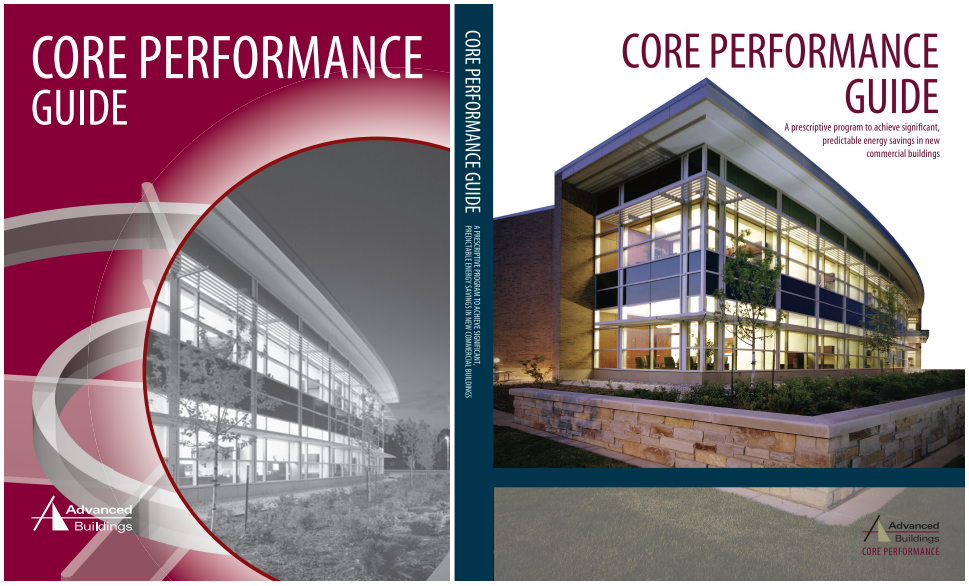
nbi new buildings institute



Updates and Errata

This file contains updates and errata for the 1.01 through 1.12 print editions of the *Advanced Buildings Core Performance Guide.* These errata and updates are produced as drop-in cut sheets that can be printed and added to your *Core Performance Guide*.

Core Performance was first published in 2007 and has been sunset. Therefore, it will not be receiving any development beyond the updates and errata contained in this file. If you have any questions, please e-mail info@newbuildings.org.

March 2017

Advanced Buildings Core Performance Guide Errata Sheet (version 1.01) The following are updates made to the *Core* ***Performance Guide*** **print version 1.01.**

Added “Integration of Core Performance with USGBC LEED Program” section

Key Design Phases of Implementation of Core Performance Program Criteria Chart (p. 22) Added 3.2 Daylighting and Controls to Required Strategies list

Role of Project Team Members in Implementation of Core Performance Program Criteria Chart (p. 23-24) Added 3.2 Daylighting and Controls to list of criteria for Architects and Lighting Designer

Integration of Core Performance with USGBC LEED Program

New content describing how Core Performance works with LEED.

1.1 Identify Design Intent (p. 32) Corrected requirement from ENERGY STAR score (from 75 to 90). New content reads: “Use Target Finder to obtain the energy performance rating of your design—scores of 90 and higher qualify (part of Criteria 1.2)

1.2 Communicating Design Intent (p. 33) Corrected requirement from ENERGY STAR score (from 75 to 90). New content reads: “A copy of the Statement of Energy Design Intent indicating a score of 90 or higher using ENERGY STAR Target Finder.”

Appendix: A.1 Outdoor Air (p. 105) Corrected reference to Credit 1.11 to read Credit 2.3 in all cases.

Advanced Buildings Core Performance Guide Errata Sheet (version 1.02)

INTRODUCTION:

Core Performance and LEED (page 14) New USGBC Statement as follows;

The *Core Performance* program also represents a comprehensive approach to the energy performance aspects of the LEED program. The USGBC has adopted Core Performance as a prescriptive achievement path for LEED. Specific requirements for using Core Performance in LEED are described later in this section (see page 25). The USGBC determines how Core Performance is recognized by LEED. Projects should confirm LEED requirements with USGBC.

Integration of Core Performance with USGBC LEED Program (page 25)
New content describing how Core Performance works with LEED please read below.

> **Revised: Integration of *Core Performance* with USGBC LEED Program**
>
> The USGBC has adopted the Core Performance Program as a prescriptive path to meet energy performance requirements of the LEED NC program. The program can be used in lieu of energy modeling to demonstrate achievement of EA credit 1 (Optimizing Energy Performance) as follows:
>
> For projects using LEED NC version 2.2 and previous versions, the Core Performance Program is worth 2 to 5 EAc1 points, depending on project conditions and how the program is used. Any project using the Core Performance program for LEED must meet *all* of the requirements in Sections One (*Design Process Strategies*) and Two (*Core Performance Requirements*) of the Core Performance Guide. No substitutions or tradeoffs are allowed in meeting these requirements. No project over 100,000 square feet may use the Core Performance Program to achieve LEED points.

(page 25 cont)

The number of EAc1 points achieved by following program requirements is dependent upon project type. Office, School, Retail, and Public Assembly project types achieve 3 EAc1 points for following the program requirements. All other project types achieve 2 EAc1 points for following the program requirements. Hospital and Lab project types may not use the Core Performance Program to achieve LEED energy points. The USGBC requires all LEED 2.2 projects to achieve at least 2 EAc1 points to receive a LEED rating.

All projects using Core Performance may achieve up to 2 additional EAc1 points in LEED by implementing additional strategies from Section Three (Enhanced Performance Strategies) of the Core Performance Guide. One additional EAc1 point is achieved for every three Enhanced Performance Strategies implemented. However, some of the enhanced strategies are not eligible in LEED and do not count toward additional EAc1 points. These strategies are 3.1 Cool Roofs, 3.8 Night Venting, and 3.13 Additional Commissioning. These measures are addressed elsewhere in the LEED program.

For LEED 2009, the USGBC has modified the point structure for EAc1. All projects must exceed ASHRAE 90.1-2007 requirements by at least 10% before any EAc1 points are awarded. The Core Performance Program is still eligible as a prescriptive path for LEED 2009. The guidelines for the program are the same as those listed above, except that in every case the first two 'points' are not counted in EAc1 but instead go toward meeting the prerequisite requirements
of this credit. For example, a lodging project which would have achieved two points in LEED NC 2.2 would achieve zero EAc1 points in LEED 2009, but would meet the prerequisite requirements of EAp2, and would therefore not be required to conduct energy modeling. This project could still achieve up to 2 EAc1 points by implementing Core Performance enhanced strategies as described above. Office, School, Retail, and Public Assembly projects which implemented Sections One and Two of the Core Performance Guide would achieve the prerequisite, as well as one EAc1 point. These projects would also be eligible to achieve up to two additional EAc1 points by implementing enhanced strategies, as described above.

