TRI-SERVICE PAVEMENTS WORKING GROUP (TSPWG) MANUAL

LIFE-CYCLE COST ANALYSIS OF RETROREFLECTIVE GLASS BEADS

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TRI-SERVICE PAVEMENTS WORKING GROUP MANUAL (TSPWG M)

LIFE-CYCLE COST ANALYSIS OF RETROREFLECTIVE GLASS BEADS

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Change No.	Date	Location

FOREWORD

This Tri-Service Pavements Working Group Manual supplements guidance found in other Unified Facilities Criteria, Unified Facility Guide Specifications, and Service-specific publications. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and, in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the most stringent of the TSPWG Manual, the SOFA, the HNFA, and the BIA, as applicable. This manual provides guidance on how to accomplish a life-cycle cost analysis (LCCA) comparing Type I to Type III retroreflective glass beads on military airfield facilities using the ECONPACK LCCA economic analysis software program. The information in this TSPWG Manual is referenced in technical publications found on the Whole Building Design Guide. It is not intended to take the place of Service-specific doctrine, technical orders (TOs), field manuals, technical manuals, handbooks, tactics, techniques, and procedures (TTP) or contract specifications but should be used along with these to help ensure pavements and markings meet mission requirements.

TSPWG Manuals are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction, maintenance, repair, or operations. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and the Air Force Civil Engineer Center (AFCEC) are responsible for administration of this document. Technical content of this TSPWG Manual is the responsibility of the Tri-Service Pavements Working Group (TSPWG). Defense agencies should contact the preparing activity for document interpretation. Send recommended changes with supporting rationale to the respective Service DWG member.

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**TRI-SERVICE PAVEMENTS WORKING GROUP MANUAL (TSPWG M)
NEW SUMMARY SHEET**

Document: TSPWG Manual 3-260-04.18-01, *Life-Cycle Cost Analysis of Retroreflective Glass Beads*

Superseding: None

Description: The National Defense Authorization Act for Fiscal Year (NDAA FY) 2018, Section 2872, allows the use of Type I glass beads on military airfields provided a life-cycle cost analysis (LCCA) is performed that appropriately considers the local site conditions, life-cycle cost maintenance, environmental impact, operational requirements, and the safety of flight. The Department of Defense (DOD) allows the use of higher retroreflective media other than Type I glass beads on military airfield facilities on a case-by-case basis, in accordance with UFGS 32 17 23, *Pavement Markings*, section 2.2.21.1, "Reflective Media for Airfields." The type of beads used on DOD airfields is determined by the installation facility management group (e.g., Director of Public Works, Base Civil Engineer, Senior Airfield Authority) after performing an LCCA in accordance with NDAA FY 2018, Section 2872.

Reasons for Document:

This manual provides guidance on how to accomplish a LCCA comparing Type I to Type III retroreflective glass beads on military airfield facilities using the ECONPACK LCCA economic analysis software program in accordance with NDAA FY 2018, Section 2872.

Impact: There is no cost impact. The following benefit should be realized.

- Supplemental information on how to perform an LCCA on retroreflective bead alternatives will be available to all Services.

Unification Issues

None.

Note: The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by DOD.

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CHAPTER 1 INTRODUCTION

1-1   BACKGROUND.

The National Defense Authorization Act for Fiscal Year (NDAA FY) 2018, Section 2872, allows the use of Type I glass beads on military airfields provided a life-cycle cost analysis (LCCA) is performed that appropriately considers the local site conditions, life-cycle cost maintenance, environmental impact, operational requirements, and the safety of flight. DOD allows the use of higher retroreflective media other than Type I glass beads on military airfield facilities on a case-by-case basis, in accordance with UFGS 32 17 23, *Pavement Markings*, section 2.2.21.1, "Reflective Media for Airfields." The type of beads used on DOD airfields is determined by the installation facility management group (e.g., Director of Public Works, Base Civil Engineer, Senior Airfield Authority) after performing an LCCA in accordance with NDAA FY 2018, Section 2872.

LCCA is applied to any capital investment decision in which relatively higher initial costs are traded for reduced future maintenance costs with a longer life expectancy. It is particularly suitable for the evaluation of facility design alternatives that satisfy a required level of facility performance but have different initial investment costs, different operating and maintenance and repair costs, and different design lives. LCCA provides a significantly better assessment of the long-term cost-effectiveness of a project than alternative economic methods that focus only on first costs or on short-term operating-related costs.

LCCA is a method for assessing the total cost of facility ownership. It takes into account all costs of acquiring, owning, and disposing of a facility or facility system. LCCA is especially useful when project alternatives fulfill the same performance requirements but differ with respect to initial costs and operating costs. In this case, the alternative has to be compared to select the one that maximizes net savings. Lowest life-cycle cost (LCC) is the most straightforward and easy-to-interpret measure of economic evaluation.

1-2   PURPOSE AND SCOPE.

This TSPWG Manual provides guidance on how to accomplish an LCCA comparing Type I to Type III retroreflective glass beads on military airfield facilities using the ECONPACK LCCA economic analysis software program.

1-3   APPLICABILITY.

This TSPWG Manual is applicable to all DOD entities performing LCCA of retroreflective glass bead alternatives on military airfield facilities.

1-4   REFERENCES.

Appendix A contains a list of references used in this document. The publication date of the code or standard is not included in this document. Unless otherwise specified, the most recent edition of the referenced publication applies.

1-5   **GLOSSARY.**

Appendix B contains acronyms, abbreviations, and terms.

CHAPTER 2 ECONPACK SOFTWARE

2-1   ECONPACK LCCA ANALYSIS TOOL.

The ECONPACK LCCA-related software program is used for this LCCA guidance. The use of ECONPACK considerably reduces the time and effort spent on formulating the LCCA, performing the computations, and documenting the study. ECONPACK is an approved software package to load and use on DOD information technology (IT) systems.

