

# **A Public Work in Progress: Incorporating Energy Efficiency Into Guide Specifications for New Federal Construction**

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## **ABSTRACT**

Guide specifications, the templates from which individual building project specifications are developed, should require energy efficient products and design. Incorporating energy efficiency requirements into guide specification for building envelopes, mechanical and electrical equipment, and installed special purpose equipment can result in substantial long term reductions in energy consumption and operating cost for federal facilities. This presentation builds on the concepts introduced in a previous Summer Study paper on integrating efficiency requirements into guide specifications (Coleman 2000).

The authors address current efforts to incorporate energy efficiency recommendations into the Department of Defense (DoD) Unified Facilities Criteria (UFC) and Unified Facilities Guide Specification (UFGS) (DoD 2002). This initiative unifies guide specifications of the military services and those of other federal agencies. An example of the impact guide specifications have on military housing is presented along with a brief discussion of other efficiency standards and programs. The paper concludes by suggesting actions federal agencies can take to facilitate this process.

## **Guide Specifications – The Basis for Quality and Performance in Buildings**

The contract documents for every major building construction or renovation project include a set of specifications that contain written descriptions of the quality and performance expected from materials, equipment, systems and workmanship. Preparing specifications is a difficult process because of the complex nature of building construction and the need to clearly express quality and performance standards to a broad audience. Although specifications are customized for individual projects, they are based on master or guide specifications.

There is a clear federal mandate for government agencies to purchase products that are energy efficient. Agencies must purchase items that are either labeled as ENERGY STAR<sup>®</sup> or “are in the upper 25 percent of energy efficiency as designated by the Federal Energy Management Program.” Further supporting this policy is the Federal Acquisition Requirement (FAR), which states that agencies shall “implement cost-effective preference programs favoring the acquisition of energy efficient products.” The Federal Energy Management Program (FEMP) was established to help federal agencies meet this mandate.

Several federal agencies, including the military, Veterans Administration and Postal Service, maintain their own guide specifications to ensure uniformity in the construction

of their facilities. Since these are the templates by which many federal building project specifications are developed, FEMP is working with these agencies to incorporate its purchasing recommendations into their guide specifications.

### **Federal Efforts to Achieve Uniformity – The Unified Facilities Criteria / Guide Specification (UFC/UFGS)**

House Conference Report 105-247, dated September 9, 1997 directed the Department of Defense (DoD) to prepare a report by March 31, 1998 to address: “areas where uniform procedures, systems and/or criteria are already in use, other possible areas where it may be practical to create more uniformity, and the most cost effective system for implementing improvements.” (US Congress 1997). In their response, the military services reported that 43% of their specifications were already unified, and most of the remaining specifications could be unified. The report recommended the most effective approach to unifying the remaining specifications was to use the existing Tri-Service Working Group to manage the effort.

Based on this, DoD directed the Tri-Service Working Group to administer a process of developing, maintaining, and promulgating the Unified Facilities Criteria (UFC) and Unified Facilities Guide Specification (UFGS) documents. This group consists of representatives from the Headquarters US Army Corps of Engineers (HQUSACE), the Naval Facilities Engineering Command (NAVFAC), and the Air Force Civil Engineering Support Agency (AFCESA). The group collected all facilities criteria and guide specifications issued by all the services into an index. When more than one service document address the same topic, they were coded to indicate the “owning” service. Once the criteria and specifications are unified into a single document this coding is eliminated. As a result, the documents currently carried in the index range from relatively new to quite old. The group is prioritizing the remaining criteria and guide specs to establish the sequence in which they will be revised, based on need and available funding.

The National Aeronautics and Space Administration (NASA) recently adopted the UFC/UFGS and become part of the group. However, there are some other federal agencies with major construction programs that have not joined this process.

