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SUBJECT: Life-Cycle Cost Analysis Requirements for the Design Phase of USACE Buildings, Central Energy Systems and Associated Supporting Facilities

1. Applicability: Directive and Guidance

2. References:

- a. Memorandum, ASA (IE&E), 16 Dec 2013, subject: Sustainable Design and Development Policy Update.
- b. Unified Facilities Criteria 1-200-02, 1 March 2013, subject: High Performance and Sustainable Building Requirements.
- c. CFR Title 10 Part 436, Subpart A and National Institute of Standards and Technology (NIST) Handbook 135, "Life-Cycle Costing Manual for the Federal Energy Management Program, Annual Supplement to **NIST Handbook 135.**"
- d. ECB 2014-12, 25 April 2014, Subject: MCA & SRM Building Energy and Sustainability Policy.
- e. Memorandum, Office of the Assistant Chief of Staff for Installation Management, 18 December 2012, District and Islanded/Decentralized Heating Systems Selection Evaluation with Life Cycle Cost Analysis Guidance.
- f. Unified Facilities Criteria 2-100-01, 15 May 2012, subject: Installation Master Planning.
- g. OMB Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, revised December 2013.
- h. NISTIR 85-3273, "Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis," updated annually.
- i. American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) Handbook, HVAC Applications, Current Edition.
- j. Army Regulation 420-1, Subject: Facilities Engineering Army Facilities Management.

3. Purpose: This Engineering and Construction Bulletin (ECB) describes the minimum requirements for performing Life-Cycle Cost Analysis (LCCA) for energy conservation alternatives during the design phase for buildings, renewable energy systems, central energy plants and heating or cooling distribution networks. As stated in the Sustainability Design and Development (SDD) Policy (Ref. a): "The Army will plan, design, build, and operate facilities to achieve the highest-performing sustainable design that is life-cycle cost-effective within the program amount." Compliance with this ECB will ensure LCCA activities for energy conservation alternatives are being performed and documented in accordance with the referenced requirements. These LCCA requirements are significant design activities that must be performed for a building design to achieve high performance and sustainable facilities that comply with legislative mandates referenced by Unified Facilities Criteria 1-200-02 (Ref. b)

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4. Scope: This directive applies to all Military Construction, Army (MCA) projects executed by USACE that have not achieved 35% Design by date of issuance and are subject to any of the referenced standards regardless of location (CONUS/ OCONUS) that include over 5,000 gross square feet (GSF) of interior space or the construction cost is greater than \$2.5 million. For overseas construction activities on permanent basing and in support of contingency operations, this policy will apply to the greatest extent practical considering mission objectives and Host Nation agreements. Projects in progress will implement this requirement to the extent practical for the current phase with the expectation to achieve full compliance in future project phases.

This ECB is not applicable to projects, features or systems that are justifiable by benefits not easily quantified by cost, such as “energy security goals.” Project justification must specifically identify that the project, feature or system is justified by means other than an economic basis to waive the requirement of an LCCA.

5. Background: Life-Cycle Cost Analysis has been a legally mandated requirement of Federal building projects for many years. To date, there are many inconsistencies in the execution and application of LCCA in the design of buildings on USACE projects. As a result, this directive and guidance is intended to improve compliance, standardization and uniformity of LCCA requirements in the design of USACE building projects. This ECB is also intended to improve the delivery of design decision documentation and operational information to designers, future occupants, building owners and operators.

A LCCA provides important information to influence design decisions and choices early in the design phase. The results of a LCCA can help prioritize energy efficiency and water conservation measures that demonstrate a strong return on investment, guard against future cost increases (such as fuel or electricity costs), and reduce the total ownership costs of the facility. The LCCA information can be used by the owner and design team to select building features that enhance facility performance and better quantify long term investment decisions

6. Guidance: This section provides a summary of the LCCA requirements and design phase expectations.

a. Minimum LCCA Requirements: Subpart A of Title 10 Code of Federal Regulations (CFR) Part 436 (Ref. c) establishes Methodology and Procedures for Life Cycle Cost Analyses for determining energy and water conservation improvements (Ref. a and b) for Federal Buildings which is an administrative law and the authority for it rests in 42 U.S.C. 6361, 42 U.S.C. 8251-8263, 42 U.S.C. 828708287C. A LCCA requires a systematic evaluation of alternatives according to the energy requirements stated in this ECB.

