Pilot Study

Commercial Building Energy Code Compliance Evaluation

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1 Introduction

This report documents the results of a pilot study, designed to test the survey instruments and study procedures developed for the commercial building energy code compliance evaluation in the states of Washington and Oregon.

We began by selecting buildings to be studied, followed by an initial screening of architects involved with these buildings and attempts to secure building plans and specifications. We then reviewed the building plans we obtained to assess code compliance. We also conducted field visits to the buildings to verify specifications. Finally, we interviewed the architects and engineers responsible for the code compliance process for these buildings. We also interviewed building officials in relevant jurisdictions about general code compliance issues.

During the pilot study, we evaluated certain assumptions which informed the study design. For instance, we proposed the sequence of plan review, site visit and interview because we believed we could elicit more detailed and direct responses from building professionals and code officials if we focused on a specific building rather than asking general questions about code compliance.

2 Sample Selection

We used the Dodge Construction Database as the sampling frame. This database, which is used by contractors and subcontractors to identify clients and bidding opportunities, contains information on building permits, designers and owners. Much of the information in the database comes from building departments. It is believed that this database contains the most complete data on current construction in the commercial sector.

From this database, we drew a random sample of one year's commercial construction for each state. The Oregon sample was drawn from the year April 1, 1990 to April 1, 1991. The Washington sample was drawn from construction permits issued between January 1, 1990 and January 1, 1991.

We stratified the sample to draw an equal number of buildings over 40,000 square feet and under 40,000 square feet. Then, we drew 50 buildings at random from each group and each state for a total of 200 buildings. Appendix A summarizes the final sample.

Assuming that we will not be able to study some buildings because of lack of cooperation or other problems, we expect to evaluate a final sample of 140 buildings (70 from each state) with an equal number of large and small buildings.

3 Recruitment and Screening

We used the recruitment instrument found in Appendix C to contact the person listed as the primary contact in the Dodge database (usually the architect) to ask if they would participate in the study. During this initial contact, we tried to get access to building plans and specifications and to identify the persons responsible for code compliance so we could set up interviews.

As of this date, we have contacted the designers of about 40 buildings in both Washington and Oregon. The designers of 36 buildings indicated they would be willing to participate in the study and we obtained permission to access drawings and specifications for about 30 of these buildings.

The six buildings which responded most promptly in providing drawings and permitting interviews and site visits were chosen for the pilot study. We completed all the study tasks for five of these buildings. At the last minute, the owner of the sixth building refused permission for a site visit. Table 1 summarizes the five buildings selected for the pilot study.

Table 1
Pilot Study Buildings

Building Type	Square Feet	Cost (000,000)	County
Washington			
Office	3,500	.3	King
Office	4,100	.7	King
School	106,000	13.0	King
Library	21,000	1.7	Thurston
Oregon			
Department Store	185,000	18.0	Clackamas

Securing plans and specifications was problematic. Some architects were reluctant to release these documents and referred us to owners or general contractors. The architects of the smaller buildings did not have all the documents relevant to code compliance since some of the specifications (especially for HVAC systems) were left to the determination of the subcontractor installing the equipment.

Based on our experience recruiting buildings for the pilot study, obtaining building documents will be difficult for the Washington sample. We received more cooperation from the Oregon architects.

We also have access to scan film, using the Dodge SCAN Field Service. This service provides a full set of drawings with specifications to subscribers. These drawing sets are used as bid documents for general contractors and larger subcontractors. They are usually available for public projects and large private projects but not for smaller buildings.

SCAN films are available for approximately 30 percent of the buildings in the Washington sample. We will review these films when the building architect is willing to participate in the study but unwilling to provide a full set of plans and specifications.

In the pilot study, we secured plans and, in some cases, specifications for four of the five buildings studied. For the fifth one, we used the SCAN film provided by Dodge.

4 Data Collection

Appendix B contains detailed summaries of the data collected for each building in the pilot study. We collected data in the following areas:

4.1 Plan Review

We began by reviewing plans to determine code compliance and compiling data for each building. During this process, we encountered several problems.

We had to develop a standard form to compile code compliance data. Appendix C contains a copy of the current version. The Oregon code compliance program (CODECOMP) was used as a model for a data collection format for building envelope and lighting data. However, the CODECOMP program identifies mechanical systems and controls by cross-referencing the plans and specifications. This does not provide a permanent database entry for this part of the code. The Oregon Department of Energy is revising CODECOMP to permit direct documentation of mechanical equipment code compliance. Once this revision is complete, it should be a useful tool. In the meantime, we used a manual format similar to CODECOMP for the pilot study.

The manual format was more difficult to use since most buildings have numerous components. Even when the system was fairly simple, the list of all fans, heating and cooling equipment expanded to several pages. The only way to simplify this process was to combine entries (e.g., supply fans) into a single entry.

While the Oregon code does not require any particular level of fan efficiency, the Washington code requires that the energy associated with moving heating and cooling air meet a minimum requirement, or Air Transport Factor (ATF). To assess code compliance, we summed the power requirements and capacities of supply and return fans and compared the results to the ATF requirement. We expanded the simple forms provided for this purpose so we could document the details associated with mechanical system code compliance.

The type of information provided about the equipment varied greatly from project to project. Many plans contained no information which would allow us, or code officials for that matter, to review the system for code compliance without extensive cross-referencing to manufacturing data and inferences about system performance criteria.

This was also the case for lighting requirements. Project plans did not always indicate overall lighting levels. In some cases, we went through the plans and counted fixtures. However, this still left unanswered questions about ballast power consumption and installed lamps. It is unclear how code officials determine code compliance in these cases.

4.2 Field Review

The field visits were designed to verify that those building components relevant to code compliance identified on the plans and specifications were actually installed in the building. This was more difficult than we expected.

Of the five buildings in the pilot study, only three were completed. One small office building in Seattle had just broken ground; construction was delayed due to financing difficulties. The large school was under construction; we could observe insulation levels but not HVAC and lighting equipment. In the completed buildings, we verified mechanical equipment and lighting fixture types and counts. However, we had difficulty verifying insulation levels and determining the type of lighting ballasts installed since the fixtures were often hard to access.

In the two smaller buildings, the construction documents did not include information about mechanical systems because the design was left to the installer. The mechanical contractor had not yet been selected for the small office building which was just beginning construction. Thus, it was impossible to review the mechanical equipment compliance for this building. In the case of the other small office building, the mechanical contractor installed equipment to meet performance specifications. The building owner gave us the name of the mechanical contractor during the field visit but we have been unable to secure information directly from the installer. However, we were able to verify code compliance during the field visit.

In large buildings, it is difficult to document all the lighting. Depending on the configuration and judgement of the field evaluator, we conducted spot checks for at least 25% of the available area. During these spot checks, we confirmed lighting specifications and fixture types and verified the fixture counts from the building drawings. We also confirmed lighting fixture specifications throughout the buildings. We found little variance between the fixture counts in the drawings and the number of fixtures installed in the space, although some minor differences occurred, especially in the small buildings.

We verified mechanical equipment by comparing the equipment name plate to the specifications. In some cases, the mechanical equipment installed matched the specifications exactly. In other cases, equipment was installed to meet performance specifications (e.g., heating or cooling output) but did not necessarily meet the Energy Efficiency Requirement (EER). Since the change occurred after the plan review, only a site inspection could reveal the change.

We verified insulation levels whenever possible. Where we could see insulation in open wall cavities and ceiling areas above finished ceilings, the insulation levels seemed consistent with the plans. It is impossible to verify slab insulation levels, unless one is present during the pouring of the slab.

4.3 Interviews with Architects and Engineers

We interviewed building professionals using the interview format found in Appendix C. This format was useful for interviewing both architects and engineers. However, the participants responded with more general answers than we expected. Even though questions focused on the specific buildings in the pilot study, the answers were based on a broader range of experience. Direct references to the specific building were absent or limited. When we asked specific questions about a building based on the plan reviews or field data, the answers were still vague. The participants were unwilling to review their records and answered these questions from memory. Thus the accuracy of the responses is uncertain. Because of this, we decided to interview building professionals even if the field evaluation or plan review has not been completed. If specific questions arise during these reviews, we expect to call them later.

Frequently, due to personnel turnover or office workload, the projects changed hands within a firm at least once. Sometimes one person dealt with the energy code during the design and another person was primarily responsible for following through on code compliance during permitting.

Architects tended to rely on engineers to describe energy code requirements as they relate to building design. This was especially true for lighting and mechanical systems, but also for the building envelope. Few architects seemed to understand how to implement the component approach to code compliance, relying instead on meeting prescriptive requirements or

guidelines described by engineers. They felt the prescriptive path was the easiest and quickest route to code compliance. Most architects responded favorably to the idea of training seminars on the energy code.

In the case of the large school, the engineers, who were responsible for code compliance in the building, consented to be interviewed. However, the architects, who were responsible for some specifications, refused to be interviewed. We proceeded with this building anyway, since we had the drawings, answers to most of the questionnaire, and permission for a field visit from the owner and general contractor.