The ECONPACK economic analysis tool was developed by the U.S. Army Corps of Engineers to support DOD funding requests. ECONPACK is not available to the public. Go to https://pax.csd.disa.mil/ (DOD Common Access Card [CAC] required). Click "I Accept" at the notice and consent message then click the "DD1391 Apps" button on the next screen to download ECONPACK.

Figure 2-1 ECONPACK Software
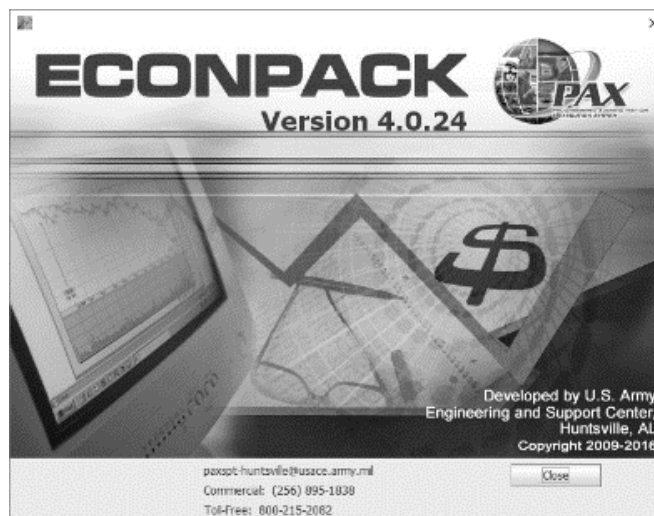
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CHAPTER 3 ECONPACK PROCESS

3-1   ECONPACK STEP-BY-STEP PROCESS DESCRIPTION.

The following subparagraphs describe a step-by-step process for generating an LCCA using ECONPACK software.

3-1.1   Step 1: Add LCCA Project.

Once ECONPACK has been successfully downloaded, the first step is to add a new LCCA project. Figure 3-1 illustrates ECONPACK's initial screen view and Economic Analyses project tree. New projects are displayed under the **User Generated** folder by choosing the graphic user interface (GUI) icon with a ☆ or use the **File** dropdown menu and choose **New**.

Figure 3-1 ECONPACK Initial Screen View
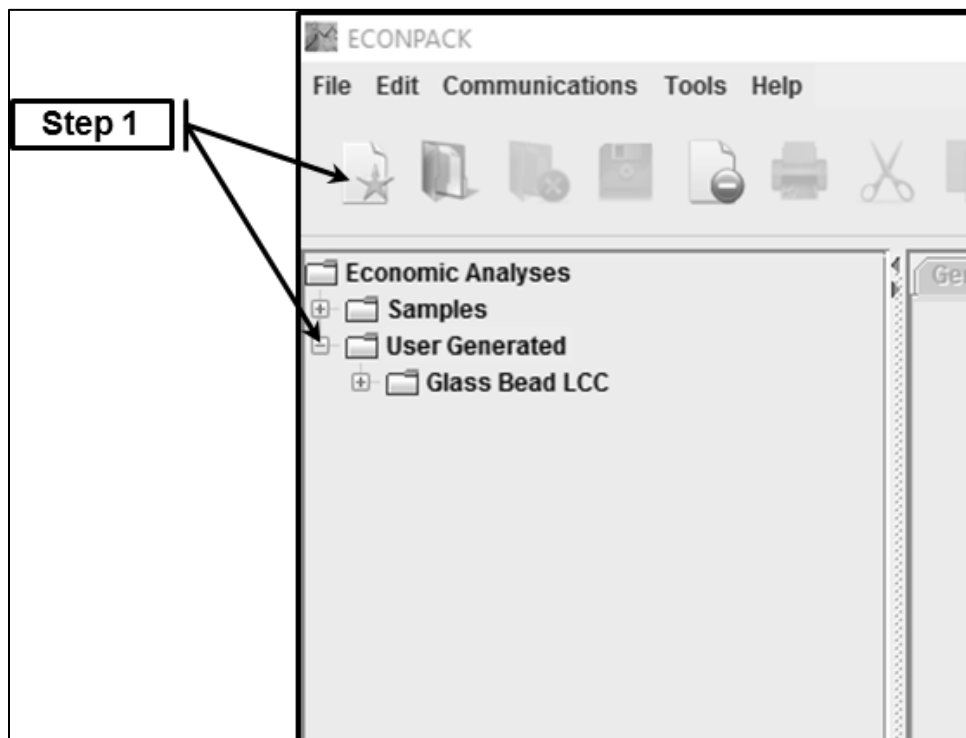
3-1.2   Step 2: General Information Tab.

Steps 2, 3, and 4 are illustrated in Figure 3-2, ECONPACK'S **General Information** tab. Fill in the life-cycle cost general information. Note this information is used in ECONPACK's standard reports. Write complete sentences. An example for **Project Objective** is, "The Objective of this LCCA is to estimate the overall costs of project alternatives, Type I compared to Type III retroreflective glass beads, and to select the material that ensures the facility will provide the lowest overall cost of ownership consistent with its quality and function."

3-1.3   Step 3: Type of Analysis.

Type of Analysis is always **Mission Requirement** and **Full**. **Project Type** is always **MILCON/Other**. By making this selection, the LCCA is set as a net present value (NPV) analysis. NPV is the sum of all discounted costs for all years of the analysis period. All costs are discounted to present value and alternatives are ranked according to NPV.

3-1.4   Step 4: Alternatives, Text, and Cost Sensitivity Analysis.

Once complete, select **OK** and the greyed-out tabs—**Alternatives**, **Text**, and **Cost Sensitivity Analysis**—become active.