### **Incorporating FEMP and ENERGY STAR Efficiency Recommendations into the UFC/UFGS**

Facilities criteria and guide specifications are powerful documents for improving the energy efficiency of federal facilities because they direct contractors’ selection of materials and products in construction and renovation projects. In general a construction or renovation contract specifies the scope of work the contractor is to complete and the performance requirements of the various building systems, but leaves the selection of products to the contractor. If the contractor is not directed to meet specific energy efficiency requirements, then energy efficiency will not be primary decision criterion in equipment selections. Including energy efficiency requirements in the guide specifications means they will also be incorporated into the performance requirements of project specific contracts. This, in turn, drives contractor to construct more efficient

buildings. Incorporating the FEMP and ENERGY STAR criteria into the guide specification will also leverage a large amount of construction dollars for the purchase of energy efficient products.

Recognizing the importance of uniform, government-wide product energy efficiency recommendations, FEMP has been a contributor to the Tri-Service Working Group developing the UFC/UFGS. As individual UFC/UFGS sections have been addressed and individual service specifications integrated, FEMP has provided information on its energy efficiency recommendations along with supporting information. While this effort provides an avenue for the FEMP and ENERGY STAR efficiency recommendations to be considered for UFC/UFGS, it also provides a practical insight into the magnitude of the UFC/UFGS development effort and the extended period of time required to perform this extremely complex task. The unification of separate criteria and guide specs is still a work in progress, and many sections have not yet been reviewed and updated.

Two of the most important factors for achieving consistently high levels of efficiency in federal facility construction and renovation projects are: 1) the uniform application of well crafted guide specifications for all construction and renovation, and 2) keeping these energy efficiency requirements current with changing technology. Technologies to increase the productivity of energy use are constantly evolving, and advance even faster in times of volatile prices, energy shortages, and national crisis. As a result, standards and specifications must be managed as living documents, continuously reviewed and updated. For example, the recent electricity crisis in California and other states prompted new technologies to reduce energy use in general, and peak electricity demand specifically, to be deployed on a faster schedule. Broader market acceptance and availability will follow for those products that prove to be effective. Specifications must also be readily available to the design and construction community. In addition, to foster confidence in their validity among the users, the process by which they are developed must be both transparent and accessible.

To find out the extent to which DoD has adopted FEMP and ENERGY STAR recommendations, FEMP conducted a review of some UFGS documents covering primary energy using systems. The review process selected individual FEMP and ENERGY STAR commercial products appropriate to the types of commercial and industrial building components specified in the UFGS, and reviewed the UFGS requirements for these product types. Because of differences in structure of the FEMP recommendations and the UFGS, there were often several UFGS sections that addressed a particular FEMP Product Recommendation. For the purpose of presentation, these have been aggregated to provide an overview on the status of energy efficiency requirements in the UFGS.

Several comments are in order before discussing the overall findings. First, these are interim findings, as the integration of service specifications into unified UFC/UFGS specifications is not yet complete. However, this also presents an opportunity for close collaboration between the energy efficiency community and the UFC/UFGS Tri-Service Working Group.

The authors reviewed specifications for a number of products within four categories to determine the level of energy efficiency required. The results are summarized in the chart below. The rating system, scaled from no stars (O) to three stars, is as follows:

- O -No efficiency requirement currently in UFC/UFGS
- \* -UFGS efficiency requirement less stringent than FEMP/ ENERGY STAR
- \*\* -UFGS efficiency requirement essentially equal to FEMP/ ENERGY STAR
- \*\*\* - UFGS efficiency requirement more stringent than FEMP/ ENERGY STAR.

Where several UFGS sections are combined and their requirements vary, multiple entries been used to indicate a range of efficiency levels. For those products not addressed by ENERGY STAR: “Yes” indicates an efficiency requirement is given but we have not judged the level, a single star in parentheses indicates we feel a moderate efficiency requirement is specified, and triple stars in parentheses indicate we feel a high efficiency requirement is specified. These ratings reflect the judgment of the reviewers.

