practices in New Hampshire ("NH"). Primary and secondary research activities were performed, consistent with the scope of work developed and commissioned by a "Study Group" made up of two New Hampshire utilities (Granite State Electric Company and Public Service Company of New Hampshire) and the NH Governor's Office of Energy and Community Services.[1]

Research activities included plan and print reviews, field inspections, baseline study reviews, and interviews with a number of NH building code officials, architects, equipment suppliers and design engineers. Throughout these activities, the GDS Team was focused on determining energy efficiency levels for each major equipment and construction practice area addressed within the current *NH Commercial and Industrial Energy Code (structures greater than or equal to 4,000 square feet in floor area)* - revised 7/93, 4th Edition[2], including:

- Building Envelope (i.e., roofs, walls, ceilings, windows, and foundations);
- Electric Power (i.e., motors);
- Heating, Ventilation and Air Conditioning (HVAC);
- Service (or domestic) Water Heating;
- Lighting and Lighting Controls; and
- Total Energy Management Systems (EMS).

Where possible, efforts were made to identify variations in current practice based on building type and geographic location within the state.

Results were analyzed to develop a set of tentative findings, conclusions and recommendations that were tested and confirmed in a roundtable discussion group meeting held in Concord, New Hampshire on March 22, 2000. Earlier, on October 14, 1999, the Study Group sponsored a focus group with the New Hampshire chapter of the American Institute of Architects for the purpose of discussing current practices relating to the NH Commercial and Industrial Energy Code.[3] The

[1] ECS' share of funding for this study was provided through a grant from the U.S. Department of Energy.
[2] The current New Hampshire Commercial and Industrial Energy Code, 4th Edition - July, 1993 is based on a "National" code ASHRAE/IESNA Standard 90.1, published by the American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE) and the Illuminating Engineering Society of North America (IESNA) in 1989.
[3] Although this focus group was conducted prior to implementation of the GDS Team's activities, results from the October 14th meeting were carefully reviewed and have been incorporated into the findings presented in this report.

findings from these surveys, site inspections and roundtables reveal important themes that are highlighted in this report.[4] In addition, they offer valuable insight into why certain building practices may or may not be occurring. Examples of such themes are illustrated by responses such as, but not limited to, the following:

- Four out of the nine recorded responses from the GDS Team's building code officials interviews indicated that they do not check for compliance with the energy code - and none of the nine indicated that they have ever rejected a building for failing to meet current energy code requirements.

- Only one of the respondents from GDS's building code officials interviews described their knowledge of NH's commercial energy code as "very good". In addition, most described their training on the code as being little to none.

- Architects, design engineers, and equipment suppliers generally indicated that NH's existing commercial energy code is hard to follow, that the calculations are complicated, time consuming and costly, and that it's difficult to assess compliance.

- A clear desire was identified by focus group participants and interview respondents for: 1) a methodology/computer program that would integrate the code from the start of the design process, incorporate simple checks earlier in the designs, provide flexibility, and simplify the process, and 2) not letting the code lag behind technology quite so much.

NOTE: these findings relate only to New Hampshire's *Commercial* Energy Code - not *Residential* which, based on general unsolicited feedback, seems to be better understood and utilized. In addition, these findings relate only to newly constructed facilities that are at least 4,000 square feet and major remodeling projects that are at least 50% of the value of the original structure - they do not generally relate to the renovation market. Finally, these findings have been verified and confirmed by the surveys and roundtables conducted as part of this study.

Following is a more detailed summary of key findings:

Code Utilization and Compliance - General Findings:

- Discussion with design professionals revealed that they do not spare time to integrate systems (as envisioned in New Hampshire's commercial energy code) or to test for compliance when developing plans and specifications for new buildings in the state. This is due in part to a lack of clarity within the code that such integration and testing is required, excessive costs and associated time burden. In addition, although the tools

[4] In total, the plans and prints of thirty buildings were reviewed, site inspections were conducted at twelve of them, two focus groups were held, and interviews were conducted with five regional equipment suppliers, two design engineering firms, and nine building code officials. Refer to Sections 1 and 2 for further discussion of objectives and methodologies.

that facilitate such tests are available, it appears that few design professionals have these tools or know how to utilize them.

- Building Code Officials said they rely almost solely on architect/design engineer certifications to determine compliance with the Commercial Energy Code.

- Plan and print reviews and site visits showed that technological advances have resulted in the specification and installation of equipment and practices that easily meet and often exceed current code requirements for certain measures (i.e., lighting, motors, HVAC heating unit efficiency).[5]

- Plan and print reviews and site visits also showed that nearly half of the facilities reviewed met or exceeded the code in all seventeen of the major categories for which this study quantified compliance. Of the remaining facilities, roughly half failed to meet the code in only one major code category and the other half failed to meet the code in just two major code categories. None of the facilities reviewed failed more than two of the seventeen major categories. Failure to meet the code is occurring most frequently in the heating system distribution insulation and service water pipe insulation areas.

- *Assembly* practices were identified by focus group participants as not being well accommodated or taken into account under the current energy code.

- Systems using low cost fuels were found during site inspections to be less likely to meet code than those dependent on higher cost fuels (i.e., fossil fuel/thermal systems appear to be in compliance less often than electricity consuming systems).

- Architects complained that consumers do not recognize the long term benefits of meeting or exceeding the energy code, and equipment suppliers surveyed said that if consumers do not ask for energy efficiency, the building community won't provide it.

- Respondents indicated that additional training on the energy code targeted at architects, design engineers, construction contractors, and building code officials is needed. They indicated if these entities were armed with a few key items (energy code "rules of thumb") to address within each major building category, they would be more likely to increase the use of more energy efficient practices when designing and constructing new commercial buildings in the state.

Code Utilization and Compliance -Measure-Specific Findings:

A summary of measure-specific findings is presented in the table below. More details are presented in Sections 3 and 4 of this report along with other general observations and suggestions for potential code modifications.

[5] There remain other measures where this is not true (e.g., piping insulation).

Equipment or Building Practice Addressed in NH Commercial Energy Code	Summary of Findings from Plans and Prints Reviewed and Sites Inspected
Building Envelope	Most measures and practices were in compliance
HVAC - Heating	All unit efficiencies exceeded code
HVAC - Cooling	Only 27% met code and 20% were below code
Electric Power/Motors	All exceeded code
Lighting Fixtures	Generally exceeded code
Lighting Controls	Specified very infrequently
Energy Management Systems	Found in most facilities sampled, although sophistication varied by size (mostly overridden to solve immediate comfort problems)
Service Water Systems	24% did not meet code insulation requirements
Energy Recovery Practices/Energy Storage	Not seen in facilities reviewed

Definitions of Premium, Standard, and Code Efficiency Practices in NH Commercial Construction:

The findings above should be interpreted within the context of working definitions for premium, standard, and code efficiency practices in NH's commercial new construction. Appendix A presents a table identifying efficiency practices for key types of commercial and industrial building construction measures (i.e., building envelope, electric power, HVAC equipment, service/domestic water heating, lighting fixtures and controls, and energy management systems). Premium, standard and NH commercial energy code-required efficiency levels are presented for each specific construction measure. An initial version of this table (presented in Appendices E-1 and E-2) was developed based on an extensive review of secondary data sources and through discussion with Study Group members, and was then tested and refined during interviews with building code officials and equipment suppliers. Its purpose in this report is to provide key definitions, based on a compilation of the above sources, so that comparisons and discussions can take place starting from common ground.

Recommendations for Next Steps and Further Actions:

The following recommendations have been grouped into three areas:

1) Near-Term Actions:

- Communicate findings (i.e., PUC filing, public release of report, presentations per request at various trade group meetings, conferences, etc.).

- Pursue opportunities for training (identify rules of thumb & develop monthly sessions around the state to increase code compliance and improve the awareness and energy efficiency practices of target audiences including architects, design engineers and building code officials).

- Integrate the code with currently available software tools that allow for design professionals to more quickly and effectively meet or exceed code compliance.

2) Mid-Term Actions:

- Use findings to help utilities and private and public entities prioritize potential follow-up initiatives and to aid in the design of energy efficiency programs that will target specific barriers to using higher efficiency measures and practices in the construction of new commercial buildings. For example, this study found various barriers to the use in new construction of premium efficiency building envelope measures, high efficiency HVAC cooling units, more efficient lighting fixtures and control technologies, and efficient EMS measures.

3) Longer-Term Actions:

- Modify the energy code language to render it easier to understand and improve the compliance process to a less cumbersome format. Consider, at a minimum, utilizing the International Energy Conservation Code's (IECC) version of ASHRAE 90.1-1989, which was written in a more understandable "code"-type format (the ASHRAE 90.1-1989 version was not written in understandable code language), and consider updating the code to ASHRAE/IESNA 90.1-1999, that recognizes many of the technological advances discussed throughout this report and is written in a more user-friendly "code" manner.[6] For other potential measure-specific code modifications, see section 4.3.

Report Overview:

Section 1 of this report provides some background information about this research project. A discussion of the GDS Team's methodology is presented in Section 2, followed by a detailed presentation of research results in Section 3. An overview of key findings, conclusions and recommendations are discussed in Section 4 of the report.

[6] The U.S. Department of Energy (DOE) is in the process of reviewing ASHRAE/IESNA Standard 90.1-1999 and the International Energy Conservation Code (IECC) and will likely be making a determination this summer that they are more stringent than Standard 90.1-1989. States will then have two years to update their commercial standards to meet or exceed the new Standard 90.1.

Acknowledgements:

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1.0 BACKGROUND and INTRODUCTION

The relationship between current practice and efficiency levels set through building energy codes has been recognized in New Hampshire by the Public Utilities Commission in Order number 23,172 (DR 98-174), dated March 25, 1999, stating:

> "…. we agree with ECS's witness that a baseline study of current practices could assist in determining whether the current commercial building codes are ripe for upgrading to promote more up-to-date efficiency practices."

In response to this Order, a Study Group, made up of Granite State Electric Company (GSECo), Public Service Company of New Hampshire (PSNH), and the Governor's Office of Energy and Community Services (ECS) issued an RFP (dated September 28, 1999) for a baseline study on commercial construction practices to assist in determining the level of adherence to New Hampshire's current commercial energy code and whether the code is ripe for upgrading to promote more up-to-date practices. GDS Associates, Inc. and Entech Engineering (the "GDS Team") were chosen through a competitive bidding process to perform all requested work. Appendix B provides a copy of the GDS Team's scope of work for this project.

Although it was recognized from the start that the time and resources available for this study were not adequate to do a statistically significant analysis of commercial buildings, the Study Group agreed that valuable insights could still be gained by assessing building characteristics to identify the relationship between current code requirements and current energy efficient commercial new construction practice.

Research, analysis, and reporting activities performed by the GDS Team included:

- developing a profile of the concentrations of commercial and industrial construction activity in the state by location and building type;
- designing a sample selection methodology for plan and print reviews and physical site inspections;
- reviewing plans and prints from a selected sample of building types to determine baseline standards for specification of commercial energy code-related equipment, materials, and construction practices;
- inspecting a subset of the sample to determine what is actually being constructed and what equipment is actually being installed;
- interviewing equipment suppliers and design engineering firms to assess standard efficiencies of measures being purchased for installation;

- interviewing building code officials in jurisdictions where new construction is most active;
- reviewing existing studies, specific or applicable to New Hampshire;
- synthesizing results into a series of bulleted tentative findings about standard commercial design and new construction practices in New Hampshire;
- testing these finding in a roundtable discussion group setting;[7] and
- producing a final report.

The Study Group monitored the activities of the GDS Team, received periodic status reports, and provided guidance to the Team, as necessary. Throughout these activities, the GDS Team was focused on determining energy efficiency baselines for each major equipment and construction practice area addressed within the current *NH Commercial and Industrial Energy Code (structures greater than or equal to 4,000 square feet in floor area)* - revised 7/93, 4th Edition. This code is based on a "National" code ASHRAE/IESNA Standard 90.1, published by the American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE) and the Illuminating Engineering Society of North America (IESNA) in 1989 ("ASHRAE/IESNA Standard 90.1-1989"). Major areas addressed within the current code include:

- Building Envelope (i.e., roofs, walls, ceilings, windows, and foundations);
- Electric Power (i.e., motors);
- Heating, Ventilation and Air Conditioning (HVAC);
- Service (or domestic) Water Heating;
- Lighting and Lighting Controls; and
- Total Energy Management Systems (EMS).

Where possible, efforts were made to identify variations in current practice based on building type and geographic location within the state.

As a result of these efforts, key energy efficient building construction characteristics have been identified along with their relationship to New Hampshire's current commercial energy code, and the distribution of these characteristics throughout small and large buildings in the state. This report presents results from the research and analysis activities performed by the GDS Team.

[7] This was in addition to the Study Group's AIA focus group conducted on October 14, 1999.

2.0 METHODOLOGY

This Section of the report describes the methodologies used by the GDS Team when performing each of the research and analysis tasks identified in Section 1.

2.1 Profile of the Concentrations of Commercial and Industrial New Construction Activities in New Hampshire (1997, 1998, and 1999)

The objective for this research activity was to develop a profile of the concentrations of commercial and industrial construction activity in the state by location and building type. By working off of local services that track construction activities in New Hampshire, and through utilization of broad based services, an extensive listing of activities for 1999 was developed along with similar listings for 1997 and 1998.