Figure 3-2   ECONPACK General Information
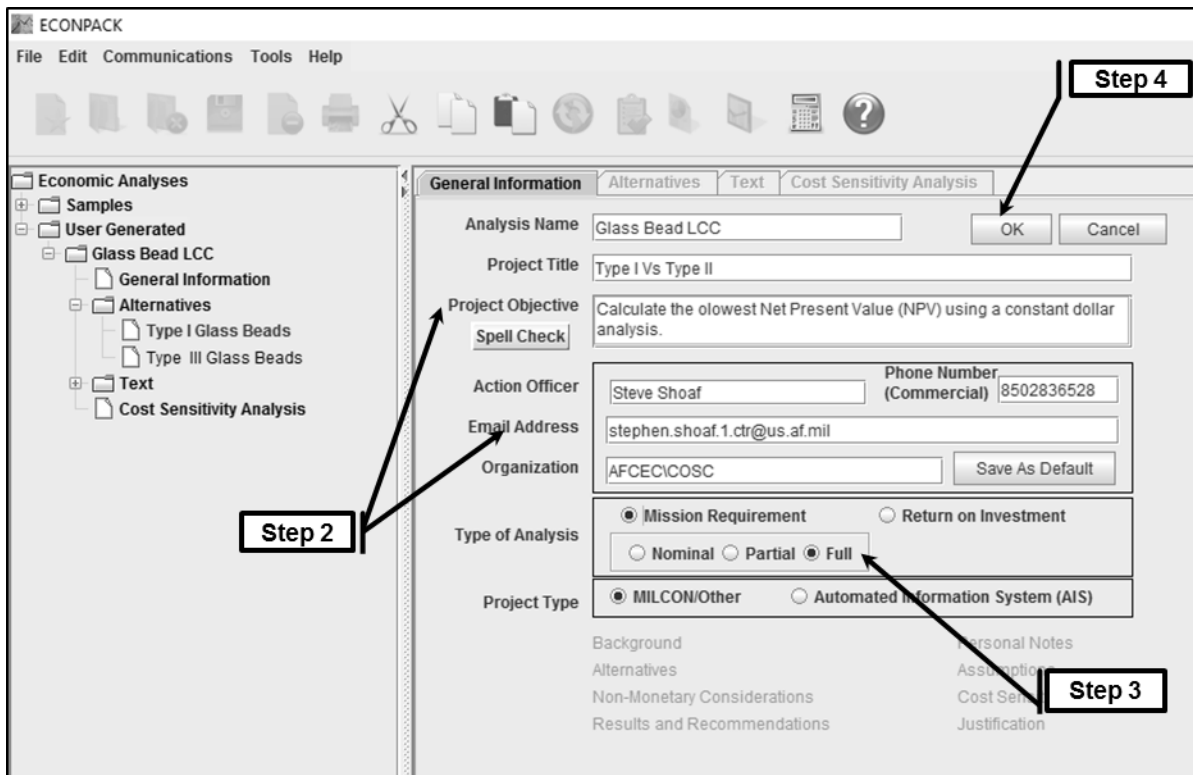
3-1.5   Step 5: ECONPACK'S Alternatives Tab.

Steps 5, 6, and 7 are illustrated in Figure 3-3, ECONPACK'S **Alternatives** tab. ECONPACK will open with multiple default alternatives. Delete these or, at a minimum, ensure they are marked **Nonviable**. If marked **Nonviable**, they will be displayed in ECONPACK's standard reports. Select **Add Alternative**. ECONPACK will add a new alternative, labeled **Alternative #**. Rename **Alternative #** to **Type I Glass Beads** and a second alternative to **Type III Glass Beads**.

Note: To document the alternatives, select **Discussion**. This will open a Word document, allowing the analyst to add narrative descriptions for each alternative.

3-1.6   Step 6a: Global Discounting Convention.

For this glass bead LCCA, all annually recurring cash flows (e.g., operational costs) are discounted from the **Middle-of-Year**. All single amounts (e.g., replacement costs, residual values) are discounted from their dates of occurrence, **Beginning-of-Year**, or **End-of-Year**.

3-1.7   Step 6b: Period of Analysis.

3-1.7.1. The **Period of Analysis** includes any planning, construction, or implementation period and the service or occupancy period. The **Period of Analysis** is the same for all alternatives considered.

3-1.7.2. Local conditions and maintenance activities are considered in the evaluation of the life expectancy of an installed reflective stripe. Historic patterns of restriping, rubber removal, expected paint life by type of paint, striping location, pavement material, stripe color, snow removal, or other maintenance activities are considered as components of the expected cost and life of the striping.

3-1.7.3. In accordance with AFMAN 65-506, *Economic Analysis*, the common denominator method assumes the assets associated with each alternative are replaced in the last year of their lives with identical equipment and replacement continues until all alternatives have assets reaching the last year of their lives during the same year. Choose that year as the last year of your analysis.

3-1.7.4. To illustrate this approach, suppose an analyst must choose between two machines, A and B. The two machines are designed differently but have identical capacity and do exactly the same job. Machine A has an economic life of three years while Machine B has an economic life of two years. The first Machine A reaches the end of its life in year three and the second Machine A reaches the end of its life in year six. The B Machines reach the end of their lives in years two, four, and six, with year six being the first ending year common to both machine alternatives. It's important to keep in mind the major assumption being made: that "chaining" the assets in this manner represents a realistic investment strategy.

3-1.8   Step 6c: Discount Rate (%).

In order to be able to add and compare cash flows incurred at different times during the life-cycle of a project, they are made time-equivalent. To make cash flows time-equivalent, the LCC method converts them to present values by discounting them to a common point in time, usually the base date.

The discount rate for federal projects not primarily concerned with energy or water conservation is determined by the Office of Management and Budget (OMB). Use OMB's Real Discount Rate versus their Nominal Discount Rate. The Real Discount Rate does not include the general rate of inflation.

Discount rates are updated annually on the OMB website between January and February. To confirm that you are using the latest rate, refer to the general OMB circular

site, select Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, and then select Appendix C. The OMB site is:

https://www.whitehouse.gov/omb/information-for-agencies/circulars

or

https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/memoranda/2017/m-17-10.pdf

3-1.9   Step 6d: Start Year.