LEED CI projects may use a subset of Core Performance (sections 1.4, 2.9, and 3.10) to achieve EAc1 points, as described in the LEED Reference Guide.

The USGBC has developed submittal requirements for the Core Performance Program as part of the LEED on-line submittal process. The USGBC may modify the way LEED uses Core Performance, so project teams should check with the USGBC for any modifications to the requirements described here.

CORE PERFORMANCE REQUIREMENTS:

2.7 Lighting Controls (page 56)
Figure 2.7.1 Occupancy Sensors footer now reads

> Occupancy sensors can save substantial amounts of energy by turning lights off when a space is unoccupied. This graph shows the relative energy use of a pre-programmed timeclock vs. occupancy sensors with a 20 minute delay in a typical school classroom application

C- Time Clock Controls (page 57)
Exceptions to automatic Control Requirements: added

- Lodging guest rooms

2.9 Mechanical Equipment Efficiency Criteria (page 62)
Second bullet now reads

- Gas Unit Heaters shall include an intermittent ignition device and have either power venting or a flue damper. Gas Furnaces <225,000 Btu/hr should have an AFUE rating of 90 or higher. Gas furnaces that are part of rooftop package equipment should have an AFUE of at least 80.

2.9.2 Unitary and Applied Heat Pumps, Electrically Operated Chart (page 64)

Edits to table are marked in yellow.

TABLE 2.9.2 - UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY OPERATED

(Voluntary guidelines for use in energy efficiency programs. For Terms and Usage, please see the CEE website at www.cee1.org.)

EQUIPMENT TYPE	SIZE CATEGORY	SUB-CATEGORY OR RATING CONDITION	REQUIRED EFFICIENCY
AIR COOLED, (COOLING MODE)	< 65,000 Btu/h	Split System	15.0 SEER* 12.5 EER
		Single Package	15.0 SEER* 12 EER*
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	11.5 EER 11.9 IPLV
	≥ 135,000 Btu/h and <240,000 Btu/h	Split System and Single Package	11.5 EER 11.9 IPLV
	≥240,000 Btu/h	Split System and Single Package	10.5 EER 10.9 IPLV
AIR COOLED (HEATING MODE)	< 65,000 Btu/h (Cooling Capacity)	Split System	8.5 HSPF
		Single Package	8.0 HSPF
	≥ 65,000 Btu/h and < 135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.4 COP
		17°F db/15°F wb Outdoor Air	2.4 COP
	≥ 135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.2 COP
		17°F db/15°F wb Outdoor Air	2.1 COP
WATER SOURCE (COOLING MODE)	< 135,000 Btu/h (Cooling Capacity)	85°F Entering Water	14.0 EER
WATER-SOURCE (HEATING MODE)	< 135,000 Btu/h (Cooling Capacity)	70°F Entering Water	4.6 COP

Source: Consortium for Energy Efficiency (June 2008). CEE's high-efficiency specifications are periodically revised. For the most current version, please see the CEE website at www.cee1.org/com/hecac/hecac-main.php3

** These CEE Tier 2 values (as of June 2008) were incorporated into Core Performance in December 2008, version 1.02.*

2.13 Fundamental Economizer Performance (page 71)
Criteria Edited as follows

When economizers are required/installed, they should incorporate the following features. Performance of these features should be verified at project completion.

- **Proportional damper control.** For hydronic cooling coils, locate an analog sensor upstream of the cooling coil in a location where the return and outside air streams have been adequately mixed to control the economizer's modulating dampers. For direct expansion cooling coils, locate the analog sensor downstream of the cooling coil to control the economizer's modulating dampers.

- **Relief air and modulating return air damper.** Provide relief air with either a barometric damper in the return air duct upstream of the return air damper, a motorized exhaust air damper or an exhaust fan with backdraft dampers. Return air relief and outside air intake hoods shall be installed so that relief dampers operate freely.

ENHANCED PERFORMANCE STRATEGIES

3.14 Fault Detection and Diagnostic (page 94)

Sample FDD Criteria Paragraph changed to 60-70+%

This is not an exclusive list of diagnostic functions. This list covers the minimum set in including refrigeration cycle, economizer and controls. These are the recommended minimum fault alarm set that should be specified in the HVAC equipment bid specification. At this time, there are limited models that would meet 100% of the FDD functions listed. However, HVAC equipment that meets the requirements of Criteria 2.9, Mechanical Equipment Efficiency (CEE Tier 2) will at minimum include the 60-70+% of the functions listed. Manufacturer's technical manuals provide detailed descriptions of embedded and optional fault alarms functions.

Update to Version 1.11

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ABOUT NEW BUILDINGS INSTITUTE

New Buildings Institute (NBI) is a nonprofit corporation helping make buildings better for people and the environment. NBI supports policies, accelerates the adoption of new technologies and practices, and enables field research that improves the energy performance of new commercial buildings.

NBI works with national, regional and state organizations, as well as with utilities and design professionals, to advance our mission. We closely coordinate our building research, design guidelines and other tools, as well as policy efforts so that all of the elements of good building design are integrated into the products and services we make available for use by energy efficiency programs and building professionals throughout the country.

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Western Massachusetts Electric (WMECO)

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DEVELOPMENT PROCESS FOR *ADVANCED BUILDINGS CORE PERFORMANCE*

The Criteria and information provided in *Advanced Buildings Core Performance* is based on NBI's previous *Advanced Buildings* protocol, *Benchmark*. New Buildings Institute developed *Benchmark* following a set of requirements largely based on the ANSI Procedures for the Development and Coordination of American National Standards©.

In accordance with those requirements, a national Criteria Review Committee consisting of a balance of code officials, utility new construction program staff, and interested and affected parties representing the design, construction, real estate and manufacturing communities reviewed, voted on and approved the *Benchmark*.

As the next version of *Benchmark, Core Performance* has retained much of the original publication's content in terms of process and priorities. However, based on our experience with how people use *Benchmark,* information in the *Core Performance Guide* has been reorganized and updated to facilitate ease of use.

We want to acknowledge *Benchmark's* author, Jeff Johnson, former executive director of NBI. His dedication to the cause of high performance building made development of *Benchmark* and the *Advanced Buildings* program possible. In addition, special thanks goes to the Energy Center of Wisconsin for their partnership in these efforts. Finally, we'd like to thank the members of the *Benchmark* Criteria Review Committee for the countless hours they contributed to this process.

EDITION 1.11

CP 1.1 is a comprehensive update to *Core Performance*. The update includes editorial changes to the requirements, guidance and location of specific measures, as well as a new cover design.