The major sources for information to compile these lists came from F.W. Dodge's Market Analysis Group and commercial/industrial construction activity records from the Study Group's member utilities themselves. Additional New Hampshire commercial and industrial construction project information was collected through review of other data sources where available including:

- *Construction Summary of NH and ME, Inc.*;
- *Works in Progress*; and
- *New England Construction News.*

Projects were sorted alphabetically, first by County, then by Town. Information regarding contract size, building type (size and usage) and type of construction (new construction, alterations/renovations, addition, etc.) were also provided where available. In addition, important information regarding project owners, architects, mechanical and electrical engineers was collected to help identify potential buildings for plan and print reviews and physical site inspections. Appendix C presents a summary of the Profile of Commercial and Industrial Construction Activities in the State of New Hampshire.

2.2 Sample Selection Methodology for Plan and Print Reviews

As specified in the GDS Team's Scope of Work, a sample of 30 buildings was proposed to be selected for plan and print review. The sample originally included: 16 small commercial, 8 large commercial, 3 small industrial, and 3 large industrial construction projects. Adjustments to this proposed sample were made during meetings and discussions with the Study Group as follows:

- Total sample size for plan and print review remained 30

- 16 Small Commercial, including:
  - 1 "chain"-type building

- 9 Large Commercial, including:
  - 2 large office buildings (1 owner occupied)
  - 2 schools
  - 2 hotels
  - 1 hospital
  - 1 large retail building, and
  - 1 large apartment building

- 3 Small Industrial Buildings

- 2 Large Industrial Buildings

The purpose of plan and print reviews was to assess the extent to which energy efficiency has been incorporated into each building's construction and equipment specifications. Following is a summary of the GDS Team's approach used to ultimately select the actual projects making up the plan and print review sample. Appendix D presents a copy of the sample form used to collect data when conducting plan and print reviews.

It is important to note that because of time and resource constraints, there was no intention on the part of the Study Group to select a population that contained sufficient observations to draw statistically valid conclusions concerning adherence to the code or exceeding the code. As envisioned in the original scope of work for this project, the GDS Team's research is intended to provide a sense of energy efficiency awareness as reflected in the practice of design based upon: 1) information collected from the plan and print reviews on a small sample of buildings; 2) findings from follow-up field visits from a subset of this sample; and 3) interviews with various members of the construction community.

<u>Information Resources and Selection Criteria</u>

Based on results from the GDS Team's data collection and profile development activities, and input from the Study Group, a sample of 30 buildings was ultimately selected for plan and print review. At final count, the NH Commercial Construction Profile database contained over 2,900 individual projects (approximately 1,360 in 1997/1998 and over 1,550 in 1999) that have recently been, or are currently being, constructed or renovated here in New Hampshire. This data was sorted by geographic location, size, building type, and use. Where available, the database included information on the owner, lead architect, and mechanical and electrical engineering firms involved in the building's design and construction. For the 1997/1998 data, over 500 records included data on the owner, architect, etc. As agreed to with the Study Group, the 1997/1998 population was used for a sample selection base to maximize the likelihood of construction completion (a prerequisite to physical site inspections).

Three key categories were considered by the GDS Team when developing a project sample for plan and print review: geography, building type, and availability. Following is a summary of these selection criteria (filters) that were used to develop the sample:

1. Geography - To account for potential regional variations in standard practice, care was taken to draw samples geographically. To the greatest extent possible, the sample was chosen to include buildings (with similar uses) in multiple regions across the state and within urban, suburban, and rural settings. The four distinct geographic areas chosen were southern, seacoast, western, and northern.

2. Building Type - It is reasonable to assume that the energy efficiency infrastructure specifications will be largely a function of the interest and knowledge of the architects and engineers. However, building economics, which is largely a function of building use, will play a major role in determining what actually gets built. The following criteria were used to filter the sample based on building type:

<u>Small Commercial (retail, office, institutional - including municipal):</u>

- *16 Proposed Plan and Print Reviews* - Based on a detailed review of the NH commercial construction profile database, it appeared that the most frequent type of construction is small commercial retail. Therefore, this type of construction received the most plan and print reviews and follow-up site visits. Through these reviews, the GDS Team was looking to ascertain the architectural specification of building shell, and electrical and mechanical devices, and to assess the level of energy efficiency specified in the plans, compared with current NH energy code requirements. This sample size may be large enough to conduct some further segmentation. Where possible, recently constructed small commercial facilities with similar end uses were selected from different geographic regions. It was believed that schools offered the greatest chance for evaluating geographic segmentation. Specifically excluded from this selection was more than one building of any retail chain.

<u>Large Commercial (retail, office, institutional - including hospitals):</u>

- *9 Proposed Plan and Print Reviews* - The NH commercial construction profile database identified a significant number of large commercial facilities. Given the smaller size of this sample, it was difficult to allow for regional segmentation. Nonetheless, identification of the architectural specification of the building shell and electrical and mechanical devices was ascertained by the GDS Team to assess levels of energy efficiency specified in the plans.

<u>Small Industrial (manufacturing/assembly):</u>

- *3 Proposed Plan and Print Reviews* - Based on this sample size, the GDS Team's ability to assess any geographic variations was not possible. However, plan and print reviews and limited follow-up did allow for an assessment of efficiency levels included in architectural specifications for building shell, and electrical and mechanical devices. Implicit in the random selection of the design and engineering firms was the assumption that it is possible to examine trends from the sample and consider their extrapolation to the population of all buildings constructed in this category.

Large Industrial (Includes manufacturing/assembly):

- *2 Proposed Plan and Print Reviews* - As with the Small Industrial section discussed above, due to the small sample size it was not possible to assess any geographic variations across this sector. Random selection of the design and engineering firms was based on the assumption that the GDS Team could consider conclusions across a wider population regarding specification practices for comparison against code requirements.

Operating under the assumptions that design and specification practices are largely reflective of the individual or the firm, it was agreed that the GDS Team would review no more than three buildings from any one design firm.

3. Availability - Ready access to critical data was also key when making sample selections. During review of the construction profile data, careful attention was devoted to identifying projects that met the following criteria:

   - Architectural/engineering conceptual plans are available;
   - Access to the site can be gained and the owner is willing to cooperate; and
   - "As-built" plans are available.

   Determination of whether or not a facility met this "availability" criteria was done through direct phone calls to the architects, engineers, owners, or facility managers.

   During our work, the GDS Team found it necessary to adjust strategies in order to ensure access to the proper number of plans. Many phone calls to design firms were not returned. We believe that these firms assumed our work was compliance based, and not merely research oriented. The team attempted to overcome this concern by passing along the names of Tom Coughlin (GSECo) and Brad Parkhurst (PSNH) as reference checks. However only one individual chose to contact these people to inquire as to the legitimacy of our work. If a design professional did not answer our letters, phone calls or faxes, the GDS Team decided it was most expedient to get the necessary information on facilities identified by going to the Building Departments within the towns and cities where the buildings were being constructed. This allowed us to obtain the information needed to complete our tasks.

Application of these three "filters" to the NH Commercial Construction Profile database yielded a sample that met all of the criteria specified by the Study Group. Table 1 provides a listing of the building types ultimately selected and utilized for plan and print reviews.

Confidentiality

Based on discussions with the architectural and engineering community, confidentiality was identified as being of utmost importance. As is common practice in research activities of this type, the identity of specific buildings or design/engineering firms is not included or published in this report. Assurances of this confidentiality have been communicated to all parties participating in this effort and a coding mechanism was used to ensure anonymity while gathering and disseminating data and results. Any compromise of this standard would have endangered the GDS Team's ability to complete this work.

- TABLE 1 -
BUILDING-TYPE LIST FOR PLAN AND PRINT REVIEWS

Commercial/Industrial Building Type	Number of Building Plans for Review	Counties Covered
Small Commercial (<2000 square feet)	**16**[8]	
- Schools	4[9]	Rockingham, Hillsborough, Hillsborough/Cheshire, Merrimack
- Retail	6 (3 different chains)	Hillsborough (6)
- Office	1	Grafton
- Municipal	5	Merrimack, Hillsborough (2), Stratford, Coos
- Other	1	Hillsborough
Large Commercial (>2000 square feet)	**9**	
- Apartment complexes	1	Hillsborough
- Hospitals	1	Rockingham
- Hotels	1	Hillsborough
- Large Offices (Owner Occupied)	1	Grafton
- Large Offices (Non-Owner Occupied)	1	Grafton
- Other	1	Grafton
- Retail Establishments	1	Grafton
- Schools	2	Cheshire, Hillsborough
Small Industrial	**3**	Hillsborough (2), Grafton
Large Industrial	**2**	Rockingham, Grafton

8 Although 16 were specified, 17 actual reviews were conducted.

9 No plan/print reviews were conducted on schools in Coos county. However, northern climate was important and attempts were made to review the same building type in regions representative of northern climates.

2.3 Sample Selection Methodology for Physical Site Inspections

As specified in the GDS Team's Scope of Work, based on results from the plan and print review activities, a subset of 12 buildings was proposed to be selected for on-site inspection/review. This subset originally included: 6 small commercial, 3 large commercial, and 3 industrial sites. Adjustments to this proposed sample were made during meetings and discussions with the Study Group as follows:

- Total sample size for on-site inspections remained 12
- 6 Small Commercial Buildings
- 4 Large Commercial Buildings
- 2 Industrial Facilities

Table 2 presents a list of the building types and locations for actual physical site inspections.

- TABLE 2 -

BUILDING-TYPE & LOCATION LIST FOR PHYSICAL SITE INSPECTIONS

Small Commercial	Large Commercial	Industrial
Education -- Rockingham	Education -- Hillsborough	Hillsborough
Retail/Chain -- Hillsborough	Hotel -- Hillsborough	Hillsborough
Retail/Chain -- Hillsborough	Non Owner Occupied -- Grafton	
Municipal -- Merrimack	Retail -- Grafton	
Municipal -- Hillsborough		
Municipal -- Rockingham		

The purpose of the site inspections was to determine what was actually constructed and installed in contrast (if any) to what was originally specified in the plans/prints. In addition, physical site inspections allowed for identification and verification of installation practices that exceed current energy code requirements. The GDS Team worked with companies and their architectural/engineering firms who have kept their proposed drawings and as-builts. Discrepancies in the actual vs. proposed materials and equipment were noted, where identified, including: building shell, lighting, heating, ventilation, refrigeration and process operations (if applicable). Aspects of construction that were not in compliance with or which exceeded the energy code, and which varied from the original plans on file, were also noted along with the reasons behind such variances.

2.4 Equipment Supplier, Design Engineer, and Building Official Interviews

In parallel with the plan and print reviews and physical site inspection activities, five regional equipment suppliers and two design engineering firms were successfully recruited and interviewed to assess the standard efficiencies of measures that these experts identified as being specified and purchased for installation in New Hampshire commercial/industrial new construction and renovation projects. Similar efforts were undertaken to ultimately interview nine building code officials in jurisdictions within New Hampshire where new construction has been most active.

Two separate interview guides/questionnaires were developed for use in performing these approximately one hour telephone interviews (one for the Equipment Suppliers/Design Engineers, and a different guide for the Building Code Officials). Materials, equipment and building practices assessed through these interviews include:

- Building Envelope;
- Electric Power;
- HVAC;
- Service Water Heating;
- Lighting and Lighting Controls; and
- Energy Management Systems.

Additional questions were asked to solicit opinions regarding each interviewee's definition of premium and standard efficiency levels for specific equipment, and to assess their current understanding of the New Hampshire Commercial Energy Code, compliance approaches, training needs and other related items. Appendix E includes both sets of interview guides. In certain cases, and to allow for the most complete and time efficient responses, copies of the actual questionnaires were faxed to potential interviewees and follow-up time slots were scheduled for reviewing responses and probing more deeply into areas of special interest or expertise.

Table 3 identifies the number of equipment supplier/design engineers who made up the GDS Team's recruiting pool. Care was taken to recruit at least one expert from each of the major categories. Regarding the Building Official interviews, care was taken to recruit interviewees from a town, within each county, that had been identified through the Commercial and Industrial Construction Profile research as having one of the highest levels of construction activity. Table 4 presents a list of towns, within each county, identified by the GDS Team's research as having high levels of construction activity in 1999. This list formed the recruiting pool for all Building Official interviews.