Engineers commented that energy code requirements had the most impact on the building envelope and were therefore in the architect's realm. Energy code requirements for mechanical systems were fairly straightforward, but we found in one field visit that the equipment installed did not meet the mechanical code. In this particular case, the equipment specified did not meet EER requirements. The manufacturer's specifications indicted that the equipment would meet these requirements under certain installation conditions. However, the equipment was installed under different parameters and thus did not meet the requirements.

One engineer pointed out an inherent contradiction in the code. He has encountered cases where occupancy requirements from other aspects of the building code generated the need for more ventilation than the energy code supported. We have not yet isolated any examples of this.

For both small buildings, a single architect or project architect was responsible for designing the building envelope and ensuring code compliance. No plans or specifications were available for mechanical systems. At one site, the owner, who owns a separate contracting business, will eventually install roof-top heat pumps. The other site has six heat pumps, installed by a subcontractor hired by the general contractor. We presume this work was permitted separately but have not been able to verify this. We expect to see this pattern repeated in the smaller buildings: subcontractors doing all of the work but the building shell so that there is no one designer.

In the case of the large department store in Portland, the owner was responsible for code compliance. The local utility offered energy conservation incentives which resulted in some improved specifications. The architects and engineers took direction from a code specialist working for the owner. We interviewed the code specialist and the project architect. The drawings and interview responses described a highly efficient HVAC system. Although the actual system installed was less efficient than specified, it met the code.

None of the participants in the interviews viewed code compliance as a problem although they did not always agree with the code. One project architect said his firm was planning to incorporate aspects of the energy code at the beginning of the design process in an effort to get a handle on the new code and streamline the current haphazard way of dealing with it.

4.4 Interviews with Code Officials

During the pilot study, we interviewed three building code officials from King County, Yakima County, and Grays Harbor County, all in Washington. Appendix C contains a copy of the interview protocol used. These interviews were somewhat unproductive, although we gained some information.

Especially in smaller counties, code officials, although experienced with residential code, are poorly informed on the commercial code. As a result, even though the questionnaire and the interviewer tried to keep the focus on the commercial code, most of the answers came from experience in the residential sector.

In the smaller jurisdictions, one or two people handle the entire code compliance process. Therefore, every inspector and every plan checker in the office should be well versed in the energy code to assess code compliance.

In a larger jurisdiction, like King County, the commercial energy code is actually administered by a single individual who has a depth of experience. In fact, the King County official's comments were most instructive. He pointed out conflicts between the energy code and fire and structural codes, particularly relating to insulation located above ceiling plenums and slab insulation thermally broken from the foundation. He also had several specific comments on code improvement. First, he observed that the ventilation rate required by the Washington code is too high for commercial buildings and does not allow for air re-circulation. Second, he noted that the non-residential code is geared toward larger buildings. Many smaller buildings are envelope-dominated and should be asked to meet the same insulation standards as large residences. This is particularly true of small clinics and strip malls which use single zone heating equipment and where heating load dominates the building energy use. Finally, he pointed out that the ambiguities in the part of the energy code which deals with remodels makes it difficult to assess code compliance. He strongly recommended clarifying the energy code sections related to remodeling and renovation.

Both officials in the smaller jurisdictions were interested in receiving more training on code compliance. Both commented on the inconsistency of the existing training program and the need for more focused training. While there was some disagreement on the quality of the existing training, there was a general agreement on the need for more training on mechanical system components and compliance procedures. In the large jurisdiction, code officials attend internal training sessions to keep them updated on new technologies. However, additional state or utility-sponsored training programs would be welcome.

5 Conclusions

We gained many insights from conducting the pilot study. It became apparent that some of the assumptions which informed the study design were not valid. For instance, even where we had specific information from plan reviews and site visits about code compliance in a particular building, interviews with building professionals remained general.

5.1 Problems Encountered

Many difficulties arose which were not anticipated.

- The Dodge database was more expensive than originally anticipated. We could not draw a random sample for the state of Washington using the initial database purchased. Obtaining the additional data increased the cost.
- In certain cases, we could not secure the cooperation of one of the principals in the building process. For instance, we could not secure cooperation from the installer of the mechanical system in one small building. In the case of the school, the architects would not cooperate although we had the building drawings and cooperation from the engineers (who did most of the code compliance work), the owner and the contractor.
- Especially in Washington, we had some problems obtaining permission to use building documents. Fortunately, we have access to SCAN films for approximately one-third of the Washington sample. In smaller buildings architects often left the design of mechanical systems to the installer. In some cases, we may need to secure the cooperation of subcontractors to obtain all documents relevant to code compliance.
- The information on code compliance available on building drawings varied greatly. In some cases, it was virtually impossible to evaluate energy performance of mechanical systems,lighting and even some aspects of the building envelope without extensive cross-referencing and computation.
- Although it was difficult to devise the forms necessary to document code compliance based on plan review, the data collection format we evolved appears to be workable. However, some information on mechanical and lighting systems is simply not available from plan reviews.
- Depending on the state of the building, we could only verify certain aspects of code compliance during site visits. For buildings under construction, we could check insulation levels but not equipment or lighting. In buildings where construction was completed, we could check the mechanical system and lighting fixtures and counts but it was difficult to verify insulation levels and to determine the type of ballasts used in the lighting fixtures. Slab insulation levels cannot be checked unless we are present during the pouring of the slab. Although site visits can provide information on how buildings actually comply with the code, we cannot verify all code compliance aspects for every building.
- Architects and engineers tended to respond to the interview questions, even those focused on a specific building, with general answers based on their total experience with code compliance. When pressed for more specific answers, they were generally reluctant to dig into their files and tended to answer from memory. Although we did not gather as much specific information as anticipated, we did learn a great deal about how architects and engineers view the code compliance process.

- The same tendency was observed in code officials whose answers to questions reflected their general experience, which, in the smaller jurisdictions, was primarily in the residential sector. Nonetheless, we gathered useful information, particularly from the building official in the large jurisdiction who specialized in commercial construction.

5.2 Recommended Changes

As a result of the pilot study, we recommend the following changes in study design:

- In cases where we cannot secure cooperation from one of the key decision-makers in the code compliance process or where we cannot obtain permission for a site visit, we may decide to study the building anyway if we determine that we can obtain most of the necessary data from other sources.
- The need to contact mechanical engineers and subcontractors to obtain adequate code compliance may extend the number of professional hours necessary to conduct the recruitment and interview phases of the study.
- Given the general responses to the interview format, we can be more flexible about scheduling interviews. Although we still plan to conduct plan reviews and site visits before interviews, we can alter this sequence when necessary to accommodate the availability of building professionals.
- We obtained more valuable data on code compliance from reviewing drawings and field visits than from interviews. Therefore, we will place more importance on the data gleaned from plan reviews and site visits and use the interviews for supplementary information.
- We will add specific questions to the building designers interview, i.e., what procedures do you use to demonstrate code compliance in mechanical, electrical, lighting and envelope? We will also add similar questions to the code official interview about how they interpret code compliance based on the available drawings and specifications.
- Where mechanical engineers are a key part of the design team, we expect to rely more heavily on engineer interviews than on interviews with architects.

5.3 Preliminary Findings

Although based on a very small number of responses, our preliminary findings indicate:

- The combination of plan review and site visits provides a great deal of information on building practices and code compliance in commercial construction.
- Especially in Washington, mechanical engineers provide the criteria and evidence of code compliance to architects and building departments even when the specifics of this compliance are not part of mechanical system design.
- Both architects and engineers favored the prescriptive path rather than the component path to code compliance because it was easier and quicker. However, none of the buildings met the code unless the component path was used.

- Many comments about the energy code reflected its political nature. Although most participants reported no problem with code compliance procedures several disagreed with certain provisions of the code. One engineer and one building code official pointed out inherent contradictions and ambiguities in the code and made recommendations for improvement. These comments should be evaluated and considered in future code revisions.
- Architects and code officials would like more training on the energy code, especially on mechanical systems.
- We found substantial differences between the lighting (fixture counts and lighting power density estimates) specified in the permit sets and installed in the building. This may be because lighting is often redesigned by tenants and not inspected by building officials after full occupancy.
- The lack of detailed information, particularly on mechanical and lighting systems, on building drawings probably limits the ability of code officials to evaluate code compliance.