During the 2012 code development cycle of the International Energy Conservation Code (IECC), New Building Institute (NBI) collaborated with the American Institute of Architects (AIA) and the US Department of Energy (DOE) to submit proposals to update the IECC based on *Core Performance*. Through a public review and development process, many *Core Performance* requirements were updated before the proposals were finalized and accepted for the 2012 IECC. Measure 2.5 Opaque Envelope Performance, Measure 2.6 Fenestration Performance, Measure 2.8 Lighting Power Density, Measure 2.9 Mechanical Equipment Efficiency Requirements, Measure 3.3 Additional Lighting Power Reductions and Measure 2.2 Air Barrier Performance were all updated to align with these proposals.

Measure 1.5 Construction Certification (Acceptance Testing) and Measure 1.7 Performance Data Review were moved to Section 2 for greater ease of use and implementation of the *Guide*. Additionally, the Introduction has been updated to more fully explain how the savings of *Core Performance* are calculated.

AUTHORIZATION

DISCLAIMER OF WARRANTIES

The following parties have participated in funding, creating and/or preparing the *Core Performance Guide:* NBI, the Energy Foundation, California Energy Commission, Cape Light Compact, Efficiency Vermont, National Grid USA, New York State Energy Research and Development Authority, Northwest Energy Efficiency Alliance, NSTAR, Sacramento Municipal Utility District, Southern California Edison, and U.S. Environmental Protection Agency (collectively referred to herein as "the Parties"). The *Core Performance Guide* is provided "as is" and is for informational purposes only. No building application should be undertaken without first consulting a licensed contractor, or other building professional.

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INTRODUCTION TO *ADVANCED BUILDINGS CORE PERFORMANCE*

Advanced Buildings Core Performance is a prescriptive program to achieve significant, predictable energy savings in new commercial construction. The program describes a set of simple, discrete integrated design strategies and building features. When applied as a package, they result in energy savings of at least 16% to 26% (depending on climate) beyond the performance of a building that meets the prescriptive requirements of ASHRAE 90.1-2007, at least 20% to 30% beyond a building that meets ASHRAE 90.1-2004, and at least 25% to 35% beyond a building that meets ASHRAE 90.1-2001.

This program is the revised and updated version of the *Advanced Buildings Benchmark* program released previously.

Elements of the program can be applied to new commercial construction projects of all sizes, but the Criteria and analysis supporting the program were designed particularly for smaller scale commercial projects ranging from 10,000 to 70,000 square feet. At the larger end of this range, HVAC system complexity may suggest additional energy savings opportunities not fully addressed by a prescriptive program. However, even much larger projects with simple mechanical systems can benefit from the *Core Performance* savings strategies. Building envelope and lighting system energy savings strategies in *Core Performance* are scalable to projects of any size.

The program is based on the results of an extensive energy modeling protocol used to identify consistent strategies that lead to anticipated energy savings across climates. These strategies are combined in a prescriptive guideline for new construction to guide energy performance improvements. The analysis included evaluations of three major building prototypes, four HVAC system permutations for each prototype, evaluated for climate variations for 16 U.S. cities. The program also includes guidelines on implementing improved design processes to foster design integration, thereby improving overall building performance opportunities. These strategies set the stage for additional whole building performance improvements beyond the basic requirements of this program.

A key aspect of the *Core Performance* program is that the strategies that make up the program represent 'state of the shelf' technologies and practices that are broadly available in the building industry, and have been demonstrated to be cost-effective.

The basic component of the program is the *Core Performance Guide* (this document), which identifies the specific strategies that make up the *Core Performance* program. Design teams can use the *Guide* to identify and implement all of the strategies (referred to as Criteria) that must be implemented to comply with program requirements. The *Guide* also identifies additional strategies that can be used to go beyond the basic performance goals of the *Core Performance* program.

To support the *Core Performance* program, an extensive set of reference materials provides additional information on implementation, design practice, research, additional strategies and advanced practices for more effectively using the *Core Performance Guide*. This information is available for review and download by program participants at **www.advancedbuildings.net/refmaterials.htm**. Password information that will allow access to these materials is located on the inside cover of this guide.

The *Core Performance* program is also supported by an extensive training curriculum delivered periodically by *Advanced Buildings* (AB) program partners in various regions around the country.

Within this *Core Performance Guide,* the relationship of specific Criteria to the requirements of LEED NC 2.2 is identified in the margin at the end of each Criteria. This information indicates specific LEED credits that overlap or parallel the performance Criteria. Actions taken to meet *Core Performance* requirements will contribute directly to achievement of LEED credits. Users should review the LEED reference guide to identify specific requirements and credit achievement opportunities.

The *Core Performance* program also represents a comprehensive approach to the energy performance aspects of the LEED program. The USGBC has adopted Core Performance as a prescriptive achievement path for LEED. Specific requirements for using Core Performance in LEED are described later in this section (see page 25). The USGBC determines how Core Performance is recognized by LEED. Projects should confirm LEED requirements with USGBC.

ANALYSIS SUPPORTING *CORE PERFORMANCE*

When the *Advanced Buildings Core Performance Guide* was developed, an extensive energy modeling protocol was implemented to support development of the program. The results of over 30,000 energy modeling runs using eQUEST software to run DOE-2 were evaluated using a batch analysis protocol built into the eQUEST energy modeling tool. Since the initial development phase, significant additional analyses and consideration of updated code baselines have been added to the body of analysis supporting the program. These analyses represent tens of thousands of additional modeling runs and additional code baseline comparisons for ASHRAE 90.1-2007, IECC 2006, 2009, and 2012 and Canadian Energy Code baselines.

The modeling analysis for *Core Performance* is based on analysis of three to five building prototypes representing the characteristics of a portion of the national building stock. For each prototype, three to five typical mechanical systems were defined to represent typical construction practice. Sixteen representative U.S. cities were identified to serve as "typical" climate representatives of the eight ASHRAE climate zones and the various permutations identified within those climate zones by ASHRAE. (Several Canadian climate zones have been added to the analysis.)

A baseline building meeting the requirements of various code baselines was defined for each permutation of the above Criteria (building type, system type, climate). Note that the baseline building is defined using the prescriptive requirements of the code (ASHRAE 90.1 2001, 2004, or 2007). As a prescriptive standard, *Core Performance* will be applied to buildings that would typically not complete energy modeling, and therefore the prescriptive requirements more accurately represent the target market for this program.

Modifications to the batch protocol software in eQUEST were developed to provide an ordered ranking of the energy efficiency measures modeled for this project. There are approximately 14-16 discrete energy performance measures (depending on system configuration) within the analysis that can be applied to each baseline. The batch protocol ran each measure individually against the appropriate baseline and identified the one with the most significant energy savings impact. This measure was then added to the baseline, and the remaining measures were run individually against this revised baseline. This process continued until all of the measures were

ranked by energy savings impact, and the final run represented the sum total energy savings of all the measures if considered as a package.

