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## Standard Guide for Summarizing the Economic Impacts of Building-Related Projects<sup>1</sup>

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~~$\epsilon$ <sup>1</sup>Note—Section 2 was editorially corrected in February 2009.~~

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### INTRODUCTION

Quantitative descriptions of economic impacts are a basic requirement in many organizations for evaluating budget requests and the value of a project to the organization. Several measures of economic performance are available for evaluating building-related investments. These measures include, but are not limited to, life-cycle cost, the benefit-to-cost ratio, adjusted internal rate of return, and net benefits. This guide provides a generic format for presenting these economic measures of building-related investments.

### 1. Scope

1.1 This guide covers a generic format for summarizing the economic impacts of building-related projects.

1.2 The guide provides technical persons, analysts, and researchers a tool for communicating project impacts in a condensed format to management and non-technical persons.

1.3 The generic format described in this guide calls for a description of the significance of the project, the analysis strategy, a listing of data and assumptions, and a presentation of the key economic measures of project impact.

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:*<sup>2</sup>

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](#)

E1369 [Guide for Selecting Techniques for Treating Uncertainty and Risk in the Economic Evaluation of Buildings and Building Systems](#)

E1699 [Practice for Performing Value Analysis \(VA\) of Buildings and Building Systems and Other Constructed Projects](#)

~~E1765 Practice for Applying Analytical Hierarchy Process (AHP) to Multiattribute Decision Analysis of Investments Related to Buildings and Building Systems~~  
[Practice for Applying Analytical Hierarchy Process \(AHP\) to Multiattribute Decision Analysis of Investments Related to Buildings and Building Systems](#)

E2506 [Guide for Developing a Cost-Effective Risk Mitigation Plan for New and Existing Constructed Facilities](#)

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

## 2.2 Adjuncts:

Discount Factor Tables, Adjunct to Practices E917, E964, E1057, E1074, and E1121<sup>3</sup>

## 2.3 ASTM Software Product:

MNL 29, Software to Support ASTM E1765: Standard Practice for Applying Analytical Hierarchy Process (AHP) to Multiattribute Decision Analysis of Investments Related to Buildings and Building Systems<sup>2</sup>

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology E833.

## 4. Summary of Guide

4.1 This guide presents a standard format for presenting the economic impacts of building-related projects. It includes the entire range of private and public construction projects, as well as research related to those projects.

4.2 The generic format provided in this guide helps decision makers and managers understand the background and objectives of a project, the data from which impacts were calculated, how impact was measured, and the significance of the project's measures of worth.

## 5. Significance and Use

5.1 This guide reduces the time and effort to communicate the findings of project impact studies and improves the quality of communication between those who measure economic impacts and those who evaluate and interpret them.

5.2 Following the guide assures the user that relevant economic information on the project is included in a summary format that is understandable to both the preparer and user.

5.3 Since the standard guide provides a consistent approach to reporting the economic impacts of projects, it facilitates the comparison of economic studies across projects and over time.

5.4 The guide focuses on projects in construction and building-related research. It applies to government as well as private projects. And while the examples treat building-related projects, the guide is applicable to non-building-related projects as well.

5.5 Building-sector users of this guide include building owners and managers, private-sector construction companies, research groups in building and construction industry trade associations, parties to public-sector construction projects, and government laboratories conducting building-related research.

5.6 Use the guide to summarize the results of economic impact studies that use Practices E917 (Life-Cycle Costs), E964 (Benefit-to-Cost and Savings-to-Investment Ratios), E1057 (Internal Rate of Return and Adjusted Internal Rate of Return), E1074 (Net Benefits and Net Savings), E1121 (Payback), E1699 (Value Analysis), and E1765 (Analytical Hierarchy Process for Multiattribute Decision Analysis).

5.7 Use this guide in conjunction with Guide E1369 to summarize the results of economic impact studies involving natural or man-made hazards, or both, that occur infrequently but have significant consequences.