Enter the year the economic analysis is to begin or the first-year costs are to be incurred. The **Start Year** is usually the "program year."

3-1.10   Step 6e: Base Year.

Enter the reference year for all present value calculations; that is, the year to which all costs are to be discounted. This typically is the year the economic analysis is prepared. The **Base Year** can be either before or the same year as the **Start Year**. From a purely mathematical viewpoint, the choice of a base year does not affect the rankings or the magnitude of differences between them.

3-1.11   Step 6f: Cost Input.

The economic analysis is expressed in **Dollars** ($) unless all the project expenses are of such magnitude that expressing them in **Thousands** (of dollars) is considered reasonable.

### 3-1.12   Step 6g: Dollar Analysis

Select **Constant**. Cost estimates expressed as constant dollars imply the purchasing power of the dollar remains unchanged over the period of analysis. Assuming an unchanged dollar purchase power is why a Real Discount Rate is used (Step 6c).

3-1.13   Step 7: Expenses/Residuals.

Select **Expenses/Residuals**, which will open a new ECONPACK dialogue window.

Figure 3-3 ECONPACK Alternatives
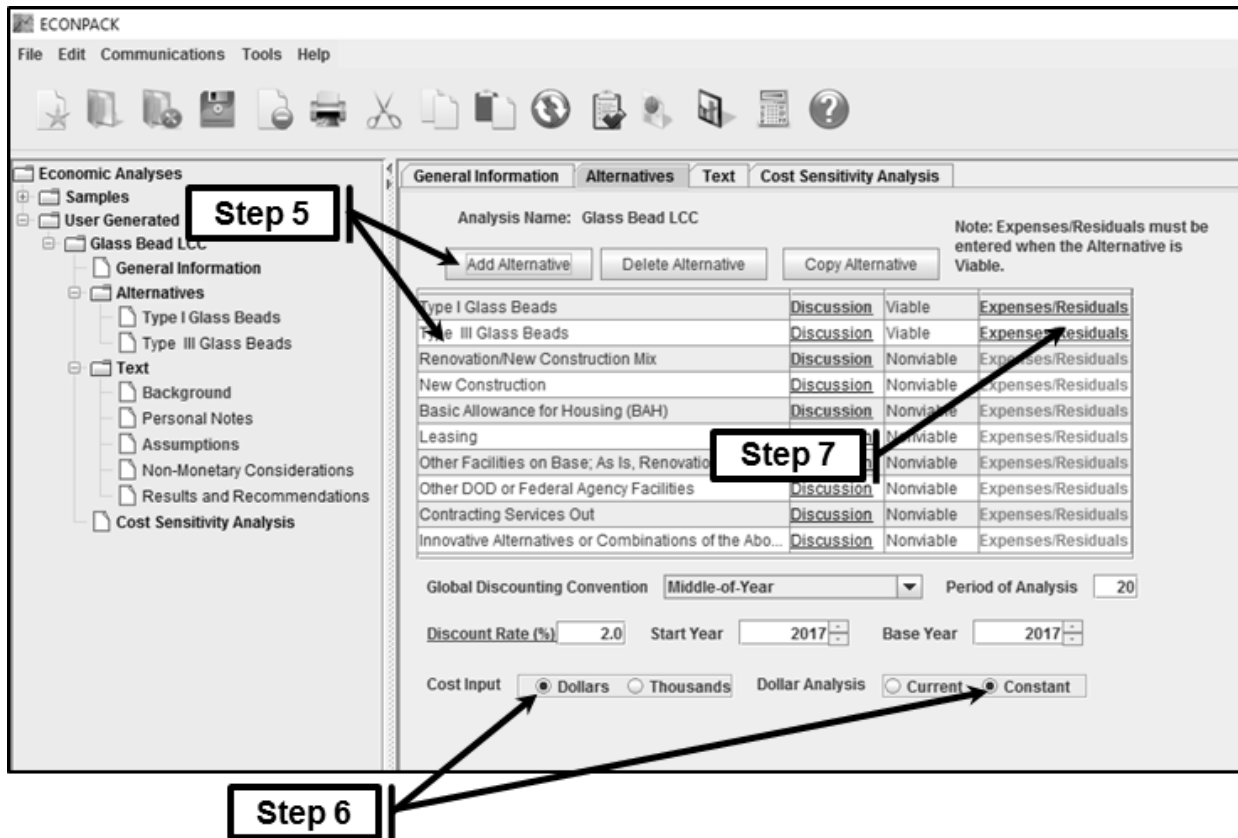
3-1.14   Step 8a: Add Expense.

Steps 8, 9, 10 and 11 are illustrated in Figure 3-4. Select **Add Expense**. ECONPACK provides default dropdown menu choices for **Name** and **Category**. If these are not applicable, **Name** and **Category** can be input directly.

3-1.15   Step 8b: Inflation Schedule.

3-1.15.1. As stated in Step 6g, using a constant dollar analysis negates the use of an inflation schedule.

3-1.15.2. An LCCA can be performed in constant dollars or current dollars. Constant dollar analyses exclude the rate of general inflation and current dollar analyses include the rate of general inflation in all dollar amounts, discount rates, and price escalation rates. Both types of calculation result in identical present-value life-cycle costs. Generally, use the method that is easier to use. If a majority of the costs are already in constant dollars, then use constant dollars with the real discount rate. If, on the other hand, the majority of the costs are already in future year dollars (also known as out-year dollars) then it is better to use the nominal rate with future year dollars.

3-1.15.3. Constant dollars reflect the value or purchasing power of a dollar in a single, specific year (as in "constant FY18 dollars") and, as such, do not include the effects of

inflation. Its value is "constant" throughout the years of the analysis period. Expressed this way, the cost of a certain cost element (assuming no other changes to that element) is the same in the first year of the analysis as it is in the last. This is also called "real" dollars.