6 Appendix A

Commercial Building Sample

OREGON

AREA <= 40,000 FT2 (variable random is random order)

random	dodgeno	category	county	month	yr	area	value
1	547306	ASSEMBLY	DESCHUTE	7	90	34000	726
2	559660	ASSEMBLY	WASHINGT	10	90	10000	400
4	608306	RETAIL	LANE	7	90	6000	400
5	605484	RETAIL	CLACKAMA	8	90	6000	250
6	604935	RETAIL	MULTNOMA	8	90	10080	0
7	624799	RESTAURA	MULTNOMA	2	91	3000	300
8	588445	OFFICE	JACKSON	9	90	7475	450
9	610045	GROCERY	DESCHUTE	10	90	24000	800
10	601027	RESTAURA	MARION	7	90	3500	2500
11	574697	ASSEMBLY	MULTNOMA	7	90	5685	0
12	627608	SCHOOL	CLACKAMA	3	91	6000	325
13	611434	RETAIL	WASHINGT	11	90	30000	800
14	632545	RETAIL	MARION	3	91	2700	350
15	614029	HEALTH	WASHINGT	3	91	10900	1229
16	627376	OTHER	MULTNOMA	2	91	7300	1300
17	609631	OFFICE	LINN	12	90	25000	2000
18	606605	OFFICE	JACKSON	7	90	4000	202
19	596812	ASSEMBLY	WASHINGT	4	90	7000	300
20	623601	RESTAURA	MALHEUR	12	90	4000	0
22	611049	ASSEMBLY	MULTNOMA	1	91	31179	0
24	567577	ASSEMBLY	MARION	7	90	22200	600
25	543778	ASSEMBLY	CLATSOP	8	90	22000	1000
27	574694	HEALTH	MULTNOMA	4	90	20000	1500
28	584828	PUB INST	DOUGLAS	5	90	5654	438
29	616786	OTHER	LANE	10	90	7000	0
30	591225	PUB INST	CURRY	5	90	1500	393
31	591226	PUB INST	LANE	5	90	1500	453
32	595070	SCHOOL	LANE	11	90	16400	1240
33	624859	RETAIL	CLACKAMA	3	91	6000	189
34	625387	OFFICE	MARION	1	91	26000	2000
35	587051	OFFICE	CLACKAMA	4	90	7800	900
36	616413	ASSEMBLY	JACKSON	10	90	18600	0
37	621387	SCHOOL	JEFFERSO	4	91	3936	378
38	627033	RETAIL	CLATSOP	2	91	31000	0
42	600427	HEALTH	CLACKAMA	7	90	39999	0
44	598304	RETAIL	LANE	7	90	32000	1000
45	602576	OFFICE	MULTNOMA	6	90	39999	0
46	613201	OFFICE	MARION	9	90	9000	450
47	615690	RETAIL	CLACKAMA	11	90	31000	0
48	624860	RETAIL	WASHINGT	3	91	5000	232
49	616061	HEALTH	DESCHUTE	12	90	28000	2800
50	611662	OFFICE	MULTNOMA	1	91	30000	1500
51	591050	RESTAURA	LANE	6	90	6500	450
53	559659	ASSEMBLY	MARION	7	90	15000	600
54	619360	SCHOOL	WASHINGT	11	90	18000	900
55	624929	RESTAURA	WASHINGT	1	91	5000	250
56	625253	RETAIL	MULTNOMA	3	91	30500	0
57	532558	ASSEMBLY	MULTNOMA	12	90	17000	680
58	573875	RETAIL	LANE	1	91	10000	0
119	573875	RETAIL	LANE	1	91	16500	0
153	624653	OFFICE	LANE	1	91	30000	2500

OREGON

AREA > 40,000 FT2 (variable random is random order)

random	dodgeno	category	county	month	yr	area	value
3	571813	WAREHOUS	CLACKAMA	10	90	250000	0
21	625254	RETAIL	MULTNOMA	3	91	75040	2500
23	591768	HEALTH	MULTNOMA	12	90	150000	8000
26	549785	OFFICE	WASHINGT	8	90	98000	3000
39	571027	RETAIL	DESCHUTE	1	91	98000	0
40	580612	OFFICE	MULTNOMA	6	90	360000	18000
43	475072	SCHOOL	BENTON	6	90	180000	19256
52	626722	GROCERY	UMATILLA	2	91	40800	2000
61	622311	RETAIL	DESCHUTE	12	90	55000	2500
62	608102	GROCERY	COOS	1	91	43000	1483
65	596810	OFFICE	WASHINGT	5	90	200000	10000
73	627704	GROCERY	MULTNOMA	3	91	40495	0
78	604820	OFFICE	WASHINGT	5	91	58235	2912
81	596039	WAREHOUS	MULTNOMA	5	90	100000	943
85	467340	ASSEMBLY	MULTNOMA	1	91	200000	23480
86	588299	WAREHOUS	MULTNOMA	8	90	600000	25000
90	613068	RETAIL	MULTNOMA	9	90	40001	0
94	573273	RETAIL	MULTNOMA	11	90	65000	0
95	611540	RETAIL	CLACKAMA	10	90	150000	20000
98	569865	OFFICE	MULTNOMA	7	90	122000	3000
99	630790	GROCERY	CLATSOP	3	91	44000	0
101	616371	OFFICE	LINN	10	90	53537	375
105	512043	SCHOOL	CLACKAMA	8	90	57000	4909
108	534443	OFFICE	MULTNOMA	1	91	266953	15000
109	555416	SCHOOL	CLACKAMA	7	90	90000	7073
121	593115	WAREHOUS	WASHINGT	7	90	45000	1100
129	559666	ASSEMBLY	LANE	11	90	106000	5280
134	609628	UWAREHOU	WASHINGT	8	90	127000	0
142	591079	GROCERY	LINN	7	90	50000	0
147	608959	OFFICE	MULTNOMA	11	90	200376	3000
160	513072	WAREHOUS	MARION	9	90	65000	7690
162	511892	OTHER	MARION	6	90	218000	10880
164	590893	SCHOOL	CLACKAMA	8	90	64200	5939
174	406897	SCHOOL	MULTNOMA	5	90	80000	16700
176	632020	WAREHOUS	MARION	3	91	100000	0
178	592861	ASSEMBLY	WASHINGT	3	91	66000	2100
182	596811	OFFICE	MULTNOMA	11	90	365000	30000
183	544630	OFFICE	CLACKAMA	4	90	500000	40000
184	609219	SCHOOL	WASHINGT	1	91	104000	6759
188	620632	WAREHOUS	MULTNOMA	12	90	52400	0
189	596034	ASSEMBLY	LANE	12	90	40001	0
196	615978	RETAIL	CROOK	11	90	77000	3000
201	564181	HEALTH	MULTNOMA	8	90	132000	5000
203	602576	OFFICE	MULTNOMA	6	90	40001	0
211	611417	RETAIL	CROOK	10	90	72000	3000
214	577401	SCHOOL	LAKE	9	90	53000	4392
218	517038	SCHOOL	MULTNOMA	11	90	92000	11920
220	596039	WAREHOUS	MULTNOMA	5	90	100000	943
224	601561	RETAIL	MULTNOMA	1	91	43030	866

WASHINGTON

AREA <= 40,000 FT2 (variable sorder is random sort):

sorder	dodgeno	category	county	month	yr	area	value
1	615510	OFFICE	SNOHOMIS	11	90	11100	1500
2	545782	RETAIL	SKAGIT	2	90	20000	500
3	595243	GROCERY	BENTON	12	90	3000	300
4	590587	OFFICE	KING	4	90	19000	1200
5	611113	UWAREHOU	KING	8	90	6500	200
6	582978	OFFICE	THURSTON	9	90	7500	350
7	584988	OFFICE	WHATCOM	11	90	3600	420
8	525156	OFFICE	SNOHOMIS	1	90	15000	600
9	585370	UWAREHOU	CLARK	2	90	5000	233
10	596841	OFFICE	SPOKANE	11	90	9500	450
11	533639	RETAIL	BENTON	2	90	5800	472
12	606288	UWAREHOU	CLARK	7	90	9000	200
13	618882	OFFICE	KING	11	90	3000	200
14	597478	GROCERY	SPOKANE	4	90	2600	200
15	578917	OFFICE	SNOHOMIS	1	90	9200	360
16	617595	OFFICE	SPOKANE	12	90	8200	475
17	533639	OFFICE	BENTON	2	90	3100	328
18	596868	OFFICE	KING	9	90	9000	640
19	596818	RETAIL	PIERCE	4	90	15600	1000
20	593269	OFFICE	PIERCE	5	90	5000	750
21	600919	GROCERY	SPOKANE	8	90	3500	250
22	588804	RETAIL	KING	2	90	7400	294
23	576254	SCHOOL	KING	4	90	20000	2305
24	584626	OFFICE	KING	2	90	18000	1100
25	582249	UWAREHOU	SNOHOMIS	1	90	6700	200
26	573173	RETAIL	CLARK	8	90	12100	300
27	537957	SCHOOL	SNOHOMIS	10	90	7000	350
28	580406	SCHOOL	KING	7	90	33300	4624
29	548223	ASSEMBLY	KING	5	90	20600	1300
30	548673	LODGING	SNOHOMIS	9	90	15000	800
31	612717	UWAREHOU	KING	8	90	25300	530
32	618475	HEALTH	SNOHOMIS	10	90	7600	408
33	621672	UWAREHOU	MASON	12	90	16600	355
34	534138	RETAIL	KING	2	90	24700	2000
35	581847	OFFICE	SPOKANE	4	90	11800	629
36	587471	UWAREHOU	THURSTON	4	90	15700	300
37	593914	SCHOOL	KING	4	90	3300	211
38	608667	UWAREHOU	KING	10	90	24300	752
39	569273	GROCERY	SNOHOMIS	1	90	3500	200
40	586562	RETAIL	SPOKANE	6	90	20000	750
41	607233	GROCERY	CLALLAM	7	90	2500	250
42	580380	ASSEMBLY	SPOKANE	10	90	11000	1100
43	583094	HEALTH	SNOHOMIS	1	90	4300	220
44	576047	HEALTH	KING	6	90	24000	2300
45	530928	PUB INST	PIERCE	6	90	10500	949
46	589819	UWAREHOU	KING	10	90	12000	200
47	588331	GROCERY	WHATCOM	5	90	5300	450
48	600112	UWAREHOU	KING	6	90	32300	1000
49	538822	PUB INST	THURSTON	3	90	20000	1742
50	604982	PUB INST	PIERCE	10	90	5300	512