5.8 Use the guide to summarize the impacts of projects that affect exclusively initial costs, benefits, or savings, as well as projects that affect life-cycle costs, benefits, or savings.

NOTE 1—Examples of projects dealing exclusively with initial costs, benefits, or savings include design modifications or innovative construction practices that reduce labor or material costs, reduce construction duration, or increase construction productivity, but leave future costs, benefits, or savings unchanged.

5.9 Use the guide to summarize the impacts of projects that affect parties that are internal to the organization preparing the summary as well as projects that affect not only the organization preparing the summary but also groups external to the organization.

NOTE 2—Projects whose impacts are internal only correspond to situations where the organization preparing the summary bears all of the costs and receives all of the benefits or savings, or both, from the project. Examples include, but are not limited to, the use of innovative construction practices or alternative building materials, components, or systems that reduce initial costs or future costs, or both, to the building owner.

NOTE 3—Projects with a public-sector component frequently have impacts that reach beyond the organization preparing the summary. Examples include, but are not limited to, building-related research conducted by government laboratories, projects aimed at mitigating the consequences of natural or man-made hazards, or both, that have the potential to cause collateral damage, and highway and bridge constructions that affect traffic patterns.

5.10 There is no limitation to the use of the guide in facilitating communication between project analysts and project managers and other decision makers. Substantial benefits from using the guide, however, are likely to come from its application in a large institution, such as a federal agency, where many projects are competing for funding, and a systematic presentation of results that can be compared across projects and agencies is needed to allocate efficiently scarce funds.

## 6. How to Use This Guide

6.1 The generic format for summarizing project impacts is outlined in Fig. 1.

<sup>3</sup> Available from ASTM International Headquarters. Order Adjunct No. ADJE091703.

<p><b>1.a Significance of the Project:</b></p> <p><i>Describe why the project is important and how the organization became involved.</i></p> <p><i>Describe the changes brought about by the organization.</i></p>	<p><b>1.b Key Points:</b></p> <p><i>Highlight two or three key points which convey why this project is important.</i></p>
<p><b>2. Analysis Strategy:</b></p> <p><i>Describe how the present value of total benefits (savings) both internal and external stemming from all contributions to the project was determined.</i></p> <p><i>Describe how the present value of total costs both internal and external stemming from all contributors to the project was determined.</i></p> <p><i>Describe how the present value of net benefits (savings) both internal and external was determined.</i></p> <p><i>Describe how the present value of total benefits (savings) attributable to the organization was determined.</i></p> <p><i>Describe how the present value of total costs attributable to the organization was determined.</i></p> <p><i>Describe how the present value of net benefits (savings) attributable to the organization was determined.</i></p> <p><i>Describe how any additional measures were calculated and how the organization's contribution was determined.</i></p> <p><i>Summarize key data and assumptions: (a) base year; (b) length of study period; (c) discount rate or minimum acceptable rate of return; (d) data; and (e) other.</i></p>	
<p><b>3.a Calculation of Benefits, Costs, and Additional Measures:</b></p> <p><b>Total Benefits (Savings):</b> Report the present value of the total benefits (savings) attributable to the organization.</p> <p><b>Total Costs:</b> Report the present value of the total costs attributable to the organization.</p> <p><b>Net Benefits (Savings):</b> Report the present value of net benefits (savings) attributable to the organization.</p> <p><b>Additional Measures:</b> Report the values of any additional measures calculated.</p>	<p><b>3.b Key Measures:</b></p> <p>Report the calculated value of the Present Value of Net Benefits <b>or</b> the Present Value of Net Savings attributable to the organization carrying out the project or conducting the research <b>and</b> at least one of the following:</p> <ul style="list-style-type: none"> <li>❖ Benefit-to-Cost Ratio <i>or</i> Savings-to-Investment Ratio</li> <li>❖ Adjusted Internal Rate of Return</li> </ul> <p><b>3.c Traceability</b></p> <p>Cite references to specific ASTM standard practices, ASTM adjuncts, or any other standards, codes, or regulations used.</p>

FIG. 1 Format for Summarizing the Economic Impacts of Building-Related Projects

6.1.1 To promote a better understanding of the information called for in Fig. 1, the numbered headings in the table are cross-referenced to the subsections of 6.2. Specifically, the information called for under Headings 1.a and 1.b is covered in 6.2.1, the information called for under Heading 2 is covered in 6.2.2, and the information called for under Headings 3.a, 3.b, and 3.c is covered in 6.2.3.