3-1.15.4. Current dollars have a value that is different from year to year and reflect the value of that dollar in the current year in which it is spent. A current dollar implicitly includes the effects of inflation. This is also called "nominal" or "then-year" dollars.

3-1.15.5. Choose real rates when conducting a constant dollar economic analysis and nominal rates when conducting a current dollar economic analysis. Constant dollar economic analyses are preferred. They are simpler in that they are run without inflation factors and thereby use real interest rates. Occasionally, current dollar economic analyses are performed. These analyses are more complex in that they are run with inflation factors and thereby use nominal interest rates.

3-1.16   Step 8c: Discounting Convention.

Discounting Convention is discussed in Step 6a.

3-1.17   Step 9: Source/Derivation.

When **Source/Derivation** is selected, ECONPACK launches a Word file where the analyst documents any assumptions such as cost estimate source or repair/replacement frequency.

3-1.18   Step 10: Year.

Note: The years are arranged in chronological order and equal the **Period of Analysis** discussed in Step 6b. **Period of Analysis** is selected to ensure there are no residuals using the common denominator method discussed in Step 6b.

3-1.19   Step 11a: Value.

Individual expenses are placed in the **Value** column in the year they occur (expensed).

3-1.20   Step 11b: Common Cost.

Common cost (also known as wash cost) (see AFMAN 65-506) is any cost that is "common" to all alternatives in the analysis. For costs to be considered common, they must be identical in terms of both amount and timing. Common costs add no additional information to the decision-making process and may be excluded from the analysis unless there is a requirement to show the total program costs. Whenever such costs are excluded from an economic analysis, such exclusion must be clearly and explicitly stated in the Assumptions documentation of the economic analysis. However, if a decision-maker wants to see the total cost of the alternatives in an economic analysis, the analyst should include common costs to show the full costs of each alternative. While a category of cost may be common, the amount may differ, even significantly,

among alternatives. Exercise caution before deciding to exclude common costs and be able to defend doing so.

There are numerous costs associated with acquiring, operating, maintaining, and disposing of an airfield system. The retroreflective bead life-cycle system-related costs will usually fall into the following categories:

- Initial costs: purchase, acquisition, construction costs

- Operation, maintenance, and repair (OM&R) costs

- Replacement costs

- Residual values: resale or salvage values or disposal costs

- Non-monetary benefits or costs

Only those costs within each category that are relevant to the decision and significant in amount are needed to make a valid investment decision. Costs are relevant when they are different for one alternative compared with another. Costs are significant when they are large enough to make a credible difference in the LCC of a project alternative. For a constant dollar analysis, all costs are entered as Base Year amounts in today's dollars. As an example, a cyclic replacement cost of $100,000 occurs every five years. Here, the replacement cost is in today's dollars but is entered in the Base Year, Base Year plus (+) 5 years, Base Year plus (+) 10, etc. The LCCA constant dollar method discounts these cost for each year entered back to the Base Year to convert them to present values.

3-1.21 Step 11c: Initial Costs.

3-1.21.1. Initial costs include capital investment costs for initial construction or renovation and for the equipment needed to operate a facility. Initially, construction costs are estimated by reference to historical data from similar facilities. Alternately, they can be determined from government or private-sector cost-estimating guides and databases.

3-1.21.2. The recommended initial cost would be limited to the placement of the airfield markings: paint, glass beads, labor, and equipment. All other costs are common costs and can typically be excluded.

3-1.21.3. When comparing installation costs by contract, the most accurate method is to obtain current contractor pricing for the same scope of restriping with Type I or Type III glass beads as separately priced contract line item numbers (CLIN). If this cannot be done, document the reason why. Historic information, not older than 24 months, on the price of Type I and Type III installed bead striping, can be used with clear documentation of source, reasons why this data is considered valid, and any other pertinent information.

3-1.21.4. If the restriping is to be completed with an in-house workforce, the analysis would account for the material costs of Type I or Type III beads as a component of the

overall work cost. An installed cost estimate should be completed for the entire striping scope with each bead type and then used in the LCCA.

3-1.22   Step 11d: Operation, Maintenance, and Repair Costs.

Operation, maintenance, and repair (OM&R) costs are often more difficult to estimate than other facility expenditures. Operating schedules and standards of maintenance vary from facility to facility. There is variation in these costs even for facilities of the same type and age. It is therefore important to use engineering judgment when estimating these costs.

Supplier quotes and published estimating guides sometimes provide information on maintenance and repair costs. Some of the data estimation guides derive cost data from statistical relationships of historical data (RSMeans or BOMA) and report, for example, average owning and operating costs per square foot, by age of facility, geographic location, number of stories, and number of square feet in the facility.

Costs to consider include potential additional rubber removal with Type III compared to Type I glass beads due to the larger Type III gradation.

3-1.23   Step 11e: Replacement Costs.

The number and timing of capital replacements of airfield systems depend on the estimated life of the system and the length of the study period. Use the same sources that provide cost estimates for initial investments to obtain estimates of replacement costs and expected useful lives. A good starting point for estimating future replacement costs is to use their cost as of the base date. The LCCA method will discount future time of occurrence to their base year amounts.

For the study period, replacement cost can occur multiple times. Examples include the frequency at which re-striping occurs for Type I compared to Type III beads. Snow removal and sweeping are known to have a more damaging effect on Type III beads due to their larger gradation. This potentially results in a higher replacement frequency for Type III compared to Type I in snow and ice locations.

3-1.24   Step 11f: Residual Values.

The residual value of a system (or component) is its remaining value at the end of the study period or at the time it is replaced during the study period. Residual values can be based on value in place, resale value, salvage value, or scrap value, net of any selling, conversion, or disposal costs. As a rule of thumb, the residual value of a system with remaining useful life in place can be calculated by linearly prorating its initial costs, straight line depreciation. For example, for a system with an expected useful life of 15 years, which was installed five years before the end of the study period, the residual value would be approximately 2/3 (= (15-10)/15) of its initial cost.