The results of this analysis were then compared across prototype, system and climate to determine which measures were the most consistently significant across these variants. Those measures then became the basis for the *Core Performance* package of Criteria requirements. Other measures which were applicable to a subset of the variants or which had climate- and system-specific advantages were included in the Enhanced Performance section.

The importance of identifying the most significant strategies from an energy savings standpoint can be seen in Figure 1 below. As successive energy savings strategies are added to the baseline, the impact on energy performance becomes less significant. Failure to consider measure impacts as a package may lead to over-estimation of the energy savings associated with each measure.

FIGURE 1 - CUMULATIVE EFFECT OF ENERGY EFFICIENCY MEASURES

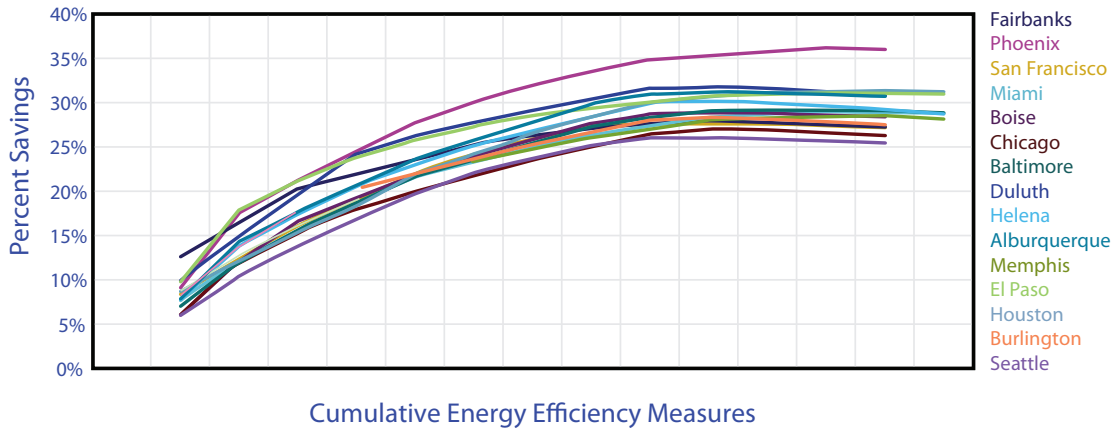

Figure 1 shows the anticipated average energy savings over the prescriptive requirements of the original code baseline, ASHRAE 90.1-2004, as the modeled measures in *Core Performance* are incorporated into the analysis sequentially. Each line in this graph represents one of the representative cities modeled using the *Core Performance* Criteria (note that some of the Criteria included in the program do not directly address modeled energy use, and are not represented on this graph).

The results of the analysis are described as demonstrating a savings percentage beyond various code baselines. It is important to keep in mind that comparing codes and standards is a complicated process, and such savings numbers represent a range of anticipated savings outcomes. The US Department of Energy commissions a 'determination analysis' of each new version of energy code, which includes a comprehensive weighted calculation of the energy impact of the code across a representative mix of project types and building population by climate zone. The analysis is conducted on a range of building prototypes that represent typical practice in the industry for a series of representative building types. The weighting factors account for population density of each project type across the range of national climates.

NBI uses a protocol that is aligned with the determination analysis but based on a subset of the prototypes that are more focused on the project types targeted by *Core Performance*. These project types directly or indirectly represent over half of the national building stock. The NBI protocol uses the same project type and climate weighting factors used by the national analyses on the subset of projects that we analyze. However, NBI includes a wider range of HVAC system types for each prototype. The different system type permutations are weighted equally among the individual prototypes because no data is available to support alternate weighting priorities by system.

When the analysis is completed, there is a range of savings associated with the code or program depending on climate, project and system type. Different codes and programs (like *Core Performance)* have varying effects on different project types, so savings can vary significantly among project types. When a single savings or a savings range is given, it represents an average savings across all of the weighted variables for the whole portfolio of projects, not a prediction of specific savings impact on a specific project. This range is inherent in all comparisons of different codes and standards that affect multiple building types.

More information about the analysis protocol and results can be found at **www.advancedbuildings.net**.

APPLICABILITY OF *CORE PERFORMANCE*

In general, the *Core Performance* program requirements are best suited to buildings ranging from less than 10,000 to 70,000 square feet. For larger projects, the program represents a good set of guidance on design strategies and performance measures.

BUILDING SIZE

Small to mid size buildings are the focus of *Core Performance,* but the energy savings strategies that are part of the program are valid at a larger scale. The design strategies, envelope, lighting, and most system measures in *Core Performance* are applicable to buildings of any size. However, larger building types are more likely to adopt more complicated systems and energy conservation strategies that are not as predictably described in a prescriptive standard. Larger buildings have opportunities for more robust systems and controls and are also more likely to benefit from full-scale energy modeling. For larger projects, the design team should evaluate the complexity of the HVAC systems to determine if the project would be better served by an effective energy modeling strategy, as described in Section Four: Energy Modeling.

BUILDING TYPE

The *Core Performance* program was developed on the basis of prototype analysis of several major project categories. The prototype buildings used in the analysis represent approximately two-thirds of commercial buildings, according to the Commercial Building Energy Consumption Survey (CBECS). In addition, a number of other project types have strong similarities to these project types in the context of the energy performance measures in *Core Performance*.

3.14 Fault Detection and Diagnostics

PURPOSE

Provide tools to verify and maintain ongoing operational performance of HVAC equipment by monitoring key operating condition and performance parameters and providing reporting through a communications gateway, either to a device in the building or to a remote site. Commercial building HVAC equipment including direct expansion (Dx) rooftop units (RTU), chillers, ground source heat pumps and variable capacity (variable refrigerant flow) equipment have fault detection and diagnostic (FDD) monitoring and reporting capabilities, often described by the manufacturers as 'alarms.' This section is focused on the most widely used HVAC system in smaller commercial building applications, the RTU, which is typically packaged with a cooling and gas heating component or as a heat pump.

CRITERIA

Incorporate (FDD) capabilities in all RTU equipment selected for Advanced Buildings *Core Performance* projects to monitor and report operating conditions in the following areas, at minimum:

- **AIRFLOW**
- **ECONOMIZER OPERATION**
- **LOW REFRIGERANT CHARGE**
- **SENSOR OPERATION**

RTU product lines from HVAC manufacturers differentiate by price, efficiency, other features and control strategies. The majority of RTUs made and sold are the lowest priced units with the lowest allowable EER/IEER and are electromechanically controlled, providing minimum component failure alarm notification potentially at the thermostat in the building, as well as at the unit on the roof. Typically these alarms are only for catastrophic failures such as belt breakage or compressor failure along with a pre-programmed 'change filter' signal. These units are not designed to be hooked into a Direct Digital Controller (DDC) or building energy management system through a communications gateway in order to provide operating condition data remotely to a building owner, facilities manager or service contractor.