WASHINGTON

AREA > 40,000 FT2 (variable sorder is random sort):

sorder	dodgeno	category	county	month	yr	area	value
1	557419	UWAREHOU	KING	1	90	55000	1500
2	403940	SCHOOL	KING	8	90	54000	5585
3	580208	SCHOOL	CLALLAM	7	90	43500	3369
4	608098	RETAIL	KING	10	90	70000	2750
5	571845	RETAIL	CLARK	7	90	46000	2000
6	573556	OFFICE	SNOHOMIS	7	90	55000	3507
7	606950	LODGING	SNOHOMIS	7	90	190000	8000
8	580891	OTHER	SNOHOMIS	9	90	75000	6500
9	571523	UWAREHOU	PIERCE	10	90	56800	3579
10	610633	UWAREHOU	KING	10	90	60000	2400
11	569017	OFFICE	KING	1	90	79400	5000
12	621379	OFFICE	THURSTON	11	90	50000	1891
13	538072	SCHOOL	GRAYS HA	1	90	64000	5599
14	586083	SCHOOL	SNOHOMIS	8	90	56000	5608
15	442392	HEALTH	KING	8	90	312000	27209
16	588788	RETAIL	KING	3	90	104000	5000
17	571000	LODGING	KING	2	90	73000	6000
18	601799	ASSEMBLY	PIERCE	10	90	77700	5300
19	585160	RETAIL	SNOHOMIS	5	90	107000	10000
20	564082	SCHOOL	YAKIMA	7	90	105000	8742
21	519819	OFFICE	KING	7	90	300000	32600
22	571372	OFFICE	SNOHOMIS	7	90	176900	13000
23	521612	SCHOOL	CHELAN	5	90	100000	6802
24	576788	OFFICE	THURSTON	10	90	410000	44130
25	543005	RETAIL	PIERCE	9	90	58500	2000
26	527357	SCHOOL	KING	12	90	117000	7989
27	589480	OFFICE	PIERCE	5	90	470000	35000
28	601494	RETAIL	WHATCOM	7	90	50000	2500
29	592560	RETAIL	SPOKANE	5	90	90000	6000
30	592245	SCHOOL	WHATCOM	8	90	90000	8917
31	545532	SCHOOL	KING	8	90	125000	12111
32	525354	SCHOOL	PIERCE	5	90	80000	6787
33	612717	UWAREHOU	KING	8	90	42300	884
34	527354	HEALTH	SPOKANE	6	90	55000	2500
35	474352	UWAREHOU	KING	2	90	83300	2500
36	556506	OFFICE	KING	9	90	97000	6500
37	545940	OFFICE	KING	1	90	75000	7000
38	613316	LODGING	KING	12	90	83700	3500
39	584992	UWAREHOU	SNOHOMIS	2	90	50000	2692
40	570570	UWAREHOU	SNOHOMIS	2	90	92000	4915
41	572423	LODGING	KING	2	90	75000	4500
42	579528	UWAREHOU	KING	5	90	210000	6000
43	546236	SCHOOL	KING	8	90	53000	6039
44	597305	LODGING	SPOKANE	4	90	46300	2500
45	582241	OFFICE	KING	6	90	267000	15000
46	606065	RETAIL	MASON	9	90	45000	2200
47	611232	OFFICE	WHATCOM	10	90	88000	6000
48	610761	SCHOOL	PIERCE	12	90	48300	3631
49	588918	RETAIL	PIERCE	2	90	186000	9000
50	564368	SCHOOL	KING	7	90	115000	13036

7 Appendix B

Building Summaries

REPORT SUMMARY

DODGE NUMBER	596 868
BUILDING TYPE	Office
LOCATION	14623 NE 190th St, Woodinville, WA (King County)
CONTACTS	Scott Harm, Project Manager, GMS Architects Gail Conner, Property Manager, GAC Associates
VITAL STATISTICS	Area: 4,110 ft^2; valuation: $640,000; 3-story office building
FIELD/PLANS SUMMARY	**Building envelope:** Uninsulated slab-on-grade and crawlspace with R-11 batt insulation, 2x6 stud walls with R-19 batt insulation, R-38 batt ceiling insulation, non-thermally broken aluminum frame argon-filled double glazed windows. The walls have an overall U_o of 0.190, and the roof has a U_o of 0.039. A window shade coefficient of 0.77 is specified, although a clear glass of about 0.91 was actually installed. Using a component trade-off, the building envelope complies with the state energy code. **HVAC:** Split-system heat pumps with single-zone, constant volume air handlers. 2 Trane 3-ton heat pumps with an HSPF of 7.5, and SEER of 12.45, and 3 Trane 4-ton heat pumps with an HSPF of 7.8 and SEER of 12.20. 3 Trane 1600 cfm air handlers, 2 Trane 1200 cfm air handlers. The HSPF required for these heat pumps is 6.35, and the EER is 7.8. There is one General Electric Zoneline packaged heat pump with a COP of 2.7 and an EER of 8.7. The requirements for this heat pump are a COP of 2.3 and an EER of 7.8. In addition, there are two 50 cfm bathroom exhaust fans. All the heat pumps comply with the code. **Lighting:** All lighting information is from the audit -- no lighting information was included on the original plans. 4-lamp (34W each) lensed fluorescent fixtures with two energy-efficient ballasts per fixture, and 2-level switching. Lobby has can lights with 75W incandescent bulbs. Bathrooms have wall-mounted fixtures with 50W incandescent bulbs. The lighting power density of 3.98W/ft^2 does not comply with the state energy code limit of 1.7W/ft^2 for this type of occupancy.
INTERVIEWS	Project Manager: Responsible for envelope code compliance; usually projects are designed according to the client's wishes and then "retro-fitted" for code compliance as needed before submittal. The prescriptive path was used for this building. There was nothing outstanding about the code submittal for this building; HVAC and lighting were not included in plans, and their design and installation was left to subcontractors; this is the case for 85-90% of the buildings this firm designs. Knowledge of the energy code is from reading the code and from "in-house" knowledge. This firm is participating soon in a seminar given by the Energy Extension Office (?) on code compliance.

GENERAL OBSERVATIONS

The subcontractor responsible for installing the heat pumps and air handling equipment was not willing to be interviewed. We were able to confirm the compliance of the HVAC system with the energy code during the audit.

The lighting design was done by the installer, and there does not appear to be any real effort to comply with the lighting code.

The window specifications were changed from low-E coating to argon-filled. This made little difference in the U_o of the building, but raised the shade coefficient and thus the building cooling load. Since OTTV and cooling load are not controlled by the code there was no impact on code compliance.

The envelope U_o seemed to employ a component trade-off methodology, although no documentation of this trade-off is contained on the drawings.

REPORT SUMMARY

DODGE NUMBER	618 882
BUILDING TYPE	Office
LOCATION	470 S. Kenyon St., Seattle, WA (King County)
CONTACTS	Craig McClelland, Project Architect
VITAL STATISTICS	Area: 3,496 ft^2; valuation: $200,000; 1-story office building
FIELD/PLANS SUMMARY	**Building envelope:** Thermally-broken slab-on-grade with R-5 rigid insulation and crawlspace with R-19 batt insulation, 2x6 stud walls with R-19 batt insulation, flat truss ceiling with R-30 batt insulation, wood frame double-hung, casement and fixed double-glazed windows. The U_o of the walls is 0.11, and the U_o of the roof was 0.036. The overall envelope meets the code requirements by a component trade-off. **HVAC:** To be installed by owner; not yet designed. Architect says it will be some form of roof-top heat pump. **Lighting:** All lighting information is from the plan review. 3-lamp (34W each) fluorescent fixtures, can fixtures with incandescent (60-75W) lamps, and wall-mounted fixtures with incandescent (75W) lamps. The overall lighting power density of 1.28W/ft^2 complies with the state energy code.
INTERVIEWS	Project Architect: Responsible for envelope and lighting code compliance. The prescriptive path was used for this building. This is usually chosen as the quickest and simplest avenue when not up against "tight" situations. Code compliance has the most pronounced effect on building design in the actual design phase, in terms of stud sizes and spacing to use. Knowledge of energy code is from having read the code and participating in a seminar held at the Olympia Courthouse (though this was for residential code), and he would participate in more training if it were free. He comments that he might use the component performance path if all the information were published in such a way as to be at his fingertips all at once.
GENERAL OBSERVATIONS	The owner of the building has a general-contracting business, so the design of the building was deliberately kept to just the building envelope. The building envelope greatly exceeds the code requirements largely because of the use of wood windows. The value of the project is probably underestimated and reflects only the cost of the shell.

