Guide Specifications: An Overlooked Avenue for Promoting Building Energy Efficiency

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ABSTRACT

Guide specifications, the templates from which individual building project specifications are based, can be written to require high-efficiency products or systems. This paper documents a few selected instances where federal, state, or commercial guide specifications have incorporated such provisions, resulting in estimated annual savings in 2010 of over $30 million. The argument is made that promoting higher efficiency through guide specifications has several advantages over other avenues, including the improvement of building codes. The paper calls for increased attention to this overlooked opportunity from the energy policy community.

Introduction

When an architect or engineer is assigned to create a specification to incorporate specific products or systems (for instance, electrical transformers or a sprinkler system) into a proposed building, he rarely starts from scratch. Instead, he will generally create the specification from a template, a more generalized "master" maintained either by his firm, the client's company or agency, or perhaps by a commercial specifications writing firm. These template specifications are referred to as guide, or master, specifications ("specs"). Their purpose is to provide the foundation for an individual project specification that not only meets the relevant codes, but also captures the collected wisdom from previous attempts (both successful and failed) to utilize such products or systems in similar building projects. Once the individual project specification is developed, it is then incorporated into the bid documents for the given construction or renovation project, contractually binding the chosen contractor to follow it.

This paper addresses the role that guide specifications can have in promoting energy-efficient products in commercial buildings. It documents several instances where this has already occurred and estimates the savings. It also discusses the advantages and disadvantages of using guide specs to promote greater energy efficiency, as compared to more conventional approaches, especially improvements to building codes.

Guide specifications are produced for sale in the U.S. by several commercial firms and are also maintained internally by some large corporations engaged in substantial in-house construction work. Several U.S. government agencies (Army, Navy, Veterans Administration, National Aeronautics and Space Administration, and the U.S. Postal Service) maintain their own guide specs, as do some states and large state universities.

Commercial guide specifications are generally quite flexible, providing a range of system and product options. Guide specs maintained by private firms, states, or the federal agencies, can be significantly more prescriptive. They effectively establish quality levels among the options offered by commercial specs. For instance, the State of Wisconsin requires that all distribution transformers installed in state buildings meet the highly efficient thresholds prescribed in the National Electrical Manufacturers Association (NEMA)'s Standard TP-1.

Examples of Energy-Efficient Guide Specifications

Guide specs can easily be written to exceed the minimum requirements of building codes, e.g., for safety or durability. Two federal agencies (the Army Corps of Engineers and the Navy), the State of Wisconsin, and a major U.S. commercial specifications writing firm (ARCOM Master Systems, publisher of MASTERSPEC®), have recently added to their guide specs energy efficiency requirements that substantially exceed the minimum levels required by the major national building codes. All of these building codes currently incorporate the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)'s Standard 90.1 as their energy efficiency component.

One instance where the Corps of Engineers exceeds code on energy efficiency is in its guide specification for electric water-cooled chillers. The Corps chose to adopt the efficiency levels proposed by the Department of Energy's Federal Energy Management Program (DOE/FEMP). DOE/FEMP is tasked by Presidential Executive Order 13123 with identifying thresholds in the upper 25% of efficiency for energy-using products. The Corps of Engineers' specification includes a table of minimum chiller efficiencies using the DOE/FEMP thresholds. In addition, it encourages efficiencies beyond the proposed threshold levels, directing users to prepare life-cycle cost analyses using energy and demand charges, and to "develop a sole source justification (if applicable) to procure the most life cycle cost effective chiller applicable." Similar high efficiency requirements are in other Corps of Engineers specifications for mechanical and electrical equipment such as heat pumps, unitary air conditioning equipment and electric motors.

The Navy has incorporated efficiency criteria that exceed code requirements in its guide specification for pad-mounted transformers (single- and three-phase). The spec incorporates simple tables that identify levels of full-load and no-load electrical losses to be specified for various electricity costs. Project spec writers, after determining electricity costs at the intended facility, are instructed to use the tables to select the most cost-effective transformers. The authors of the Navy's guide spec developed the tables by consulting major transformer manufacturers to identify approximate cost increments for higher efficiency models.

