CHAPTER A-7

ENERGY ANALYSES, ECONOMIC ANALYSES, CONTROL SYSTEMS, EMCS

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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. Note well that changes may necessitate revised economic and engineering analyses.

7.2 APPLICABLE PUBLICATIONS. The most current editions of the publications listed below, as of the date of contract award, constitute an addendum to this chapter.

7.2.1 Army Projects. The following are applicable only to Army projects.

UFC 4-510-01 Design: Medical Military Facilities

7.2.2 All Projects. The following apply for all Military construction:

UFC 3-400-01	Energy Conservation
UFC 3-401-01FA	Utility Monitoring and Control Systems
UFC 3-410-01FA	Heating, Ventilating, and Air Conditioning
UFC 3-410-02A	Heating, Ventilating, and Air Conditioning (HVAC) Control Systems
NIST Handbook 135	Life-Cycle Cost Estimating Manual for the Federal Energy Management Program

7.3 PRECONCEPT SUBMITTAL REQUIREMENTS. Unless otherwise stated, the following items shall be submitted prior to the Concept Design Submittal.

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 Electricity is not to be used for heating except for the following:

a. Where used as supplemental heat in a heat pump.

b. The load is less than 4395 watts AND is life-cycle cost effective.

c. Electricity is life-cycle cost effective AND approved by the base major subordinate command.

7.3.2 Modeling Input Data. Pre-concept submittal of modeling data is only required when called for in the design instructions. When required, submit the following items to CESAS-EN-DM for review prior to computer modeling runs.

a. Two copies of all modeling input data.

b. Single-line rough layout sketches (8½ inches x 11 inches - Not to Scale) for each alternative in sufficient detail to show zoning, approximate pipe and such lengths, and quantities for major components.

7.3.3 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-DEM.

COMPUTER SOFTWARE OPTION	MOST DETAILED SIMULATION
BLAST	hourly calculations for 365 days
DOE 2	hourly calculations for 365 days
EnergyPlus	hourly calculations for 365 days
TRACE	hourly based on typical days
Carrier HAP	hourly based on typical days

7.4 CODE 3 DESIGN REQUIREMENTS.

7.4.1 Submittal. Submittal content and format shall be as described in UFC 3-710-01A, "Code 3 Design with Parametric Estimating".

7.5 CONCEPT / EARLY PRELIMINARY (35%) DESIGN SUBMITTAL REQUIREMENTS. Unless otherwise specified, the following items shall be submitted at Concept. See paragraph 7.10, TECHNICAL REQUIREMENTS, for instructions on methods and content.

a. Printouts of I/O data for Life-Cycle Cost simulations
b. U-value calculations for exterior surfaces
c. ASHRAE 90.1 compliance
d. EPAct 2005 compliance
e. Life Cycle Cost Analysis, including approval of alternatives which are to be studied
f. Energy conservation methods report
g. List of specifications to be used
h. I/O data diskette (when required)

7.6 PRELIMINARY (60%) DESIGN SUBMITTAL REQUIREMENTS. No submittal required. If a 35 percent design was not submitted, then the 35 percent requirements apply.

7.7 FINAL (100%) DESIGN SUBMITTAL REQUIREMENTS. 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 MC plates) and specifications
b. Annotated responses to all review comments
c. Revised design energy usage calculations and report for any significant changes

7.8 CORRECTED FINAL DESIGN SUBMITTAL REQUIREMENTS. The following items shall be submitted for review:

a. HVAC controls drawings and specifications with final comments incorporated.

b. Annotated responses to all review comments.

7.9 REQUIREMENTS FOR DESIGN/BUILD RFP PACKAGES. To be furnished with specific instructions relevant to the contract or delivery order.

7.10 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.

7.10.1 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.