REPORT SUMMARY

DODGE NUMBER	538 822
BUILDING TYPE	Public Institution
LOCATION	Lacey, WA (Thurston County)
CONTACTS	Tom Johansen of Streeter-Dermanis Architects; Mike Quiroconi of Abacus Engineering
VITAL STATISTICS	Area: 21,000 ft^2; valuation: $1,742,000; public library
FIELD/PLANS SUMMARY	**Building envelope:** Concrete block wall with interior furred-out R-11 insulation. Thermal break and perimeter insulation at slab. R-30 insulation at roof (Some trade-off for glazing area) Double glazed, low-E. Some frames with thermal breaks. The wall U_o is 0.24 and the ceiling U_o is 0.027. Meets prescriptive code requirements. **HVAC:** Heat pump system, 4 zones. The performance rating of equipment meets code requirements of 8.2 for EER when it is installed at the ideal capacity specified by the manufacturer. In the specific conditions of this installation, none of the units are installed for the capacity calculated to reach this efficiency; consequently only one of four rates above 8.2 for EER. One unit does not meet COP requirement (units seem slightly oversized). All units have economizers installed as required by the energy code (air handlers larger than 3500 cfm). Total air flow for the whole building is rated at 1.11 cfm/ft^2 and has an ATF of 7.7, well above what is required by the Washington State Energy Code. **Lighting:** Custom HID fixtures and fluorescent, including compact fluorescent down lights. Lighting Power Density meets code at $1.56W/ft^2$. Exterior lighting is installed at 1.25W/ft of perimeter, well below the energy code maximum of 7.5W/ft.
INTERVIEWS	Tom Johansen, construction manager; Streeter/Dermanis Architects. Primarily involved with project after design (construction manager). Primary responsibility for energy code compliance is with project architect for this and other projects in the office. Energy code issues are usually addressed in the design development phase of the project. Typically the mechanical engineer provides guidelines for insulation levels. Project was coordinated with city officials early in the process. This led to early consideration of energy code issues and few or no conflicts during construction. There were no changes affecting energy performance during construction. Puget Power incentive program provided partial funding for heat pump system (Arranged after system design?). Toughest part of code to meet was lighting requirements.

Mike Quiroconi, Abacus Consultants. No special lighting or daylighting controls were integrated. Energy management system with direct digital control operates mechanical system. Zone control for office areas. Smaller jurisdictions seldom if ever require energy code submittals/calculations for mechanical systems. Some larger jurisdictions require submittals but seldom respond to them. Only Seattle reviews/responds to calculations on a regular basis.
Engineer was unaware of any utility company incentive programs which were applied to this project.

GENERAL OBSERVATIONS

Despite sophisticated controls and the architect's claim of high efficiency, our analysis of the mechanical system indicates that some aspects of it fail to meet energy code requirements (see above). Users seem to be generally uninformed on how to operate system controls.
Lighting controls not incorporated in project; all switched manually. The lighting design seemed very good, although the opportunity for daylighting controls was missed.
Because of the use of economizers, the impact of the low EER may not be significant; clearly, no effort was made to review the EER of the equipment during code review.
In general, the drawings contained all the information needed for an effective review of energy code compliance in an easy to read format.

REPORT SUMMARY

DODGE NUMBER	564 368
BUILDING TYPE	School
LOCATION	Woodinville, WA (King Co.)
CONTACTS	Reno of the Lee Architectural Group; Joe Dorman of Hargis Engineers; Herb Schwarc of the Northshore School District
VITAL STATISTICS	Area: 106,000 ft; valuation: $13,036,500; elementary school
FIELD/PLANS SUMMARY	**Building envelope:** Walls face brick over 2x6 with R-19 or CMU with 11/2" rigid insulation. Slab-on-grade, thermal break on plans, not visible at site (covered). Roof is wood trusses with R-19 to R-50, varying. Double glazing, no coating or thermal break in evidence. Not all insulation levels could be verified at site, but plans indicate wall Uo of .125 and a ceiling Uo of .032. Both meet the component performance requirements. **HVAC:** There are 67 small gas furnaces supplying classrooms and other areas varying from 41,000 to 110,000 BtuH input with AFUE ratings of .88 to .97. In addition there are 59,000 kW of electric resistance duct heaters and unit heaters throughout the project. Finally, there are four large gas burners supplying heat to the four packaged HVAC units. With a nominal efficiency rating of 0.75, the total heating capacity of the building is 4,500 MBH. The calculated building load is about 2,000 MBH, making the overall heating capacity about 2.5 times the calculated peak load. A total of 118,000 cfm of supply and return air is included in the heating and ventilation system with an ATF of 8.6 (at 20°F temperature difference.) In addition 20,000 cfm of exhaust fans are included. There is no cooling equipment although two large heat pump dehumidifiers are specified for the pool room. These are not regulated by code. **Lighting:** The school uses mainly fluorescent lighting. The connected LPD for interior spaces is 1.64 W/ft^2; well below the code limits for this occupancy. Exterior lighting is 8.8 W/ft of perimeter, or about 17% above code maximum. Exterior lighting is mainly metal halide and HPS.
INTERVIEWS	Joe Dorman, Hargis Engineers: Firm works mostly on schools. Energy code issues addressed in ECR forms. ECR leads to prescriptive approach assumptions about building envelope, lighting and mechanical loads. Use of component method very rare. (Note that this building used component trade-offs to meet code requirements.) Code officials seldom if ever review mechanical systems for energy code compliance. Code enforcement officials seem not to look at ECR submittals. Other codes have more effect on mechanical system; i.e. min. ventilation requirements. Main effect of code is on building envelope. These items checked most

frequently by inspectors. Efficiency of building envelope affects mechanical requirements.
Simultaneous enforcement of multiple energy codes on one project is biggest problem with energy code. ECR, State, Northwest, Seattle, Tacoma City Light, etc.

GENERAL OBSERVATIONS

The code compliance for this building appears to be somewhat ad hoc. While compliance with state ECR requirements insured reasonable energy efficiency (especially in the gas furnaces), the energy code itself is not referenced. The buildings do meet code in almost every area except exterior lighting and total heat capacity.
The site visit was only moderately productive since the contractor was just finishing framing. It was too late to check on slab insulation. The pool seems to have no insulation underneath or around it.
A great deal of attention was paid to ventilation and exhaust air, and as a result 60% of the calculated heating load is necessary to offset the ventilation rates.
Architect was unwilling to take the time to be interviewed for this project.

REPORT SUMMARY

DODGE NUMBER	613 068
BUILDING TYPE	Retail
LOCATION	Johnson Creek Fred Meyer Department Store, 82 Avenue & Johnson Creek Rd (Clackamas County)
CONTACTS	Christopher Galati, P.E./Fred Meyer Inc.
VITAL STATISTICS	Area: 183,000 ft^2; valuation: $18,000,000; occupancy: retail store
FIELD/PLANS SUMMARY	**Building envelope:** Flat, built-up roof assembly with a rated thermal value of R-13.4. One percent of the roof is skylight. 42,000 square feet of tilt-up concrete walls with R-11 insulation. Nine percent of the wall area are windows, mostly of the single glazed type. 1,800 perimeter feet of slab-on-grade floor with R-6 insulation. The building envelope complies with the Energy Code.

HVAC: 17 Package gas/electric rooftop units with capacity ranging from 4 to 40 tons, constant volume supply fan control, and for return fan on the 40 ton unit. The other units are without return fans. Cooling system is air cooled, direct expansion, heating system is a gas furnace. The 17 units supply a total of 106,000 cfm to the space or 0.58 cfm per square feet.

3 package gas rooftop furnaces with a capacity of 192,000 BTU/hr. The controls cycle the supply fan with call for heating. 5 gas unit heaters with capacity ranging from 115,000 to 173,000 Btu/h. The controls cycle the fan unit with call for heating. 22 exhaust fans exhaust a total of 46,000 cfm from the space or 0.25 cfm per square feet. The control system is Energy Management System with 7-day auto setback and a system which purges the building with outside air during morning start when conditions warrant (morning purge).

Economizers -- all 17 package gas/electric rooftop units had air economizer with enthalpy sensors. Many of these units do not require air economizer system by the Energy Code. Fan systems under 5,000 cfm or 134,000 BTU/hr cooling capacity do not need this type of control. All 17 package gas/electric rooftop units meet the efficiency requirements for cooling.

Heating Efficiency -- Some gas equipment clearly meets the efficiency requirements. However, for other gas equipment, compliance is unknown. Five units have the steady state efficiency rating, when they should have the seasonal AFUE rating. Eight units above 225,000 Btu/h input rating should have a maximum and a minimum capacity efficiency, but none of the these units have the minimum capacity efficiency. Four units did not have nameplate information such as model number, capacity, efficiency, etc., just the manufacturer's name.

Lighting: The Interior Lighting Power Budget is 2.3W/ft^2. The total connected load less the energy credits is 2.1W/ft^2. The connected load is less than the budget, therefore meets the requirements.

For dual switching, the Energy Management System for 97 percent of the luminaries exceeded the requirements. For individual switches in rooms less than 400 ft^2, the rooms with occupancy sensor also exceeded the requirements. However, a few small rooms are not switched separately. For separate switches of luminaries next to window, none of luminaries next to the windows is switched separately.

The Exterior Lighting Power Budget is 7.5W/ft (by perimeter). The total connected load is 10W/ft. The connected load is more than the budget, therefore does not meet the requirements. All exterior luminaries have controls to turn off the lights during daylights or periods of non-use as required by the Energy Code.