- TABLE 3 -

EQUIPMENT SUPPLIER/DESIGN ENGINEER INTERVIEWEE RECRUITING POOL

Equipment/Supplies Category
1 - Building Envelope
2 - Electric Power (Distribution Systems, Transformers, and Motors)
3 - Systems and Equipment for Auxiliaries (Transportation Systems, Freeze Protection, Retail Food and Restaurant Refrigeration)
4 - Heating, Ventilating, and Air-Conditioning (HVAC Systems and/or Equipment)
5 - Service Water Heating
6 - Lighting and Lighting Controls
7 - Energy Management

Equipment Supplier/Designer Number	Equipment Supply/Design Category
Building Envelope	
- 1	1
- 2	1
- 3	1
- 4	1
- 5	1
Electrical	
- 1	2,6
- 2	2,6
- 3	2,6
Electrical -- Lighting	
- 1	6
- 2	6
- 3	6
- 4	6
- 5	6
- 6	2,6
Engineers -- Electrical	
- 1	2,6,7
- 2	2,6
- 3	2,6

Equipment Supplier/Designer Number	Equipment Supply/Design Category
- 4	2,6
- 5	2,6
- 6	2,6,7
Engineers -- Mechanical	
- 1	3,4,5,7
- 2	3,4,5,7
- 3	3,4,5,7
- 4	3,4,5,7
Mechanical	
- 1	4,5
- 2	3,4,7
- 3	4,7
- 4	4,7
- 5	4,5
- 6	3,4,7
- 7	4,5
- 8	4,7
- 9	4,5
- 10	4,5
- 11	3,4,7
- 12	4,5
- 13	3,4,7
- 14	3,4,7
- 15	4,7
Energy Management	
- 1	7
- 2	7
- 3	7
- 4	4,5,7
- 5	7
- 6	7
- 7	7
- 8	7

- TABLE 4 -

BUILDING OFFICIALS INTERVIEWEE RECRUITING POOL

TOWNS WITH HIGHEST COMMERCIAL NEW CONSTRUCTION ACTIVITY IN 1999
- BY COUNTY -

County and Towns with Highest Activity (i.e., greater than 10 projects)	**Estimated Number of Commercial Construction Projects in 1999***
Belknap County	**41**
- Laconia	15
Carroll County	**44**
- Conway/North Conway	17
Cheshire County	**99**
- Keene	63
Coos County	**23**
- Berlin	7
Grafton County	**109**
- Lebanon/West Lebanon	39
- Hanover	24
Hillsborough County	**512**
- Manchester	187
- Nashua	119
- Bedford	35
- Merrimack	33
Merrimack County	**183**
- Concord	112
Rockingham County	**369**
- Portsmouth	100
- Salem	62
- Londonderry	31
- Derry	24
- Exeter	23
Strafford County	**142**
- Rochester	45
- Durham	41
- Dover	33
Sullivan County	**31**
- Claremont	11
Total 1999	**1,553**

* Includes major renovations

2.5 Review of Existing Studies

As specified in the Study Group's original scope of work, the GDS Team reviewed the Northmark Focus Group Study: *"Findings of the Commercial and Industrial Lighting Market in New Hampshire"* conducted for the PUC's Energy Efficiency Working Group in April, 1999, and the Northeast Energy Efficiency Partnerships (NEEP) *"Northeast Regional Building Energy Codes Impact Analysis"*, June 1999. In addition, GDS reviewed its own extensive database of studies and, through discussion with key members of NEEP and other knowledgeable stakeholders in the Northeast Region, identified other related studies that may be applicable to New Hampshire. Results from these research and review efforts are summarized in Section 3.4 of this report.

2.6 Tentative Findings Development and Roundtable Discussion Group

Based on results from the research, site visits and interviews performed during this study, a set of 10 tentative findings were developed and presented to the Study Group as a bulleted list. These findings related mainly to specific equipment, installation and construction practices identified within each of the major categories addressed by the current New Hampshire Commercial and Industrial Energy Code and compared those code requirements to commercial new construction and equipment installation practices currently being seen in the state.

These tentative findings were tested in a roundtable discussion group held in Concord, New Hampshire on March 22, 2000. Participants at the roundtable were drawn from a large and knowledgeable group of design engineering firms, equipment suppliers and building code officials from across the state. A copy of the moderator's guide and tentative findings tested at the roundtable are included as Appendix F to this report. Please refer to Section 3.5 for more details on the tentative findings and roundtable session.

The Study Group also hosted a roundtable on October 14, 1999 that was attended by members of the American Institute of Architects (AIA) - NH Environmental Guild. The purpose of this focus group was to discuss current practices relative to the New Hampshire Commercial and Industrial Energy Code. A copy of the moderator's guide and transcripts from the event are included as Appendix G to this report. Results from the AIA roundtable were used by the Study Group to help guide development of the scope of work for this commercial new construction research project. In addition, comments from AIA roundtable participants were reviewed, and consistently supported the findings presented in this report.

3.0 DATA COLLECTION RESULTS

3.1 Commercial New Construction Activities Profile

Appendix C presents results from the GDS Team's research leading to development of a profile of commercial and industrial construction activities in the State of New Hampshire for the years 1999 and 1997/1998. In summary, this research identified over 1,500 small and large commercial/industrial construction projects in various stages of design or completion during 1999 (and nearly 1,400 projects in 1997/1998 combined). Over one third of the 1999 projects were being planned for construction in the following ten towns (i.e., the town in each county having the highest level of commercial construction activity):

-TABLE 5 -

1999 CONSTRUCTION ACTIVITY BY COUNTY & HIGHEST TOWN

County/Town	# of Projects	
	Town	Total
Belknap - Laconia	15	41
Carroll - Conway/N. Conway	17	44
Cheshire - Keene	63	99
Coos - Berlin	7	23
Grafton - Lebanon/W. Lebanon	39	109
Hillsborough - Manchester	187	512
Merrimack - Concord	112	183
Rockingham - Portsmouth	100	369
Strafford - Rochester	45	142
Sullivan - Claremont	11	31
Total	**596**	**1,553**

Based on the information collected and summarized in Table 6 below, it appears that a slight majority of construction activity is falling in the small commercial area. This finding holds true in at least half the regions of the state.

-TABLE 6 -
1999 CONSTRUCTION ACTIVITY BY COUNTY & BUILDING SIZE*

County	Small (< 20,000 sq. ft.)	Large (>=20,000 sq. ft.)
Belknap	2	4
Carroll	6	2
Cheshire	8	14
Coos	1	2
Grafton	21	18
Hillsborough	63	63
Merrimack	27	20
Rockingham	60	63
Strafford	23	10
Sullivan	6	3
Total	**217**	**199**

* Note: Information on building size was not available on all projects identified in the 1999 commercial and industrial construction activities profile database.

Concerning building types, construction activities can be grouped into the following categories:

-TABLE 7 -
1999 CONSTRUCTION ACTIVITY BY COUNTY & BUILDING TYPE*

County	Assembly	Hospital	Housing	Manuf-acturing	Office	Retail	School	Warehouse
Belknap	5	-	4	4	3	3	7	-
Carroll	10	-	8	-	2	7	5	2
Cheshire	16	4	6	3	11	12	8	9
Coos	8	-	1	-	2	2	5	-
Grafton	21	6	12	3	30	11	16	2
Hillsborough	55	9	35	16	94	73	57	21
Merrimack	29	2	16	4	25	27	16	9
Rockingham	50	8	34	14	57	59	23	29
Strafford	24	4	13	6	12	8	16	7
Sullivan	6	-	3	1	6	3	-	1
Total	**224**	**33**	**132**	**51**	**242**	**205**	**153**	**80**

* Note: information on building type was not available on all projects identified in the 1999 commercial and industrial construction activities profile database.

3.2 Plan/Print Reviews and Physical Building Inspections

Data collected during plan and print reviews and physical site inspections were summarized and analyzed using a number of charts as discussed in more detail below. Each figure is presented on a separate page immediately following this discussion. Note that all references to "Code", below and throughout this report, relate to the New Hampshire *Commercial and Industrial Energy Code (structures greater than or equal to 4,000 square feet in floor area)* - revised 7/93, 4th Edition. Also note that these findings are based on the small sample sizes identified previously in Section 2 which, although not statistically valid, can provide important information on energy efficient technology trends and new commercial construction practices across the state.

Discussion of Charts:

Figure 1 - Motor, Lighting, and lighting Control Practices: consists of individual charts A, B and C as described in some detail below:

A. Motor Efficiency

Efficiency or Compliance Determination: Efficiency percentage rating per plan and specification review and site inspection.

Findings: All motors specified exceeded code.

Discussion: Motors installed today generally must exceed code due to federal laws that mandated an improvement in efficiency beginning in 1997. We did not find any buildings in our study that had motors specified that were below code. Relating this to what has been defined as Exceeds Standard Efficiency/Standard Efficiency/Below Standard Efficiency shows that the majority of motors exceed the federal EPAct standard that went into effect in 1997.

B. Lighting Efficiency

Efficiency or Compliance Determination: Watts/square foot per plan and specification review and site inspection.

Findings: Lighting installed generally exceeds code.

Discussion: The advent of T-8 lamps is replacing the specification of T-12 lamps. This, and the increased use of CFLs in lieu of incandescent lamps, has lowered the watts per square foot required to achieve a desired illumination level. Relating this to what has been defined as Exceeds Standard Efficiency/Standard Efficiency/Below Standard Efficiency shows that the majority of buildings meet or exceed standard efficiency.

As an adjunct review, the GDS Team noted the type of exit lamp fixtures specified, as it is a good example of the changes in technology since the current code was adopted. Incandescent exit lamps (30 to 45 watts) had been the standard used up until about ten years ago, when they were replaced by fluorescent bulbs (8 watts), which now have been replaced by LEDs (2 watts). This, coupled with the ten-fold increase in the life of the illumination device, has resulted in a paradigm shift, making LEDs the new standard. This new standard was found to be met in nearly all cases observed by the GDS Team.

C. Lighting Controls

Efficiency or Compliance Determination: Plans and specification review and site inspection.

Findings: Automatic lighting controls are specified very infrequently.

Discussion: Four possible lighting control practices were noted: Multilevel switching, occupancy sensors, daylight dimming, and photosensor control. Of these, only photosensor control is actually required by code. Photosensor control is practiced throughout the facilities reviewed, unlike the other control technologies. One architect who had specified an autodimming daylighting control design relayed that the owner could not justify the added expense for the projected savings and thus had that option eliminated.

Figure 2 - Heating/Cooling Unit Efficiency Practices: consists of individual charts D, E, and F as described in some detail below:

D. Cooling Unit Efficiency

Efficiency or Compliance Determination: EER typically, though COP, IPLV, and SEER are alternate determination methods per plan and specification review and site inspection.

Findings: A surprising twenty percent of cooling units were below efficiencies required by code, and only twenty seven percent of the units specified met code.

Discussion: Substantial increases in efficiencies have been made since the code was adopted. This led the GDS Team to believe that we would find most cooling units far exceeding code. However, we found forty-seven percent of the units specified not utilizing the improvements made in cooling unit efficiencies. Fifty-three percent were categorized as exceeding the code (i.e., defined for this report as cooling units having efficiency ratings at least 5% greater than current code requirements).

The range of efficiency increases is very large and requires the designer and owner to undertake a cost/benefit analysis to determine the optimum unit that should be selected. The GDS Team is puzzled by the finding that 20% of the sample size was below code. Most units in the study sample were within the specifications of NH Energy Code Table 10-1, Unitary Air Conditioners - Air Cooled (i.e., the minimum code performance rating in these cases is specified between an EER of 8.9 and a SEER of 10). However, we found units installed with an EER rating of 8.5, which met the code previous to January 1, 1992, but do not meet the code as of the date of our work. Note: the American Refrigeration Institute (ARI, partial source of the ratings), or the manufacturer, may have derated some of the units that have been installed, lowering their EER after they were installed.

E. Heating Unit Efficiency

Efficiency or Compliance Determination: AFUE rating, nameplate or specification rating per plan and specification and site inspection.

Findings: All heating units exceeded code requirements.

Discussion: Increases in fossil fuel device efficiency have been in smaller percentage increases than for cooling devices. However, we did not find any units that did not at least have an AFUE efficiency rating of 80%. The code requires a minimum AFUE of 78%.

F. Unit Heater Unit Efficiency

Efficiency or Compliance Determination: Nameplate or specification rating per plan and specification and site inspection.

Findings: All heating units exceeded code requirements.

Discussion: These are units that combust fossil fuel in open atmospheric conditions, releasing the heat to the working/living space in the form of warm air. Most units have increased their efficiency from the code-required 78% to 80% by converting the pilot flame to a spark ignited flame, thus reducing standby losses.

Figure 3 - Heating/Cooling Distribution Practices: consists of individual charts G, H, I, J and K as described in some detail below:

G. Hydronic Heating Distribution Power Efficiency

Efficiency or Compliance Determination: Plan and specification review.

Findings: All sampled buildings that were subject to this code were found to be in compliance.

Discussion: Energy efficient delivery of fluid for a hydronic heating system can be accomplished in several ways. The two most popular appear to be control of the circulating pump and/or control of the hydronic fluid temperature (boiler reset) based upon outside temperature. The assumption is that as outside air temperature rises, the hydronic fluid temperature can decrease, as less energy is needed to maintain a facility's temperature. Control of the circulating pump can be accomplished through use of a variable speed drive that receives its signal based upon the temperature of the return, zone or outside air. The GDS Team determined compliance based upon the following outcomes:

Case	A. Required	B. Installed	C. Pass	D. Fail
1. Variable pumping, no boiler reset	Yes	Yes	Yes	
2. Variable pumping & boiler reset	No	Yes	Yes	
3. No pumping control & no boiler reset	Yes	No		Yes
4. Boiler reset & no variable pumping	No	No	NA	NA

We felt the "Below, Meets or Exceeds Code" rating would not effectively communicate the results. A facility that does not use boiler reset needs to use variable pumping (Case 1). However, it is also possible that a facility may have both types of controls, boiler reset and variable pumping (Case 2). This exceeds code. The only failure to meet code is when there is no control of the pump and there is no boiler reset (Case 3). This is below code. A facility that uses boiler reset does not need to use variable pumping (Case 4). This meets code. The bar chart used in Figure 3 allows a determination to be made as long as it is understood that Case 4 is not included in the data.

H. Hydronic Heating Distribution Insulation

Efficiency or Compliance Determination: Plan and specification review for overall R-value.

Findings: It appears that the specifications do not always meet code. We found twenty-nine percent of the facilities below code in this area.

Discussion: Review of specifications and prints showed that approximately one quarter of the hydronic systems sampled had insulation levels that appeared to not meet code. Compliance with code typically requires two pieces of information: thermal conductivity and thickness. This information together will determine the more-often used R-value rating. The GDS Team's determination that the insulation levels did not meet code was based upon the observation that the insulation conductivity ratings met code, but the insulation thickness was below requirements. It is possible that in-field insulation had a higher conductivity than specified, thereby allowing the insulation to not be as thick as code required. However, this would have required removing insulation from the facilities during our site visits to confirm this possibility. In general, the workmanship found in the installation of the insulation was quite good.

I. Constant Air Volume Distribution Power Efficiency

Efficiency or Compliance Determination: CFM/Watt per plan and specification review.