Increasing numbers of RTU models are microprocessor-controlled. These units cost more due to generally higher efficiency levels and a greater set of features that can include a number fault alarms and remote communications gateways. The gateway is usually a BACnet- or LonWorks-enabled device that can provide equipment condition information to an operator in the building through a DDC system or to a remote site via an ethernet connection to the internet. It is assumed due to energy efficiency requirements that Core Performance projects using RTUs would specify higher-end equipment that is microprocessor controlled, with more comprehensive feature sets and embedded fault alarms. However, the availability of specific FDD features differs across manufacturer product lines, even at the high end.

GENERAL

Studies conducted by NBI and many others have indicated multiple performance problems in RTUs, even those that are one to four years old.[1] At present, nothing has changed in this regard based on continuing field experience through utility and public benefit-funded programs around the country. In any RTU equipment, potential operating faults may occur at any time. There is no grace period during which one expects flawless operation with optimal efficiency and performance. There is little attention paid to quality installation and maintenance practice although national quality installation and maintenance standards and guidelines are available through the Air Conditioning Contractors of America (Standard 180 - **www.accca.com**) and the Sheet Metal and Air Conditioning Contractors National Association (**www.smacna.org**). These standards should be part of all utility HVAC program requirements.

Service contracting ("If it blows hot and cold, don't worry about it.") is the most common approach and is typically linked to the lowest priced HVAC contractor that can be found. Maintenance, more usefully defined as ongoing retrocommissioning, including planned and thorough equipment review, is less often the case. Some problems are simply an artifact of Dx cooling technology and its engineering design and manufacturing quality. For example, one pathway for refrigerant loss over time is pinhole leaks in refrigerant line solder. However, most refrigerant mis-charge in RTUs is attributable to poorly trained technicians trying to fix a customer comfort problem by adding too much refrigerant or allowing too much refrigerant to accidentally escape during the procedure. Sensor quality is also a common problem area for all units.

In fact, most problems are related to inadequate technician training, poor sizing (oversizing of systems is typically ½-1 ton), poor installation/commissioning and poor maintenance, which is primarily driven by customer lack of understanding of the increased costs that often result. The single largest sources of energy waste in RTUs and most other HVAC systems however are related to equipment control by users topped by 1) 24x7 fan operation where there is no special ventilation requirement and 2) improper HVAC scheduling, especially with equipment running when there is no zone or building occupancy during any given day, night, weekend or holiday.

Some faults may be severe and lead to shutting down part or all of the system or unit. These are usually quickly detected by the occupants before any warning light is noticed. However, most faults cause degradation in operating performance and efficiency over time, allowing the system to run, while wasting energy, potentially shortening equipment life (primarily the compressor-the most costly component) and potentially compromising occupant comfort and air quality.

The purpose of this Enhanced Criteria is to acknowledge the benefits of specifying embedded, automated fault detection and, as available, diagnosis of common degradation faults in the operation of HVAC equipment. The distinction made between fault detection and fault diagnosis is this: some fault conditions have single causes, while others may have multiple potential causes. For example, a sensor may drift out of range or fail, but there is no

[1] *New Buildings Institute. Small HVAC Problems and Potential Savings Reports. Prepared for the California Energy Commission. (2003). Available at http://newbuildings.org/small-hvac-problems-potential-savings-reports.*

differentiation of the actual condition in the alarm that is signaled. The science of diagnosis lags behind detection. Also, multiple faults can occur simultaneously and can take time, something most technicians don't have on the roof during a typical service call, to fully diagnose.

FDD is fundamentally an adjunct function to the overall control system. FDD capabilities monitor a range of system conditions and hardware status, while some components are directly linked to control functions and settings. In larger rooftop units (>20 tons), most manufacturers offer optional communications modules to interconnect unit-level conditioning monitoring and reporting to a DDC building energy management system.

Among the HVAC OEMs, each manufacturer chooses the embedded, standard alarm features. One company offers five economizer performance alarms along with other important alarms. However, the introduction of the High Performance Rooftop Challenge by US DOE and the Commercial Building Energy Alliances (CBEA) provides a look at where several major national retailers want RTU equipment to go, including higher efficiency (40%+ over current federal minimum standards) and comprehensive FDD features currently not offered by any OEM HVAC manufacturer.[2]

DOE and CBEA believe this feature set is appropriate for RTUs that CBEA members want to put on their buildings. All microprocessor RTUs should eventually have all of these faults alarmed and a communications gateway to get the information off the roof.

Two leading third-party providers of advanced FDD approaches are Field Diagnostic Services, Inc. (FDSI - **www.fielddiagnostics.com**) and Sensus Machine Intelligence (**www.sensusmi.com**). FDSI has developed its 'Synergy' product, designed specifically for enterprise applications. It offers the most fully featured product that also includes financial analysis of faults and fixes and comes closest to meeting the DOE/CBEA requirements. Carrier, Trane and York have licensed an FDSI product called the 'Service Assistant,' currently in use as a handheld field diagnostic tool utilized by technicians on the roof and focused on the refrigeration cycle. The tool's diagnostic features are being embedded in RTUs by these three HVAC OEMs, likely early in 2012. This is a significant step forward since the Service Assistant provides accurate refrigeration cycle fault detection capability. Coupled with existing embedded alarm functions, RTUs with these more comprehensive capabilities should be the units of choice for *Core Performance* projects where RTUs are appropriate. Sensus, with support from the California Energy Commission (CEC), is working with researchers to develop a set of virtual diagnostic tools for RTUs. In addition, a report by the CEC on the Advanced Rooftop Unit,[3] should guide the specification of a number of important RTU features including FDD in *Core Performance* projects.

DOE/CBEA RTU CHALLENGE FDD SPEC
SENSOR FAILURE/FAULT (INCL. DRIFT)*
HIGH REFRIGERANT CHARGE
LOW REFRIGERANT CHARGE
COMPRESSOR SHORT CYCLING
LOW EVAPORATOR AIR FLOW
DIRTY FILTER
CAPACITY DEGRADATION
EFFICIENCY DEGRADATION
NOT ECONOMIZING WHEN IT SHOULD
DAMPER NOT MODULATING
EXCESS OUTDOOR AIR
LOW VENTILATION

* *While detecting drift may be laudable, field service practice would have to change dramatically to enable technicians to take the time to re-calibrate the sensor on the roof.*

[2] *US Department of Energy and Commercial Building Energy Alliances. High Performance Rooftop Unit Challenge. Available at http://www1.eere.energy.gov/buildings/alliances/rooftop_specification.html*

[3] *Available at http://www.newbuildings.org/document-library*

NON-ENERGY BENEFITS OF FDD

LOWER OPERATIONAL AND MAINTENANCE COSTS. Maintaining optimal system performance ensures energy cost savings will occur over the life of the system. Fault detection features can actually decrease maintenance costs for a building owner by eliminating unnecessary maintenance costs. This approach is now being incorporated into high-end automobiles and trucking fleets; these vehicles can monitor driving habits and engine performance and extend maintenance periods in response to actual operation and conditions.

