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Standard Guide for Selecting Economic Methods for Evaluating Investments in Buildings and Building Systems[1]

This standard is issued under the fixed designation E1185; 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.

ε1 NOTE—Section 2.2 and Footnote 4 were editorially corrected and Section 7 was editorially added in January 2009.

1. Scope

1.1 This guide identifies types of building design and building system decisions that require economic analysis and recommends ASTM practices, adjuncts, and computer programs that may be used to implement the appropriate economic methods for each decision type.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions
E833 Terminology of Building Economics
E917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems
E964 Practice for Measuring Benefit-to-Cost and Savings-to-Investment Ratios for Buildings and Building Systems
E1057 Practice for Measuring Internal Rate of Return and Adjusted Internal Rate of Return for Investments in Buildings and Building Systems
E1074 Practice for Measuring Net Benefits and Net Savings for Investments in Buildings and Building Systems
E1121 Practice for Measuring Payback for Investments in Buildings and Building Systems

2.2 *Adjuncts:*

Discount Factor Tables Adjunct to Practices E917, E964, E1057, E1074, and E1121[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminologies —For definitions of general terms related to building construction used in this guide, refer to Terminology E631and ; and for general terms related to building economics, refer to Terminology E833.

4. Significance and Use

4.1 Standard practices for measuring the economic performance of investments in buildings and building systems have been published by ASTM. A computer program that produces economic measures consistent with these practices is available.[4] Discount Factor Tables has been published by ASTM to facilitate computing measures of performance for most of the practices.

4.2 This guide can be used to: (*1*) identify types of building design and system decisions that require economic analysis; (*2*) match the technically appropriate economic methods with the decisions; and (*3*) locate the methods in the ASTM practices and adjuncts listed in Section 2.

4.3 More than one method can be technically appropriate for many building decisions. Therefore the choice in practice of which technically appropriate economic method to use for evaluating a particular building decision will often depend on the perspective of the user. Some examples of factors that influence the user are: (*1*) ease of applying the methods, (*2*) level of familiarity of the user with the methods, (*3*) preference of the user for different methods, and (*4*) presence of budget limitations for the projects.

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[1] This guide is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.81 on Building Economics.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

[4] The NIST Building Life-Cycle Cost (BLCC) Computer Program helps users calculate measures of worth for buildings and building components that are consistent with ASTM standards. The program is downloadable from http://www.eere.energy.gov/femp/information/download_blcc.html.

4.4 This guide identifies some features and limitations of the methods that might influence users' choices under varying conditions.

5. How to Use This Guide

5.1 Table 1 indicates which standard practices (that is, economic methods) are technically appropriate for the following four types of building investment decisions: acceptance/rejection, design, size, and priority.

5.1.1 In the context of this guide, an acceptance/rejection decision pertains to the cost effectiveness of an individual building or building system. This type of decision is made independently of other project evaluations. It focuses on the merits of a single choice rather than on determining the most cost-effective design or size.

5.1.2 A design decision pertains to choices among competing designs for an individual building or building system, where only one design can be chosen.

5.1.3 A sizing decision pertains to choices among competing sizes or investment levels for an individual building or building system, where only one size or level can be chosen.

5.1.4 A ranking decision entails choosing one or more projects from a group of cost-effective projects when the available budget is not sufficient to fund them all.

5.1.5 Examine Table 1 to find which methods should be considered for a given decision. The ASTM designations are given in parentheses under the method names.

5.2 If there is any doubt as to which type of building decision shown in Table 1 best applies, consult the examples in Table 2. Table 2 lists examples for each of the four types of decisions shown in Table 1. Find in Table 2 a building decision similar to the one being analyzed, and select the corresponding decision type from Table 1. Section 6 contains illustrative cases of this process.

5.3 Once the type of decision has been identified and Table 1 has been consulted for the technically appropriate method, there will be several methods from which to choose. Note that while all of the methods that are marked as appropriate for a given decision will generally give answers that support the same decision (with the exception of payback), there are likely to be special considerations that make one or more methods preferred over the others. Examine the special considerations listed in Table 3 before making a final choice of methods.

5.4 Examine the practice(s) that corresponds to the chosen method(s). In the selected practice(s), read the sections on significance and use, applications, and limitations. If the practice(s) still seems appropriate, follow its procedures. If not, repeat the process using Tables 1 through 3 until an acceptable practice has been found or it has been determined that none of the practices is suitable for the decision at hand.

5.5 For assistance in calculating the measure(s) of economic performance provided by the selected method(s), use the adjunct and the Building Life-Cycle Cost Computer Program (BLCC).[4] The adjunct on Discount Factor Tables supports manual calculations for all of the methods. The BLCC supports computer calculations for all the methods except net benefits where revenues are involved and payback.

6. Illustrative Cases

6.1 Section 6 illustrates how to use this guide to choose the appropriate practice for each of the four types of building investment decisions listed in Table 2.

