ENERGY ANALYSES, ECONOMIC ANALYSES, CONTROL SYSTEMS, UMCS

INDEX

CHAPTER A-7

ENERGY ANALYSES, ECONOMIC ANALYSES, CONTROL SYSTEMS, EMCS

7.1 **GENERAL**

As stated by Public Law 100-615, it is United States policy that the Federal Government has the opportunity and responsibility to develop, demonstrate, and promote energy conservation, solar heating, solar cooling, and renewable energy sources in Federal buildings.

7.1.1   Analyses. Terminology, acronyms, abbreviations, and symbology shall be defined. All calculations, data, methods, and conclusions documented. Technical analyses shall be performed using approved methods.

7.1.2   Site Adaptations. Requirements given in this chapter apply equally to new designs, major renovations, and adaptations of previous designs. Designers may have to modify previous designs in order to bring the design into accord with current criteria. All pertinent analyses must be submitted for adaptations of previous designs unless specifically exempted by the Government. Previous design analyses for solar applications, conservation methods, life cycle cost analysis (LCCA), and energy system simulations may be submitted, in lieu of a new analysis, for cases where the following conditions are fully satisfied.

    a. The Designer reviews and verifies the previous analysis.

    b. Climate, siting, and orientation must be equivalent.

    c. Design factors impacting analyses must be equivalent.

    d. Alternatives being studied must be equivalent.

    e. Previous analysis methods meet current requirements.

7.1.3   Changes During Design. All significant changes and their impacts shall require that applicable analyses (EB, LCCA) be revised and resubmitted, regardless of when or how the change occurs during the project. Changes may also necessitate revised economic and engineering analyses.

7.2 **APPLICABLE PUBLICATIONS**

This list is a minimum requirement, and is not intended to be an all inclusive requirement. The most current editions of the publications listed below, as of the date of contract award, shall be used, unless directed otherwise.

7.2.1   Unified Facilities Criteria (UFC).

UFC 1-200-02   High Performance and Sustainable Building
                    Requirements

UFC 3-101-01   Architecture

UFC 3-400-02   Design: Engineering Weather Data

UFC 3-410-01   Heating, Ventilating, and Air Conditioning Systems

UFC 3-410-02   Direct Digital Control for HVAC and Other Building Systems

UFC 3-420-01   Plumbing Systems

UFC 3-440-01   Facility-Scale Renewable Energy Systems

UFC 3-470-01   Utility Monitoring and Control System (UMCS) Front End and Integration

UFC 4-010-06   Cybersecurity of Facility-Related Control Systems

7.2.2 American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), Inc. Standards.

ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE Standard 90.2 Energy-Efficient Design of Low-Rise Residential Buildings

ASHRAE Standard 189.1 Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

ASHRAE Standard 202 Commissioning Process for Buildings and Systems

ASHRAE Guideline 0 The Commissioning Process

7.2.3 Guide Specifications.

See Chapter 11 of this manual.

7.2.4 Engineering Regulations (ER).

ER 1110-1-8173 Energy Modeling and Life Cycle Cost Analysis

ER 1110-345-723 Total Building Commissioning Procedures

7.2.5 Army Regulations (AR).

AR 11-18   The Cost and Economic Analysis Program

7.2.6 Code of Federal Regulations (CFR).

10 CFR Part 436 Federal Energy Management and Planning Programs

7.2.7   Life-Cycle Cost Analysis (LCCA) Criteria.

NIST Handbook 135 Life-Cycle Cost Estimating Manual for the Federal Energy
                   Management Program

OMB Circular   Guidelines and Discount Rates for Benefit-Cost Analysis of
Number A-94   Federal Programs

7.2.8   Energy Criteria.

EPAct 2005   Energy Policy Act of 2005 (Public Law 109-58)

EISA 2007   Energy Independence and Security Act of 2007

7.3   **PRECONCEPT SUBMITTAL REQUIREMENTS**

Pre-concept submittal of the following items is only required when called for in the specific
instructions to the contract for delivery order.

7.3.1   HVAC Alternatives Coordination. Before commencing analysis of HVAC systems,
contact CESAS-EN-DM for approval of selected alternatives. Submit written confirmation
of approvals documenting alternatives considered, persons contacted, basis of alternatives
chosen, alternatives approved, and date.