6.2 *Presentation and Analysis of the Results of an Economic Impact Assessment*—The presentation and analysis of the results of an economic impact assessment are central to understanding and accepting its findings. If the presentation is clear and concise, and if the analysis strategy is logical, complete, and carefully spelled out, then the results will stand up under close scrutiny. This section describes a generic format and procedure for summarizing the results of an economic impact assessment that meets the two previously cited conditions. The generic format is built upon the following three factors: (1) why the project is important; (2) how the analysis strategy was employed; and (3) how the key measures are calculated, summarized, and traced to relevant standards, codes, and regulations. These factors, taken together, constitute a three-step procedure for summarizing the results of an economic impact assessment. FiveSix case studies are used to illustrate what a completed impact assessment using the generic format would look like. The fivesix case studies were chosen so that there is at least one case study for each combination of affected parties (see 5.9) and affected costs, benefits, or savings (see 5.8), and at least one involving natural or man-made hazards, or both. The fivesix case studies are presented in Appendix X1-Appendix X5X6. Appendix X1 is based on a private-sector commercial building application where all impacts are internal and only initial costs are relevant. Appendix X2 is based on a highway project where both internal and external impacts are important and only initial costs are relevant. Appendix X3 is based on an energy conservation project where all impacts are internal and both initial and future costs and future savings are included. Appendix X4 is based on a public-sector research application where both internal and external impacts are important and past, present, and future costs, benefits, and savings are included.<sup>4</sup> Appendix X5 is based on a case study on the application of life-cycle cost analysis to homeland security issues in constructed facilities, where both internal and external impacts are important and both initial and future costs and future savings are included.<sup>5</sup> Appendix X6 is based on a case-study example that was designed to illustrate the three-step protocol (Guide E2506), and summarizes a public evaluation of alternative approaches to minimizing the damage from intentionally-set fires in at-risk communities in Michigan, where both internal and external impacts are important, and both present and future costs, benefits, and savings are included.<sup>6</sup> While the case-study is based on a real-world example and uses actual data, its description, assumptions, and findings are meant to highlight elements of the three-step protocol rather than to justify certain actions or policies in Michigan. Appendix X6 is designed to demonstrate a summarization of the economic analysis resulting from the use of the three-step protocol.

#### 6.2.1 *Why the Project Is Important:*

6.2.1.1 Headings 1.a and 1.b in Fig. 1 set the stage for summarizing the results that follow. The information called for under these headings provides the opportunity to discuss the objective of the project and why doing this project was noteworthy.

6.2.1.2 Heading 1.a in Fig. 1 calls for a short but concise summary of the project. Make the summary sufficiently detailed to enable senior management and non-technical readers to understand the significance of the project. The goal of the information presented under Heading 1.a is to clearly describe: (1) why the project is important and how the organization carrying out the project or conducting the research became involved; and (2) why some or all of the changes brought about were due to the organization's contribution.

6.2.1.3 The objective of Heading 1.b is to highlight two or three points which convey why this project is important. These points are intended for use as talking points by senior management when they make presentations to non-technical audiences or for use in press releases.

#### 6.2.2 *How the Analysis Strategy Was Employed:*

6.2.2.1 Heading 2 of Fig. 1, analysis strategy, has two components. The first component focuses on documenting the steps taken to ensure that the analysis strategy is logical and complete. The second component places particular emphasis on summarizing the key data elements and associated assumptions needed to calculate the values reported under Headings 3.a and 3.b of Fig. 1.