Findings: Improvement in fan, duct and motor efficiencies has resulted in almost all facilities exceeding code.

Discussion: The efficiency of an air distribution design is a measurement of the flow of air volume per unit time with respect to the power required to move the volume of air. Improvements in duct design, motor efficiency and fan design have increased the efficiency of moving air. All but one system exceeded code.

J. Variable Air Volume Distribution Power Efficiency

Efficiency or Compliance Determination: CFM/Watt per plan and specification review.

Findings and Discussion: The finding and discussion is similar to I above.

K. Forced Air Distribution Insulation

Efficiency or Compliance Determination: Plan and specification review and site inspection.

Findings: A high percentage of facilities comply with code.

Discussion: As shown on Chart K, a large number of the facilities reviewed meet code. This chart, however, should be reviewed carefully with regard to the requirements of the code. Code does not require insulation on ductwork that is in conditioned space. Therefore, for many unitary rooftop units, no insulation is required. This explains the large number of facilities that met code. Also, the advent of pre-insulated ductwork contributed to the number of facilities that met or exceeded the code.

<u>Figure 4 - Other Important Practices:</u> consists of individual charts L, M, N and O as described in some detail below:

L. Service Water System Insulation

Efficiency or Compliance Determination: Plan and specification review and site inspection.

Findings: A fairly high number of facilities sampled (twenty-four percent) did not meet code. The findings are consistent with H for hydronic heating system insulation.

Discussion: Determination of compliance with the code faces the same challenges as that existing for forced hot air and hydronic distribution system insulation. Two variables are required: thermal conductivity and thickness of the insulation. The GDS Team found that the thermal conductivity (*k)* values cited in the specifications closely followed the code, while specified thickness were below, met and exceeded the code. On-site inspections verified that thickness did not meet code in all cases, though it is possible that the conductivity exceeded the specifications and code, resulting in an overall R-value that met or surpassed code.

M. Service Water System Pumping Control

Efficiency or Compliance Determination: Plan and specification review and site inspection.

Findings: All sampled facilities had pump controls that were required.

Discussion: Circulating service water systems provide hot water upon demand to the fixture in a short period of time which eliminates water being wasted while waiting for hot water to arrive at the fixture. Circulating service hot water systems require a control device that will essentially stop the unnecessary circulation of water when demand for hot water is reduced or non-existent. There are several ways the control can be accomplished. Pumps can be controlled by a time clock for buildings that are used less than 24 hours a day and have a known schedule. It is more common to control the pump by use of a temperature sensing device that turns the pump off once the water in the loop reaches a specified temperature. The assumption is that once the temperature is reached, demand for service water has been curtailed and it is no longer necessary to circulate service water. It is important that the sensor be placed properly for this control strategy to work.

N. Building Envelope

Efficiency or Compliance Determination: Plan and specification review. Use of procedure outlined in Code Table 8A-32.

Findings: Most facilities sampled were found to be in compliance with building envelope requirements using the modified Prescriptive Methodology we employed.

Discussion: A specification and print review does not lend itself well to determining compliance with the code. A substantial amount of information is required in order to determine the level of compliance. The GDS Team approached determination of compliance in two areas: Fenestration and Other Criteria. Other Criteria is relatively simple to determine if the specifications include information on the foundation, wall and roof assemblies.

Fenestration is much more time consuming and difficult to determine. Allowable fenestration percentage is essentially a trade off between wall insulation unit characteristics and fenestration unit characteristics. The range of allowable tradeoffs are a function of the internal electrical load density, which we determined using review of the lighting design and Code Table 8.4. Compliance determination can be simplified if the buildings are not of unusual envelope design with great expanses of windows, unusual skin material and skylights. None of the buildings we included in determining compliance were atypical. Therefore, by assuming average values for projection and shading factors and fenestration assembly, the GDS Team was able to estimate compliance.

The following assumptions were made:

- Projection Factor: 0 to 0.249
- Shading Factor: 0.37
- Fenestration Assembly: 0.45 to 0.29
- Heat Capacity a)>= 10; b)>= 15 use HC_{avg} = 12.5

Examination of Code Table 8A-32 shows insensitivity between allowable fenestration and interior insulation for any given Internal Load Density. Therefore, as long as the facility has insulation levels noted in Other Criteria, and can be assumed to be of a typical design, it will usually meet the trade-off requirements between fenestration percentage and wall assembly.

O. Suggested Energy Recovery Practices

Efficiency or Compliance Determination: Plan and specification review.

Findings: Energy recovery or energy storage was not seen in the facilities reviewed by the GDS Team.

Discussion: Suggested energy recovery practices were inventoried as part of our print and specification review process. Three categories were evaluated:

- Condensate Recovery,
- Thermal Storage (Cooling), and
- Ventilation Heat Recovery.

Condensate and Ventilation Recovery captures and utilizes heat that would otherwise be wasted. We interpreted Thermal Storage to mean cooling storage, which allows for a low temperature medium to be stored and then utilized at some later time to provide cooling. Thermal Storage is not a true energy recovery practice. It is an economic practice dictated by the difference in the cost of providing cooling on demand versus a stored medium. The savings of providing cooling from the stored medium is a function of electric utility time differentiated rates. The GDS Team's experience in the Northeast shows that most utilities do not have time differentiated rates conducive to thermal storage. In New Hampshire, the GDS Team did not find any cooling storage systems in the sample studied.

Condensate Recovery captures the heat from flashing steam from high to low pressure that ordinarily is lost. Typically this heat is captured and used to heat service water. Steams systems are common in industrial facilities, however, they are not common in commercial facilities. The GDS Team did not find any steam systems in the buildings reviewed and therefore did not find any condensate heat recovery.

Ventilation Heat Recovery captures the heat in air that is being exhausted from a facility and typically uses it to preheat outside (make-up) air that is at a lower temperature. This strategy displaces the use of energy to increase the temperature of the outside air to the desired level. Exhausted air is usually at a low temperature, typically 65 to 85 F. Heat wheel or high surface area unmixed air-to-air heat exchangers are utilized. It is possible to have much higher exhaust air temperatures from an industrial facility and utilize this energy stream to preheat make-up air or service water. However, the GDS Team did not find any facilities doing this, although one facility in the sample was using exhaust to preheat combustion air for an industrial process.

Figure 5 - Suggested Energy Management Practices: consists of individual chart P as described in some detail below:

P. Suggested Energy Management Practices

Efficiency or Compliance Determination: Plan and specification review.

Findings: Energy Management Systems, though not mandated, were found to be installed in almost all sampled facilities, although the sophistication of the systems varied by the size of the facility, and building operators were often over-riding controls to solve immediate comfort problems.

Discussion: Energy Management Systems control energy consuming devices in a way that does not, when operating properly, affect the comfort of those in a facility. Implicit is that the control provides energy cost savings and may provide energy saving. Energy Management also indicates a process of gathering data that will allow review and analysis. Hopefully the process is dynamic, allowing for continual improvement of the facility to lower its energy costs.

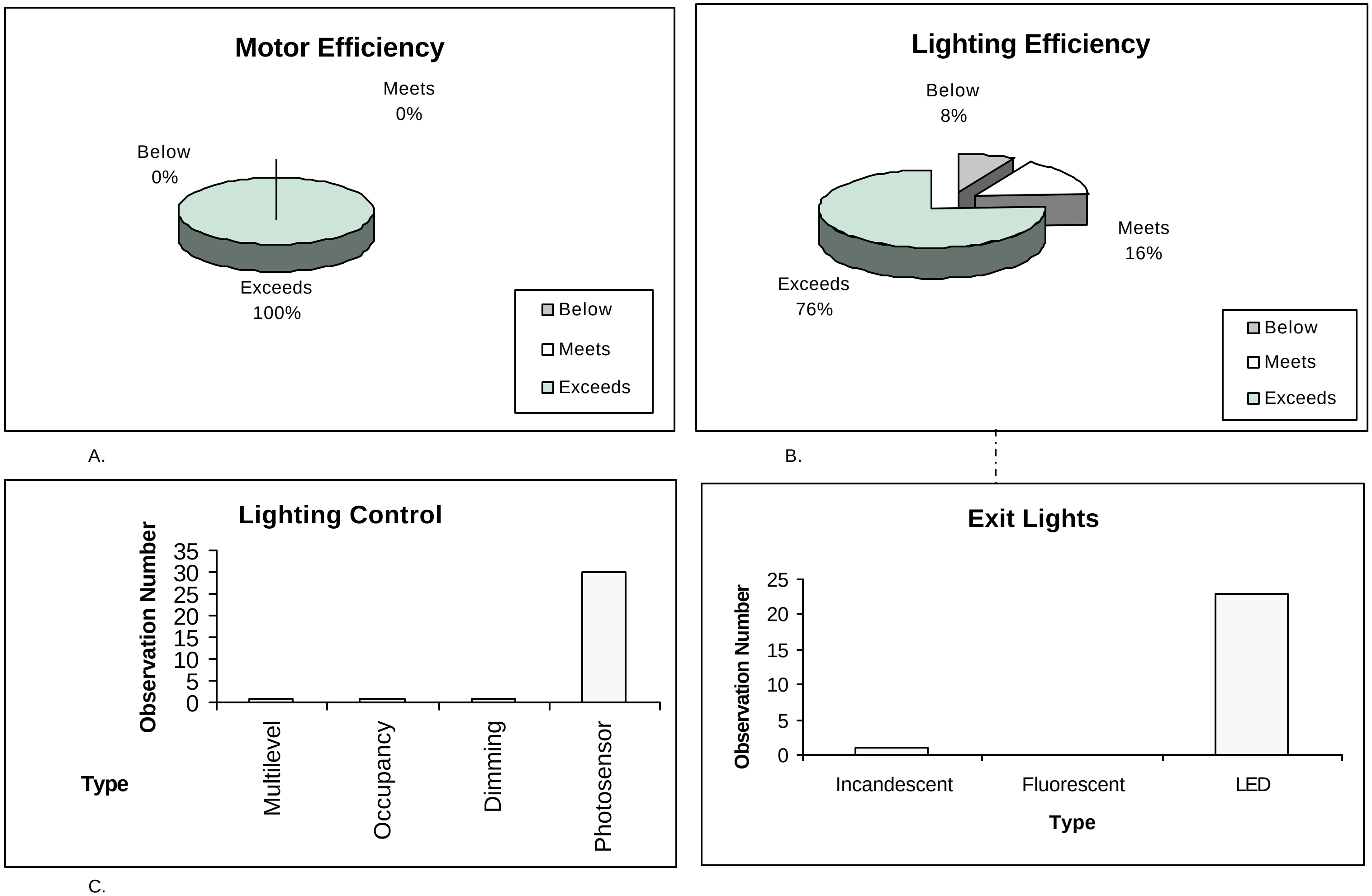
There are many types of energy management systems. A programmable thermostat could be considered such a system, albeit very limited, and unable to accomplish the vast majority of operations suggested by the code. Cooling systems have evolved to where they have energy management abilities integral to their controls package. While the energy management control abilities are not centralized into a central unit, nonetheless they do practice some of the suggested energy management practices (HVAC on/off, HVAC Optimization, and HVAC Monitoring and Verification).

It should be noted that Energy Management systems are not required in NH's current energy code. The code only specifies that buildings over 40,000 square feet *consider* the use of energy management systems. The code suggests a number of control and information gathering processes as part of the energy management strategy. However, the GDS Team could not find any energy management system described in the specifications that gathered all the suggested data. In particular, the code included a dearth of information on the energy management system's ability to gather data on fossil fuel use. The code suggested that fossil fuel consumption data be gathered on a daily and weekly basis, though the GDS Team did not find this suggestion implemented in any of the plans and prints reviewed or buildings that were inspected.