We also have made qualitative assessments of the possible impact for each product type, based on a judgment about the quantities purchased and the degree to which improved efficiency for that product can significantly reduce energy use at the facility level for the federal sector. The purpose is to focus on those products where the potential for savings is greatest. The scale used here is simple: H – high, M – medium, and L – low.

Incidentally the analysis also highlights products specified in the UFGS documents that are not covered by FEMP or ENERGY STAR. This may indicate new product categories for which FEMP should develop efficiency recommendations.

Table 1 lists important energy consuming products specified within the UFGS and shows how efficiency levels compare with the FEMP and ENERGY STAR recommendations. Even though the data are aggregated and therefore generalized, this table does provide insight into where the FEMP and ENERGY STAR work can be leveraged in the revision process. A few examples serve to illustrate this point.

Within the Commercial Equipment category in UFGS, specifications for commercial boilers range from providing no recommended minimum efficiency to efficiency levels lower than those recommended by FEMP. In UFGS Section 1551N, updated in September 1999, there is no specific efficiency requirement stated. The FEMP recommendation is that commercial space heating boilers with output capacities between 300 KBtu/h and 10 MBtu/h should have thermal efficiency (as defined by ANSI Z21.13) of at least 80% if gas fired, and 83% if oil fired. FEMP has researched this equipment in detail, and the published Recommendation provides users with sources of boiler thermal efficiency testing and manufacturers of compliant equipment.

In the Commercial Industrial Technologies category, there are several sections addressing electric motors that have yet to be integrated. Of these two provide no efficiency recommendations and a third, dated 1993, references outdated National Electrical Manufacturers Association (NEMA) documents. However, an additional section, 16415A, was revised in February 2002 and provides highly detailed efficiency recommendations for all motors addressed by FEMP, most of which match, or in a few instances exceed, FEMP recommendations.

The electric motor industry is moving in the direction of producing even more efficient equipment. Recently NEMA initiated a labeling program to promote these products. The Consortium for Energy Efficiency (CEE), a group that coordinates utility and state funded energy efficiency efforts, has worked with the electric motor industry in the development of the “NEMA Premium” program. FEMP recently revised its

recommendations to be in line with NEMA and CEE. It would be beneficial if all sections of the integrated guide specification used the same criteria.

**Table 1. UFC/UFGS Requirements Overlap with FEMP/ ENERGY STAR Efficiency Recommendations**

| UFC/UFGS Products Specified   | Efficiency Criteria | Impact |
|---|---------------------|--------|
| <b>FEMP/ENERGY STAR products:</b>   |                     |        |
| <b>Commercial Equipment</b>   |                     |        |
| • Electric Chillers (air- and water-cooled)   | O,*,**              | H      |
| • Unitary Air Conditioners  | O,*                 | H      |
| • Heat Pumps  | O,*,**              | H      |
| • Commercial Boilers  | O,*,**              | H      |
| • Ground Source Heat Pumps  | *                   | M      |
| <b>Commercial Industrial Technologies</b>   |                     |        |
| • Distribution Transformers   | O,**,***            | M      |
| • Electric Motors   | O,*,**,***          | H      |
| <b>Lighting Technologies</b>  |                     |        |
| • Fluorescent Fixtures & Lamps  | O,*,**,***          | H      |
| • Lighting Controls   | *                   | H      |
| • High Intensity Discharge Fixtures & Lamps   | O                   | M      |
| <b>Other Products (not FEMP/ENERGY STAR)</b>  |                     |        |
| • Evaporatively-cooled split & packaged systems, less than 65KBtu/h, 65KBtu/h – 135KBtu/h     | Yes                 | L      |
| • Unitary air-cooled split & packaged systems, greater than 240 KBtu/h                        | (***)               | L      |
| • Unitary water-cooled spit & packaged systems, 65 – 135 KBtu/h, greater than 135Kbtu/h       | (***)               | L      |
| • Steam Boilers greater than 10 MBtu/h (industrial scale)                                     | (*)                 | L      |
| • Warm air heating systems – unit heaters, wall furnace, duct furnace                         | Yes                 | L      |
| <small><sup>a</sup> See text for explanation of efficiency criteria and impact scales</small> |                     |        |