EQUIPMENT LIFE. By maintaining operational peak efficiency, the life of the system (particularly the compressor) will be extended.

INDOOR AIR QUALITY AND OCCUPANT COMFORT. The ability to maintain proper outside airflow to meet air quality and thermal comfort requirements is directly tied to the operating condition of the system and faults that may arise.

PROPERTY MANAGEMENT. Organizations managing multiple properties would perceive a significant benefit by having this component of building maintenance automated and reporting to a central operations monitoring system.

FDD CRITERIA

The following FDD framework should be reviewed and compared with the FDD or alarm functions that HVAC manufacturers already embed in the RTUs or offer as an additional feature. This is not an exclusive set of diagnostic functions; this list covers the minimum set including refrigeration cycle, economizer and controls and is the recommended minimum fault alarm set that should be specified in the HVAC equipment bid specification. Unfortunately, at this time there are no HVAC OEM models that meet 100% of the FDD functions listed. However, HVAC equipment that meets the requirements of Criteria 2.5, Mechanical Equipment Efficiency (CEE Tiers 1 & 2) will include the 60-70% of the FDD functionality listed. Manufacturers' product technical manuals describe the available embedded and optional fault alarms. The means and methods of calculating, describing and reporting fault conditions are at the discretion of the manufacturer of the FDD product. At present, there are no national standards or guidelines that provide consumers with test methods to substantiate the various alarms or for the conditions that determine alarm thresholds. Fault/alarm descriptions and alarm thresholds are at the manufacturer's discretion.

In addition to the fault alarms, it is critical that that there be a mechanism that "gets the information off the roof," notifying the owner and/or service organization and describing the fault condition. Examples include an indicator light or electronic notice on premises such as at the thermostat or through a communications channel including via email, pager, telephone or the web.

SEVERE FAULTS

The unit controller will detect and send a fault signal for the following conditions:

- Failed compressor
- Failed evaporator fan motor
- Failed evaporator fan belt
- Failed condenser fan motor
- Sensor failure (all OEM equipment that is microprocessor-controlled has sensor alarms)

DEGRADATION FAULTS

The FDD system should detect and report as many of the following subsystem and component faults as possible:

- Short-cycling - on time [less than 5 minutes, 10 or more times in 24 hours]
- Failed relief damper
- Simultaneous heating and cooling
- When conditions are favorable for economizer operation and economizer is not active
- When conditions are not favorable for economizer operation and economizer is active

REFRIGERANT SYSTEM

Superheat and subcooling should be within a range indicating charge is correct, assuming other faults have been addressed:

- Low refrigerant charge
- High refrigerant charge
- Air (non-condensable) in refrigeration loop
- Liquid line restriction in refrigeration loop

AIR HANDLING SYSTEM/AIRFLOW

These fault conditions affect indoor air quality and reduce refrigeration cycle efficiency:

- Dirty air filter (all OEM equipment includes this alarm, but it is often a timer-based alarm indicated at the thermostat, not an actual condition-based alarm)
- Dirty evaporator coil
- Dirty condenser coil
- Reduced airflow
- Excessive airflow

GENERAL

The energy targets of *Core Performance* vary by climate, and local equivalence should be verified with program administrators. The baseline for *Core Performance* is based on the prescriptive requirements of ASHRAE 90.1-2004. The USGBC uses the modeling guidelines of Appendix G of that standard as a baseline, and performance comparisons to the Appendix G baseline may result in different relative savings estimates compared to a prescriptive baseline. (Although projected energy use of the project itself should remain unchanged.)

For additional references and information about this measure, visit **www.advancedbuildings.net/refmaterials.htm**.

COMNET AND MODELING FOR CORE PERFORMANCE

From the Commercial Energy Services Network (COMNET - **www.comnet.org**), the Commercial Buildings Energy Modeling Guidelines and Procedures (MGP) is a new tool that adds important features to existing modeling software.

COMNET is a project jointly developed by New Buildings Institute, Architectural Energy Corporation, Institute for Market Transformation and the Residential Energy Services Network.

The COMNET MGP are inputs to existing modeling software that are compliant with the ASHRAE Appendix G Performance Rating Method. The MGP simplifies modeling and reduces the cost of modeling through the automated generation of the baseline building. It also improves accuracy and reduces the chance of "gaming" in modeling.

- The MGP has been through two rounds of national technical review by groups including software vendors, national laboratory staff, ASHRAE members/committees, USGBC staff/committees and others
- The MGP supports the ENERGY STAR Target Finder methodology
- The MGP has been recommended for use in LEED and the International Green Construction Code
- The Massachusetts Department of Energy Resources commercial building rating program (in development) is considering a requirement to use the MGP for modeling submissions
- The California Energy Commission has adopted the MGP in the new Alternative Compliance Method for the 2013 Title 24 nonresidential building energy standard
- The ASHRAE Building Energy Quotient program is adopting key components of the MGP for its building rating system
- Several components of the MGP will be reviewed for certification as national ANSI Standards
- Future use of the MGP includes compliance checking for local code officials working with performance and outcome-based building codes

FEDERAL TAX INCENTIVE COMPLIANCE[4]

One specific purpose of the MGP is to provide a compliance tool for owners apply seeking the federal commercial building energy tax deductions for achieving significant energy cost savings from whole building design efficiency or for existing building component upgrades. When implemented in existing commercial building software, MGP inputs automatically generate the baseline building to compare with the new building design. Achieving the legislation's whole building 50% reduction objective should result in a high performance building, meeting or exceeding the *Core Performance* energy efficiency goals.

LEED COMPLIANCE

When implemented in modeling software, the MGP automatically generates the baseline building based on ASHRAE 90.1-2007 for compliance checking with LEED 2.2 requirements. It is expected that the ASHRAE 90.1-2010 baseline building inputs will be incorporated into the MGP to meet future LEED energy baseline compliance requirements. COMNET is being adapted to meet project modeling submission requirements that are in development for a LEED automation, online application portal.

MGP INPUTS

MGP inputs cover a number of non-regulated end use loads that are not in the ASHRAE standard or in most energy modeling software. Currently, only *regulated* energy is considered when percent savings are calculated for tax deduction purposes. When percent savings are calculated for green building rating systems, total energy is considered. COMNET has developed XML interface standards for building energy modeling outputs and is developing building descriptors used for inputs.