6.2.2.2 Special emphasis is placed on documenting the sources and validity of any data used to make estimates or projections of key benefit and cost measures. Include any constraints that limited the scope of the study. The information called for under Heading 2 of Fig. 1 establishes an audit trail from the raw data, through data manipulations (for example, represented by equations and formulae), to the results. The audit trail consists of seven items that describe how to determine:

(1) The present value of total benefits (savings) both internal and external stemming from all contributors to the project under study, any benefits (savings) to users of products (materials, equipment, software, or procedures) stemming from the project under study, and any third parties affected positively by either the project or the use of products stemming from the project (see Practice E917 for instructions on how to compute present values);

(2) The present value of total costs for all contributors to the project under study, any costs to users of products stemming from

<sup>4</sup> Chapman, R. E., *Benefits and Costs of Research: A Case Study of Construction Systems Integration and Automation Technologies in Industrial Facilities*, NISTIR 6501, Gaithersburg, MD: National Institute of Standards and Technology, 2000.

<sup>5</sup> Chapman, R. E., *Application of Life-Cycle Cost Analysis to Homeland Security Issues in Constructed Facilities: A Case Study*, NISTIR 7025, Gaithersburg, MD: National Institute of Standards and Technology, 2003.

<sup>6</sup> Buttry, D.T., "Economic Performance of Residential Fire Sprinkler Systems." *Fire Technology*, Vol 45, 2009, pp. 117–143.

the project under study, and any third parties affected negatively by either the project or the use of products stemming from the project;

- (3) The present value of net benefits (savings) both internal and external stemming from all contributors to the project under study, any users of products stemming from the project under study, and any third parties affected by either the project or the use of products stemming from the project;
- (4) The present value of total benefits (savings) attributable to the organization's contribution;
- (5) The present value of total costs attributable to the organization's contribution;
- (6) The present value of net benefits (savings) attributable to the organization's contribution; and
- (7) The way in which any additional measures were calculated and how the organization's contribution was determined.

NOTE 4—If the focus of the analysis is on initial costs, benefits, and savings only, then all costs, benefits, and savings are already expressed in present value terms. Therefore, it is not necessary to discount costs, benefits, and savings to a present value, unless the base year for reporting the results is different from the year in which the costs, benefits, and savings occurred.

NOTE 5—If all impacts are internal to the organization preparing the summary, then items (4) through (7) suffice to establish the audit trail.

NOTE 6—If the focus of the analysis is on mitigating the consequences of natural or man-made hazards, or both, summarize how uncertainty was incorporated into the economic evaluation, and provide ranges of values or computed statistics for key measures of economic performance.

### 6.2.3 How Key Measures Are Calculated, Summarized, and Traced:

6.2.3.1 Heading 3.a of Fig. 1 calls for information that provides enough detail on the calculations of the key measures for others to understand how the calculated values were produced. Report summaries (for example, using text, mathematical expressions, tables, graphs, comparative statistics) of the following information:

- (1) The present value of the total benefits or the present value of the total savings attributable to the organization's contribution;
- (2) The present value of the total costs attributable to the organization's contribution;
- (3) The present value of net benefits or the present value of net savings attributable to the organization's contribution; and
- (4) The values of any additional measures calculated.

6.2.3.2 Heading 3.b of Fig. 1 calls for the calculated values of the key benefit and cost measures, as well as any additional measures that are deemed appropriate. Report the calculated value of the present value of net benefits or the present value of net savings attributable to the organization's contribution and at least one of the following:

- (1) The benefit-to-cost ratio or the savings-to-investment ratio; or
- (2) The adjusted internal rate of return.

NOTE 7—If the focus of the analysis is on initial costs, benefits, and savings only, then report only the present value of net benefits or the present value of net savings attributable to the organization's contribution.

6.2.3.3 To ensure traceability, cite references to specific ASTM standard practices, ASTM adjuncts, or any other standards, codes, or regulations used. This information is called for under Heading 3.c of Fig. 1.