Table 1 also illustrates the product areas in which the UFGS sections meet or exceed recommendations by FEMP or ENERGY STAR. For example, in the area of distribution transformers two sections directly reference NEMA TP-1 efficiency levels as a minimum requirement (NEMA 1996). Moreover, several sections, 16272N, 16273N, 16301N, and 16360N, go beyond either FEMP or ENERGY STAR recommendations by providing the user with tables of transformer loss and impedance data, and corresponding energy cost data, to enable specifiers to optimize transformer losses based on facility-

specific load curves and actual electrical costs. These tables have reportedly been developed in conjunction with manufacturers, to ensure product availability and reliability of cost data. Although FEMP has not assumed that many users have this level of technical sophistication, the UFGS sections do enable technically oriented staff to use these tables to ensure exceptionally high levels of transformer efficiency.

In summary, our interim review of selected UFGS sections specifying energy-consuming products shows that DoD has made much progress by including many current energy criteria in their unification efforts. Considerable opportunity remains for them and the other federal agencies to further incorporate efficiency standards in the process of unifying and updating UFC and UFGS documents. The Tri-Service Working Group has inherited an extensive collection of guide specifications from a variety of sources, and faces a formidable task in consolidating them into a single set of documents that reflects the most current technology. Continued cooperation among the UFC/UFGS developers and FEMP and ENERGY STAR can add significant value to the benefit of both the agencies using UFC/UFGS and the organizations tasked with providing technical assistance to achieve mandated efficiency standards.

## **Other Federal Energy Efficiency Standards and Complementary Programs**

In addition to FEMP and ENERGY STAR, there are other federal standards and programs dealing with energy efficiency in buildings. Some industry groups and non-governmental organizations also sponsor efficiency programs.

One of these is the “Energy Code for New Federal Commercial and Multi-Family High Rise Residential Buildings” that took effect on October 8, 2001. This Department of Energy (DOE) rule includes efficiency standards for lighting, mechanical ventilation, motors, building envelopes, fenestration rating test procedures, and test procedures for heating and cooling equipment. Section 305(a) of the Energy Conservation and Production Act (ECPA) requires that DOE establish energy standards that meet or exceed ASHRAE/IESNA 90.1. These are mandatory for all new federal buildings and major renovations. ECPA also requires that the federal standards meet or exceed specifications of the 1992 Model Energy Code for residential buildings. ECPA Section 306 prohibits the head of any federal agency from spending federal funds for the construction of a new federal building unless it meets or exceeds these standards. An initial review of this code reveals broad categories of overlap with the UFC/UFGS provisions for energy efficiency; in general the UFC/UFGS efficiency criteria are more stringent.

The programs that deal with energy efficiency in buildings include ENERGY STAR for Homes (EPA), Building America (DOE), Rebuild America (DOE), Partnership for Advancing Technology in Housing (HUD) and Leadership in Energy and Environmental Design (US Green Building Council). Some of these programs strictly address energy efficiency, while others include efficiency within a broader context of sustainability. Some are clearly cutting-edge, focused on the highest efficiency segment of the market, while others establish a minimum acceptable standard of performance. Some programs cover specific segments of the building industry, such as housing, while others are more broadly focused.

## **Savings Potential of Guide Specifications - Military Family Housing**

Military family housing (MFH) is a relevant example of the potential that incorporating energy efficiency criteria into guide specifications can have on new federal facilities. One of the means that DoD relies on for housing its married or single head of household personnel is MFH units that are built, owned and operated by the services. Because military construction (MILCON) uses funds appropriated by Congress, DoD has direct control over the standards to which it is constructed. This section focuses only on family housing, not on barracks for single military members.

MFH construction is governed by guide specifications published by both the USACE and NAVFAC. The Air Force has adopted Army standards. Table 2 summarizes a comparison of these two guide specifications with FEMP and ENERGY STAR recommendations.