INTERVIEWS

Christopher Galati from Fred Meyer; principle in-house designer and responsible for compliance with the Energy Code. He completed the Energy Code Compliance Forms and submitted them to the Clackamas County Building Department. The plans examiner did ask Mr. Galati for additional information, cut sheets on the equipment. Mr. Galati stated that the plans examiner did not know what he was doing when he checked for compliance with the Energy Code. It was apparent the relationship between Mr. Galati and the building department was poor.

Mr. Galati had concerns about the Energy Code: "The exterior lighting budget conflict with security measures for the building."
"The new ASHRAE 62 Standard for indoor air conflicts with the Energy Code," he said. "How do I design my buildings; tight or loose?"
"The energy simulation model shows that we save more energy if we remove the insulation from the building. However, the Energy Code requires it."

GENERAL OBSERVATIONS

Mr. Galati has a good understanding of the Energy Code. Future Fred Meyer stores will continue to be energy efficient, if there is an incentive program. A review of the compliance forms submitted to the county showed that they were generally correct, except for the count of the interior luminaries. The form showed a connected load for the interior luminaries that was about 75% of the estimate made from the field audit. The difference in the count could be traced to the drawings. Mr. Galati noted that "There were many changes to the drawings, because of the requirements of the retail staff. However, the building still complies." Except for the exhaust fans, all HVAC equipment was specified as Trane, most likely because of the better efficiency. However, the only Trane product on the project was the 40 ton gas/electric rooftop. The smaller gas/electric rooftops were Carrier. The gas unit heaters and gas rooftop furnaces were Madine.

8 Appendix C

Interview Formats

INITIAL SCREENING INTERVIEW

Dodge Number:

Project Name:

Location

Firm:

Telephone #

Project Architect
(or energy contact)

Address

Good (Afternoon), My name is _____ from Ecotope Inc. We are representing the Washington (Oregon) State energy office in a study of the impact of energy codes on building design and construction. Information from this study will be used to evaluate potential modifications in the code and in the way it is implemented. _____ is part of our study sample.

We would like to set up a time when we could conduct a telephone interview with the person in your office who was primarily involved with the energy code as it applies to this project. Would that be you? The interview takes approximately 1/2 hour, and is confidential. Your cooperation would assist in the improvement of the energy code. Could we set up a time when it would be convenient for you to answer some questions about how the energy code was applied to this project?

If it is convenient, we would like to review a set of the contract documents. Would this present a problem?

Would it be possible for us to make a brief visit to the site?

I would like to verify some information about the project.

Contractor's name:

Building Owner:

Project completion date:

(Make arrangements to pick up documents)

Thank you for your time. We will be contacting you (at time arranged) for the interview

SUMMARY

ECOTOPE Plan Reviewer

Name _____ Date _____

ECOTOPE Field Inspector

Name _____ Date _____

Construction Stage _____

Project

Dodge Report No. _____

Name _____

Street address _____

_____

City _____ State _____ County _____

Area _____ Valuation _____ Date of Construction _____

Owner Representative

Name _____

Company _____

Street address _____

_____

City _____ State _____ ZIP _____

Phone ( ) _____

Building Envelope Designer

Name _____

Company _____

Phone ( ) _____

Mechanical Designer

Name _____

Company _____

Phone ( ) _____

Lighting Designer

Name _____

Company _____

Phone ( ) _____

Contractor

Name _____

Company _____

Phone ( ) _____

BUILDING ENVELOPE

Heating Load Budget

Find the allowable Uo from Table 53-A.

(a) Component	(b) Quantity	(c) Allowable	(d) Mult. Col. b by c
Wall	(sf)	(Uo)	
Roof and Ceiling	(sf)	(Uo)	
Floor	(sf)	(Uo)	
Slab-on-grade	(ft)	0.52	
1. Heating Load Budget, Btu/h · °F. Add amounts in Column (d).			

Heating Load

(a) Component	(b) Quantity	(c) Thermal Value	(e) Mult. b, c & d	Field Verify, √, U or F
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(sf)	(U)		
	(ft)	(F)		
	(ft)	(F)		
2. Heating Load, Btu/h · °F. Add amounts in Column (e)				
3. Enter "Y" if Line 1 is greater than Line 2.				

BUILDING ENVELOPE CONT'D

Cooling Load Budget

Find Uo, OTTV and outdoor summer design temperature from Table 53-A. When indoor summer design temperature is unknown, use 75 °F.

(a) Component	(b) Quantity	(c) Allowable	(d) Summer ΔT, °F	(e) Mult. Col. b, c & d
Walls	(sf)	(OTTV)		
Roof and Ceiling	(sf)	(Uo)		
1. Cooling Load Budget, Btu/h. Add amounts in Column (e).				

Solar Loads

Find SF from Table 53-A.

(a) Windows	(b) Area, sf	(c) SC	(d) SF	(e) Mult. b, c & d	Field Verify √ or SC
2. Window Solar Load, Btu/h. Add amounts in Column (e).					

Conductive Loads

TD_{EQ}:
- *44 °F for wall mass of 0-25 lbs/sf.*
- *37 °F for wall mass of 26-40 lbs/sf.*
- *30 °F for wall mass of 41-70 lbs/sf.*
- *23 °F for wall mass of 71 lbs/sf and above.*

(a) Wall, Roof, & Glazing	(b) Area, sf	(c) U-Value	(d) TDeq or ΔT	(e) Mult. Col. b, c & d	Field Verify √ or U
3. Cooling Load, Btu/h. Add amounts in Column (e) + Line 2					
4. Enter "Y" if Line 1 is greater than Line ~~2~~ 3					

Air Leakage and Moisture Control

5. Enter "Y" if all joints sealed against air leakage, incl. windows and doors.		
6. Enter "Y" if manufactured windows are rated 0.37 cfm/ft or less.		
7. Enter "Y" if manufactured doors are rated 11 cfm/ft or less.		
8. Enter "Y" if the envelope vapor barrier are rated for one perm or less.		

EQUIPMENT EFFICIENCY

System

No.	System Description	Supply Fan Control	Return Fan Control	Cooling System	Heating System

Gas/Oil Fired Units

Boilers, Furnace, Duct Heaters, Unit Heaters

Equipment ID	Description	Heating Cap., Btu/h	Heating Eff., COP		
			Allow.	Actual	Field

Chillers

Equipment ID	Reciprocatin Centrifugal or Absorption	Water or Air Cooled, w/ Condenser	Cooling Capacity Tons	Cooling Eff., COP		
				Allow.	Actual	Field

Electric Air Conditioners & Heat Pumps

Equip. ID	Heating Cap., Btu/h	Heating Eff., COP			Cooling Cap., Tons	Cooling Eff., EER		
		Allow.	Actual	Field		Allow.	Actual	Field
	DESCRIPTION							
	DESCRIPTION							
	DESCRIPTION							
	DESCRIPTION							

HVAC SYSTEMS

Controls

[ ] Direct Digital Control
[ ] Energy Management Control
[ ] Pneumatic Control
[ ] Low Voltage Control

[ ] Single Set Point Thermostat
  [ ] w/ Manual HEAT/FAN
  [ ] w/ Auto Setback
  [ ] w/ 7 Day Auto Setback

[ ] Dual Set Point Thermostat
  [ ] w/ Manual HEAT/COOL/FAN
  [ ] w/ Auto Setback
  [ ] w/ 7 Day Auto Setback

[ ] Morning Warm-up Cycle Control
  [ ] w/ Time Clock
  [ ] w/ 7 day Time Clock
  [ ] w/ Optimum Start-up Control

Special Controls
  [ ] w/ Off Hour Isolation
  [ ] w/ Temp. Reset Controls

Others: _____

_____

_____

Fan System

Supply Fan ID	Discription	Fan Capacity, cfm	Input Wattage	Economizer, Y/N		
				Allow	Actual	Field

Pumps

Variable Flow Code:
1. No Variable Flow Control
2. Variable Speed Driven Pumps
3. Staged Multiple Pumps

Supply Pump ID	Discription	Pump Capacity, gpm	Input Wattage	Variable Flow Code	Reset Controls (Y/N)	No. of Control Valves

Misc Measures

Use first column for plan review, and use second column for field verication.

Enter "Y" if ducts located in unconditioned space are insulated, have a vapor barrier for AC systems, and have a weather barrier for outdoor applications		
Enter "Y" if pipes with fluid temperature of <120°F or >55°F are insulated, and have a vapor barrier for chilled water applications.		
Enter "Y" if each mechanical ventilation system has a readily accessable shut-off.		
Enter "Y" if each heat pumps has controls to prevent supplementary heating when the load can be met by the heat pump.		
Enter "Y" if each humidifier and dehumidifier system has controls prevent new energy to be used between 30 to 60 percent relative humidity.		
Enter "Y" if the domestic showers have a flow of 3.0 gpm or less.		

INTERIOR LIGHTING POWER

Interior Lighting Power Budget

(a) Occupancy Group	(b) Space Type	(c) Power Density, W/sf	(d) Floor Area, sf	(e) Multiple Col. (c) by (d)
1. Interior Lighting Power Budget, W. Add amounts in column (e)				

Interior Lighting Power

Include in the lamp description the number of lamps per luminaire, size, wattage and type (fluorescent, incandescent, etc.)