Projects must meet the minimum energy and sustainability requirements described in UFC 1-200-02 (Ref. b) including all applicable referenced UFCs therein (also see ECB 2014-12 (Ref. d) for further guidance). As stated in Army’s SDD Policy Update, projects must achieve the maximum energy savings that is life-cycle cost effective within the programmed amount. Therefore, a life-cycle cost analysis (LCCA) is required for each project whether it meets, exceeds or falls below the applicable target as compared to a baseline that includes actual design features and systems that would have been included if the requirement was only to meet minimum requirements of the project/building. In general, standard design facilities which have had an LCCA completed based on design parameters set by the Centers of Standardization do not require a LCCA. However, standard

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design facilities that do not have a regional model, or features that have not been pre-determined, require a LCCA. Standard design projects will only be required to provide an updated LCCA when changes proposed by the project delivery team (PDT) to the standard result in an increase to the project cost and/or energy and water consumption.

All project delivery teams must use the Building Life-Cycle Cost (BLCC) program and follow the methodology in Subpart A of Title 10 of CFR Part 436 to perform the LCCA for each building. The BLCC program, incorporates these factors developed by the National Institute of Standards and Technology (NIST), complies with 10 CFR Part 436 and includes a MILCON Analysis module. The following link is provided that includes instructions on how to download the BLCC program for free: http://www1.eere.energy.gov/femp/information/download_blcc.html.

A LCCA for a facility as a whole must be completed for efficiency or conservation features provided in excess of the baseline to ensure the discounted payback period is no greater than 40 years or the projected life of the facility, if shorter than 40 years. This is not the same as evaluating separate sub systems (i.e., HVAC, lighting, etc) that have a shorter individual system life than the facility as a whole. As stated previously, UFC 1-200-02 (Ref. b), including all referenced UFCs therein, define the minimum building requirements and will be used as the project baseline for life-cycle cost comparisons. Equipment procurement, fuel, maintenance, repair, replacement, and any other quantifiable benefits and costs are to be included in a LCCA. Fuel cost escalation factors will be taken from the DOE Energy Information Administration NIST Guidelines embedded within the BLCC program. Paragraph 6 e. and f. below provide additional guidance on factors that must be considered and included in a LCCA.

A LCCA will be a separate document that is included as part of the design analysis and/or basis of design. LCCAs will be conducted in accordance with References (a) through (e). Final LCCA documentation must include a comprehensive summary that defines each alternative considered, including assumptions and references provided for each parameter. The assumptions must be clear, documented and of a level of detail sufficient to be used by a third party or audit team to duplicate the results of the LCCA. LCCAs must be completed using the same matrix of baseline information consistently across alternatives to ensure a fair comparison is made between alternatives.

b. LCCA Schedule Requirements: The LCCA must be initiated to validate the cost effectiveness of the highest energy efficient project within PA. During Code 3 (Ref. j), the project scope and cost must be shown to support a cost effective project as described in the 1391. The final LCCA is to be completed no later than Code 3 or conceptual design (35%). The LCCA must validate a cost effective project as part of the 3086 project review and be made part of the Design Analysis and available for review upon request. Any subsequent changes in project scope beyond the initial design that impact energy savings or project cost require an update to the LCCA.