PLACEHOLDER FOR FIGURE 1 - MOTOR, LIGHTING, AND LIGHTING CONTROL PRACTICES

SEE "Figure 1-5.xls"

FIGURE 1

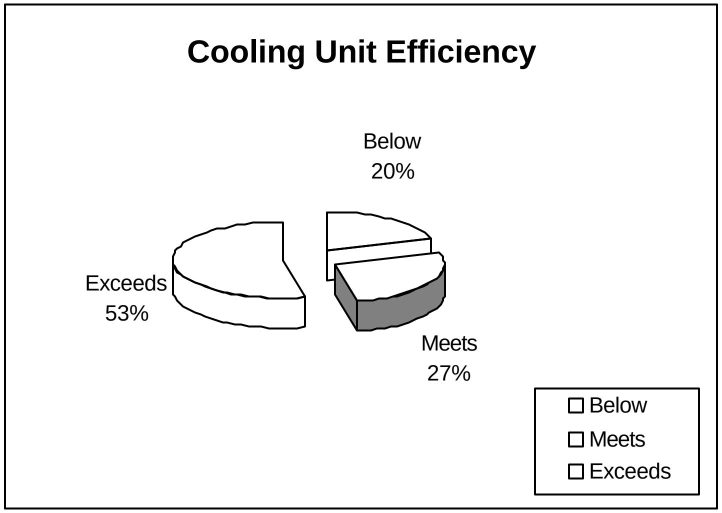


MOTOR, LIGHTING, AND LIGHTING CONTROL PRACTICES

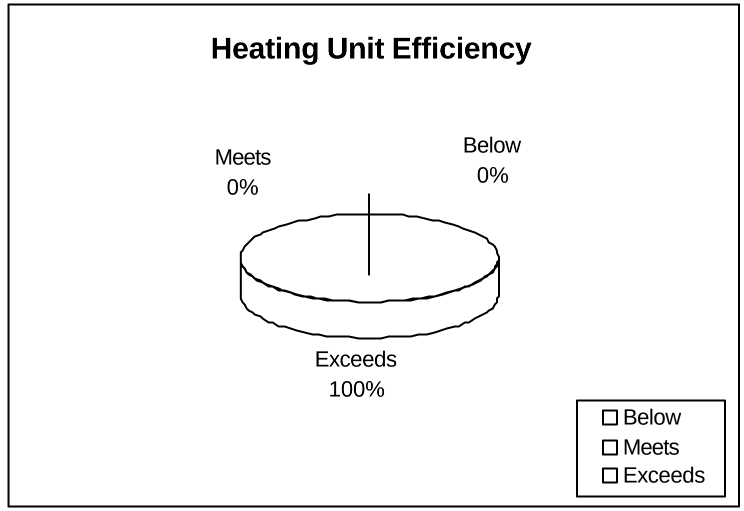
PLACEHOLDER FOR FIGURE 2 - HEATING/COOLING UNIT EFFICIENCY PRACTICES

SEE "Figure 1-5.xls"

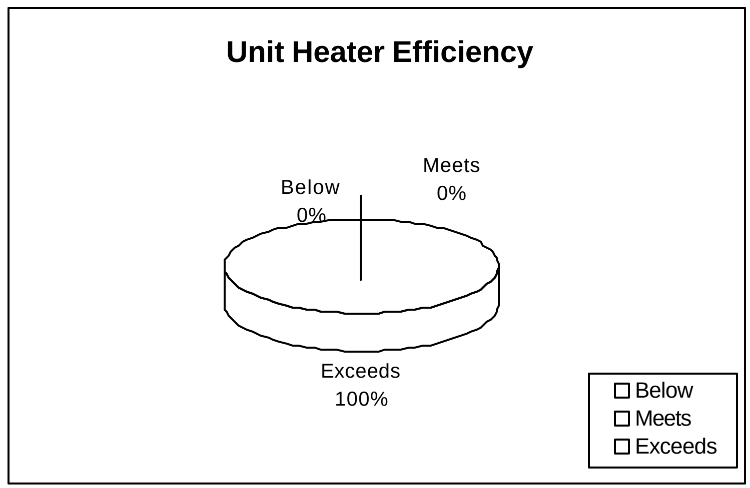
FIGURE 2


Cooling Unit Efficiency
Below
20%
Exceeds
53%
Meets
27%
Below
Meets
Exceeds

D.


Heating Unit Efficiency
Meets
0%
Below
0%
Exceeds
100%
Below
Meets
Exceeds

E.

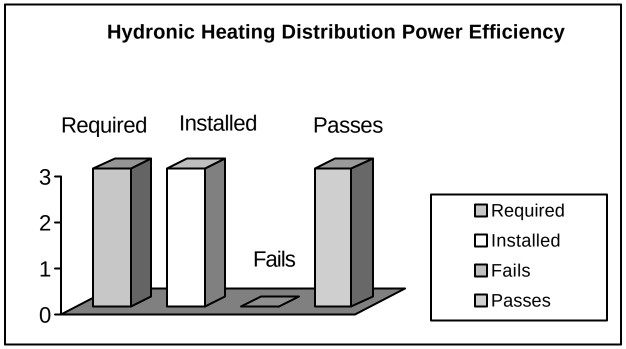

Unit Heater Efficiency
Below
0%
Meets
0%
Exceeds
100%
Below
Meets
Exceeds

F.

PLACEHOLDER FOR FIGURE 3 - HEATING/COOLING DISTRIBUTION AND INSULATION PRACTICES

SEE "Figure 1-5.xls"

FIGURE 3



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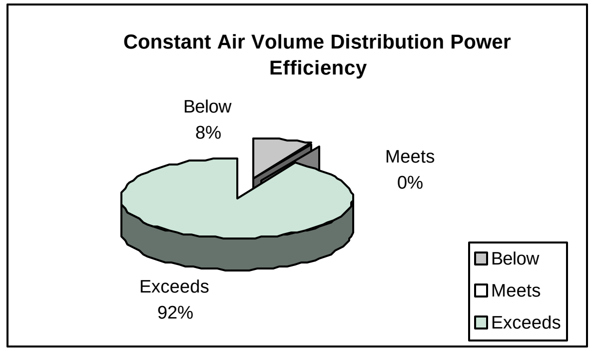
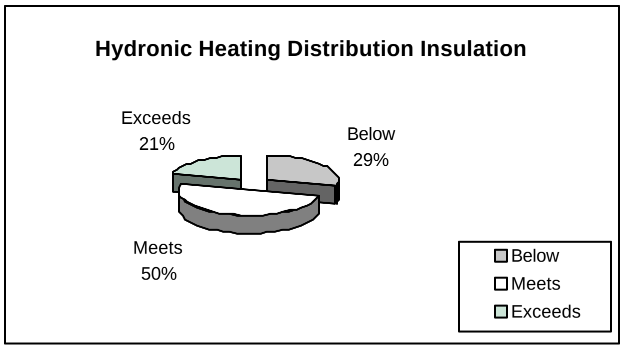


I.



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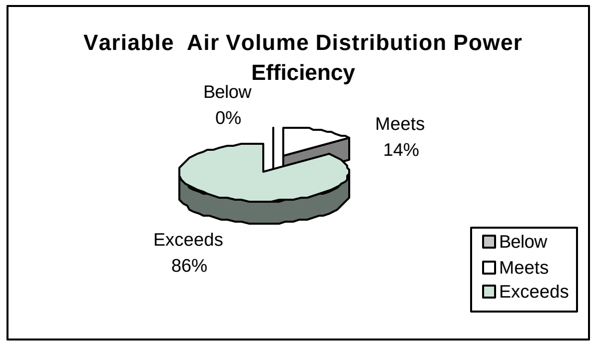
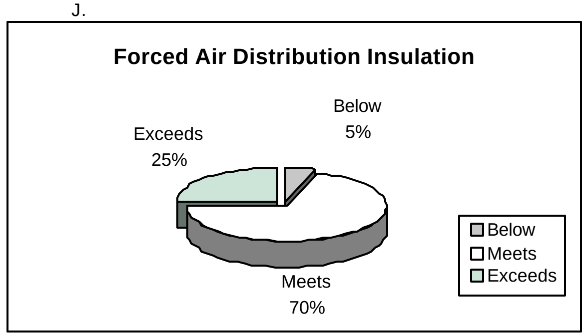


J.

HEATING/COOLING DISTRIBUTION AND INSULATION PRACTICES

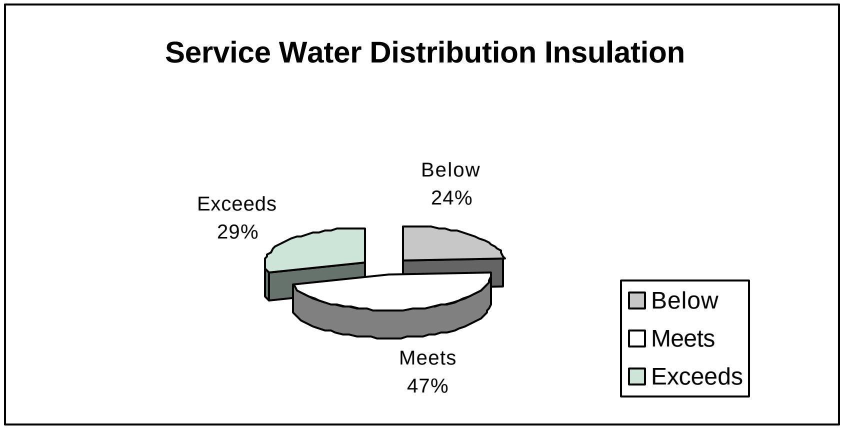


K.

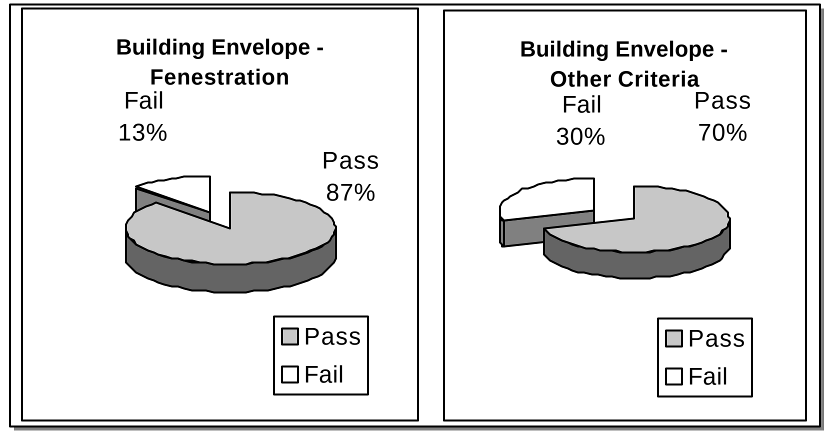
PLACEHOLDER FOR FIGURE 4 - OTHER IMPORTANT PRACTICES

SEE "Figure 1-5.xls"

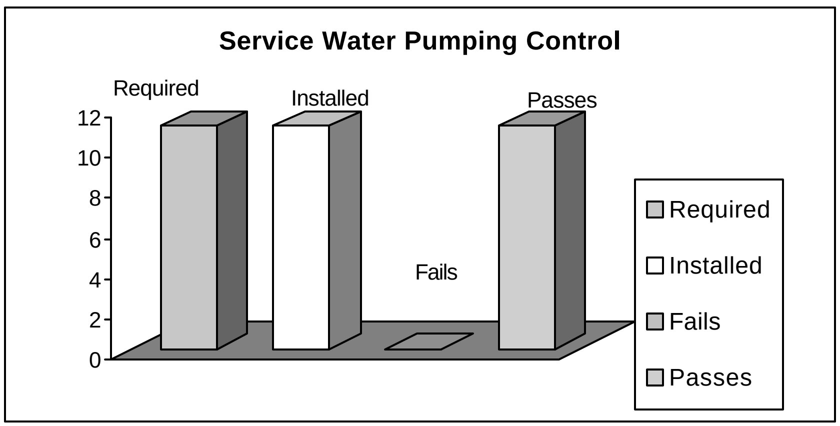
FIGURE 4



L.



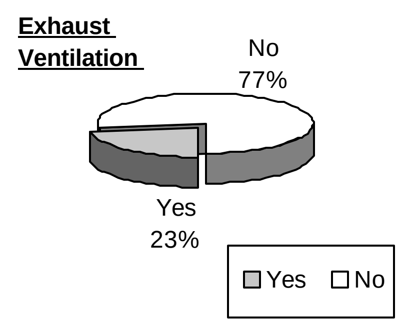
N.



M

Suggested Energy Recovery Practices

Condesate Recovery was not applicable as no steam systems were included. **Thermal Storage** (cooling) was not practiced.



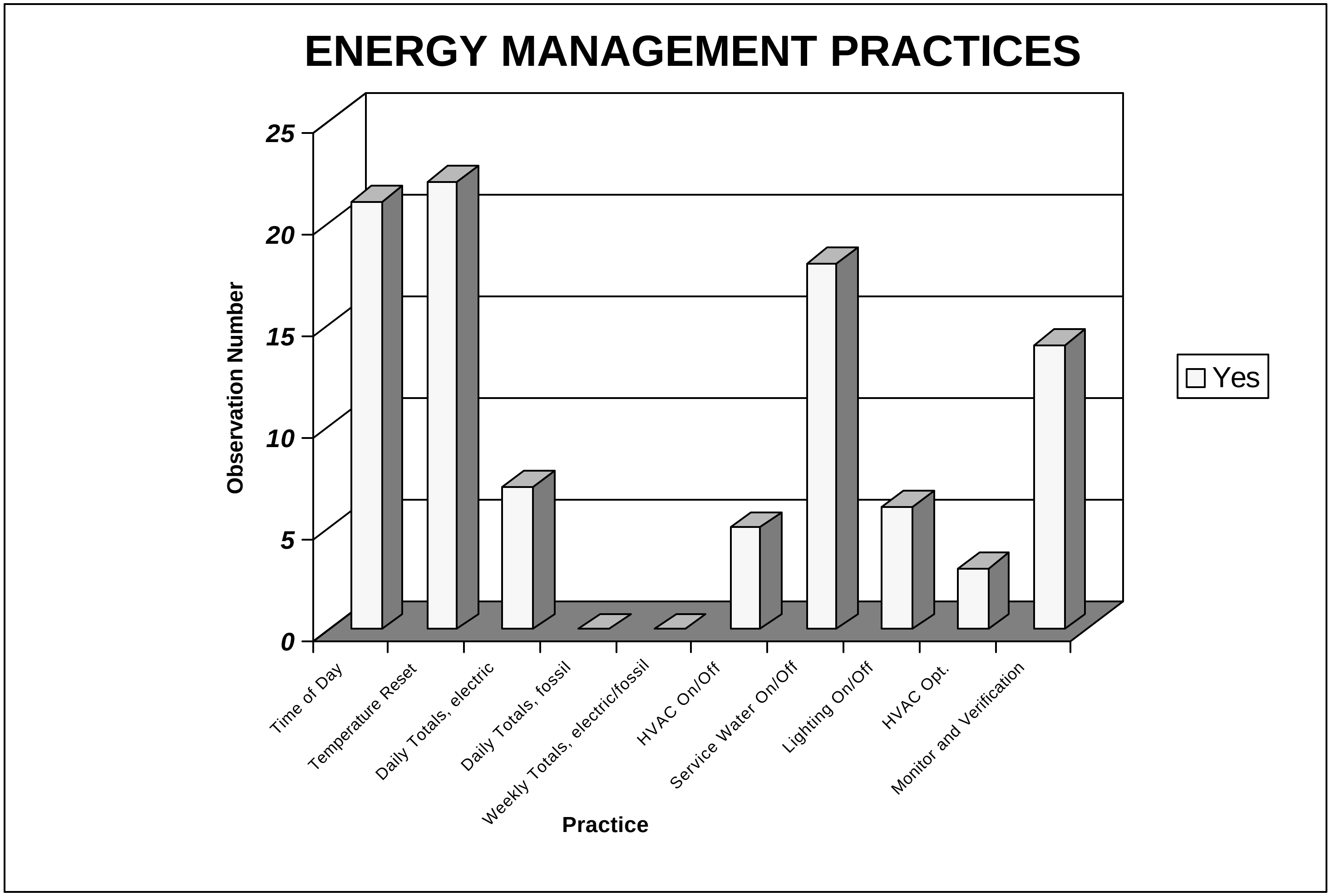
O.