We were favorably impressed with the results of this comparison. As the table illustrates, both USACE and NAVFAC have incorporated the FEMP and ENERGY STAR recommendations into their specifications. Most of the products specified require the ENERGY STAR label. These guide specifications also contain progressive requirements for heating and air conditioning system design, construction methods, solar applications, as well as performance testing and verification.

Home Energy Rating System (HERS) analyses performed by the Environmental Protection Agency (EPA) estimate that MFH units built to these specifications would be between 35 and 50% more efficient than homes built to meet Model Energy Code. Since HERS does not include lighting and appliances, the services will achieve additional savings. ENERGY STAR for Homes granted “equivalent program” status to both the USACE and NAVFAC. The services have only to submit documentation to EPA that new MFH units were built to their guide specification and they will receive the ENERGY STAR labels to place on the electrical panels.

In the current fiscal year the Army MILCON program includes funding for the construction of approximately 300 MFH units in the continental United States. Utility cost savings will vary between \$20 and \$40 per unit each month depending on climate. By incorporating the FEMP and ENERGY STAR recommendations into their guide specifications the Army will save between \$72,000 and \$144,000 per year on utility cost for these 300 homes.

Through a conversation with a representative from NAVFAC, we learned that future distribution of their guide specifications would be on-line. This will allow headquarters to revise the document easily. Major updates will be completed as needed, but typically no more than every two years. In the near future, personnel from regional commands and bases will be able to download the most recent version of the MFH guide specifications whenever they need it.

**Table 2. Military Family Housing Energy Efficiency Requirements**

| <b>Products Specified</b>            | <b>USACE<br/>(TI 801-02)</b> | <b>NAVFAC<br/>(11101.85H)</b> |
|--------------------------------------|------------------------------|-------------------------------|
| <b>FEMP/ENERGY STAR products:</b>    |                              |                               |
| <b>Envelope</b>                      |                              |                               |
| • Windows - Thermal                  | ***                          | ***                           |
| • Windows - SHGC                     | 0                            | *                             |
| • Windows – Air Leakage              | ***                          | ***                           |
| <b>Equipment</b>                     |                              |                               |
| • Boilers and Furnaces               | **                           | **                            |
| • Heat Pumps – Air and Ground Source | **                           | **                            |
| • Central Air Conditioners           | **                           | ***                           |
| • Exhaust Fans                       | 0                            | **                            |
| • Ceiling Fans                       | *                            | **                            |
| • Water Heaters – Gas and Electric   | **                           | **                            |
| • Programmable Thermostats           | **                           | **                            |
| <b>Appliances</b>                    |                              |                               |
| • Refrigerators                      | **                           | **                            |
| • Dishwashers                        | **                           | **                            |
| <b>Lighting</b>                      |                              |                               |
| • Fluorescent Lamps                  | *                            | 0                             |
| • Fluorescent Ballasts               | 0                            | 0                             |
| • Compact Fluorescent Lamps          | *                            | 0                             |
| • Light Fixtures                     | 0                            | **                            |
| <b>Other</b>                         |                              |                               |
| • ENERGY STAR for Homes              | Required                     | Required                      |
| • Envelope Air Sealing               | Required/Tested              | Required/Tested               |
| • HVAC System Design                 | Required                     | Required                      |
| • Ducts – Air Leakage                | Required/Tested              | Required/Tested               |
| • Sustainable Design                 | Optional                     |                               |
| • Passive Solar Measures             | Optional                     |                               |
| • Advanced Framing                   |                              | Optional                      |
| • Raised Heel Trusses                | Required                     |                               |



## Conclusions and Recommendations

While UFC/UFGS started as a DoD only program, many of the types of facilities DoD builds and manages are like those of other agencies. Although there are some mission-unique requirements, the military facilities themselves and the energy consuming equipment within them have much in common with civilian buildings. We believe that it is in the government's interest to encourage all federal agencies to adopt the UFC/UFGS and participate in the UFC/UFGS process. This would improve consistency of construction standards and raise the level of energy efficiency across the federal sector, while still giving agencies the option to add their own mission-specific criteria to the basic UFC/UFGS document, either for individual projects or for all projects with specialized requirements.