Prior to the start of the design phase, the building site, orientation and configuration must be determined. For most military projects, these have been established in the planning phase (DD1391) per UFC 2-100-01(Ref. f). Early in the design phase, the building envelope passive design features and components (i.e. roofs, walls, windows/fenestrations, day lighting) need to be selected and analyzed for life-cycle cost effectiveness. Selection of passive (non-mechanical) features will help minimize energy demands for the active systems. After the passive building envelope strategies are determined, the active and mechanical systems (e.g. HVAC, plumbing, water heating systems, lighting systems, control systems, elevators, and fire protection systems) are selected, analyzed,

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designed and integrated into the overall design. The active and mechanical systems are the largest building energy consumers. It is critical that design teams utilize LCCA information to optimize selection of these systems.

For projects with scope variations impacting energy savings following the initial design, the final LCCA document submittal for passive and active energy and water features within the building must be completed and incorporated into the Design Analysis no later than the second design submittal (i.e. 65%). The LCCA progress and discussion will be included in all In-Progress-Reviews.

c. System Selection Requirements: A LCCA provides the decision maker a full, unbiased presentation of candidate alternatives, including the costs for maintaining viable alternatives. The decision maker may select an alternative based on operational considerations, aesthetics and project budget. In this case, the justification for selecting an alternative that does not achieve the highest energy savings must be included in the final LCCA document. A LCCA must include documentation of the thought process used to support the selection of a specific alternative. The LCCA document should summarize why the selected alternative is the best alternative for the project.

Good engineering judgment must be exercised in the analysis of at least three alternatives for each system (where available, e.g. walls, roof, glazing, lighting, HVAC, etc) that meet the requirements defined in paragraph 6.a. of this ECB. Where it is clear that the cost of an alternative exceeds the potential savings, do not perform the analysis; rather, use judgment and experience to select cost effective features. Where substantial costs between alternatives are involved, e.g. renewable energy applications, installing district heating, cooling or central energy plants (see Ref. e), ensure that the alternatives are analyzed towards the most economical solutions to meet the specific requirements.

d. LCCA Project Team Responsibilities: Performing a building level LCCA requires an integrated team. A design team must have representation from all applicable disciplines, including owner operations, to identify all opportunities to improve building performance and increase savings potential. Project team roles and responsibilities for performing LCCA are as follows:

- (1) Project Managers are responsible for establishing an integrated team.
- (2) Design Team Leads are responsible for employing integrated design principles to develop the energy and cost input data for implementation of the system-level LCCA.
- (3) The design District Chief of Engineering is responsible for assuring execution of the LCCA, including quality assurance for A-E designs.
- (4) For Design Build contracts, the preparer of the contract documents (e.g. RFP) shall perform the required LCCA and include the documentation during each technical review period prior to issuing the Design Build contract. The Design Build selection criteria must require that proposals that offer betterments to the requirements defined by the RFP be supported by a LCCA. Design Build contractors that provide proposals that conform to the requirements of the RFP are not required to submit a LCCA since the assumption is that the preparer of the RFP documents has already completed a LCCA in the RFP development stage.
- (5) Architects, Mechanical Engineers and Structural Engineers are generally responsible for the building envelope passive features.

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(6) Mechanical and Electrical Engineers are responsible for the active mechanical and electrical systems.

(7) Construction Representatives/Project Engineers are responsible for providing input related to construction execution that may affect an LCCA.

(8) Cost Engineering is responsible for cost input data for all LCCAs.

(9) Owner/Operator (i.e. DPW, BCE) have valuable information for operations and maintenance practices, evaluating options for space management and workplace alternatives, establishing energy and water operational performance goals, participating in development of Owner Project Requirements, and providing historical and empirical operating and maintenance cost data.

(10) The LCCA Regional Technical Center of Expertise (RECX) may provide assistance in the development of the LCCA and review of typical considerations on a reimbursable, project funded basis. The LCCA RECX point of contact is Mike Ternak, at 602-230-6985 or Mike.Ternak@usace.army.mil.

e. Critical LCCA Factors: The following factors have significant influence in LCCA outcomes and must be included in calculations for analysis. All calculations and assumptions must be clearly documented in LCCA document that is required to accompany the design analysis and/or basis of design.