Non-regulated load inputs in the MGP include:

- Commercial refrigeration
- ENERGY STAR office equipment
- Exterior lighting
- On-site power generation
- Restaurant equipment
- Swimming pools
- Vertical transport (baseline only)

Review **www.comnet.org** to learn more about the MGP and its benefits to *Core Performance* projects that use the modeling path.

LEED Relationship

SS
WE
EA **credit 1**
MR
EQ

[4] *Energy Independence and Security Act of 2007 (EISA07 allows $1.80/sf tax deduction for whole buildings with 50% lower energy costs. For details, see ACEEE site: http://energytaxincentives.org/business/commercial_buildings.php*

Errata for Version 1.11

CRITERIA SPECIFICATIONS:

TABLE 2.6.1 – WINDOWS (MAX. 40% WWR OR LESS)

full assembly (i.e not just glass by itself or each pane of glass)

CLIMATE ZONE	1	2	3	4 (Except Marine)	5 (and Marine 4)	6	7	8
OTHER FRAME PRODUCTS U-FACTOR	0.50	0.40	0.35	0.35	0.32	0.32	0.32	0.32
SHGC: ANY PF	0.25	0.25	0.25	0.40	0.74	0.40	0.45	0.45
METAL FRAMED PRODUCTS U-FACTOR	0.57	0.57	0.50	0.42	0.45	0.42	0.35	0.35
SHGC: ANY PF	0.25	0.25	0.25	0.40	~~0.74~~ 0.40	0.40	0.45	0.45
ALL PRODUCTS VLT/SHGC RATIO	> 1.5	> 1.5	> 1.5	> 1.5	> 1.5	> 1.5	> 1.5	> 1.5

SHGC=SOLAR HEAT GAIN COEFFICIENT PF= PROJECTION FACTOR VLT=VISIBLE LIGHT TRANSMITTANCE

TABLE 2.6.2 – SKYLIGHTS (MAX 5% OF ROOF AREA OR LESS)

CLIMATE ZONE	1	2	3	4 (except marine)	5 (and marine 4)	6	7	8
FACTORY ASSEMBLED FENESTRATION PRODUCTS*								
U-FACTOR	0.57	0.57	0.45	0.45	0.45	0.45	0.45	0.45
SHGC	0.40	0.40	0.40	0.40	0.40	0.40	Any	Any
GLASS, NO CURB								
U-FACTOR	0.57	0.57	0.57	0.57	0.54	0.54	0.54	0.54
SHGC	0.19	0.19	0.19	0.32	0.36	0.46	0.46	0.46
VLT/SHGC RATIO	> 1.25	> 1.25	> 1.25	> 1.25	> 1.25	> 1.25	> 1.25	> 1.25
GLASS, WITH CURB								
U-FACTOR	0.75	0.65	0.55	0.50	0.50	0.50	0.50	0.50
SHGC	0.19	0.19	0.19	0.32	0.36	0.46	0.46	0.46
VLT/SHGC RATIO	> 1.25	> 1.25	> 1.25	> 1.25	> 1.25	> 1.25	> 1.25	> 1.25

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**Skylight products designed to actively harvest daylighting with tracking collectors, reflectors, etc. must meet U-value requirements, but are exempt from the SHGC requirements listed.*

LEED Relationship

SS
WE
EA credit 1
MR
EQ

Errata for Version 1.12

MECHANICAL SYSTEM CRITERIA SPECIFICATIONS:

TABLE 2.9.1 - UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED

(Voluntary guidelines for use in energy efficiency programs. For Terms and Usage, please see the CEE website at www.cee1.org.)

EQUIPMENT TYPE	SIZE CATEGORY	SUB-CATEGORY OR RATING CONDITION	REQUIRED EFFICIENCY
AIR CONDITIONERS, AIR COOLED	< 65,000 Btu/h	Split System	15.0 SEER 12.5 EER
		Single Package	15.0 SEER 12.0 EER
	> ~~≥~~65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	**12.0** ~~12.2~~ EER **13.8** ~~14.0~~ IEER
	> ~~≥~~135,000 Btu/h and < 240,000 Btu/h	Split System and Single Package	**12.0** ~~12.2~~ EER **13.0** ~~13.4~~ IEER
	> ~~≥~~240,000 Btu/h **and < 760,000 Btu/h**	Split System and Single Package	**10.6** ~~11.0~~ EER **12.1** ~~11.6~~ IEER
	> 760,000 Btu/h	**Split System and Single Package**	**10.2 EER** **11.4 IEER**
~~AIR CONDITIONERS, WATER AND EVAPORATIVELY COOLED~~	~~All Sizes~~	~~Split System and Single Package~~	~~14.0 EER~~
AIR CONDITIONERS, WATER COOLED	**< 65,000 Btu/h**	**Split System and Single Package**	**14.0 EER**
	> 65,000 Btu/h and < 135,000 Btu/h	**Split System and Single Package**	**13.8 EER** **15.1 IEER**
	> 135,000 Btu/h	**Split System and Single Package**	**13.8 EER** **14.6 IEER**
AIR CONDITIONERS, EVAPORATIVELY COOLED	**< 65,000 Btu/h**	**Split System and Single Package**	**14.0 EER**
	> 65,000 Btu/h and < 135,000 Btu/h	**Split System and Single Package**	**13.8 EER** **15.1 IEER**
	> 135,000 Btu/h	**Split System and Single Package**	**13.3 EER** **14.1 IEER**

a. For electrical resistance heating section types, increase required minimum EER by 0.2.

Source: Consortium for Energy Efficiency (June 2009). CEE's high-efficiency specifications are periodically revised. For the most current version, please see the CEE website at **www.cee1.org/com/hecac/hecac-main.php3**

TABLE 2.9.2 - UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY OPERATED

(Voluntary guidelines for use in energy efficiency programs. For Terms and Usage, please see the CEE website at www.cee1.org.)

