APPENDIX Q

GUIDELINES FOR LIFE CYCLE COST ANALYSIS (LCCA)

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APPENDIX Q

RECOMMENDED GUIDELINES FOR LIFE CYCLE COST ANALYSIS (LCCA)

Note: For UT Austin capital projects, do **not** use this Appendix Q. UT Austin projects should adhere to the UT Austin Design & Construction Standards 4.02.00 *Project Design Evaluation and Approval Process* current edition.

A. PURPOSE

Cost effectiveness is a key component of a building design, and Life Cycle Cost Analysis (LCCA) is an essential design process for controlling the initial and future cost of building ownership. Life Cycle Cost (LCC) is defined by the National Institute of Standards and Technology (NIST) Handbook 135 as the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or building system over a period of time.

LCCA is based on the premise that multiple building design options can meet programmatic needs and achieve acceptable performance, and that these options have differing initial costs, operating costs, maintenance costs, as well as different life cycle costs. By comparing the life cycle costs, LCCA can show the trade-offs between low initial first cost and long-term cost savings. Thus, the most cost-effective system for a given use can be identified, and the length of time it will take to "pay back" the incremental cost for this system can also be determined.

In keeping with the Institution's sustainability practices, LCCA can identify environmentally desirable solutions. Careful design choices that result in efficient use of energy and water often yield long-term cost savings. In addition, should environmentally friendly choices not save money over time, LCCA may reveal that their additional cost over time is minimal.

These guidelines define the LCCA process, and establish the standards and metrics to ensure accurate and consistent life cycle data collection and evaluation across projects.

B. GENERAL REQUIREMENTS

1. During the Schematic Design (SD) and Design Development (DD) phases of a project, the Project Architect/Engineer will be directed by the Owner and Project Team to perform up to five (5) LCCA comparative analyses from several building system categories. Each LCCA comparative analysis can have up to four (4), or more if deemed necessary, alternatives (one base case plus three alternate cases). Building system categories are as follows, but are not limited to:

a. Energy Systems
   1) Central plant vs. stand alone system (steam and chilled water)
   2) Equipment options (air cooled chillers vs. refrigerant-based direct expansion [DX] units)
   3) Alternative energy systems

b. Mechanical Systems
   1) Air distribution systems (variable volume vs. constant volume, overhead vs. underfloor)
   2) Water distribution systems

c. Electrical Systems
   1) Indoor lighting sources and controls
   2) Outdoor lighting sources and controls
   3) Power distribution (transformers, buss ducts, cable trays)

d. Building Envelope Systems
   1) Skin and insulation options
   2) Roofing systems materials and insulation methods
   3) Glazing, daylight, and shading options

e. Siting Systems
   1) Orientation, floor to floor height, and overall building height
   2) Landscape, irrigation, and hardscape options

f. Structural Systems
   1) Systems/materials selection (wood vs. steel vs. concrete, cast-in-place vs. pre-cast)

C. THE LCCA PROCESS

1. GENERAL: The LCCA process involves the Project Architect and Project Team establishing clear objectives, determining the criteria for evaluating alternatives, identifying and developing design alternatives, gathering cost information, and developing a life cycle cost for each alternative.

2. ESTABLISH CLEAR OBJECTIVES: The Project Architect and Project Team should establish clear objectives in evaluating alternatives. LCCA can capture dollar cost variations between alternatives and show which option has the overall lowest cost. However, LCCA cannot evaluate the improved comfort or occupant satisfaction with different glazing materials.

3. DETERMINE LCCA METRICS: The two metrics to be used and calculated in the LCCA are the Life Cycle Cost of each alternative and its Payback over an agreed upon study life. Consideration is given to total costs and the time it takes to recover an incremental initial investment incorporating the time value of money. As mentioned above, Life Cycle Cost is defined as the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or building system over a period of time.

4. IDENTIFY BASE CASE AND ALTERNATIVE DESIGNS: The Project Architect and Project Team should develop up to four alternative designs. The first alternative design is the "base case" and is the standard design or minimum requirement for a project. The base case is typically identified as having the lowest initial cost of all the alternatives. The remaining three alternative designs are developed to evaluate against the "base case." The Project Team should use their experiences and judgment in selecting relevant building and system component alternative designs.

5. GATHER COST INFORMATION: For each alternative design, the Project Architect should gather cost information. Cost information should include, but not be limited to, the following:

    a. Initial Costs
        i. Construction costs (labor, materials, equipment, etc.)
        ii. Soft costs (design fees, permit fees, etc.).

    b. Annual Future Costs
        i. Operating Costs (utility costs such as electricity, gas, water, steam, chilled water, etc. and service costs such as custodial, etc.)
        ii. Maintenance Costs (preventative and reactive)

    c. Non-Annual Future Costs
        i. Replacement Costs (planned maintenance, renovation at a future date, etc.)
        ii. Demolition Costs (if required)

Note: Residual Value default is set at zero ($0) for all studies and not included in LCCA unless otherwise directed.

6. PERFORM LIFE CYCLE COST ANALYSIS: For each alternative, including the base case, the Project Architect should calculate the LCC and Payback metrics. Each alternative should be evaluated using these two metrics, and recommendations should be made as to which alternative design should be incorporated into the project.