(1) First Costs:

(a) Capital cost of new equipment: Pricing must be based on quotations received from manufacturers. Where quotations from manufacturers are not available pricing will be based on RS Means data. Costs must include all components required for a complete and usable system to include distribution network costs. Costs per square foot from other similar projects or parametric cost software are acceptable methods to develop these costs.

(b) Labor for installation priced per location: If available, pricing may be based on data from recent projects at the installation of comparable scope and scale. Where such data does not exist, pricing will be based on the most accurate data available. RS means data is acceptable for this.

(2) Maintenance Costs:

(a) Required Maintenance: Hours must be based on manufacturer provided component and system maintenance requirements. These costs are also available from the DPW, Business Operations and Integration Division (BOID). The BOID will have the records of labor and supply costs applied for each maintenance instance. If this data is not available or provided in a timely fashion then the use of RS Means is an acceptable alternative. Components and/or systems that are recommended to be replaced within the 40 year study period the manufacturer's recommendations must be accounted for in the LCCA. The ASHRAE HVAC Applications Handbook (Ref. i) should be utilized for estimated service life.

(b) Labor Rates: Pricing must be based on data from existing Installation maintenance contracts. Where such contracts do not exist, pricing must be based on RS Means data.

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(c) **Systems & Equipment Compatibility with Maintenance Staff:** Systems and equipment can be sophisticated. The design team should consult with the DPW in forecasting maintenance staff or contract requirements for maintaining systems selected and included for the building.

(3) Operations Costs:

(a) **Energy and fuel used by system:** Usage data will be based on measured use, or obtained from utility bills for existing buildings, when available. If measured data does not exist, usage will be estimated using engineering analysis, including taking the energy and fuel usage directly from the energy model.

(b) **Labor for operation priced per location:** Pricing will be based on data from existing installation operation contracts of comparable scope and scale. These operational costs are typically available from the DPW BOID, the O&M Division, and should also be available from the Installation Energy Manager. Where such contracts do not exist, pricing will be based on RS Means data.

f. Additional Factors:

(1) **End-of-Life Removal:** Pricing will be based on escalated demolition costs, as appropriate; to include any surcharge for material recycling, reuse, and special disposal costs (e.g. photovoltaic panels).

(2) **Salvage value at end of useful life:** Pricing will be based on data from recent projects at the Army Installation on projects of comparable scope and scale. Where such projects do not exist pricing will be based on RS Means data.

(3) **Discount and escalation rates:** Data will come from the most current edition of Appendix C of OMB Circular A-94 (Ref. g).

(4) **Differential escalation rate for energy:** As instructed in NIST Guidelines (Ref. h) the differential escalation rates must be obtained from the DOE Energy Information Administration (EIA).

g. LCCA for District and Central Plant Heating Systems: Initial technical guidance on "district and islanded/decentralized" heating systems selection is available in Reference d. The guidance will help bring consistency and alignment for facilities on Army installations with central heating plants.

h. Sensitivity Analysis: Sensitivity analysis is required on all LCCA to show how significantly the results change due to potential variations in key input data parameters. If a change in a variable causes a change in the ranking of alternatives, the LCCA is "sensitive" to that variable. Good engineering judgment should be used in selecting the most important input variables that will be included in the sensitivity analysis.

The results of the sensitivity analysis are required to be included in the Executive Summary of the LCCA document. Performing a sensitivity analysis and including its results in the report, assures the decision maker that uncertainties in the LCCA have been tested and the results documented. At a minimum, sensitivity analysis should be considered as part of the analysis of benefits and costs; the discount rate; and potential variations in energy and water costs.

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7. A request for an exemption through HQUSACE (CECW-CE) may be made for any specific LCCA requirement in this ECB. Any approved exemptions to this policy must be documented with reference to the specific requirement in conflict and included in the project documentation.

8. The Headquarters USACE point of contact for this policy is Daniel Carpio (CECW-CE), at (213) 452-3667 or Daniel.Carpio@usace.army.mil.

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