The apparently unprecedented inclusion by a commercial guide specifications service of energy-efficient stipulations is presently (Summer, 2000) occurring in the American Institute of Architect (AIA)'s MASTERSPEC®, authored by ARCOM Master Systems. ARCOM updates each section of MASTERSPEC® every three to five years. In the most recent revision to its electric chillers specification, ARCOM is adding a reference to the electric chiller standard of Green Seal, a U.S. environmental group. The Green Seal standard (GS-31) incorporates the "upper 25%" efficiency levels recommended by DOE/FEMP (the same ones referenced by the Corps of Engineers), as well as other environmental components (regarding refrigerant type and leakage rates). As stated above, MASTERSPEC® is a commercial specification system. It does not dictate the use of the Green Seal standard – it is an important part of ARCOM's mission to be inclusive of all, or at least most, codecompliant options for chillers or any other building product. However, it will prominently reference GS-31, and plans to provide the entire text of the standard in an appendix.

The State of Wisconsin maintains a set of guide specifications to be used by architects and engineers involved in constructing State buildings. Wisconsin has incorporated requirements for energy-efficient motors (complying with the Consortium for Energy Efficiency's "premium" thresholds) and distribution transformers (complying with the National Electrical Manufacturers Association's Standard TP 1 levels).

Each of the specifications described above is identified in Table 1, along with estimated dollar savings (to be discussed at length in the following section).

Savings Potential from Guide Specifications

The energy savings figures from the inclusion in these guide specifications of energy-efficient product provisions are dramatic. With the exception of Arcom's MASTERSPEC®, each of these guide specs is supposed to be a *de facto* mandatory standard. In other words, architects and engineers designing buildings for these organizations are directed to comply with the provisions, regarding energy efficiency and otherwise, in the guide specs (actual compliance rates have not been studied, though – this will be discussed in the conclusions). In the case of MASTERSPEC®, the adoption scenario is more difficult to estimate, since compliance with the Green Seal standard is not a requirement, but instead a voluntary option.

Although the effort to estimate the impacts of each of these energy-efficient guide specs is a broad-brush one – especially in the case of the MASTERSPEC® chiller specification – it does provide a picture of the impressive potential savings from including energy-efficient directives in guide specs. The results are summarized in Table 1. While we feel that our assumptions for the calculations are conservative, even if the savings figures are halved – due to incomplete compliance with the specs, lower equipment operating hours, reduced average product capacities, etc. – they are still very compelling.

The Army Corps of Engineers claims that its fiscal year 1998 military construction work represented about $1.5 billion in vertical construction. Additionally, the Corps does significant construction work for civilian federal agencies. In our work for DOE/FEMP, we estimate that an average size (500-ton) water-cooled chiller that just meets FEMP's "recommended" efficiency level (0.56 kW/ton) – the same minimum adopted by the Corps – will save about $7,200 in electric costs each year over a standard efficiency model (0.68 kW/ton). This assumes average load conditions and a conservative average electricity rate of $0.06/kWh (including all demand charges). Thus, if the Army installs 100 chillers in a year – a rough estimate by the head of its mechanical specifications – it stands to save about three-quarters of a million dollars ($750,000) annually from the efficiency stipulations in this specification.

The Navy specifier for transformers estimates that well over 1,000 liquid-filled transformers covered by its energy-efficient specification are installed in Navy projects each year. Annual savings from these transformers vary with capacity but frequently range from several hundred to well over a thousand dollars per transformer when compared to the typically specified standard efficiency models (DOE 2000). The savings from this upgraded specification is likely between half a million and a million dollars per year.

The estimated savings from the State of Wisconsin's transformers and motors specifications are also impressive, given the considerably smaller construction effort for State buildings. Wisconsin purchases transformers and electric motors for State Government facilities under its master specs. Their rough estimate is that about 50 transformers (worth approximately $500,000) are purchased each year. Assuming a conservative savings of $200 each per year, the annual savings from the specification would be about $10,000. Approximately 2,000 motors of various sizes and types worth about $4,000,000 are also purchased each year. Assuming an average 10 horsepower model operating at 3,000 equivalent full-load hours per year, the annual savings (again using $0.06/kWh) amount to about $70,000.