A recent review by FEMP of DoD's specifications and standards issued to date indicates high levels of energy efficiency requirements in many of the documents. In general, the more recent specifications are the most likely to include strong energy efficiency requirements, indicating this is a high priority for DoD, but also that a number of older documents are in need of updating. The updates are included in the UFC/UFGS program plan, and participation by FEMP could help accelerate those efforts. For the UFC/UFGS specs that do include energy efficiency requirements, some specify a numerical value while others reference existing standards or recommendations by others such as FEMP and ENERGY STAR. In the cases where numerical values were cited, some corresponded to the existing FEMP or ENERGY STAR criteria, while others did not. Where UFC/UFGS criteria differ from FEMP or ENERGY STAR, they generally are not as stringent. There are a few cases where the UFC/UFGS value is higher. It is not always easy to determine the rationale for choosing a specific criterion.

The federal government established the FEMP and ENERGY STAR programs to identify and encourage the purchase of highly efficient, cost-effective equipment available on the market. In our view these criteria are appropriate for the Tri-Service Working Group to adopt across all UFC/UFGS sections that include covered equipment. While there may be a few occasions where the FEMP and ENERGY STAR efficiency criteria are not universally appropriate due to site-specific or mission-specific requirements, these situations should be the exception rather than the rule. By simply referencing the FEMP and ENERGY STAR criteria, those charged with maintaining and updating the UFC/UFGS will not be forced to continuously monitor changes in individual FEMP or ENERGY STAR criteria or to constantly update their specifications except where efficiency recommendations are developed for new products not currently covered.

FEMP and ENERGY STAR do not cover all items included in the UFC/UFGS. The two programs are both adding new equipment and systems as well as keeping existing standards and recommendations current with changing technology and market conditions. We believe that it would be of mutual benefit for FEMP, and possibly ENERGY STAR, to establish a more formal relationship with the UFC/UFGS effort as an explicit participant in those sub-groups dealing with energy-related equipment. The purpose would be twofold. First, equipment that is important to DoD and other federal agencies but not currently covered by FEMP or ENERGY STAR recommendations could be moved up on the priority list for future work. Second, by working more closely with FEMP and ENERGY STAR, UFC/UFGS would have a better appreciation for the analysis of product

efficiency underlying the recommendations and may be more ready to adopt them in future UFC/UFGS revisions. For example, DoD specification writers must be sure that any criteria they use will result in equipment selections that are easily maintained and for which there is adequate commercial competition among manufacturers and suppliers, both to meet FAR standards for competition and to ensure competitive pricing. Through this working relationship, both DoD and FEMP will be able to appreciate each other's points of view and program requirements.

There are currently several programs directed at efficiency and sustainability in federal buildings. Some of these may be complementary, but as a whole they create a confusing pattern for program managers in DoD and civilian agencies alike. We believe that there should be more effort to bring together the agencies and outside organizations sponsoring these programs to determine how they can best relate to each other, make changes to create a coherent set of policies and implement actions, and then cooperate in preparing outreach materials and campaigns to inform federal program managers and designers how to choose and combine programs to meet the needs of each project. Because both the FEMP and UFC/UFGS efforts are government-wide efforts and still relatively early in their evolution, a closer link now would help both to set priorities and to see their results effectively used.

This process has already been completed for residential construction. Both USACE and NAVFAC have revised their MFH guide specifications to include FEMP and ENERGY STAR recommendations. New on-line processes will allow these guide specifications to be updated quickly. The results are that new federally owned and operated housing units will consume much less energy and have lower operating cost than typical residences. When this process is completed for non-residential buildings it will result in substantial long-term reductions in energy consumption and operating cost for facilities throughout all federal agencies.

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