Residual values should be avoided when possible using the "common denominator" method described under Step 6b, **Period of Analysis**.

3-1.25 Step 11g: Other Costs.

Non-monetary benefits or costs are project-related effects for which there is no objective way of assigning a dollar value. Examples of non-monetary effects are the benefit derived from the higher initial retro-reflectivity of Type III compared to Type I beads, or from a particularly quiet HVAC system, or from an expected—but hard to quantify—productivity gain due to improved lighting. By their nature, these effects are external to the LCCA, but, if they are significant, they should be considered in the final investment decision and included in the LCCA documentation.

Note that UFGS 32 17 23 does not differentiate minimum performance levels between Type III compared to Type I beads.

Figure 3-4 Expenses and Residuals

3-1.26   Step 12: Text Report Folders.

Step 12 is illustrated in Figure 3-5. ECONPACK provides the analyst with five folders to document the LCCA. These include **Background**, **Personal Notes**, **Assumptions**, **Non-Monetary Considerations**, and **Results and Recommendations**. Select the **Text** tab or use the economic analysis folder tree, and select any of the five available folders. When selected, ECONPACK will launch Word, where the analyst can document the basis of their LCCA assumptions. When saved, these narratives will be displayed in ECONPACK's standard reports.

Figure 3-5 Text Report Folders
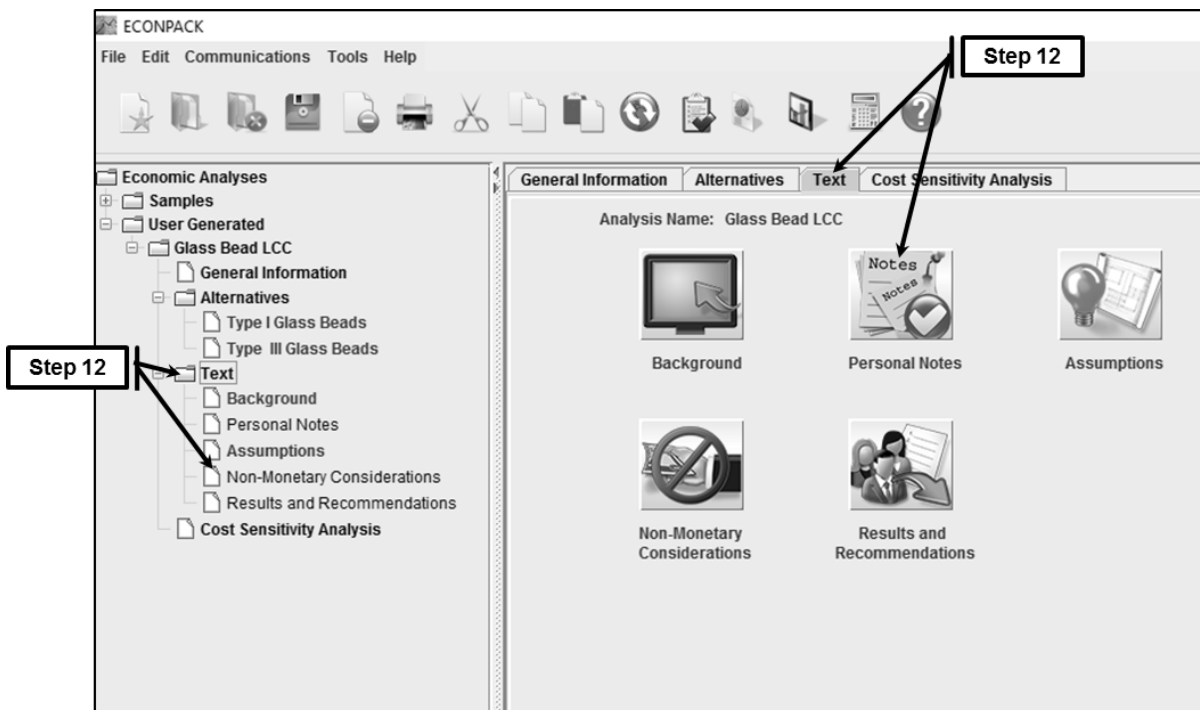
CHAPTER 4 SENSITIVITY ANALYSIS, LCCA UNCERTAINTY ASSESSMENT

4-1   SENSITIVITY ANALYSIS STEP-BY-STEP PROCESS DESCRIPTION.

Decisions about facility-related expenses can involve a great deal of uncertainty about their costs and potential savings. Performing an LCCA greatly increases the likelihood of choosing a project that saves money in the long run. Yet, there may still be some uncertainty associated with the LCC results. LCCA's are usually performed early in the design process when only estimates of costs and savings are available rather than certain dollar amounts. Uncertainty in input values means that actual outcomes may differ from estimated outcomes.

There are techniques for estimating the cost of choosing the "wrong" project alternative. Deterministic techniques, such as sensitivity analysis, are easily done without requiring additional resources or information. They produce a single-point estimate of how uncertain input data affect the analysis outcome. Since sensitivity analysis is an approach that is simple to perform, it should be part of every LCCA.

Sensitivity analysis is the technique recommended as it is useful for:

- Identifying which of a number of uncertain input values has the greatest impact on a specific measure of economic evaluation;

- Determining how variability in the input value affects the range of a measure of economic evaluation; and

- Testing different scenarios to answer "what if" questions.

To identify critical parameters, arrive at estimates of upper and lower limits, or answer "what if" questions, simply change the value of each input up or down, holding all others constant, and recalculate the economic measure to be tested.

4-1.1   Step 13: Cost Sensitivity Analysis.

Steps 13, 14, 15, 16, and 17 are illustrated in Figure 4-1. Select the **Cost Sensitivity Analysis** tab then select the **Add Cost Sensitivity Analysis** button. ECONPACK provides a default naming convention where the sensitivity analyses are added in chronological order as **CSA1**, **CSA2**, etc. This title is not editable.