Include in the ballast description the number of ballasts per luminaire, type (energy efficient, electronic) and if the ballast is tandem wired.

If the value of the input wattage is not from Table 5a, attach supporting product data.

(a) Lum. I.D.	(b) Luminaire Type			(c) Quantity, each	(d) Input Wattage	(e) Multiply (c) by (d)	Field Verify
	Fixture	Lamp	Ballast				
2. Total Interior Lighting Power, W. Add amounts in column (e).							
3. Oregon Compliance. Enter "Y" if line 2 is less than line 1.							
4. Enter "Y" if small rooms have individual controls.							
5. Enter "Y" if large spaces have dual level switching							
6. Enter "Y" if luminaires nearest to windows have separate switches.							

EXTERIOR LIGHTING

Lighting Power Budget

(a) Component	(b) Quantity	(c) Allowable	(d) Mult. Col. b by c
Ext. Building Lights	(ft)	7.50	
Parking Structure	(sf)	0.30 (WA only)	
Surface Parking	(sf)	0.05 (WA only)	
1. Exterior Lighting Budget, Watts. Add amounts in Column (d).			

Exterior Lighting Power

Include in the lamp description the number of lamps per luminaire, size, wattage and type (fluorescent, incandescent, etc.)

Include in the ballast description the number of ballasts per luminaire, type (energy efficient, electronic) and if the ballast is tandem wired.

If the value of the input wattage is not from Table 5a, attach supporting product data.

(a) Lum. I.D.	(b) Luminaire Type			(c) Quantity, each	(d) Input Wattage	(e) Multiply (c) by (d)	Field Verify
	Fixture	Lamp	Ballast				
2. Total Exterior Lighting Power, W. Add amounts in column (e).							
3. Oregon Compliance. Enter "Y" if Line 3 is less than Line 2.							
4. (WA only) Overall Lighting Power Budget. Add Line 1 of Page 6 to Line 1 of Page 7.							
5. (WA only) Overall Lighting Power. Add Line 2 of Page 6 to Line 2 of Page 7.							
6. Washington Compliance. Enter "Y" if Line 5 is less than Line 4.							
7. Enter "Y" if all exterior lighting have automatic controls to turn off lights.							

Interior Controls

[ ] Daylight Controls
- [ ] w/ On/off Control
- [ ] w/ Stepped Control
- [ ] w/ Continous Control
- [ ] w/ Windows
- [ ] w/ Skylights

[ ] Occupancy Sensors
- [ ] w/ Small Rooms
- [ ] w/ Larger Rooms

[ ] Programmable Controls
- [ ] w/ Time Clock
- [ ] w/ 7 day Time Clock
- [ ] w/ Sweep Controls

[ ] Lumen Maintenance Controls
[ ] Tuning Controls
[ ] Demand Limiting Controls
[ ] Telephone Access Controls

Building Designer Interview (6/13)

Dodge Number _____

Project Name _____

Project Location _____

Person Called

Name (Mr., Ms.) _____

Company name _____

Street address _____

City _____ State _____ ZIP _____

Daytime phone ( )

Interviewer

Name _____

Date and Time _____

As you may remember, the Washington State Energy Office (WSEO) and the Oregon Department of Energy (ODOE) are studying commercial buildings to investigate the following questions:

1. **What is the compliance level with the state energy codes?**
2. **What measures would improve the effectiveness of the energy codes?**

We have selected a building which you were involved with as a _____ (architect, engineer, owner), the _____ (insert building name). I would like to ask you a few questions about this building and the process that was required to comply with the energy code.

Were you involved with decisions relating to the energy code on this building?

Do you have a few minutes for the interview? (If not arrange a suitable time for the interview later.)

Project name: _____

Primary usage: _____

Other usage: _____

Project construction cost: _____

Project Information

1. What is the financing structure of this project?

Owner/occupant	[ ]
Develop for operation	[ ]
Develop for sale or lease	[ ]
Build to suit	[ ]
Franchise	[ ]
Other:	[ ] _____(specify)

2. For _____ (project name), what did you design?

Building envelope	[ ]
Mechanical system	[ ]
Plumbing system	[ ]
Lighting system	[ ]

3. Were you responsible for energy code compliance?

4. Which energy code did you use for this building?

5. At what stage in the design process was the energy code first addressed?

6. Was energy cost analysis done as part of design process, and if so, was it part of an incentive program?

No	[ ]
Utilities program (Energy Smart Design)	[ ]
State program	[ ]
(OR only) Senate Bill 1060	[ ]
Other:	[ ] _____(specify)

7. Describe which conservation measures were used:

8. Which compliance path did you use? (If more than one path was used, use the comment area to indicate the building system associated with the path.)

Component Performance	[ ]	_____
Prescriptive	[ ]	_____
Energy Budget	[ ]	_____

9. How did you decide on the compliance path used?

10. Were any additional conservation methods incorporated beyond those required by the energy code? Why?

11. Were you restricted from using innovative conservation measures by some aspect(s) of the energy code?

12. During the permit phase, did the jurisdiction request additional energy code compliance information such as test report, manufacturer's product data, or calculations (other than the compliance forms)?

No [ ]
Yes, describe [ ] _____(specify)

Building Envelope: (designer:)

13. How did you document energy compliance? (Forms, self-certification, official review, other...)

14. Did you have to make any changes in design as a result of the energy code compliance review?

15. (If so) In which of the following areas did the code require design changes or other special efforts to bring the building into compliance?

Thermal values for roof [ ] _____
Thermal values for walls [ ] _____
Thermal values for floors [ ] _____
Thermal values for slab-on-grade floors [ ] _____
Thermal values for windows [ ] _____
OTTV (window S.C.) [ ] _____
Air leakage for doors or windows [ ] _____
Moisture barriers [ ] _____

16. Was there any insulation tradeoff between the walls, floor, and roof, and if so, how did you calculate it?

No [ ]
Overall Uo calculation [ ]
Overall heat loss and gain [ ]
Annual energy use [ ]
Other: [ ] _____(specify)

17. Was code enforcement in any of these areas a particular problem, and why?

Item(s) from audit:

Mechanical system: (designer:)

18. How did you document energy compliance? (Forms, self-certification, official review, other...)

19. Did you have to make any changes in design as a result of the energy code compliance review?

20. (If so) In which of the following areas did the code require design changes or other special efforts to bring the building into compliance?

Economizers	[ ]	_____
Reset controls	[ ]	_____
Heating equipment efficiency	[ ]	_____
Cooling equipment efficiency	[ ]	_____
Thermostatic controls	[ ]	_____
Duct or pipe insulation	[ ]	_____
(WA only) Equipment sizing	[ ]	_____
(WA only) Fan efficiency (ATF)	[ ]	_____
(WA only) Ventilation	[ ]	_____

21. Was code enforcement in any of these areas a particular problem, and why?

Item(s) from audit:

Lighting: (designer:)

22. How did you document energy compliance? (Forms, self-certification, official review, other...)

23. Was a lighting budget review conducted, and if so, how close to the lighting code requirements were the initial design results?

No	[ ]
Below code	[ ]
Met code	[ ]
Significantly exceeded code	[ ]

24. If changes were required, in which if the following areas did the code require design changes or other special efforts to bring the building into compliance?

Interior lighting budget	[ ]	_____
Switches in each room	[ ]	_____
Interior lighting controls	[ ]	_____
Exterior lighting budget	[ ]	_____
Exterior automatic controls	[ ]	_____
Daylighting controls	[ ]	_____

25. Was code enforcement in any of these areas a particular problem, and why?

Item(s) from audit:

Construction:

26. Did the contractor request a design clarification or change order relating to the energy code?

No	[ ]
Yes, describe	[ ]

27. Did the contractor substitute material and equipment that relates to the energy code?

No	[ ]
Yes, describe	[ ]

28. Where any other changes or modifications made during the construction process that may have had an effect on the energy performance of this building?

29. Overall, did the energy code influence your design?

Not at all	[ ]
Some	[ ]
Extensively	[ ]

30. Please describe any errors or inconsistencies you may have encountered in the energy code. (Page number would be helpful)

Information on Firm:

31. How many employees are at your company?

1-5	[ ]
6-10	[ ]
11-25	[ ]
26 to 100	[ ]
over 100	[ ]

32. What is the primary business of your company? (check one)

Architecture	[ ]	
Engineering	[ ]	_____(specify)
General Contractor	[ ]	
Specialty Contractor	[ ]	_____(specify)
Supplier	[ ]	
Manufacturer	[ ]	
Developer	[ ]	
Other	[ ]	_____(specify)

33. How does your office typically deal with energy code issues for building envelopes, HVAC and lighting?

		Envelope	HVAC	Lighting
Project architect's discretion	[ ]	_____	_____	_____
In-house code specialist	[ ]	_____	_____	_____
Engineer	[ ]	_____	_____	_____
Consultant	[ ]	_____	_____	_____
Other	[ ]	_____	_____	_____

34. At what phase do energy code issues have the most pronounced effect on building design and/or use?

Design phase	[ ]	
Permit phase	[ ]	
Construction	[ ]	
Occupancy/Maintenance	[ ]	
Other	[ ]	_____(specify)

35. Do you find the code officials to be well informed on energy code issues?

36. Can you remember any circumstances where the code official's interpretations of the energy code have differed from yours?