7.3.1.1   Electric Resistance Heating shall comply with the requirements of UFC 3-410-01.

7.3.2   Modeling Input Data. Before commencing computer modeling runs, submit the
following items to CESAS-EN-DM for review.

  a.   All modeling input data.

  b.   Single-line rough layout sketches (Not to Scale) for each alternative in sufficient detail
       to show zoning, approximate distribution lengths, and quantities for major components.

7.4   **CODE 3 DESIGN SUBMITTAL REQUIREMENTS**

Any Base of project specific requirements will be provided with specific instructions to
contract or delivery order.

7.5   **CONCEPT (35%) DESIGN SUBMITTAL REQUIREMENTS**

The following items shall be submitted for review. See paragraph 7.10, TECHNICAL
REQUIREMENTS, for instructions on methods and content.

  a.   Printouts of input/output data for Life-Cycle Cost Analysis (all alternatives)
  b.   Printouts of input/output data for Energy Analysis (all alternatives)
  c.   U-value calculations for exterior surfaces
  d.   Energy conservation methods documentation

e. Outline specifications

7.6 PRELIMINARY (OVER THE SHOULDER) SUBMITTAL REQUIREMENTS

If project specific instructions require this section, rather than section 7.7, the requirements identified in section 7.7 shall be met for this section, otherwise, there are no requirements for this section.

7.7 PRELIMINARY (60%) DESIGN SUBMITTAL REQUIREMENTS

The Preliminary Design Submittal will be a refinement of the Concept Design. All comments from this office relating to Concept Design shall be incorporated in the Preliminary Design. The following items shall be submitted for review. See paragraph 7.10, TECHNICAL REQUIREMENTS, for instructions on methods and content.

a. The concept submitted Unified Facilities Guide Specifications (UFGS) list shall be updated to include any new specifications based on the refined preliminary design. All specifications from the list shall be tentatively marked up, with major edits, and submitted as part of the preliminary (60 percent) submittal. Specifications shall comply with the requirements of Chapter A-11, SPECIFICATIONS. Specifications shall be submitted with red-line edits indicating all deleted/modified text.

7.8 FINAL (100%) DESIGN SUBMITTAL REQUIREMENTS

The Final Design Submittal will be a refinement and completion of the Concept Design and/or the Preliminary Design. All comments from this office relating to Concept Design and Preliminary Design shall be incorporated in the Final Design. The following items shall be submitted for review. See paragraph 7.10, TECHNICAL REQUIREMENTS, for instructions on methods and content.

a. HVAC controls drawings (shown on MI plates)
b. Printouts of input/output data for Finalized Energy Analysis, that reflect actual design conditions (all alternatives)
c. ASHRAE 90.1 compliance forms
d. ASHRAE 189.1 compliance forms, as applicable per UFC 1-200-02
e. EPAct 2005 compliance documentation
f. Energy & Sustainability Record Card, per Chapter A-14 of this Design Manual
g. Typed, fully edited project specifications
h. Archived, executable modeling software files for the Finalized Energy Analysis for the proposed and baseline design, including all pertinent files. (e.g. – Trane Trace .taf file, including weather and day lighting files) (Submitted for Record Keeping Purposes)

7.9 CORRECTED FINAL DESIGN SUBMITTAL REQUIREMENTS

In the Corrected Final Design Submittal, the designer of record finalizes the construction documents. This includes the incorporation of approved comments from the previous design submittal reviews. The Corrected Final Design Submittal requirements shall be the same as the Final Design Submittal requirements. Unless indicated otherwise in the project Specific Instructions, this submittal will not be another review in ProjNet and is only for final backcheck of all comments. The following items shall be submitted for record keeping purposes:

a. Archived, executable modeling software files for the Corrected Finalized Energy Analysis for the proposed and baseline design, including all pertinent files. (e.g. – Trane Trace .taf file, including weather and day lighting files)

7.10 REQUIREMENTS FOR DESIGN/BUILD RFP PACKAGES

To be furnished with specific instructions relevant to the contract or delivery order.

7.11 TECHNICAL REQUIREMENTS

This section prescribes detailed procedures, acceptable methods and minimum content requirements for studies, analyses, and designs. Unless otherwise specified, all applicable studies shall be required for all new building design projects, major additions to existing buildings, and major renovations of existing buildings or energy systems.