OTHER IMPORTANT PRACTICES

PLACEHOLDER FOR FIGURE 5 - SUGGESTED ENERGY MANAGEMENT PRACTICES

SEE "Figure 1-5.xls"

FIGURE 5



SUGGESTED ENERGY MANAGEMENT PRACTICES

P.

3.3 Equipment Supplier/Design Engineer and Building Official Interviews

As discussed previously in Section 2.4, a major objective of the equipment supplier/design engineer and building official interviews was to assess the standard efficiencies of measures that these experts identified as being specified, purchased and installed in New Hampshire commercial/industrial new construction and renovation projects. Additional questions were asked to solicit opinions regarding the interviewees' definitions of premium and standard efficiency levels for specific equipment,[10] and to assess current understanding of the NH Commercial Energy Code, compliance approaches, training needs and other related items.

Figure 6 summarizes the findings from these interviews. Results are presented first through a series of symbols to identify the percentage of measures, on average, that the experts believed are being specified, purchased, and installed in commercial new construction projects in New Hampshire at levels that meet or exceed high efficiency ratings. The following chart key was used to summarize results:

Blank Cell = Less than 10% of measures are at or above the high efficiency level

❍ = Between 10% and 29% of measures are at or above the high efficiency level

◗ = Between 30% and 49% of measures are at or above the high efficiency level

✪ = Between 50% and 69% of measures are at or above the high efficiency level

● = At least 70% of measures are at or above the high efficiency level

Interviewees were also asked for their experienced judgement regarding availability of energy efficient equipment. A numeric rating scale (averaging responses from all interviewees) is used in Figure 6 to summarize these results.

1 = Significantly less available/utilized

2 = Somewhat less available/utilized

3 = About as easy to obtain/utilize

For a list of interviewees' responses to other key questions, please refer to Appendix H.

[10] See Question 8 in the Equipment Supplier Interview Guide and Question 15 in the Building Officials Interview Guided presented in Appendix E of this report, which presents the *initial* premium, standard and code level efficiencies for teeing up and testing. These ratings were further tested and modified, where appropriate, during the March 22, 2000 roundtable (See Table 1 in the Roundtable Moderator's Guide presented in Appendix F of this report). The *final* premium, standard and code level ratings presented in Appendix A represent the culmination of these interview and feedback efforts.

PLACEHOLDER FOR PAGE 1 OF FIGURE 6 - EQUIPMENT SUPPLIER/BUILDING OFFICIAL INTERVIEW SUMMARY

SEE "Figure 6.doc"

PLACEHOLDER FOR PAGE 2 OF FIGURE 6 - EQUIPMENT SUPPLIER/BUILDING OFFICIAL INTERVIEW SUMMARY

SEE "Figure 6.doc"

PLACEHOLDER FOR PAGE 3 OF FIGURE 6 - EQUIPMENT SUPPLIER/BUILDING OFFICIAL INTERVIEW SUMMARY

SEE "Figure 6.doc"

- FIGURE 6 -

EQUIPMENT SUPPLIER/ BUILDING OFFICIAL INTERVIEWS EFFICIENT PRACTICES SUMMARY

Commercial Building Construction Measure	Equipment Suppliers & Design Eng.	Building Officials	Comments
Building Envelope	2.67	2.33	
☐ Roof materials	◗	◗	
☐ Wall materials	✪	◗	
☐ Doors	◗	✪	
☐ Windows	●	●	
☐ Glazing – reflective, tinted, Low E, Low SC	●	✪	
☐ Foundations/Floors/Slabs			
- Wall	◗	✪	
- Slab	◗	◗	
- Floor	◗	◗	

N/A = No knowledge or opinion on practices associated with the measure's efficiency level
❑ = Less than 10% of measures are at or above the high efficiency level
❍ = Between 10% and 29% of measures are at or above the high efficiency level
◗ = Between 30% and 49% of measures are at or above the high efficiency level
✪ = Between 50% and 69% of measures are at or above the high efficiency level
● = At least 70% of measures are at or above the high efficiency level

1 = Significantly less available/utilized 2 = Somewhat less available/utilized 3 = About as easy to obtain/utilize

- FIGURE 6 -

EQUIPMENT SUPPLIER/ BUILDING OFFICIAL INTERVIEWS EFFICIENT PRACTICES SUMMARY

Commercial Building Construction Measure	**Equipment Suppliers & Design Eng.**	**Building Officials**	**Comments**
Electric Power	3.00	2.33	
❑ Motors - 1 to 10 hp - 11 to 75 hp - 76 to 200 hp	✪	●	
HVAC Equipment	2.25	2.50	
❑ Economizers (for "free" cooling)	●	◗	Building Officials aren't seeing as much in field as suppliers say
❑ Reset controls	✪	●	
❑ Air furnaces (heating)	◗	✪	
❑ Hydronic boilers (heating)	✪	✪	
❑ Cooling equipment	◗	✪	
❑ Automatic thermostat control	●	●	
❑ Variable air volume systems	◗	◗	
❑ HVAC air heat recovery	❍	●	Building Officials see 60% in schools (not offices), linked to size
❑ Heat Recovery High Temp	◗	✪	
❑ Heat Recovery Fluid/Gas	◗	✪	
❑ Duct & piping equipment and insulation	✪	●	
❑ Thermal storage (cooling)	●	❍	Building Officials aren't seeing as much in field as suppliers say
Service Water Heating	3.00	2.60	
❑ Service water heating equip.	●	✪	
❑ Service wtr. Heating controls	●	◗	
❑ Water heating tank insul.	●	✪	
❑ Service wtr. htg pipe insul.	●	✪	

N/A = No knowledge or opinion on practices associated with the measure's efficiency level
❑ = Less than 10% of measures are at or above the high efficiency level
❍ = Between 10% and 29% of measures are at or above the high efficiency level
◗ = Between 30% and 49% of measures are at or above the high efficiency level
✪ = Between 50% and 69% of measures are at or above the high efficiency level
● = At least 70% of measures are at or above the high efficiency level

1 = Significantly less available/utilized 2 = Somewhat less available/utilized 3 = About as easy to obtain/utilize

- FIGURE 6 -

EQUIPMENT SUPPLIER/ BUILDING OFFICIAL INTERVIEWS EFFICIENT PRACTICES SUMMARY

Commercial Building Construction Measure	Equipment Suppliers & Design Eng.	Building Officials	Comments
Lighting Fixtures	3.00	2.67	
☐ 4 ft./8ft. Fluorescents (T-12, T-8, T-10, T-5)	●	●	
☐ HID (hp sodium/mercury/metal halide)	●	●	
☐ Ballasts (magnetic/electronic)	●	●	
☐ Compact fluorescents	✪	◗	
☐ LED Exit Signs	●	●	
Lighting Controls	2.75	2.50	
☐ Localized switching	●	●	
☐ Multi-level switching	●	❑	Building Officials aren't seeing as much in field as suppliers say
☐ Occupancy sensors	✪	❑	Building Officials aren't seeing as much in field as suppliers say
☐ Motion sensors/outdoor ltng	✪	❍	Building Officials aren't seeing as much in field as suppliers say
☐ Daylighting controls	◗	❑	Building Officials aren't seeing as much in field as suppliers say
☐ Automatic exterior lighting controls (photocells/timeclocks)	●	●	
Energy Management Systems	3.00	2.00	
☐ Process/system controls	❍	◗	
☐ Total building energy management controls	◗	❍	

N/A = No knowledge or opinion on practices associated with the measure's efficiency level
❑ = Less than 10% of measures are at or above the high efficiency level
❍ = Between 10% and 29% of measures are at or above the high efficiency level
◗ = Between 30% and 49% of measures are at or above the high efficiency level
✪ = Between 50% and 69% of measures are at or above the high efficiency level
● = At least 70% of measures are at or above the high efficiency level

1 = Significantly less available/utilized 2 = Somewhat less available/utilized 3 = About as easy to obtain/utilize

3.4 Review of Existing Studies

As discussed in Section 2.5, the GDS Team compiled and reviewed an extensive number of studies and other documents of interest relating to commercial construction practices and energy code issues of potential relevance to New Hampshire. Much of this information was provided by and shared with members of the Study Group and proved quite useful to the GDS Team as a resource during the performance of specific tasks in this study. Following is a complete listing of all documents reviewed and compiled during this project. Although many of these reports are a bit dated, they can provide excellent background information for those who want a snapshot of energy code issues and activities in New England and other areas of the country.

Inventory of Studies and Energy Code-Related Documents:

1. *NH Commercial & Industrial Energy Code (Structures greater than or Equal to 4,000 Square Feet in Floor Area)* - Revised 7/93, 4th Edition

2. *The Commercial & Industrial Lighting Market In New Hampshire - Focus Group Research Conducted for: NH Energy Efficiency Working Group*, prepared by The Northmark Group, 4/30/99

3. *Northeast Regional Building Energy Codes Impact Analysis - Prepared for NEEP*, prepared by Battelle, Pacific Northwest Division, 6/11/99

Other Related Studies That May Be Applicable To New Hampshire

4. *American Institute of Architects Environmental Guild - NH: Focus Group*, prepared by NH Commercial Energy Code Baseline Study Group, 10/14/99

5. *NH Baseline Study - Background and Direction*, prepared by New Buildings Institute, 8/20/99

6. *Energy Code for Commercial and High-Rise Residential New Construction (780 CMR 13) AEE/ASHRAE Presentation*, prepared by David Wietz and Eric Noble, 12/8/99

7. *Energy Code Compliance Study - Honolulu and Hawaii Counties*, prepared by ELEY Associates, January 3, 2000

8. *California Non-Residential Construction Baseline Report*, prepared for Pacific Gas & Electric Company and Southern California Edison, by RLW Analytics, October 17, 1997

9. *New England C&I Lighting Market Transformation and Baseline Study, Final Report*, prepared by Easton Consultants and Shel Feldman Management Consulting, July, 1997

10. *Compliance with the 1994 Washington State Nonresidential Energy Code*, prepared by ECOTOPE & Pacific Energy Associates, 4/97

11. *The Washington State Energy Code: The Role of Evaluation in Washington State's Non-Residential Energy Code*, prepared by Tony Usibelli, Washington State University - Cooperative Extension Energy Program, January, 1997

12. *Various Papers on Washington State Non-Residential Energy Code*
    - "A New Model For Code Development", Kevin Madison, Tony Usibelli, Jeffrey Harris
    - "Quality Assurance Program Results", David Baylon, Kevin Madison
    - "Compliance with the 1994 Non Residential Washington State Energy Code", Kevin Madison, David Baylon
    - "How Well is Our Code Working?", Jim Perich-Anderson, Linda Dethonin
    - "1994 Washington State Non-Residential Energy Code Follow-up Awareness Survey", 5/97, Utility Code Group

13. *Energy Code Compliance in Commercial Buildings in Washington and Oregon*, prepared by ECOTOPE & Clark's Energy Services, 5/22/92

14. *Final Report - Project to Demonstrate Commercial Lighting Standards Implementation* - Minnesota Department of Public Service, Bruce Nelson, 11/94

15. *Lighting Code Compliance in New Small Commercial Construction in Minnesota*, Laurie Czeschin, Michael Sachi, Martha Hewett, David Vavricka, Patrick McKellips

16. *Common Practice Survey Results - Code Related Issues*, Prepared by Doug Baston, Northeast by Northwest, 2/15/96

17. *Common Practice Survey Results (Update #1)*, prepared by Doug Baston, Northeast by Northwest, 12/27/95

18. *Energy Codes and Market Transformation in the Northwest: A Fresh Look*, prepared by Jeff Harris, Northwest Energy Efficiency Alliance and Doug Mahone, Heschong-Mahone Group, presented at ACEEE '98 Summer Study

19. *Commercial Buildings Energy Consumption Survey (CBECS) - Summary Memo*, written by Eric Noble, 1/29/98

20. NH-Wide Database of Dodge Reports on municipal building activity complete through 1993

3.5 Tentative Findings and Roundtable

Results identified in Sections 3.1 through 3.3, were used to develop a bulleted list of ten tentative findings. This list was presented to the Study Group for review and comment and formed the basis for testing during a roundtable conducted in Concord, New Hampshire on March 22, 2000. Please refer to Appendix F for a copy of the Roundtable Moderator's Guide and Tentative Findings List.

All comments received during the roundtable were incorporated into a set of final findings and recommendations which are presented in Section 4.

4.0 KEY FINDINGS and RECOMMENDATIONS

4.1 Overview

A significant amount of data was collected and analyzed by the GDS Team during the commercial construction profile development, plan and print reviews, site inspections, architects, equipment supplier, design engineer and building official interviews, review of existing studies, and roundtable activities performed as part of this project. In the following sections, a summary of key findings is presented, followed by some general observations and recommendations. It is important to note that these findings relate only to New Hampshire's *Commercial* Energy Code - not *Residential* which, based on general unsolicited feedback, seems to be better understood and utilized.

