



Standard Practice for Measuring Net Benefits for Investments in Buildings and Building Systems¹

This standard is issued under the fixed designation E 1074; 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.

^{e1} NOTE—Footnote 5 of this standard was editorially corrected in September 1998.

INTRODUCTION

The net benefits (NB) method is part of a family of economic evaluation methods that provide measures of economic performance of an investment over some period of time. Included in this family of evaluation methods are life-cycle cost analysis, benefit-to-cost and savings-to-investment ratios, internal rates of return, and payback analysis.

The NB method, sometimes called the net present value method, calculates the difference between discounted benefits (or savings) and discounted costs as a measure of the cost effectiveness of a project. The NB method is used to decide if a project is cost effective (net benefits greater than zero) or which size or design competing for a given purpose is most cost effective (the one with the greatest net benefits).

1. Scope

1.1 This practice provides a recommended procedure for calculating and interpreting the NB method in the evaluation of building designs and systems.

2. Referenced Documents

2.1 ASTM Standards:

- E 833 Terminology of Building Economics²
- E 917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems²
- E 964 Practice for Measuring Benefit-to-Cost and Savings-to-Investment Ratios for Buildings and Building Systems²
- E 1057 Practice for Measuring Internal Rate of Return and Adjusted Internal Rate of Return for Investments in Buildings and Building Systems²
- E 1121 Practice for Measuring Payback for Investments in Buildings and Building Systems²
- E 1185 Guide for Selecting Economic Methods for Evaluating Investments in Buildings and Building Systems²

2.2 ASTM Adjuncts:

Discount Factor Tables,
Adjunct to Practice E 917³

Computer Program and User's Guide to Building Maintenance, Repair, and Replacement Database for Life-Cycle Cost Analysis,
Adjunct to Practices E 917, E 964, E 1057, E 1074, and E 1121⁴

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology E 833.

4. Summary of Practice

4.1 This practice is organized as follows:

- 4.1.1 *Section 2, Referenced Documents*—Lists ASTM standards referenced in this practice.
- 4.1.2 *Section 3, Definitions*—Addresses definitions of terms used in this practice.
- 4.1.3 *Section 4, Summary of Practice*—Outlines the contents of the practice.
- 4.1.4 *Section 5, Significance and Use*—Explains the application of the practice and how and when it should be used.
- 4.1.5 *Section 6, Procedures*—Summarizes the steps in making NB analysis.
- 4.1.6 *Section 7, Compute NB*—Describes calculation procedures for NB.
- 4.1.7 *Section 8, Applications*—Explains circumstances under which the NB method is appropriate.

¹ This practice is under the jurisdiction of ASTM Committee E-6 on Performance of Buildings and is the direct responsibility of Subcommittee E06.81 on Building Economics.

Current edition approved Jan. 15, 1993. Published March 1993. Originally published as E 1074 – 85. Last previous edition E 1074 – 91.

² *Annual Book of ASTM Standards*, Vol 04.11.

³ Available from ASTM Headquarters. Order PCN 12-509179-10.

⁴ Available from ASTM Headquarters. Order PCN 12-509171-10 for the 3.5 in. disk. Order PCN 12-509172-10 for the 5.25 in. disk.

TABLE 1 Calculation of Net Benefits

Year, <i>t</i>	Benefits, <i>B_t</i> , dollars	Costs, <i>C_t</i> , dollars	Net Cash Flow ^A <i>B_t - C_t</i> , dollars	SPV Factor ^B for <i>i</i> = 15 %	PVNB, dollars
0	0	10 000	-10 000	1.000	-10 000
1	4 000	3 000	+1 000	0.8696	+870
2	11 500	4 500	+7 000	0.7561	+5 293
3	10 000	4 000	+6 000	0.6575	+3 945
4	8 000	5 000	+3 000	0.5718	+1 715
Total	33 500	26 500	+7 000		+1 823

^A To find the PVNB of the net cash flow for each discounting period, the single present value (SPV) discount factor is multiplied times the net cash flow. For an explanation of discounting factors and how to use them, see *Discount Factor Tables*, adjunct to Practice E 917.