EQUIPMENT TYPE	SIZE CATEGORY	SUB-CATEGORY OR RATING CONDITION	REQUIRED EFFICIENCY
AIR COOLED, (COOLING MODE)	< 65,000 Btu/h	Split System	15.0 SEER* 12.5 EER
		Single Package	15.0 SEER* 12.**0** EER*
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	**11.1** ~~11.7~~ EER **12.1** ~~13.0~~ IEER
	≥ 135,000 Btu/h and <240,000 Btu/h	Split System and Single Package	**10.7** ~~11.7~~ EER **11.7** ~~12.5~~ IEER
	≥240,000 Btu/h	Split System and Single Package	**10.1** ~~10.7~~ EER **10.7** ~~11.5~~ IEER
AIR COOLED (HEATING MODE)	< 65,000 Btu/h (Cooling Capacity)	Split System	9.0 HSPF
		Single Package	8.5 HSPF
	≥ 65,000 Btu/h and < 135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.4 COP
		17°F db/15°F wb Outdoor Air	2.4 COP
	> ≥ 135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.2 COP
		17°F db/15°F wb Outdoor Air	2.1 COP
WATER SOURCE (COOLING MODE)	< 135,000 Btu/h (Cooling Capacity)	85°F Entering Water	14.0 EER
WATER-SOURCE (HEATING MODE)	< 135,000 Btu/h (Cooling Capacity)	70°F Entering Water	4.6 COP

a. For electrical resistance heating section types, increase required minimum EER and IEER by 0.2.

Source: Consortium for Energy Efficiency (2010). CEE's high-efficiency specifications are periodically revised. For the most current version, please see the CEE website at **www.cee1.org/com/hecac/hecac-main.php3**

** These CEE Tier 2 values (as of June 2010) were incorporated into Core Performance in June 2010, version 1.02.*

TABLE 2.9.3 – PACKAGE TERMINAL AIR CONDITIONERS AND HEAT PUMPS, ELECTRICALLY OPERATED

EQUIPMENT TYPE	SIZE CATEGORY	REQUIRED EFFICIENCY
AIR CONDITIONERS	< 7,000 Btu/h	11.9 EER
& HEAT PUMPS (COOLING MODE)	≥ 7,000 Btu/h and < 10,000 Btu/h	11.3 EER
	≥ 10,000 Btu/h and <13,000 Btu/h	10.7 EER
	≥13,000 Btu/h	9.5 EER

TABLE 2.9.4 – BOILERS

TYPE	FUEL	SIZE CATEGORY	TEST PROCEDURE	EFFICIENCY REQUIREMENT ~~(3 MANUFACTURERS)~~
STEAM	GAS	< 300,000 Btu/hr	DOE 10 CFR Part 430	**83.4%** ~~83%~~ AFUE
		300,000 - 2,500,000 Btu/hr	DOE 10 CFR Part 431	**80.6%** ~~81%~~ Et
		> 2,500,000 Btu/hr		**80.5%** ~~82%~~ Ec
	OIL	< 300,000 Btu/hr	DOE 10 CFR Part 430	**85.6%** ~~85%~~ AFUE
		300,000 - 2,500,000 Btu/hr	DOE 10 CFR Part 431	**83.0%** ~~83%~~ Et
		> 2,500,000 Btu/hr		**83.5%** ~~84%~~ Ec
HOT WATER	GAS	< 300,000 Btu/hr	DOE 10 CFR Part 430	**97.3%** ~~97%~~ AFUE
		300,000 - 2,500,000 Btu/hr	DOE 10 CFR Part 431	**94.5%** ~~97%~~ Et
		> 2,500,000 Btu/hr		**94.5%** ~~94%~~ Ec
	OIL	< 300,000 Btu/hr	DOE 10 CFR Part 430	**88.6%** ~~90%~~ AFUE
		300,000 - 2,500,000 Btu/hr	DOE 10 CFR Part 431	**85.3%** ~~88%~~ Et
		> 2,500,000 Btu/hr		**86.2%** ~~87%~~ Ec

Et = thermal efficiency, Ec = Combustion Efficiency

* Systems must be designed with lower operating hot water temperatures (<150°F) and use hot water reset to take advantage of the much higher efficiencies of condensing boilers.

TABLE 2.9.5 – CHILLERS

EQUIPMENT TYPE	SIZE CATEGORY	REQUIRED EFFICIENCY-CHILLERS		OPTIONAL COMPLIANCE PATH-REQUIRED EFFICIENCY-CHILLERS WITH VSD	
		FULL LOAD (KW/TON)	IPLV (KW/TON)	FULL LOAD (KW/TON)	IPLV (KW/TON)
AIR COOLED W/ CONDENSER	All	1.2	1.0	N/A	N/A
AIR COOLED W/O CONDENSER	All	1.08	1.08	N/A	N/A
WATER COOLED, RECIPROCATING	All	0.840	0.630	N/A	N/A
WATER COOLED, ROTARY SCREW AND SCROLL	< 90 tons	0.780	0.600	N/A	N/A
	≥ 90 tons and < 150 tons	0.730	0.550	N/A	N/A
	≥ 150 tons and ≤ 300 tons	0.610	0.510	N/A	N/A
	> 300 tons	0.600	0.490	N/A	N/A

EQUIPMENT TYPE	SIZE CATEGORY	REQUIRED EFFICIENCY-CHILLERS		OPTIONAL COMPLIANCE PATH-REQUIRED EFFICIENCY-CHILLERS WITH VSD	
WATER COOLED, CENTRIFUGAL	< 150 tons	0.610	0.620	0.630	0.400
	≥ 150 tons and ≤ 300 tons	0.590	0.560	0.600	0.400
	> 300 tons and ≤ 600 tons	0.570	0.510	0.580	0.400
	> 600 tons	0.550	0.510	0.550	0.400

a. Compliance with full load efficiency numbers and IPLV numbers are both required.
b. Only chillers with variable speed drives (VSD) may use the optional compliance path for chiller efficiency.
c. Water-cooled centrifugal water-chilling packages that are not designed for operation at ARI Standard 550/590 test conditions (and thus cannot be tested to meet the requirements of Table 2.9.5) of 44° F leaving chilled water temperature and 85° F entering condenser water temperature shall meet the applicable full load and IPLV/NPLV requirements.

TABLE 2.9.6 – ABSORPTION CHILLERS

EQUIPMENT TYPE	REQUIRED EFFICIENCY FULL LOAD COP (IPLV)
AIR COOLED, SINGLE EFFECT	0.60, but only allowed in heat recovery applications
WATER COOLED, SINGLE EFFECT	0.70, but only allowed in heat recovery applications
DOUBLE EFFECT – DIRECT FIRED	1.0(1.05)
DOUBLE EFFECT – INDIRECT FIRED	1.20

For additional references and information about this measure, visit **www.advancedbuildings.net/reference-materials/reference-materials-access-form**.

TABLE 2.9.7 – VRF MULTISPLIT

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	
VRF AIR COOLED (COOLING MODE)	< 65,000 Btu/h	All	15.0 SEER 12.5 EER
	> 65,000 Btu/h and < 135,000 Btu/h	Resistance or None	11.7 EER 14.9 IEER
	> 135,000 Btu/h and < 240,000 Btu/h	Resistance or None	11.7 EER 14.9 IEER
	> 240,000 Btu/h	Resistance or None	10.5 EER 13.0 IEER

LEED Relationship

SS
WE
EA **credit 1**
MR
EQ