As mentioned previously, estimating the impact of ARCOM's inclusion of the energy-efficient Green Seal chillers standard is difficult, because it is an option only. MASTERSPEC® is widely used by U.S. architectural firms (with several thousand site-licensed subscribers) dwarfing its three major competitors (Matinkah 1998). The Air Conditioning and Refrigeration Institute (ARI) estimates that 3,600 chlorofluorocarbon-containing chillers were replaced in 1999 (ARI 1999). Assuming that two-thirds (2,400) were centrifugal and rotary screw compressor chillers covered by the Green Seal standard and 300 chillers of this type were placed in new buildings, then roughly 2,700 of these machines were installed in the U.S. during the year. If MASTERSPEC® was employed in one-third of the projects in which these chillers were installed (i.e., for 900 chillers) and one-fourth of the projects specified the Green Seal standard, this would affect 225 chiller installations. Again assuming operation at 2,000 equivalent full-load hours per year and electricity costing a conservative $0.06/kWh (demand inclusive), the resulting savings from installing these more efficient chillers, would amount to roughly one and a half million dollars ($1,500,000) per year.

Adding together the estimate of savings from the modified specifications by these four organizations' results in a total of more than three million dollars per year (see Table 1). It is important to note that this is the annual savings figure for the use of the four guide specs in one year alone. Given the same effect of these guide specs in promoting the higher-efficiency products in a second year (i.e., next year), as is likely, the savings would approximate $6 million ($3 million from the products installed in the first year, and another $3 million for the newly installed products); $9 million would be saved in the third year, and so on. Shown in the second to last column of Table 1 are the annual (not cumulative) savings that would occur in 2010 from ten years of installations pursuant to each of these specifications. The final column shows the cumulative effect after ten years. This is a static analysis; it assumes that increases in the minimum legal efficiencies of the products (e.g., through national standards or codes) would be mirrored by equal increases in the efficiencies of the corresponding guide specs.

Table 1. Savings from Profiled Energy-Efficient Guide Specifications

Organization	Products covered in guide spec	Est. annual savings from one year's installations	Est. annual savings in 2010 from ten years' installations	Est. cumulative savings by 2010 from ten years' installations
U.S. Army Corps of Engineers	Water-cooled electric chillers	$750,000	$7,500,000	$41,250,000
U.S. Navy	Liquid-filled distribution transformers	$750,000	$7,500,000	$41,250,000
State of Wisconsin	Distribution transformers, electric motors	$80,000	$800,000	$4,400,000
Arcom (MASTERSPEC®)	Water-cooled electric chillers	$1,500,000	$15,000,000	$82,500,000

One remarkable aspect of these impressive savings is how readily they can be achieved. It simply requires modest due-diligence research by the spec writers to develop confidence that the higher efficiency products are widely available and provide a good benefit-to-cost ratio for the agency, state, etc. Beyond that, implementation of these savings is accomplished through the "stroke of a pen."

Of course, the savings are not achieved without added first cost. More efficient products almost always cost more. However, all these products, when compared to their standard-efficiency alternatives, have reasonably short paybacks – ranging from two or three years to about five or six given average price premiums, electricity prices, and product duty cycles.

Guide Specs: A Policy Priority?

Given the demonstrated potential of guide specs as a means to promote energy efficiency beyond code levels, this area should clearly command much greater attention from the energy policy community. In the wake of a ten-year struggle that resulted in an only moderately more efficient commercial building energy standard (ASHRAE 90.1-99) – and left conservation advocates flustered – the desirability of pursuing efficiency gains through guide specs seems even more appealing.

There are numerous benefits, but also some potential negatives, in trying to promote efficiency through guide specs rather than through building codes or other conventional means (e.g., utility rebate programs or direct design assistance). Table 2 summarizes the relative strengths and weaknesses of various approaches.

Table 2. Relative Strengths of Approaches to Promoting Commercial Building Efficiency

Policy Mechanism	Breadth of Impact	Depth of Impact	Speed of Impact
ASHRAE 90.1	Very thorough – only potential gap is where areas do not adopt building codes based on major model code	Little – advances from previous standard, and compared to potential, are small	Very slow* – first must be incorporated into model codes, which must in turn be incorporated into state and local codes
Guide Specs	Varies – some specs are very directive, but may affect very little construction; others (e.g., MASTERSPEC®) are flexible but widely used	Varies – some specs promote vanguard efficiency while others do not exceed code-required levels	Fast – once finalized, impact is on any subsequent bldgs. planned
Utility Rebates	Minimal – affect generally on a limited number of projects, though local impact may be strong	High – assuming that threshold levels are set stringently	Fast – rebates usually given for complying projects in given fiscal year
Direct Assistance	Minimal – affect is generally on project-by-project basis	Usually high – potential for "deep" savings and on multiple measures	Fast – buildings addressed are affected immediately upon construction

* There is one exception to this: by virtue of the Energy Policy Act of 1992, certain efficiency levels for HVAC equipment become mandatory national minima at the same time they become effective in the standard, unless DOE chooses to pursue more stringent levels.