4.1.8 *Section 9, Report*—Identifies information that should be included in a report of a NB analysis.

5. Significance and Use

5.1 The NB method provides a measure of the economic performance of an investment, taking into account all relevant monetary values associated with that investment over the investor’s study period. The NB measure can be expressed in either present value or equivalent annual value terms, taking into account the time value of money.

5.2 The NB method is used to decide if a given project is cost effective and which size or design for a given purpose is most cost effective when no budget constraint exists.

5.3 The net benefits method can also be used to determine the most cost effective combination of projects for a limited budget; that is, the combination of projects having the greatest aggregate net benefits and fitting within the budget constraint.

6. Procedures

6.1 The recommended steps for applying the NB method to an investment decision are summarized as follows:

- 6.1.1 Make sure that the NB method is the appropriate economic measure (see Guide E 1185),
- 6.1.2 Identify objectives, alternatives, and constraints,
- 6.1.3 Establish assumptions,
- 6.1.4 Compile data (see the adjunct entitled “Computer Program and User’s Guide to Building Maintenance, Repair, and Replacement Database for Life-Cycle Cost Analysis”),
- 6.1.5 Convert cash flows to a common time basis (discounting),
- 6.1.6 Compute NB⁵ and compare alternatives, and
- 6.1.7 Make final decision, based on NB results as well as consideration of risk and uncertainty, unquantifiable effects, and funding constraints (if any).

6.2 Since the steps mentioned in 6.1.1-6.1.4 and in 6.1.7 are treated in detail in Practice E 917 and briefly in Practices E 964 and E 1121, they are not discussed in this practice. In calculating NB, these four steps should be followed exactly as described in Practice E 917. The remainder of this practice focuses on the computation and application of the NB measure.

⁵ A computer program that produces NB measures consistent with this practice is Petersen, S. R., “The NIST Building Life-Cycle Cost (BLCC) Computer Program” and documentation—*The NIST Building Life-Cycle Cost (BLCC) Program: User’s Guide and Reference Manual*, NISTIR 5185-3, National Institute of Standards and Technology, 1995.

7. NB Computation

7.1 Computation of net benefits for any given project requires the estimation, in dollar terms, of differences between benefits, and differences between costs, for that project relative to a mutually exclusive alternative. The mutually exclusive alternative may be a similar design/system of a different scale, a dissimilar design/system for the same purpose, or the *do nothing* case. Benefits can include (but are not limited to) revenue, productivity, functionality, durability, resale value, and tax advantages. Costs can include (but are not limited to) initial investment, operation and maintenance (including energy consumption), repair and replacements, and tax liabilities.

7.2 Eq 1 is used to compute the present value of net benefits (PVNB) for the proposed project relative to its mutually exclusive alternative.

$$PVNB = \sum_{t=0}^N (B_t - C_t)/(1 + i)^t \tag{1}$$

where:

- B_t* = dollar value of benefits in period *t* for the building or system being evaluated less the counterpart benefits in period *t* for the mutually exclusive alternative against which it is being compared,
- C_t* = dollar costs, including investment costs, in period *t* for the building or system being evaluated, less the counterpart costs in period *t* for the mutually exclusive alternative against which it is being compared,
- N* = number of discounting time periods in the study period, and
- i* = the discount rate per time period.

7.3 Eq 2 can be used to convert the present value of net benefits to annual value terms, where *N* is the number of years in the study period.

$$AVNB = PVNB \cdot [(i(1 + i)^N)/((1 + i)^N - 1)] \tag{2}$$

where AVNB = annual value of net benefits.

7.4 For a given problem and data set, solutions in either present value or annual value terms will be time equivalent values (although different in actual dollar values) and will result in the same investment or design decisions, provided annual values are calculated using Eq 2.

7.5 A simple application of Eq 1 is presented in Table 1 for an initial investment of \$10 000 that yields an uneven yearly cash flow over four years. (Implicitly, the mutually exclusive alternative is the *do nothing* case.) Assuming a discount rate of 15 %, the discounted cash flows yield a PVNB of \$1 823. (Note that the sum of net cash flows, \$7 000, is a much larger