4-1.2   Step 14: Lower/Upper Limit (%).

ECONPACK allows the analyst to pick a range for the **Lower Limit** and **Upper Limit** as a percentage (%) change of the expense items associated with each alternative.

4-1.3   Step 15: Alternative.

ECONPACK only allows the analyst to compare two alternatives at any one time. These are shown as a dropdown pick list. For this glass bead analysis, we only have two alternatives, but multiple alternatives (more than two) can be used.

4-1.4   Step 16: Expenses Included.

For the **Alternative** chosen, ECONPACK will display all of the associated expense items discussed in Step 11. Check the box (**Include**) for each expense item to analyze for cost sensitivity.

4-1.5   Step 17: View Graph.

Select the **View Graph** button and ECONPACK will plot the change in the expense from the lower limit to the upper limit. This graph is displayed in NPV.

Figure 4-1 Cost Sensitivity Analysis
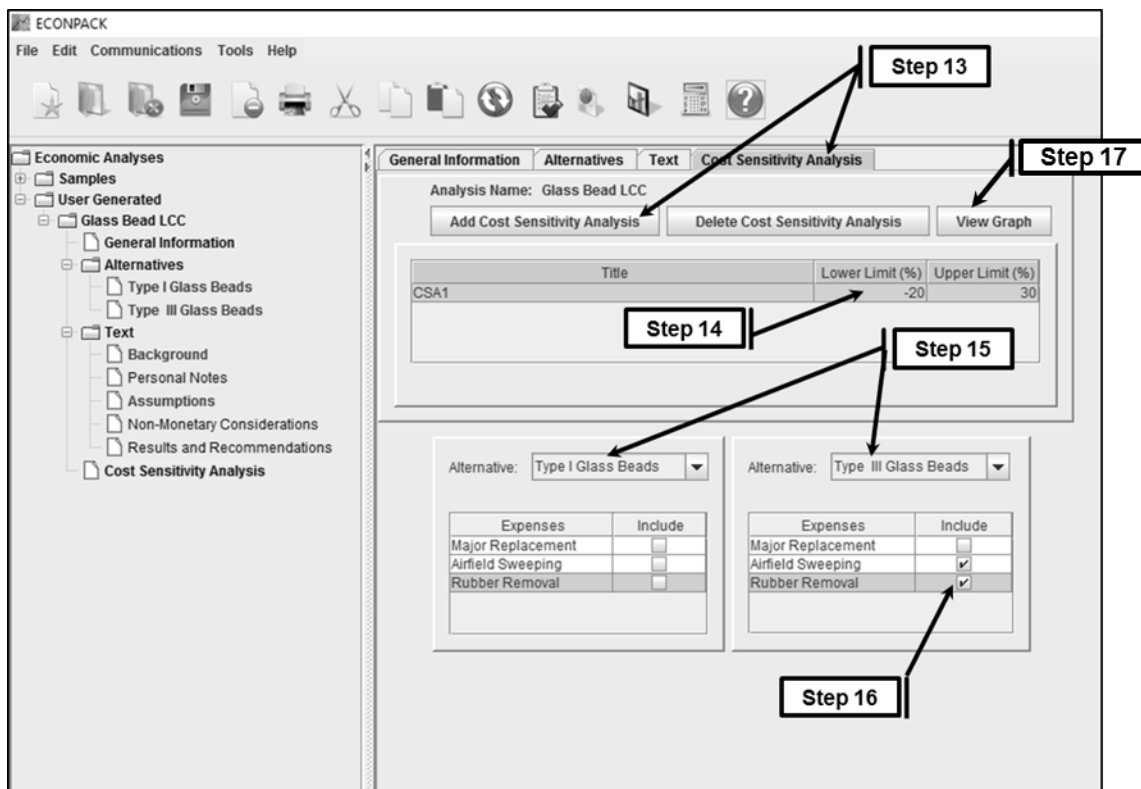
CHAPTER 5 LCCA METHOD, CALCULATION, AND EVALUATION

5-1   **LIFE-CYCLE COST ANALYSIS (LCCA) METHOD.**

5-1.1. The objective of this LCCA is to estimate the overall costs of project alternatives, Type I compared to Type III retroreflective glass beads, and to select the design that ensures the facility will provide the lowest overall cost of ownership consistent with its quality and function.

5-1.2. The first and most challenging task of an LCCA, or any economic evaluation method, is to determine the economic effects of alternative designs of the airfield systems and to quantify these effects and express them in dollar amounts.

5-1.3. An NPV analysis is recommended for the glass bead LCCA. NPV is the sum of all discounted costs for all years of the analysis period. All costs will be discounted to present value and alternatives will be ranked according to NPV.

5-1.4. The LCCA is also recommended to be in constant dollars versus current dollars. The constant dollar method has the advantage of not requiring an estimate of the inflation rate for the years in the study period.

5-2   **LIFE-CYCLE COST CALCULATION.**

NPV reflects the value today of a future amount or stream of future amounts, expressed as a single sum of dollars. It is calculated by multiplying the net amount for each year by the corresponding discount factor and summing the results.

After identifying all costs by year and amount and discounting them to present value, they are added to arrive at total life-cycle costs for each alternative: LCC = I + Repl - Res + OM&R + O

       LCC = Total LCC in present-value (PV) dollars of a given alternative

       I = PV investment costs (if incurred at base date, they need not be discounted)

       Repl = PV capital replacement costs

       Res = PV residual value (resale value, salvage value) less disposal costs

       OM&R = PV of non-fuel operating, maintenance and repair costs

   O = PV of other costs (e.g., contract costs for ESPCs or UESCs)

5-3   **EVALUATION CRITERIA.**

Lowest LCC (for determining cost-effectiveness): All costs will be discounted to present value and alternatives will be ranked according to NPV.

5-3.1   Step 18: Reports.