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

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

7.10.1.2 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 Life Cycle Cost in Design (LCCID) program, the Building Life Cycle Cost (BLCC) program or one approved by HQUSACE, CEMP-E to be the equivalent thereof. The LCCID program is available from Building Systems Laboratories at 217-333-3977, and also from the Whole Building Design Guide website at http://www.wbdg.org/tools/lccid.php . The BLCC program is available from the Federal Energy Management Program web site at http://www1.eere.energy.gov/femp/information/download_blcc.html. 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.

7.10.1.3 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).

7.10.1.4 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.

7.10.1.5 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.

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

Army	UFC 3-400-01, "Design: Energy Conservation"
Army Medical	UFC 4-510-01, "Design: Medical Military Facilities"
Air Force	UFC 3-400-01, "Design: Energy Conservation"

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

7.10.3 The design shall be in compliance with UFC 3-400-01, Design: Energy Conservation, which in turn requires compliance with ASHRAE 90.1 and the Energy Policy Act of 2005 (EPAct 05). Each system component or feature selected that impacts the energy or water usage of the facility shall be in compliance with ASHRAE 90.1. ASHRAE 90.1 has several methods of complying with the standard. The path selected to show compliance shall be clearly documented.

7.10.4 Solar Energy. Public Law requires that designers consider solar feasibility and include cost effective applications in new construction and major renovations of Federal Buildings. Designs shall comply with UFC 3-440-01, Design: Active Solar Preheat Systems.

7.10.4.1 Active Solar. According to the Generic Active Solar Feasibility Study for CONUS, active solar hot water heating systems are not feasible for DOE region 3, which includes Georgia, South Carolina and North Carolina.

7.10.5 Non-solar Energy Systems. A minimum of three alternatives shall be studied for each significant energy-using system and subsystem. Significant energy usage includes:

a. Any annual energy cost exceeding $15,000

b. All HVAC systems are considered significant energy users

7.10.5.1 Systems Other Than HVAC. Study requirements for systems other than HVAC will be issued upon request through Project Managers.

7.10.5.2 HVAC Systems. All HVAC systems are considered significant energy users until proven otherwise. Study of HVAC system alternatives is required. Alternatives must be coordinated with and approved by CESASEN-DEM.

7.10.5.3 HVAC System Analysis. Any Army facility that is heated and/or cooled or heated only and exceeds 280 ^{m2} (3,000 ft^2) of gross floor area will be analyzed with a computer program that uses established weather data files and performs 8,760 hourly calculations. Energy calculations for buildings that do not require a computer simulation may use a computer program or appropriate methods explained in Chapter 29 of the most current ASHRAE Fundamentals Handbook. When typical buildings are analyzed and the results are applied to similar facilities, the building area used in selecting appropriate methods shall be the total gross area of all similar buildings and the typical building combined. Provide the complete input (room, systems, room assignment, plants, plant assignment, custom members, custom schedules) and output of the program.

7.10.6 Major Renovation. Major renovation is defined as changes in the features of the building envelope and replacement of the lighting, HVAC and water heating systems. When instructions for projects state that the project involves major renovation Energy Budget, Active Solar, and Life Cycle Cost analyses will be required.

7.10.7 Energy Conservation Investment Program (ECIP). This article'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.

7.10.8 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.

7.10.9 HVAC Controls. HVAC control system designs shall be in accordance with the guidance presented in UFC 3-410-2A. Designs for HVAC control systems shall be for electronic controls, not to include DDC unless designated in the individual project specific instructions. Pneumatic actuators are acceptable but pneumatic controls are not allowed without specific approval.

7.10.9.1 Drawings.

7.10.9.1.1 Single Loop Digital Control (SLDC) Drawings. Savannah District has produced detailed control drawings for air handling systems which shall be used without modification for any reason other than a site specific condition. These drawings are available on the web at www.hnd.usace.army.mil/techinfo/ti/810-11/810-11.htm. CADD files are available in AutoCAD (.dwg) format. Detail designs will be required for systems for which drawings are not available. The HVAC control plates (MC-plates) include:

a. Schematics
b. Ladder diagrams
c. Equipment schedule (updated with job specific data)
d. Control panel details

7.10.9.1.2 Direct Digital Control (DDC) Drawings. Savannah District has produced detailed control drawings for air handling systems which shall be used without modification for any reason other than a site specific condition. These drawings are available on the web at www.hnd.usace.army.mil/techinfo/ti/810-11/810-11.htm. CADD files are available in AutoCAD (.dwg) format. Detail designs will be required for systems for which drawings are not available. The HVAC control plates (MC plates) include:

a. Schematics.
b. Ladder diagrams.
c. Data terminal strip.
d. I/O summary table.
e. Equipment schedule (updated with job specific data).
f. Sequence of operation.