37. From what source did you receive your training in the use of the energy code?

38. Do you feel confident in your understanding and use of the code?

39. Would you participate in a training program if it were offered? If so, what type of training program would be most valuable?

40. What suggestions do you have for improving the energy code?

41. Do you have any general comments or observations regarding the impact of the energy code in general or on this project?

Commercial Code Compliance Study:
Building Code Personnel Interview
summer, 1991

Interviewer

Name _____
Date and Time _____

Could I speak with someone who deals with commercial energy code requirements?

The Washington State Energy Office (WSEO) and the Oregon Department of Energy (ODOE) are studying commercial buildings. My name is _____, of Ecotope, and I've been hired to conduct a short interview. We are investigating the following questions:

1. **What is the compliance level with the state commercial energy code?**
2. **What measures would improve the effectiveness of the energy code?**

Your answers are all confidential. Do you have ten minutes for the interview? (If not, arrange a suitable time for the interview later.)

1. Person called:

Name (Mr., Ms.) _____

Jurisdiction name _____

Street address_____

City _____ State ____ ZIP _____

Daytime phone ( )

2. How many employees at your jurisdiction work with the commercial energy code?

1-5	[ ]
6-10	[ ]
11-25	[ ]
26 to 100	[ ]
Over 100	[ ]

3. What is your primary department or function? (check one)

Plan review	[ ]
Mechanical engineering	[ ]
Structural engineering	[ ]
Building inspections	[ ]
Electrical inspections	[ ]
Mechanical inspections	[ ]
Housing inspections	[ ]
Education or training	[ ]
Admin. or management	[ ]
Other _____	

(Oregon only)

Level A - All buildings or structures. Level B - Any building or structure not required to be designed by an Oregon registered architect or engineer (under 4,000 square feet or 20 feet in height for most buildings and structures, and under 1,500 square feet for H or I occupancies). Level C - One and two family dwelling and garages.

4. What are your certifications?

	Level A	Level B	Level C
Plans	[ ]	[ ]	[ ]
Structural	[ ]	[ ]	[ ]
Mechanical	[ ]	[ ]	[ ]
Electrical	[ ]	[ ]	[ ]
Other:	_____	_____	_____

5. What is the level of your jurisdiction's responsibility?

	Level A	Level B	Level C
Plans	[ ]	[ ]	[ ]
Structural	[ ]	[ ]	[ ]
Mechanical	[ ]	[ ]	[ ]
Electrical	[ ]	[ ]	[ ]
Other:	_____	_____	_____

6. Who checks the plans and specifications for commercial energy code requirements (job title)?

Building Envelope	_____
Mechanical System	_____
Lighting	_____

7. Who conducts site inspections for commercial energy code requirements (job title)?

Building Envelope _____
Mechanical System _____
Lighting System _____

8. What is the primary source of your knowledge about the commercial energy code? (check one)

College or University [ ]
State sponsored workshops [ ]
OBOA/WBOA classes [ ]
Circuit rider program [ ]
Self-study training course [ ]
Friend/co-worker [ ]
Self-study [ ]
Other _____

9. What portion(s) of a building do you check for energy code compliance?

Building envelope [ ]
Mechanical system [ ]
Lighting system [ ]

10. (If the building envelope is checked) Which compliance path is most often used?

Oregon only

Prescriptive path [ ]
Component path [ ]
Other (systems) [ ]

Washington (NWEC and WSEC) only

System Analysis [ ]
Prescriptive/component per- [ ]
formance [ ]
Other _____

Questions 11-15 are for respondents who deal with aspects of the building envelope. If the respondent does not fit in this category, skip to Q. 16 (mechanical) or Question 20 (lighting).

11. Which calculation method do you most often accept for analyzing insulation trade-offs between the walls, floor, and roof?

Overall U_o calculation [ ]
Overall heat loss and gain [ ]
Annual energy use [ ]
Other ___ _____

12. Which of the following aspects of the building envelope require your attention the most (check one or more)?

Thermal values for roof	[ ]
Thermal values for walls	[ ]
Thermal values for floors	[ ]
Thermal values for slab-on-grade floors	[ ]
Thermal values for windows	[ ]
OTTV (window S.C.)	[ ]
Air leakage for doors or windows	[ ]
Moisture barriers	[ ]
Other: _____	

13. What are the most common enforcement or compliance issues which come up with the building envelope?

14. Which parts of the envelope code are frequently misinterpreted or ignored by architects/designers?

15. How would you describe the overall compliance of building envelopes with the commercial energy code?

Questions 16-19 deal with mechanical systems. If respondent does not do mechanical, skip to Q. 20 (lighting), or go to Q.24.

16. Which of the following aspects of commercial mechanical systems require your attention the most (check one or more)?

Economizers	[ ]
Reset controls	[ ]
Heating equipment efficiency	[ ]
Cooling equipment efficiency	[ ]
Thermostatic controls	[ ]
Duct or pipe insulation	[ ]
(WA only) Equipment sizing	[ ]
(WA only) Fan efficiency (ATF)	[ ]
(WA only) Ventilation	[ ]
Other _____	

17. What are the most common enforcement or compliance issues which come up with mechanical systems?

18. Which parts of the mechanical system code are frequently misinterpreted or ignored by architects/designers?

19. How would you describe the overall compliance of mechanical systems with the energy code?

Questions 20-23 deal with lighting. For those respondents who don't handle lighting, skip to Q. 24.

20. Which of the following aspects of commercial lighting systems require your attention the most (check one or more)?

Interior lighting budget [ ]
Switches in each room [ ]
Interior lighting controls [ ]
Exterior lighting budget [ ]
Exterior automatic controls [ ]
Daylighting controls [ ]
Other_____

21. What are the most common enforcement or compliance issues which come up with commercial lighting systems?

22. Which parts of the commercial lighting code are frequently misinterpreted or ignored by architects/designers?

23. How would you describe the overall compliance of commerical lighting systems with the energy code?

24. Do you encounter conflicts between the commercial energy code and other applicable codes (fire, structural, etc)?

Examples:

25. Do you encounter ambiguities within the commercial energy code? Are there specific errors you have noticed? (Page number)

Examples:

26. How do you resolve these differences in interpretation and/or ambiguities?

27. How would you describe the overall compliance level of the commercial buildings you deal with?

28. In your experience, do certain building types tend to have more difficulty meeting energy code requirements?

29. On a scale of 1 to 5, with 5 the highest rating, how would you rate the overall familiarity with the energy code that each of the following groups of professionals has?

Architects/Engineers	[ ]
Contractors/Developers	[ ]
Code officials	[ ]
Plans checkers	[ ]
Field inspectors	[ ]

30. Do differing interpretations of the commercial energy code often lead to conflict between code officials and design professionals?

31. Are you comfortable with your understanding of the energy code, or would you like additional training?

32. If you need additional training, what type of training would you prefer?

Workshops [ ]
One-on-one assistance [ ]
Self-study training manual [ ]
Other:_____

33. What portion(s) of the code are you most interested in learning more about?

Building envelope [ ]
Mechanical systems [ ]
Lighting [ ]

34. Any further comments on how the code could be improved?

Follow-up questions on the energy code (Oregon only):

35. How much experience have you had with the State of Oregon Energy Code Compliance Manual (or the Energy Code Guidelines) and forms?

None [ ]
Some [ ]
Extensive [ ]

If they answer "Some" or "Extensive" on the above question, ask the following questions.

36. How much of the manual have you read?

Entire manual [ ]
Specific chapters [ ]
Reference use only [ ]

37. How did you acquire your manual and forms?

OBOA training session [ ]
Circuit rider program [ ]
Oregon Department of Energy [ ]
Other [ ]

38. Which version do you have?

November, 1989 [ ]
June, 1990 [ ]
Don't know [ ]

39. How easy did you find the process in reviewing the forms?

Difficult [ ]
Easy [ ]
Very easy [ ]

40. How easy was the manual to read and understand?

Difficult [ ]
Easy [ ]
Very easy [ ]

41. How easy was it to find the information you needed?

Difficult [ ]
Easy [ ]
Very easy [ ]

42. How would you rate the manual and forms overall?

Poor [ ]
Good [ ]
Excellent [ ]

43. For what types of buildings do you require the forms?

None [ ]
All buildings [ ]
Small buildings [ ]
Large buildings [ ]

44. Does your jurisdiction distribute copies of the Energy Code Guidelines?

Yes [ ]
No [ ]

45. How often does the permit applicant request training or assistance on completing the forms?

Often [ ]
Seldom [ ]
Never [ ]

46. Are the submitted forms complete and accurate?

Often [ ]
Seldom [ ]
Never [ ]

47. How would you rate the energy code compliance project overall?

Poor [ ]
Good [ ]
Excellent [ ]

48. Please describe any errors or inconsistencies you may have encountered in the manual and forms (Page number would be helpful)

49. What suggestions do you have for improving the manual and forms?