Regarding the concept of "avoided capital," some LCC analyses attempt to incorporate upfront cash savings (derived by a lower initial cost) into the LCC and Payback metrics of one particular design alternative. This practice circumvents true LCC analysis by treating "avoided capital" as an avoidance of initial costs only. In reality, "avoided capital" encompasses initial cost savings as well as performance savings produced by the design alternative over the life of the study period, as measured in present value terms. Put another way, "avoided capital" is the dollar amount difference between the LCCs of two design alternatives. It is an output of LCC analysis, not an input. Thus, "avoided capital" can only be accurately reflected by comparing two completed LCCs.

LCCA weighs money spent today versus money spent in the future. All costs are converted to constant dollars, and then summed to develop an LCC, or Present Value Cumulative Cost for each alternative. In general, the best alternative design is simply the alternate with the lowest LCC with an acceptable Payback period. Note: Do not confuse wanting "lowest present value" in an LCCA calculation with wanting the "highest present value" from a revenue-generating financial calculation.

D. LCCA TERMINOLOGY

1. **Life Cycle Cost (LCC**) – the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or building system over a period of time. Also referred to as Present Value Cumulative Costs.

2. **Payback** – the time it takes to recover an incremental initial investment, incorporating the time value of money.

3. **Life Cycle Cost Analysis (LCCA)** – an economic evaluation technique that determines the total cost of owning and operating a building, building system or facility over a period of time.

4. **Initial Costs** – costs incurred prior to occupation of the facility including construction costs (labor, materials, equipment, etc.) and soft costs (design fees, permit fees, etc.).

5. **Annual Future Costs** – after occupation of the facility, costs that are incurred every year over the span of the study period (utilities maintenance, etc.).

6. **Non-Annual Future Costs** – after occupation of the facility, costs that are not incurred every year over the span of the study period (replacement, renovation, demolition, etc.).

7. **Study Period** – the time period over which an LCCA is performed, or the period of time over which ownership and operations expenses are to be evaluated. The LCCA Model assumes the study period to be equivalent to the useful life of the project.

8. **Nominal Discount Rate** – generally reflects the cost of capital and is used to discount future nominal cash flows back to Current Dollars. The Nominal Discount Rate incorporates the rate of inflation.

9. **Real Discount Rate** – the Nominal Discount Rate adjusted to exclude the rate of inflation. By adjusting for inflation, the Real Discount Rate can be used to discount Constant Dollar cash flows. Real Discount Rate is expressed as:

$$\text{Real} = \frac{1 + \text{Nominal}}{1 + \text{Inflation}} - 1$$

10. **Escalation Rate** – the rate of change over time for established commodities such as materials, labor, and utilities.

11. **Constant Dollars** – dollars of uniform purchasing power whose present value is tied to a reference year and is exclusive of general price inflation or deflation.

12. **Current Dollars** – dollars of non-uniform purchasing power, including general price inflation or deflation, in which actual prices are stated. When inflation is 0%, Constant Dollars and Current Dollars are equivalent.

13. **Present Value** – the time-equivalent value of past, present, or future cash flows as of the beginning of the base year.

E. LCCA FORMULAS

1. The basic LCCA formula is:

$$LCC = I + PV_{\text{Annual Future}} + PV_{\text{Non-Annual Future}}$$

Where:

LCC = Life Cycle Cost
I = Initial Costs
$PV_{\text{Annual Future}}$ = Present Value of all Annual Future Costs
$PV_{\text{Non-Annual Future}}$ = Present Value of all Non-Annual Future Costs

2. To determine the Present Value of Annual Future Costs, the following formula is used:

$$PV_{Annual\ Future} = A*(1 + e) * \frac{(1 + d)^t - (1 + e)^t}{(d - e) * (1 + d)^t}$$

Where:
$PV_{Annual\ Future}$ = Present Value of Annual Future Costs
A = Amount of Annual Future Cost
d = Real Discount Rate
e = Escalation Rate
t = Time (expressed as number of years)

3. To determine the Present Value of Non-Annual Future Costs, the following formula is used:

$$PV_{Non\text{-}Annual\ Future} = \frac{A*(1 + e)^t}{(1 + d)^t}$$

Where:
$PV_{Non\text{-}Annual\ Future}$ = Present Value of Non-Annual Future Costs
A = Amount of non-recurring Future Costs at a time t
d = Real Discount Rate
e = Escalation Rate
t = Time (expressed as number of years)

F. ECONOMIC PARAMETERS FOR LCCA

1. FINANCIAL CRITERIA: Financial criteria used to perform an LCCA study are established by the Owner in the Basis of Design (BoD) document during the "Pre-Design Phase." These BoD financial criteria are campus- and project-specific, and are used for the selection of appropriate equipment and systems fit for project-specific purposes. The Project Architect should utilize the BoD financial criteria when calculating LCC. Financial criteria may include:

a. Real Discount Rate
b. Study Period
c. Payback
d. Initial Costs
e. Annual Future Costs
f. Non-Annual Future Costs

G. PROCESS FOR FINAL SELECTION AND DESIGN APPROVAL

1. Once the LCCs have been compiled, use a scoring system to determine the best solution for the Institution. The Design Team will work closely with the UT Project Team to develop an appropriate framework of evaluation for each project. Other factors within the scoring system might include aesthetics; land use, water, and ecosystem quality; social and programmatic factors; materials and waste; indoor environmental quality; energy and atmosphere; or adaptability for future use.