## 7. Report

7.1 The report for this guide is the summary impact statement outlined in Fig. 1 and described in 6.2. It is a stand-alone document designed to summarize the most important elements of a project impact study.

7.2 Attach the detailed technical study that underlies the summary impact statement to your report if the user requests complete background information on the project.

7.3 If you follow one of the standard economic practices listed in 5.6 for measuring economic impacts, establish traceability of your methodology by citing in your report the specific ASTM standard practice that you used.

## 8. Keywords

8.1 adjusted internal rate of return; analytical hierarchy process; benefit-to-cost ratio; building economics; economic evaluation methods; economic impacts; engineering economics; homeland security; impact assessment; internal rate of return; life-cycle costs; man-made hazards; measures of worth; multiattribute decision analysis; natural hazards; net benefits; net savings; payback; savings-to-investment ratio

## APPENDIXES

### (Nonmandatory Information)

#### X1. PRIVATE-SECTOR COMMERCIAL BUILDING APPLICATION

X1.1 See Fig. X1.1.

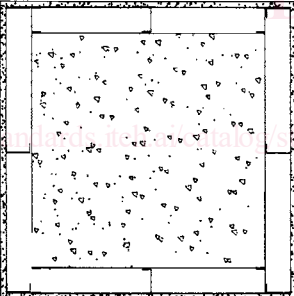
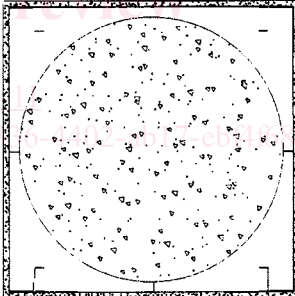
<p><b>1.a Significance of the Project:</b></p> <p>A computer program was developed to design and estimate the cost of concrete columns. The primary purpose of the program was to enable design engineers to understand the cost implications of column shapes, concrete strengths, and reinforcement patterns.</p> <p>Cost savings calculated by the computer program are limited to reductions in first cost to the client. The program does not estimate life-cycle costs or impacts to other stakeholders.</p> <p>To test the new program, a high-rise office building, which had been designed but not yet constructed, was selected as a case study. The original design of the office building's structural system used a conventional strength and serviceability approach for square columns based upon prevailing industry practice. Trial runs of the program indicated that there might be substantial cost savings from a design with round columns and high-strength concrete. These cost savings were confirmed through a comparative cost analysis.</p>	<p><b>1.b Key Points:</b></p> <p>The traditional approach to concrete column design is to use square columns. Since alternative column shapes may be more cost effective than square columns, a computer program was developed to evaluate the cost consequences of alternative concrete column shapes.</p> <p>The computer program evaluates the implications of the following shape-related variables on total column cost:</p> <ul style="list-style-type: none"> <li>• the use of high-strength concrete rather than conventional-strength concrete;</li> <li>• the reinforcing pattern, including the main vertical elements as well as dowels and ties;</li> <li>• the type of formwork; and</li> <li>• the framing requirements or "furring out" to the finished surface.</li> </ul> <p>Application of the computer program to a high-rise office building found that a design with round columns and high-strength concrete might result in substantial cost savings vis-à-vis a traditional approach based on square columns.</p>
<p><b>2. Analysis Strategy:</b></p> <p>Comparison of furring cost for square vs. round columns:</p> <div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;">  <p>Square column with support framing</p> </div> <div style="text-align: center;">  <p>Round column with support framing</p> </div> </div> <p>There is a misconception that round columns need framework (furring) to support drywall whereas drywall can be mounted directly on square columns. Since the concrete finish does not yield a plumb surface, contractors must build frameworks for square columns as well. <b>Thus, there is no additional furring cost for round columns.</b></p>	

FIG. X1.1 Computer Program for Evaluating Concrete Column Shapes

**X2. HIGHWAY PROJECT**

X2.1 See Fig. X2.1.