These findings reveal important themes and responses that have been highlighted throughout this report. In addition, they offer valuable insight into why certain building practices may or may not be occurring. Examples of such themes are illustrated by responses such as, but not limited to, the following:

- Four out of the nine recorded responses from the GDS Team's building code officials interviews indicated that they do not check for compliance with the energy code - and none of the nine indicated that they have ever rejected a building for failing to meet current energy code requirements.

- Only one of the respondents from GDS's building code officials interviews described their knowledge of NH's commercial energy code as "very good". In addition, most described their training on the code as being little to none.

- Architects, design engineers, and equipment suppliers generally indicated that NH's existing commercial energy code is hard to follow, the calculations are complicated, time consuming and costly, and that it's difficult to assess compliance.

- A clear desire was identified by focus group participants and interview respondents for: 1) a methodology/computer program that would integrate the code from the start of the design process, incorporate simple checks earlier in the designs, provide flexibility, and simplify what is trying to be achieved, and 2) not letting the code lag behind technology quite so much.

Section 4.2 presents a more detailed summary of key findings.

4.2 Summary of Findings

Code Utilization and Compliance -General Findings:

- Discussion with design professionals revealed that they do not spare time to integrate systems (as envisioned in New Hampshire's commercial energy code) or to test for compliance when developing plans and specifications for new buildings in the state. This is due in part to a lack of clarity within the code that such integration and testing is required, excessive costs and associated time burden. In addition, although the tools that facilitate such tests are available, it appears that few design professionals have these tools or know how to utilize them.

- Building Code Officials said they rely almost solely on architect/design engineer certifications to determine compliance with the Commercial Energy Code.

- Plan and print reviews and site visits showed that technological advances have resulted in the specification and installation of equipment and practices that easily meet and often exceed current code requirements for certain measures (i.e., lighting, motors, HVAC heating unit efficiency).[11]

- *Assembly* practices were identified by focus group participants as not being well accommodated or taken into account under the current energy code.

- Systems using low cost fuels were found during site inspections to be less likely to meet code than those dependent on higher cost fuels (i.e., fossil fuel/thermal systems appear to be in compliance less often than electricity consuming systems).

- Architects complained that consumers do not recognize the long term benefits of meeting or exceeding the energy code and equipment suppliers surveyed said that if consumers do not ask for energy efficiency, the building community won't provide it.

- Respondents indicated that additional training on the energy code targeted at architects, design engineers, construction contractors, and building code officials is needed. They indicated that if these entities were armed with a few key items (energy code "rules of thumb") to address within each major building category, they would be more likely to increase the use of more energy efficient practices when designing and constructing new commercial buildings in the state.

[11] There remain other measures where this is not true (e.g., piping insulation).

Code Utilization and Compliance - Measure-Specific Findings:

Building Envelope:

- Premium levels of roof and wall insulation were found to be normal practice *only* in Northern New Hampshire (not elsewhere in the state). Commercial buildings in New Hampshire's southern tier often utilize masonry-flat roof construction with resulting lower R-values.

- Roof and wall insulation was identified as often being specified incorrectly or misapplied during field installation.

- Commercial roofs, walls, doors and foundations were seen typically specified and installed at standard rating levels and limited in their levels of efficiency due to design and economic constraints (i.e., truss roof/sloped roof with fiberglass insulation; flat roof/sloped roof with rigid insulation; stud wall with fiberglass insulation; masonry wall with rigid insulation).

- Premium windows (i.e., double pane, low e-glazing and Argon gas) appear to have become standard practice in commercial construction.

- Major barriers preventing higher use of premium efficient building envelope measures were identified to include: cost (both product and installation costs); split incentives (building owners vs. tenants); education/awareness of product availability and associated benefits; and current energy code requirements.

HVAC - Heating:

- Efficiency ratings tend to vary by size of equipment and were found *not* to be an important factor in equipment selection.

- Very high efficiency equipment was identified as having had performance problems in the recent past, causing the building industry to reconsider their overall desirability.

- Unit heaters, having a very narrow range of available efficiencies (i.e., 0.79 - 0.82), were found to offer little choice based upon efficiency characteristics.

- Forced air and hydronic heating/cooling system insulation thickness was often found to be specified below code levels.

HVAC - Cooling:

- Twenty percent of the commercial cooling equipment specified and installed were found to be below code efficiency levels.

- Cost-benefit assessments of more efficient units are usually not being done.

- Major barriers to using high efficiency HVAC units were identified to include: lack of cost/benefit analyses being conducted; budget constraints (i.e., high first cost); lack of product history/experience with newer, more efficient equipment; limited availability of "premium efficiency" commercial split systems and rooftops units; and design/build method.

Electric Power/Motors:

- When directly addressed in plans, premium efficiency motors were found to almost *always* be specified and ultimately installed.

- Even when not specified, typical commercial construction practice appears to include the installation of motors that are above current code levels.

- The differences in efficiency ratings between standard, high and premium efficient motors were found *not* to be well understood.

Lighting Fixtures:

- T-8s were commonly specified and installed in commercial building fluorescent lighting designs (vs. T-12s).

- Compact Fluorescent Lamps (CFLs) were seen to be increasingly specified (vs. incandescent lamps).

- Electronic ballasts appear to have become standard practice.

- Light Emitting Diode (LED) exit signs were found to be standard practice.

- Conventional Parabolic Reflectors (PARs) and other less efficient incandescent lighting technologies still seem to be favored over CFL fixtures for accent lighting or hazardous areas.

- Barriers to more efficient lighting fixture utilization in the construction of new commercial buildings were identified to include: lighting quality concerns and lack of awareness of CFL alternatives (e.g., dimmable CFLs with good warm tones).

Lighting Controls:

- Daylight dimming and occupancy sensors were *infrequently* used or specified.

- Multi-level switching wiring was seen to be much more common than daylighting or occupancy sensors.

- Barriers to more efficient lighting control technology utilization in the construction of new commercial buildings were identified to include: the perception that wiring to allow the use of lighting control technology is expensive (i.e., high first cost) and that the new technologies cause problems or limit functionality.

Energy Management Systems (EMS):

- Sophisticated EMS were not seen to be specified or used in _small_ commercial facilities – they were limited to programmable thermostats and self-contained controls for optimizing HVAC.

- The majority of the _larger_ facilities were using some form of sophisticated EMS (e.g., centralized energy management controls with data collection and dynamic review and analysis features to monitor and optimize facility energy system operations).

- Building operators were often over-riding controls to solve immediate comfort problems.

- Barriers to additional use and specification of efficient EMS measures in commercial buildings were identified to include the need for more trained staff within facilities that are able to maintain and troubleshoot EMS installations.

Service Water Systems

- Twenty-four percent of facilities sampled did not meet the code's requirements for service water system insulation.

- All sampled facilities had pump controls that were required.

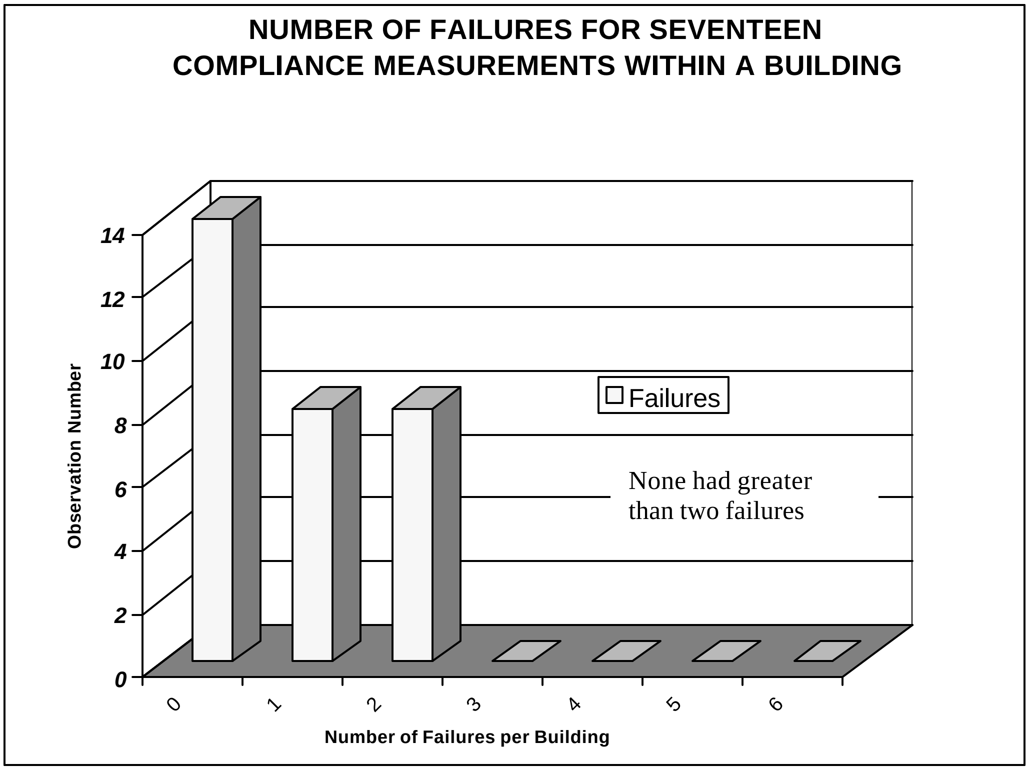
Energy Recovery Practices

- Energy recovery / storage was not seen in any of the facilities reviewed.

Other General Observations:

- *Estimated number of new commercial and industrial buildings constructed each year in New Hampshire:* Based on the construction profiles developed as part of this project, the GDS Team has identified over 1,500 new commercial and industrial construction projects in various stages of development in New Hampshire during 1999 and an additional 1,300 on the books for development in 1997/1998 combined. Appendix C provides a detailed listing of these projects. Tables 5, 6 and 7 presented in Section 3.1, show a breakdown of New Hampshire's 1999 commercial construction and major renovation activities sorted by county, building size, and building type.

- *Percentage of those buildings that meet or exceed the requirements of the state's current commercial energy code:* Of those sampled, the majority of commercial and industrial buildings being planned and constructed in New Hampshire are designed to meet or exceed the state's current energy code in nearly all major code categories. This study has quantified compliance with seventeen categories. Forty-seven percent of the facilities reviewed met or exceeded code in all of these categories. Of the remaining facilities, roughly half failed to meet the code in only one major category and the other half failed to meet the code in just two categories (Note: none of the facilities reviewed had more than two failures out of the seventeen major categories). Failure to meet the code, where observed, is occurring most frequently in the heating system distribution insulation and service water pipe insulation areas.[12] The following graph shows compliance as measured.



Please refer to Figures 1 through 5 in Section 3.2, for detailed information on the levels of efficiency being specified and built in this project's sample of New Hampshire's current fleet of commercial and industrial facilities. Specific examples of equipment and construction practices that exceed code or are coming up short are presented earlier in this Section (4.2).

- *Degree to which compliance or exceedance of the code varies by building type:*

Given the small sample sizes required within this project, it has been difficult to make any global conclusions regarding variations between building types. However, based on the plan/print reviews, physical site inspections, equipment supplier/design engineer, and building official interviews and roundtable activities conducted by the GDS Team, little to no variation between building types was identified or encountered.

[12] Although no more than two failures were observed in any one building, these were not the only two areas where code failures were observed (i.e., non-fenestration related building envelope problems and below code cooling unit efficiencies were also observed, and less frequent issues in the areas of lighting efficiency, building envelope fenestration, constant air volume flow rates, and economizer controls were also identified) .

- *Degree to which compliance or exceedance of the code is influenced by owner occupancy:* The fact that some buildings are owned by entities who do not occupy those buildings (i.e., owner vs. renter) has often been identified as a major barrier to higher efficient equipment and building practices. This was confirmed by the GDS Team on numerous occasions during discussions with building code officials, equipment suppliers, architects, design engineers and building owners throughout this project, who indicated that owner occupants involved in new construction projects are more inclined to inquire about and incorporate energy efficiency measures that exceed code.

- *Degree to which geographical factors influence compliance or exceedance:* As noted under Building Envelope findings above, climate issues in northern New Hampshire (i.e., Coos County) appear to have caused greater focus on premium efficient building insulation practices. However, the project's limited sample size makes it difficult for the GDS Team to confirm or identify a legitimate trend.

Definitions of Premium, Standard, and Code Efficiency Practices in NH New Commercial Construction:

The findings above should be interpreted within the context of working definitions for premium, standard, and code efficiency practices in NH's commercial new construction. Appendix A presents a table identifying efficiency practices for key types of commercial and industrial building construction measures (i.e., building envelope, electric power, HVAC equipment, service/domestic water heating, lighting fixtures and controls, and energy management systems). Premium, standard and NH commercial energy code-required efficiency levels are presented for each specific construction measure. An initial version of this table (presented in Appendices E-1 and E-2) was developed based on an extensive review of secondary data sources and through discussion with Study Group members, and was then tested and refined during interviews with building code officials and equipment suppliers. Its purpose in this report is to provide key definitions, based on a compilation of the above sources, so that comparisons and discussions can take place starting from common ground.