6.2 *Acceptance or Rejection Decisions*:

6.2.1 If it is known (by recognition of the type of decision or by having examined examples in Table 2) that the building decision to be made is one of accepting or rejecting an individual project, then a choice must be made from the five practices listed in Table

TABLE 1 Standard Practices For Making Building Decisions[A]

Type of Building Decision	Applicable Standards				
	LCC (Practice E917)	BCR (SIR) (Practice E964)	IRR (AIRR) (Practice E1057)	NB (NS) (Practice E1074)	PB (Practice E1121)
Acceptance or rejection	[B]	[B]	[B]	[B]	[C]
Design	[B]	[D]	[D]	[B]	[E]
Size	[B]	[D]	[D]	[B]	[E]
Priority or ranking	[E]	[B]	[B]	[E]	[E]

[A] All of the practices require discounting operations, but only Practice E917 explains discounting in detail. All of the methods can be applied using techniques for treating uncertainty and risk. Practice E917 discusses briefly some of these techniques. The other practices do not discuss them.

[B] Technically appropriate standard practice when total discounted benefits (savings) and costs are considered.

[C] Note limitations in Table 3.

[D] Technically appropriate standard practice when incremental discounted benefits (savings) and costs are considered.

[E] Not recommended.

TABLE 2 Examples of Building Investment Decisions

Type of Building Decision	Examples
Acceptance or rejection	A.1 Is a water heater insulation kit cost effective? A.2 Are fire sprinklers cost effective? A.3 Is a given control system cost effective for managing HVAC equipment? A.4 Is a solar hot water system cost effective?
Design	D.1 Is single, double, or triple glazing most cost effective? D.2 What heating system is most cost effective? D.3 Which orientation of a building is most cost effective? D.4 Which code-approved plumbing system is most cost effective? D.5 Which wall type (for example, masonry, wood frame, curtain wall) is most cost effective? D.6 What floor finish (for example, carpeting, tile, wood) is most cost effective? D.7 What kind of insulation (for example, cellulose, fiberglass, rigid foam) is most cost effective? D.8 Is an item with low first costs more cost effective than a more durable substitute with higher first costs?
Size	S.1 What is the economically efficient level (*R*value) of insulation in the walls and above the ceiling of a house? S.2 How many square feet of collector area should be installed in a solar energy system? S.3 What heat pump efficiency (for example, HSPF 1.75, 2.0, 2.25) is most cost effective? S.4 What furnace efficiency (for example, AFUE 60 %, 75 %, 90 %) is most cost effective? S.5 What air conditioner efficiency (for example, SEER 7.0, 9.0, 11.0) is most cost effective?
Priority or ranking	P.1 What combination of investments in a given building (for example, new water heater, new floor tile, and new lighting system) is economically preferred when each is justifiable on economic grounds, but insufficient funds are available to pay for all of them?

TABLE 3 Special Considerations

Method	Unit Measure of Cost Effectiveness	Nature of Cash Flows	Limitations
LCC	$	primarily costs	A single LCC measure gives no indication of economic merit of a building or building component. LCC value for two or more alternatives are required for a LCC comparison. Alternatives being compared must be equivalent in other respects than LCC and must be compared over the same study period.
BCR (SIR)	dimensionless number	benefits (savings) and costs	Alternatives must be compared over the same study period unless replacement assets can be expected to repeat the costs and savings (benefits) of the original assets.
IRR (AIRR)	percent rate of return	benefits (savings) and costs	If the assumed rate of return on the reinvested earnings (savings) is not equal to the discount rate, then the IRR may yield inconsistent results with the BCR or SIR when ranking projects. Alternatives must be compared over the same study period unless replacement assets can be expected to repeat the costs and savings (benefits) of the original assets. The Unadjusted Internal Rate of Return method may give incorrect solutions and in some cases no unique solution.
NB (NS)	$	benefits (savings) and costs	Alternatives must be compared over the same study period.
~~PB~~	~~time (usually years)~~	~~benefits (savings) and costs~~	~~Cash flows beyond the payback period are ignored.~~ ~~The simple payback measure ignores the time value of money.~~ ~~Projects based on this criterion may not be cost effective.~~
PB	time (usually years)	benefits (savings) and costs	Cash flows beyond the payback period are ignored. The simple payback measure ignores the time value of money. Projects based on this criterion may not be cost effective.

1. To illustrate how such a choice might be made, an accept/reject building decision is evaluated in terms of the special considerations in Table 3.

6.2.2 An example of an accept/reject building decision is whether to install a programmable time clock to control heating, ventilating, and air conditioning (HVAC) equipment in a commercial building. The time clock would reduce electricity consumption by turning on only that part of the HVAC equipment that is needed during hours when the building is not occupied. Each of the five practices indicated in Table 1 for this type of decision is examined to see how useful it would be in assessing the cost effectiveness of the time clock.

6.2.3 The first method indicated in Table 1 is life-cycle cost (LCC). Life-cycle costs are the sum over a given study period of the costs of initial investment (less resale value), replacements, operations (including energy use), and maintenance and repair of an investment decision (expressed in present or annual value terms). Table 3 shows that the LCC method provides a dollar measure. Thus if decision makers want a dollar measure of cost effectiveness, LCC would meet that criterion. Table 3 also shows that the LCC method is most useful where cash flows are primarily costs. If the principal items affected by the time clock are increased capital costs for the time clock and reduced energy costs, then the LCC method would be appropriate.

6.2.3.1 To determine if the time clock is cost effective in accordance with the LCC method, the LCC of providing heating and cooling without the time clock would be compared against the LCC of heating and cooling with the time clock, where the costs of the time clock and its associated energy costs are included. On economic grounds, the time clock would be acceptable if its LCC were less than the LCC without it.

6.2.3.2 Note that the LCCs for each alternative (as discussed in limitations in Table 3) must be computed to make the LCC