7.10.9.2 Specifications. Unified Facilities Guide Specifications (UFGS) can be found online at http://www.hnd.usace.army.mil/techinfo/ and http://www.wbdg.org/ccb/browse_org.php?o=70.

7.10.9.3 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 GLOSSARY OF TERMS AND ABBREVIATIONS.

AABC	American Air Balance Council
AC	Air Conditioning (or cooling)
AFF	Above finished floor
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration and AC Engineers
ASME	American Society of Mechanical Engineers
BLAST	Building Loads Analysis and System Thermodynamics
Btu	British thermal unit
C	Celsius
CDD	Cooling Degree Day method
CEGS	Corps of Engineers Guide Specifications
CERL	Construction Engineering Research Laboratory
cf	cubic feet
CFR	Code of Federal Regulations
CWE	Current work 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 Day method

hp	horsepower
HVAC	Heating, Ventilating, and/or 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 Investment Ratio
SPW	Single Present Worth
UPW	Uniform Present Worth
UPW*	Modified UPW

7.12 REFERENCES. The following were used as guidance in preparing this chapter. Unless otherwise specified, they do not constitute an addendum.

10 CFR, Part 436	Federal Energy Management and Planning Programs
Energy Policy Act of 2005	

AF ETL 84-7 MPC Energy Conservation Investment Program

Army Reg 11-27 Army Energy Program

Army Reg 11-18 The Cost and Economic Analysis Program

Public Law 100-615 Federal Energy Management Improvement Act of 1988

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EXHIBITS

GENERAL CHECKLIST FOR ENERGY ANALYSIS

Project:			
Fiscal Year:		Line Item:	
Site:			
CN:			
Designer:			
Checker:			
Date:			

A. PRECONCEPT PHASE.

_____ If previous designs are being site adapted, then previous analyses must be verified as acceptable for submission, or new analyses must be performed. In any case a complete design analysis must be made for all projects.

_____ Coordinate energy system alternatives before beginning detailed studies.

_____ When required, submit modeling data prior to modeling runs.

B. CONCEPT DESIGN PHASE.

_____ Are U-value calc provided and are any deviations from criteria justified based on a LCCA?

_____ Has ASHRAE 90.1 compliance been documented and submitted for each unique building?

_____ Are Active Solar Analyses complete and submitted for each building?

_____ Have all energy modeling I/O data been submitted?

_____ Have all analyses been checked for accuracy and completeness?

C. PRELIMINARY DESIGN PHASE.

_____ Have any significant changes occurred since Concept? If yes, then have all applicable analyses been revised and resubmitted?

_____ Have all technical comments been resolved satisfactorily?

_____ Have any Value Engineering proposals been incorporated into the design? If yes, then have all applicable analyses been revised and resubmitted?

D. FINAL DESIGN PHASE.

_____ Have any significant changes occurred since Concept? If yes, then have all applicable analyses been revised and resubmitted?

_____ Have all technical comments been resolved satisfactorily?

_____ Have any Value Engineering proposals been incorporated into the design? If yes, then have all applicable analyses been revised and resubmitted?

_____ Are U-values listed in the architectural specs in accordance with analyses?

_____ Are control plans and specs complete?

_____ Is the final design analysis complete?

_____ Have all listed submittal items been submitted?

DESIGN ENERGY USAGE SUMMARY

PROJECT: _____

BASE: _____

LI: _____

FY: _____

DOE REGION: _____

BUILDING: _____