4.3 Potential Code Modifications

The findings above indicate that there is room for improving the clarity of certain areas in the current New Hampshire Commercial and Industrial Energy Code. In addition, there are a number of areas where standard practices appear to be exceeding the current code requirement (e.g., lighting, HVAC - heating, windows, insulation). Therefore, there may well be opportunities for upgrading certain items and sections within New Hampshire's current Commercial and Industrial Energy Code. For informational purposes, following is a list of potential code modifications, both general and measure-specific, based on suggestions made by focus group participants, interviewees, the GDS Team, and / or Study Group members, along with one source citing for each suggestion:

General:

- Change "Code suggested" practices to "Code mandated" requirements, where appropriate and consistent with the "National" code and any updates thereto (i.e., Energy Management Systems are not currently mandated.). - Roundtable participants

- Stay with the utilization of the Federal Code as the basis for any code modifications but consider updating the code to a version such as ASHRAE 90.1 - 1999, or, at a minimum, consider utilizing the International Energy Conservation Code's version of ASHRAE 90.1 1989, which was written in a more understandable "code"-type format (the ASHRAE 90.1-89 version was not written in understandable code language). - Study Group

- Eliminate Table 8A-32 of the current code and replace it with specifications for building envelope components (i.e., doors, windows, walls; foundations, slabs; and roofs). Consider thinking of these as three separate systems: 1) Foundation (foundation, slab); 2) Wall (wall, door, window), and 3) Roof (roof, skylight). There doesn't seem to be a need to trade off ***among*** the three systems. However, an architect or engineer can trade off with materials, layout, etc. ***within*** a system. This will allow a "whole building" analysis to be utilized within a system (i.e., the component approach should still allow for creativity in playing off fenestration with opaque wall assemblies). - Architects/Design Engineers

- Consider adding a commissioning (or recommissioning certification) requirement to ensure that systems, including Energy Management Systems, are installed properly and continue to function effectively. - Roundtable Participants

Measure-Specific:

- Measure lighting density on a watts per square-foot basis for function of the area. - Architects/Design Engineers

- Require lighting fixtures (in areas receiving daylighting) to be wired so that daylight dimming can be installed at the time of construction or more easily in the future (or allow multi-level switching based on daylight sensing). - Architects/Design Engineers

- Eliminate credits for lighting controls if the facility is to operate more than just during daylight hours. – GDS Team

- Mandate occupancy sensors for very low use rooms (store rooms, basements, one shift operation areas, etc.). – GDS Team

- Base code-required heating and cooling delivery system insulation levels on an effective R-value. The current code does a good job of conveying the code specification. – GDS Team

- Update CFM/watts requirement to recognize that ventilation system technology has surpassed the current code. – GDS Team

- Specify a minimum R-value for water heating (storage tanks) and continue the requirement for insulation and control. – GDS Team

4.4 Recommendations for Next Steps and Further Actions

Based on the research and analysis conducted, and discussion with numerous participants throughout this project, the Study Group suggests the following recommendations regarding next steps:

1) Near-Term Actions:

- Communicate findings (i.e., PUC filing, public release of report, presentations per request at various trade group meetings, conferences, etc.).

- Pursue opportunities for training (identify rules of thumb & develop monthly sessions around the state to increase code compliance and improve the awareness and energy efficiency practices of target audiences including architects, design engineers and building code officials).

- Integrate the code with currently available software tools that allow for design professionals to more quickly and effectively meet or exceed code compliance.

2) Mid-Term Actions:

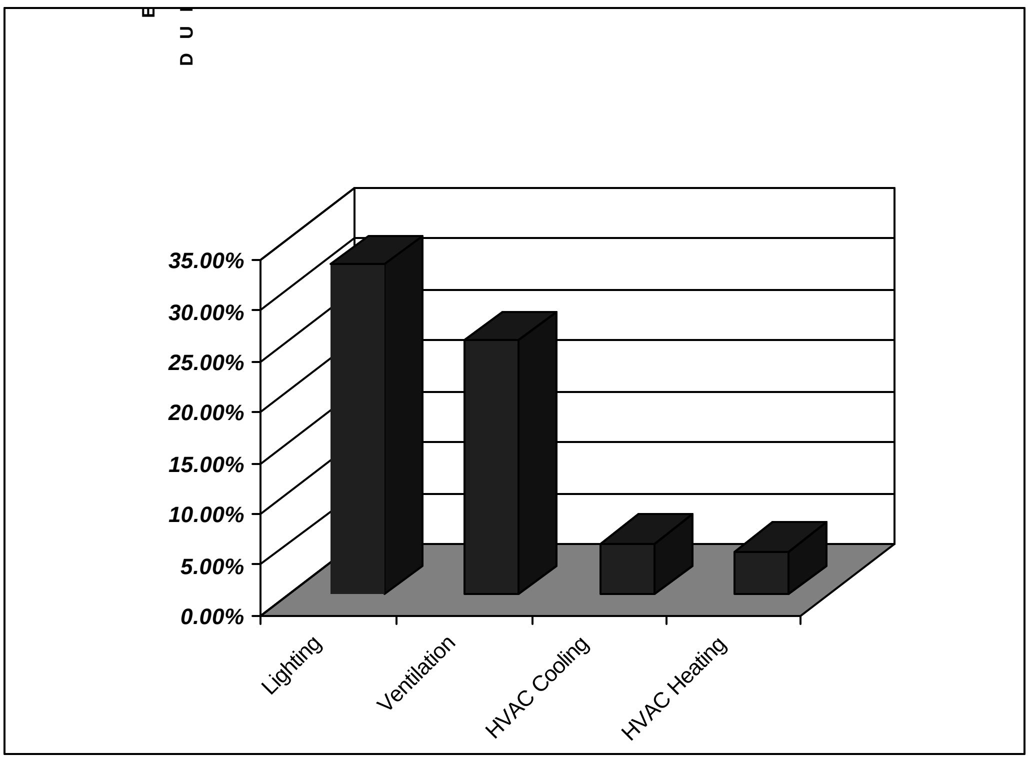
- Use findings to help utilities and private and public entities prioritize potential follow-up initiatives and to aid in the design of energy efficiency programs that will target specific barriers to using higher efficiency measures and practices in the construction of new commercial buildings. For example, this study found various barriers to the use in new construction of premium efficiency building envelope measures, high efficiency HVAC cooling units, more efficient lighting fixtures and control technologies, and efficient EMS measures.

3) Longer-Term Actions:

- Modify the energy code language to render it easier to understand and improve the compliance process to a less cumbersome format. Consider, at a minimum, utilizing the International Energy Conservation Code's (IECC) version of ASHRAE 90.1-1989, which was written in a more understandable "code"-type format (the ASHRAE 90.1-1989 version was not written in understandable code language), and consider updating the code to ASHRAE/IESNA 90.1-1999, that recognizes many of the technological advances discussed throughout this report and is written in a more user-friendly "code" manner.[13] For other potential measure-specific code modifications, see section 4.3.

4.5 Estimated Savings Associated with Codifying Currently Practiced Technological Advances

An attempt has been made to determine the percentage gain in efficiency that could be realized through the systematic use of fairly standard energy efficient technology and commercial new construction practices in New Hampshire. The following graph summarizes improvements by some of the major energy consumption categories:



Updating New Hampshire's current commercial and industrial energy code to require the use of what is now fairly standard, higher efficiency equipment would help secure these estimated savings and avoid the risk of future commercial construction in the state being built to lesser (but still legal) standards.

[13] The U.S. Department of Energy (DOE) is in the process of reviewing ASHRAE/IESNA Standard 90.1-1999 and the International Energy Conservation Code (IECC) and will likely be making a determination this summer that they are more stringent than Standard 90.1-1989. States will then have two years to update their commercial standards to meet or exceed the new Standard 90.1.

APPENDICES

- APPENDIX A -

PREMIUM, STANDARD, & CODE EFFICIENCY PRACTICES IN NEW HAMPSHIRE NEW COMMERCIAL CONSTRUCTION

Commercial and Industrial Building Construction Measure	Premium Efficiency Practice	Standard Efficiency Practice	NH Commercial Energy Code Requirement (1)
Building Envelope			
☐ Roof materials (2)	U=.02-.032 (R30 - R38)	U=0.033 (R-30)	U=.05 (R=20)
☐ Wall materials (2)	U=.045 (R19 - R22)	U= .053 (R = 19)	.08 - .11 (R = 9 -12.5)
☐ Doors	U=0.30	U=0.35	NA
☐ Windows	Double Pane Plus	Double Pane	NA
☐ Glazing – reflective, tinted, Low E, Low Shading Coefficient (SC)	Yes	No	NA
☐ Foundations/Floors/Slabs - Wall - Slab - Floor	 R-19 R-30 R-30	 R-10 R-19 R-19	 R- 4 - 11 R= 11 - 18 R= 20
Electric Power			
☐ Motors - 1 to 10 hp - 11 to 75 hp - 76 to 200 hp	 89.4% avg 93.5% avg 95.6% avg	EPAct approx. 2% lower (82.5% to 95.0%)	 78.5%-84% 85.5%-90% 90%-92.5%
HVAC Equipment			
☐ Economizers (for "free" cooling)	Fixed (Humidity control)	Temp (Dry Bulb)	Yes
☐ Reset controls	Yes	Already Standard	Yes
☐ Air furnaces (heating)	AFUE = 85%	AFUE = 80%	AFUE = 78%
☐ Unit Heaters	AFUE = 85%	AFUE= 80%-82%	AFUE = 78% - 81%
☐ Hydronic boilers (heating)	AFUE = 85%	AFUE = 83%	AFUE 78%-81%
☐ Cooling equipment >= 65 to < 135 kBTU/hr >= 135 to < 240 kBTU/hr > 240 kBTU/hr	 EER > 10.8 EER > 10.2 EER > 9.9	 EER > 10.3 EER > 9.7 EER > 9.5	 EER >= 8.9 EER >= 8.5 EER >= 8.3

Commercial and Industrial Building Construction Measure	Premium Efficiency Practice	Standard Efficiency Practice	NH Commercial Energy Code Requirement (1)
☐ Automatic thermostat control	Yes	Yes	Yes
☐ Variable air volume systems (3)	Yes	No	Recommended
☐ HVAC air heat recovery (3)	Yes	No	Recommended
☐ Heat Recovery High Temp	Yes	No	Recommended
☐ Heat Recovery Fluid/Gas	Yes	No	Recommended
☐ Duct & piping equipment insulation	K < .23 hydronic R > 5 air	K=.23 - .34 hydronic R = 3.3. - 5 air system	Thickness =0.5" - 3.5" depending on pipe diameter and temperature of transport media. No insulation required for interior ducts.
☐ Thermal storage (cooling)	Yes	No	Recommended
Service (Domestic)Water Heating			
☐ Service water heating equip.	85% fuel/size .60 EF non elec. .95+ for elec.	80% .58 EF non elec. Below .95 for el.	Not Specified
☐ Service water heating controls	Yes	Yes	Yes
☐ Water heating tank insulation	Yes	Yes	Yes
☐ Service water heat pipe insulation	Yes	Yes	Yes

Commercial Building Construction Measure	High Efficiency Practice	Standard Efficiency Practice	NH Commercial Energy Code Requirement
Lighting Fixtures			
☐ 4 ft./8ft. Fluorescent (T-12, T-8, T-10, T-5)	T-8	T-8/T-12	NA, Watts/ft2, T-12s used mostly
☐ HID (high pressure sodium/mercury/metal halide)	Pulse Start MH, HP, LP Sodium	Metal Halide, HP Sodium	NA, Mercury used mostly
☐ Ballasts (magnetic/electronic)	Electronic	Magnetic	NA
☐ Compact fluorescents (CFLs)	Yes	No	NA
☐ LED Exit Signs	Yes	Fluorescent	Mostly Incandescent
Lighting Controls			
☐ Localized switching	Yes	Yes	Yes
☐ Multi-level switching	Yes	Yes	Recommended
☐ Occupancy sensors	Yes	No	Recommended

Commercial Building Construction Measure	High Efficiency Practice	Standard Efficiency Practice	NH Commercial Energy Code Requirement
☐ Motion sensors/outdoor lighting	Yes	No	Recommended
☐ Daylighting controls	Yes	No	Recommended
☐ Automatic exterior lighting controls (photocells/timeclocks)	Yes	Yes	Yes
Energy Management Systems			
☐ Process/system controls	Yes	Yes	Yes
☐ Total building energy management controls	Yes	Yes	Yes

(1) Values may be actual code values or estimates made to facilitate comparisons. (For example, see Lighting Fixtures. There is no code specification on type of lamp required. The code is based upon a watt per square foot power consumption. We have cited lamp types based upon the available lamp technology at the time the code was implemented).

(2) Premium and Standard R- Values will vary based on the type of construction:

	Standard Practice
• Truss roof with fiberglass insulation in attic	R-38
• Sloped roof with fiberglass insulation	R-30
• Flat roof with rigid insulation	R-20
• Sloped roof with rigid insulation	R-20
• Stud wall with fiberglass insulation	R-19
• Masonry wall with rigid insulation	R-12

(3) Code "recommendation" applies only in certain circumstances

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GDS TEAM: SCOPE OF WORK

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PROFILE OF COMMERCIAL AND INDUSTRIAL CONSTRUCTION ACTIVITIES

IN THE

STATE OF NEW HAMPSHIRE

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SAMPLE FORM USED TO COLLECT DATA

WHEN CONDUCTING

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SAMPLE INTERVIEW GUIDES/QUESTIONNAIRES

FOR

EQUIPMENT SUPPLIER/DESIGN ENGINEER

AND

BUILDING OFFICIAL TELEPHONE INTERVIEWS

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ROUNDTABLE MODERATOR'S GUIDE

AND

TENTATIVE FINDINGS LIST

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AIA ENVIRONMENTAL GUILD

NH FOCUS GROUP REPORT
(OCTOBER 14, 1999)

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EQUIPMENT SUPPLIER/ BUILDING OFFICIAL INTERVIEWS

SUMMARY OF RESPONSES TO KEY QUESTIONS