One conspicuous benefit of the guide specification approach is that modifications (such as increased efficiencies) become effective immediately. Contrast this with the incorporation of the ASHRAE standard. Once a revised standard becomes final, it must still be incorporated into the three regional model building codes (now consolidated into the "International Building Code"), which in turn must be incorporated by state and municipal codes (usually requiring legislative action) before actually being implemented. This process normally takes five to ten years, and may not ever be finalized if states or municipalities choose not to adopt the new model code.

Another advantage of the guide specifications route is that guide specs are generally written by one person or by a small group (with varying degrees of review). Unlike with the ASHRAE Standard, change does not require a quasi-consensus decision. Industry representatives, who may in some cases be inclined to block higher efficiencies, are often welcomed to review and comment on guide specifications, but they do not hold power to block provisions in them.

The use of guide specifications has another less obvious, advantage. Innovative technologies (an example might be light-emitting diode exit signs in the early 1990s) can be incorporated more quickly into a guide specification, without having to wait for approval of a comprehensive standard. This way, early adopters can provide the role model so often responsible for later widespread adoption of new technologies. Thus, a guide specification may serve the role of demonstrating to manufacturers, contractors and service personnel that a new technology or higher efficiency is viable. This serves to draw in additional manufacturers, instill confidence and reduce liability concerns – driving down the cost.

Since construction sectors such as federal, state and local governments, schools, medical institutions and military installations operate on longer time horizons, they may be able to incorporate the introduction of new technologies or higher efficiency products into their building practices and accept longer payback periods. Because the larger design and construction community bids on these projects, energy-efficient guide specifications become incorporated into other building designs and are thus diffused into the larger private building community. Indeed, Wisconsin firms that are regularly involved in State construction work have then gone on to use the same (State) guide specifications in performing work for other clients (Mapp 2000).

On the other hand, no single set of guide specifications has the comprehensive impact of the ASHRAE Standard. Indeed, though only a small number of guide specs may govern the construction of a substantial proportion of U.S. buildings, there are no doubt several hundred sets of guide specs used in the country. However, the total is primarily comprised of the "office masters" of private architectural and engineering firms, some of which are responsible for only a few buildings. Because of the great number of sets of guide specs, the number of "converts" necessary to attain a thorough "market transformation" impact on a building product – approximating that of the ASHRAE standard – is considerable.

Research into the impacts of guide specifications is clearly warranted. One obvious issue that needs study is the issue of adherence to provisions (such as those requiring high-efficiency products) within guide specs, both as they are edited into project specifications, and also as these project specs are translated into actual building construction by contractors. The authors of the guide specs profiled in this paper feel that their specs are rarely compromised. They cite a disincentive on the part of project specifiers – because of the added effort and risk involved in a change – and a legal obligation for contractors (since project specifications become part of the construction contract). Nonetheless, actual compliance rates with guide specifications are certainly well worth investigating.

Despite some unanswered questions about the specifics of how these specs are actually utilized, it is clear that by applying focus and pressure on energy-intensive products and systems in widely used guide specs, an enormous savings of energy is possible at very little cost. To date, guide specifications have been almost totally overlooked as a means to promote greater efficiency in commercial buildings. Some spec writers are aware of what a powerful tool guide specs can be, but spec writers do not tend to interact with energy policy analysts and advocates. It is time for the energy policy community to take an active role in researching, developing and promoting energy-efficient guide specifications.

References

Air-Conditioning and Refrigeration Institute. 2000. "Survey Estimates Continued Use of CFC Chillers; Nearly Two-Thirds Still in Service." *Koldfax* (monthly newsletter).

Mapp, James. 2000. Personal communication. State of Wisconsin, Division of Energy & Intergovernmental Relations.

Matinkah, Angela. 1998. Personal communication. ARCOM Master Systems.

U.S. Department of Energy (DOE). 2000. *Buying Energy Efficient Products*. Washington, D.C.: Government Printing Office.