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AnAmerican National Standard

Standard Practice for Life-Cycle Cost Analysis of Plastic Pipe Used for Culverts, Storm Sewers, and Other Buried Conduits[1]

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1. Scope*

1.1 This practice establishes a procedure for using life cycle cost (LCC) analysis techniques to evaluate alternative drainage system designs, using plastic pipe that satisfy the same functional requirements.

1.2 The LCC technique measures the present value of all relevant costs to install, operate, and maintain alternative drainage systems such as engineering, construction, maintenance, rehabilitation, or replacement over a specified period of time. The practice also accommodates any remaining residual or salvage value.

1.3 The decision maker, using the results of the LCC analysis, can then identify the alternative(s) with the lowest estimated total cost based on the present value of all costs.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *Other Standards:*

TM-5-802-1 Economic Studies for Military Construction Design Applications (12/86)[2]

Federal Office of Management and Budget Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs and state documents for guidelines or requirements[3]

2.2 *ASTM Adjuncts:*

Discount Factor Tables[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *common costs, n*—costs that are common to all alternatives in nature and amount, such as initial planning fees or future annual inspection costs.

3.1.2 *discount rate, n*—the investor's time value of money, expressed as a percent, used to convert costs occurring at different times, to equivalent costs at a common point in time.

3.1.3 *drainage project, n*—a project having a definable, functional drainage requirement that can be satisfied by two or more design or construction alternatives, or both.

3.1.4 *future costs, n*—costs required to keep the system operating that are incurred after the project is placed in service, such as operation, maintenance, rehabilitation, or replacement costs.

3.1.5 *inflation, n*—the general trend or rising prices that, over time, result in the reduction of the purchasing power of the dollar from year to year.

3.1.6 *initial cost, n*—the total of all costs; such as design costs, material purchase costs, and construction/installation costs, that are specific to each alternative and are incurred to bring each alternative to a point of functional readiness.

3.1.7 *maintenance cost, n*—the annual or periodic costs, such as inspection and cleaning to keep a drainage structure functioning for the project design life, but do not extend the material service life.

3.1.8 *material service life, n*—the number of years of service a particular material, system, or structure will provide before rehabilitation or replacement is necessary.

3.1.9 *project design life, n*—the planning horizon for the project, expressed as the number of years of useful life required of the drainage structure.

3.1.10 *rehabilitation cost, n*—the total of all costs incurred to extend the material service life of a specific alternative.

3.1.11 *replacement cost, n*—the total of all costs incurred to replace a material before the end of the project design life.

3.1.12 *terminal value, n*—the remaining value of the drainage structure in place at the end of the project design life.

4. Summary of Practice

4.1 This practice outlines a procedure for conducting an LCC analysis of two or more drainage pipe alternatives using

[1] This practice is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.62 on Sewer.

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[2] Available from Headquarters, Department of the Army, Washington, DC.

[3] Available from Office of Management and Budget, Washington, DC.

[4] Available from ASTM International Headquarters. Order Adjunct No. ADJE091703.

*A Summary of Changes section appears at the end of this standard

plastic pipe over a specified project design life. This practice identifies the project data and general assumptions needed for the analysis and the method of computation.

5. Significance and Use

5.1 LCC analysis is an economic method to evaluate alternatives that are characterized by differing cash flows over the designated project design life. The method entails calculating the LCC of each alternative capable of satisfying the functional requirements of the project and comparing them to determine which have the lowest estimated LCC over the project design life.

5.2 The LCC method is particularly suitable for determining whether the higher initial cost of an alternative is economically justified by reductions in future costs (for example, operating maintenance, rehabilitation, or replacement) when compared to an alternative with lower initial costs but higher future costs. If a design alternative has both a lower initial cost and lower future costs than other alternatives, an LCC analysis is not necessary to show the former is the economically preferable choice.