Step 18 is illustrated in Figure 5-1. Once the LCCA is complete, ECONPACK has multiple standard reports. Select the GUI printer icon and a dialog box will open where the analyst can select which portions of the LCCA to print in either Word or Adobe.

Figure 5-1 Reports
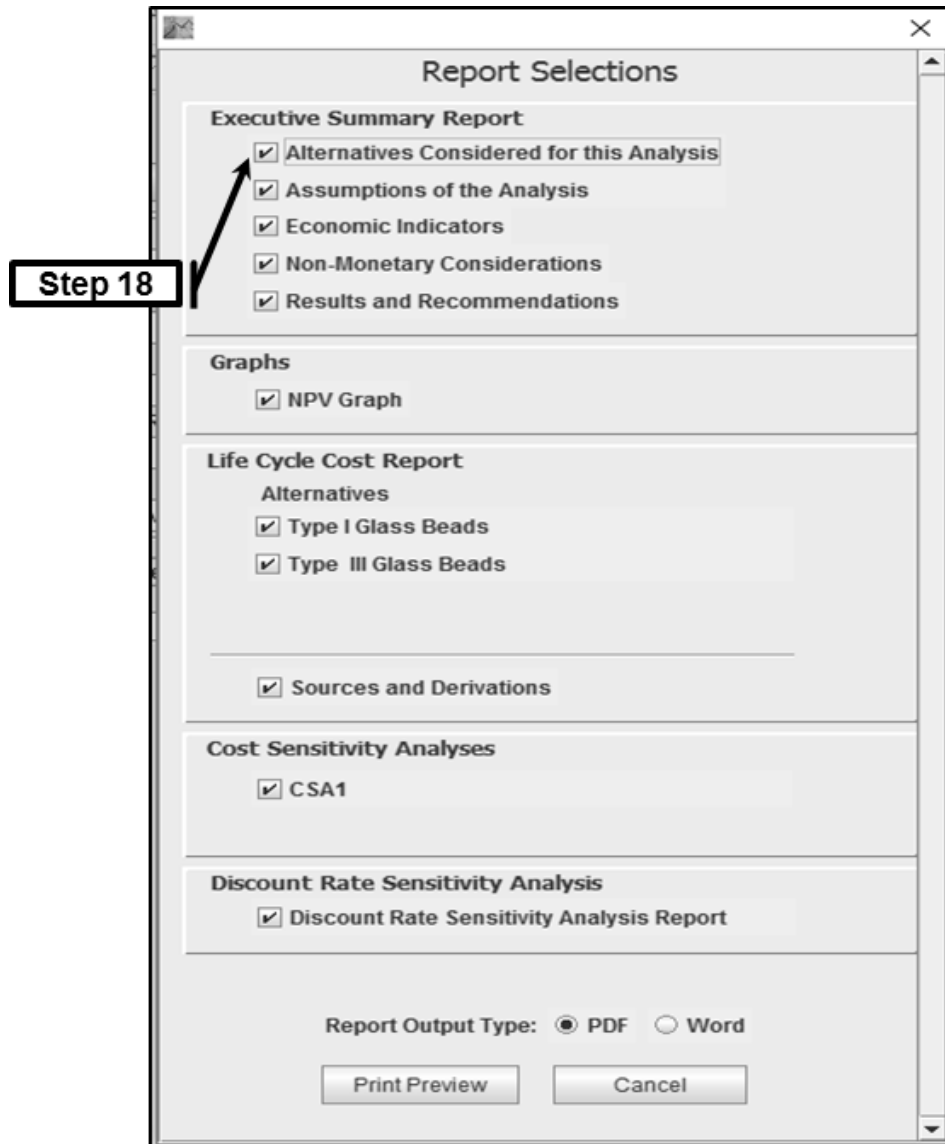
APPENDIX A REFERENCES

A-1 RELEVANT CODES AND STANDARDS.

10 CFR 436 Subpart A, *Federal Energy Management and Planning Programs*, "Methodology and Procedures for Life Cycle Cost Analyses," https://www.ecfr.gov/cgi-bin/text-idx?SID=1772217352e2b3956b37b48739ebd676&mc=true&node=pt10.3.436&rgn=div5

AFMAN 65-506, *Economic Analysis*, http://www.e-publishing.af.mil/

ASTM Standards on Building Economics, 6th edition, ISBN: 978-0-8031-5695-1, stock #BLDGECON07

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OMB Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, https://www.whitehouse.gov/omb/circulars/

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APPENDIX B GLOSSARY

B-1   **ACRONYMS.**

AFMAN   Air Force Manual

CFR   Code of Federal Regulations

DOD   Department of Defense

ESPC   Energy Savings Performance Contract

GUI   Graphic User Interface

LCC   Life Cycle Cost

LCCA   Life Cycle Cost Analysis

NAVFAC   Naval Facilities Engineering Command

NDAA FY   National Defense Authorization Act for Fiscal Year

NPV   Net Present Value

OM&R   Operation, Maintenance, and Repair

OMB   Office of Management and Budget

PV   Present Value

UESC   Utility Energy Service Contract

UFC   Unified Facilities Criteria

UFGS   Unified Facilities Guide Specification

B-2 **DEFINITION OF TERMS.**

Current Dollars: Current dollars include the rate of general inflation in all dollar amounts. Also called "nominal" or "then-year" dollars.

Constant Dollars: Constant dollars exclude the rate of general inflation. Also called "real" dollars.

Discount Rate: Discount rates are obtained from the OMB. They are used to add and compare cash flows incurred at different times during the life-cycle of a project; therefore, they are made time-equivalent. To make cash flows time-equivalent, the LCC method converts them to present values by discounting them to a common point in time, usually the base date.

Net Present Value (NPV): NPV is the sum of all discounted costs for all years of the analysis period. All costs are discounted to present value and alternatives will be ranked according to NPV.

Nominal Discount Rate: Discount rate that does include the general rate of inflation.

Real Discount Rate: Discount rate that does not include the general rate of inflation.