7.11.1 Modeling Software. The following computer software is approved for use as indicated below and allowed in Chapter A-7. Some computer packages offer various alternative solution methodologies. The designer must select appropriate options which meet the requirements given in Chapter A-7. Any computer programs other than the ones listed below must be approved by CESAS-EN-DM.

Computer Software Option	Most Detailed Simulation
DOE 2	hourly calculations for 365 days
EnergyPlus	hourly calculations for 365 days
eQuest	hourly calculations for 365 days
Trane TRACE 700	hourly calculations for 365 days
Carrier HAP	hourly calculations for 365 days

7.11.2 Life Cycle Cost Analyses. Unless otherwise authorized, constant dollar methods given in NIST Handbook 135 shall be used. Analyses shall be based on actual expected operating conditions, energy usage, and costs. Selections of major systems and equipment must be supported by economic analyses except in the situations listed below. Major systems include all HVAC systems unless stated otherwise. If documentation that no utilities are available at or near project site is provided by designer of record the life cycle cost analysis for determining the heat fuel source is not required.

a. There are no reasonable alternatives for comparison

b. A waiver has been approved exempting the requirement

c. The cost of the analysis is greater than any potential benefit

7.11.2.1 Cost Estimates. All economic analyses must include cost estimates.

7.11.2.2   Computer Analyses

a. Provide complete input and output of the economic program. The analysis shall use constant dollar methods as given in NIST Handbook135. Computerized economic analyses shall be made using the Building Life Cycle Cost (BLCC) program. The BLCC program is available from the Federal Energy Management Program web site at: https://www.energy.gov/eere/femp/building-life-cycle-cost-programs. Before using any computer program, make sure that it is updated with the most current discount factors published in the periodic supplement to NIST Handbook 135.

b. The calculations should be based on the expected hours of operation, energy usage and costs, and should include process/miscellaneous loads. Contact the installation for current utility rates.

c.   Provide a narrative describing HVAC system alternatives, zoning, and fuel sources. The LCCA should consider three alternatives. If there are only two viable alternatives provide narrative discussions on those systems that were considered but were deemed not viable.

d. Economic analyses must include cost estimates. Lump sum estimates are not acceptable. Provide sources for all costs (construction, maintenance, etc.) used, all backup information, and any assumptions made.

7.11.2.3   Site Energy Costs. When purchased energy is used, analyses shall be based on site energy usage and the actual cost of energy at the site. Purchased energy is energy for which the site is billed at a rate which includes all applicable costs (e.g. fuel costs, operating costs, generating losses, distribution losses, profit, taxes).

7.11.2.4   Source Energy Costs. When generated energy is used, analyses should be based on the system's source fuel input, fuel costs, and efficiencies. Generated energy is energy for which the Government operates or controls the generation and distribution system.

7.11.2.5   Rules. The overriding factor in selections shall be the mission function of the Customer. Alternatives must meet the functional requirements. Selections between alternatives shall be for systems with the lowest total LCC.

7.11.3 U-Values. Exterior surfaces of thermally controlled spaces shall be in accordance with the following criteria:

UFC 1-200-02   High Performance and Sustainable Building Requirements

UFC 3-101-01   Architecture

Submit U-value calculations for exterior surfaces of conditioned buildings to include typical walls, floor, roof, and gross (weighted average) walls.

7.11.4   Energy Conservation. The design shall be in compliance with UFC 1-200-02, High Performance and Sustainable Building Requirements, which in turn requires compliance

with ASHRAE 90.1 and portions of ASHRAE 189.1. ASHRAE 90.1 and 189.1 have several methods of complying with the standard. The path selected to show compliance shall be clearly documented (narrative, forms, calculations). UFC 1-200-02 can be accessed at the following website: https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

7.11.5   On-Site Renewable Energy. Designs shall comply with UFC 1-200-02, High Performance and Sustainable Building Requirements.