6. Procedure

6.1 The procedure for performing an LCC analysis for drainage pipe applications is as follows:

6.1.1 Identify project objectives, alternatives, and constraints (6.2).

6.1.2 Establish basic assumptions (6.3).

6.1.3 Compile data (6.4).

6.1.4 Compute life cycle cost for each alternative (7.1).

6.1.5 Evaluate results (7.2).

6.2 *Project Objectives, Alternatives, and Constraints:*

6.2.1 Specify the design objective that is to be accomplished, identify alternative systems or designs that accomplish that objective, and identify any constraints that may limit the options to be considered.

6.2.2 An example is the design of a storm water drainage system for a residential development project. The system must satisfy mandated drainage system objectives, such as specified rainfall intensities and storm water runoff limits. Available alternatives, such as different pipe materials and varying configurations of catch basins, ponds, or underground detention chambers may have different initial costs as well as expected future costs. The system design may be constrained by structural and hydraulic limits such as minimum and maximum slopes and depth of burial, limits on surface flows on streets, etc.

6.3 *Basic Assumptions:*

6.3.1 Establish the uniform assumptions to be made in the LCC analysis of all alternatives. These assumptions include the selection of the discount rate, the treatment of inflation, general inflation rate, the project design life, and the desired comprehensiveness of the analysis.

6.3.2 *Discount Rate*—The discount rate selected should reflect the owner's time value of money. That is, the discount rate should reflect the rate of interest that makes the owner indifferent between paying or receiving a dollar now or at some future time. The discount rate is used to convert costs occurring at different times to equivalent costs at a common point in time.

6.3.2.1 There is no single correct discount rate for all owners. Selection of the discount rate should be guided by the rate of return on alternative investment opportunities of comparable risk (that is, the opportunity cost of capital), or, in the case of some public organizations, on mandated or legislated federal or state requirements. (See Federal Office of Management and Budget.)

6.3.2.2 The discount rate may include general price inflation over the study period. This discount rate is referred to as the "nominal" discount rate in this practice. The discount rate may also be expressed as the real earning power of money over and above general price inflation, referred to as the "real" discount rate.

6.3.2.3 A nominal discount rate (d_n) and the corresponding real discount rate (d_r) are related as follows:

$$d_r = \frac{1+d_n}{1+I} - 1 \text{ or } d_n = (1+d_r)(1+I) - 1 \quad (1)$$

where:

I = the rate of general price inflation.

6.3.2.4 The same discount rate should be used in evaluating each design alternative. Annex A1 contains a procedure to follow in developing the discount rate. This procedure may be applied by those who wish to select their own values as well as those who are required to follow mandated or legislated requirements.

6.3.3 *Inflation*—This practice is designed only to accommodate a uniform rate of general inflation. Calculate the LCC in constant dollar terms (not including general inflation) or in current dollar terms (including general inflation). If the latter is used, a consistent projection of general price inflation shall be used throughout the LCC analysis, including adjustment of the discount rate to incorporate general inflation (6.3.2.2). The percentage change in GNP deflator and the Producers Price Index are two broad indicators of general inflation.

6.3.3.1 If the user desires or is required to treat inflation on an incremental (differential) basis, or uniquely to each individual cost component (for example, energy costs), consult either TM-5-802-1 or Discount Factor Tables[4], respectively.

6.3.4 *Project Design Life*—Establish the project design life (3.1.9) from mandated public policy, legislated requirements, or selection by the owner based on situation requirements. Use the same design life for each alternative under comparison and for all categories of cost under consideration. The potential for future obsolescence, that is, the potential that future changes may modify drainage system requirements, should be considered in selecting project design life.

6.3.5 *Comprehensiveness*—The appropriate degree of precision and detail to use in an LCC analysis is dependent upon the intended use of the analysis. A less comprehensive or detailed analysis may be sufficient to roughly rank many alternatives, whereas a more comprehensive analysis may be necessary to select from among a few close alternatives. In any case, omitting significant factors from an LCC analysis diminishes the usefulness of the results.