Designation:F 1675–03 Designation: F 1675 – 09

An American National Standard

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

This standard is issued under the fixed designation F 1675; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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 *ASTM Standards:*

E917 Practice for Measuring Life Cycle Costs of Building and Building Systems

2.2 *Other Standards:*

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

Circular No. A-94 Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs

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]

ASTM Adjuncts:

E 917 Discount Factor Tables

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.

[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.
Current edition approved April 10, 2003. Published May 2003. Originally approved in 1996. Last previous edition approved in 1996 as F1675–96.
Current edition approved Aug. 1, 2009. Published August 2009. Originally approved in 1996. Last previous edition approved in 2003 as F1675–03.

[2] Annual Book of ASTM Standards, Vol 04.07.

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

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

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

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

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

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

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 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 ~~requirements such as that contained in OMB Circular No. A-94.~~ 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 Practice E917~~ 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.

6.3.6 *Sensitivity Analysis*—No analysis is more precise than the accuracy of the data and assumptions used in the calculation. When there is uncertainty regarding basic assumptions (for example, cost estimates, design life, discount rate, etc.) calculate the LCC for a range of assumptions. The results of these calculations will show the user the extent to which the results are sensitive to variations of the key assumptions.

6.4 *Compiling Data*—Compile the data specific to each alternative under consideration.

6.4.1 *Initial Costs*—The estimated dollar amount of all costs is required to bring the alternative system to a point of functional readiness.

6.4.2 *Material Service Life*—Material service life is the number of years of service expected of the alternative under study, which varies depending upon the pipe material, the environment, effluent, and application. Potential changes in environmental conditions which may affect the material service life should be considered. Use job site tests, published reports, manufacturer product data, and local experience to establish service life for each material. If material service life is less than the project design life (3.1.9), the analysis shall include the future cost to sufficiently extend the service life through rehabilitation or replacement, in order to at least equal the project design life.

6.4.3 *Future Costs*—Cost estimates should be made for all significant items that are estimated to be required to allow the drainage system to satisfy performance requirements over the project design life. Common costs (1.1) may be excluded without affecting the relative ranking of the alternatives under study. The cost estimates should be made in constant dollars (not including inflation) in the same time frame as the estimate of initial costs.

6.4.3.1 *Operating Cost*—Operating cost is an estimate of the annual cost for labor, power, and consumable materials and supplies required to operate a drainage system. Except for pumped systems, most drainage systems do not have significant annual operating costs.

6.4.3.2 *Maintenance Cost*—Maintenance cost includes cost estimates and the frequency of any inspection, cleaning, and minor repair necessary to keep the system operating at capacity during the project design life.

6.4.3.3 *Rehabilitation Cost*—Rehabilitation cost is the cost of major repairs to extend the material service life to equal or exceed the project design life. If more than one rehabilitation is anticipated, the years in which the rehabilitation are planned should be noted.

6.4.3.4 *Replacement Cost*—Replacement cost is the timing and cost estimate for complete replacement of any drainage system component. Take care to see if the service life of the replaced material or component will at least equal the remaining project design life. If not, rehabilitation or further replacement will be necessary.

6.4.3.5 *Terminal Value*—Terminal value is the value of the drainage system at the end of the project design life. The potential residual or salvage value of a drainage system is dependent upon some of the factors considered in establishing project design life. For example, if a storm sewer is being evaluated and a long project design life (75 years) is used, consideration should be given to risk of future obsolescence. If the likelihood of functional obsolescence is high, then there may be no residual or salvage value. If, however, it is expected the material could be removed and either reused or sold, then the net cash value (in constant dollars) represents the terminal value. It is not recommended to use a residual value to reflect an economic value for any remaining material life in excess of the project design life. As an alternative, if the functional requirements of the system under design are for an indefinite period, then consideration should be given to increasing the project design life to an appropriately higher value, where