7.11.6   Energy Systems. Three energy efficient solutions shall be developed for each individual energy system in accordance with the following criteria:

UFC 1-200-02   High Performance and Sustainable Building Requirements

UFC 3-410-01   Heating, Ventilating, and Air Conditioning Systems

   7.11.6.1   HVAC System Analysis. Any facility that is heated and/or cooled or heated only will be analyzed with a computer program that uses established weather data files and performs 8,760 hourly calculations. Computer programs are listed in Section 7.11.1. Energy calculations for buildings that do not require a computer simulation may use a computer program or appropriate methods explained in the most current edition of the ASHRAE Fundamentals Handbook. Provide the complete input (room, systems, room assignment, plants, plant assignments, custom members, custom schedules) and output of the program for all alternatives.

      a. Weather data files shall be typical meteorological year (TMY, TMY2, and TMY3), taken from the Department of Energy's website (www.doe2.com) or the National Renewable Energy Laboratory's website (http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/)
      b. Operating and Occupancy Schedules: Use ASHRAE standard schedules for the energy calculations. If the building type being analyzed does not correspond to an ASHRAE standard schedule, the designer of record shall create schedules that match the expected occupancy and operating schedules of the building as closely as possible.

7.11.7   Renovations. Refer to UFC 1-200-02 for requirements for all Renovations.

7.11.8   Energy Conservation Investment Program (ECIP). This paragraph's instructions only apply to projects designated as ECIP funded. Validations and revalidations shall be done as specified in the Energy Conservation Investment Program (ECIP) guidance. If revalidation shows a project or a portion of a project does not meet current ECIP criteria, then designers must provide a full explanation of the reasons including discussion of significant differences between the original validation and the revalidation. All other pertinent requirements given in this chapter apply to ECIP projects, unless stated otherwise by specific instructions.

7.11.9   Energy Engineering Analysis Program (EEAP). Scope of work requirements for EEAP studies are provided on a case by case basis. No other requirements given in this chapter apply to EEAP studies unless specifically so stated in the EEAP Scope of Work.

7.11.10   HVAC Controls. HVAC control systems designs shall be in accordance with the guidance presented in UFC 3-410-02. Designs for HVAC control systems shall be for Direct Digital Control (DDC) systems.

   7.11.10.1   Drawings. Refer to UFC 3-410-02 for HVAC control drawings requirements. HVAC control drawings (MI plates) shall be provided as required for a complete design, per UFC 3-410-02 requirements.

   7.11.10.2   Specifications. Unified Facilities Guide Specifications (UFGS) can be found online at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs.

   7.11.10.3   Control Panel Locations. Clear wall and floor space shall be reserved for each HVAC control panel. Verify clearances required for adequate maintenance access are satisfied.

7.11.11   Utility Monitoring and Control System (UMCS) Integration. Coordinate with each Installation for specific requirements for integrating the Building DDC system into the Installation Utility Monitoring & Control System (UMCS).

7.12 GLOSSARY OF TERMS AND ABBREVIATIONS

AABC	Associated Air Balance Council
AC	Air Conditioning (or cooling)
AFF	Above Finished Floor
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
BLAST	Building Loads Analysis and System Thermodynamics
Btu	British Thermal Unit
C	Celsius
CDD	Cooling Degree Days
CERL	Construction Engineering Research Laboratory
cf	cubic feet
CFR	Code of Federal Regulations
CWE	Current Working Estimate
DDC	Direct Digital Control
DoD	Department of Defense
DoE	Department of Energy
DOS	Disk Operating System (e.g. IBM or Microsoft)
EB	Energy Budget
EMCS	Energy Monitoring and Control System
ETL	Engineering Technical Letter
F	Fahrenheit
FCL	Future Cabinet Location (EMCS)
FID	Field Interface Device
g	gram
h	hour
HDD	Heating Degree Days
hp	horsepower
HVAC	Heating, Ventilating, and Air Conditioning

I/O	Input/Output
J	Joule
k	kilo = 1,000
LCC	Life Cycle Cost
LCCID	Life Cycle Cost In Design (by CERL)
m	meter
M	Mega = 1,000,000
MILCON	Military Construction
Mux	Multiplexer
NBS	National Bureau of Standards
NCEL	Naval Construction Engineering Laboratory
NEBB	National Environment Balancing Bureau
NEC	National Electrical Code
NTIS	National Technical Information Service
SIR	Savings to Investment Ratio
SPW	Single Present Worth
TABB	Testing, Adjusting and Balancing Bureau
UFGS	Unified Facilities Guide Specifications
UMCS	Utility Monitoring and Control System
UPW	Uniform Present Worth
UPW*	Modified UPW

*** End of Section ***