

BLCC

**The NIST "Building Life-Cycle Cost" Program, Version 4.3
User's Guide and Reference Manual**

Stephen R. Petersen
Office of Applied Economics

Building and Fire Research Laboratory
Gaithersburg, Maryland 20899

Sponsored by:
The Federal Energy Management Program
U.S. Department of Energy
Washington, DC 20585



United States Department of Commerce
Technology Administration
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October 1995
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U.S. Department of Commerce
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National Institute of Standards and Technology
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ABSTRACT

The NIST Building Life-Cycle Cost (BLCC) computer program provides economic analysis of proposed capital investments that are expected to reduce long-term operating costs of buildings or building systems/components. It is especially useful for evaluating the costs and benefits of energy conservation projects in buildings. Two or more alternative designs can be evaluated to determine which has the lowest life-cycle cost and therefore is most economical in the long run. Economic measures, including net savings, savings-to-investment ratio, adjusted internal rate of return, and years to payback can be calculated for any design alternative relative to the designated base case. BLCC can be used for evaluating federal (including Department of Defense), state, and local government projects as well as projects in the private sector. It complies with ASTM standards related to building economics as well as Federal Energy Management Program (FEMP) and Office of Management and Budget (OMB) Circular A-94 guidelines for economic analysis of federal building projects. While BLCC is primarily intended for the economic evaluation of building systems, it can be applied to a wide range of project investments which are intended primarily to reduce future operating-related costs.

The "Quick Input" program (QI) included with BLCC can be used to set up multiple project alternatives for LCC analysis in a single input file. While the range of input data is somewhat limited, QI is sufficient for many simple LCC problems and provides a new link to the DOE ASEAM 5.0 energy calculation program. QI can also be used to generate input data files for BLCC when more comprehensive analysis is required.

BLCC and QI are designed to run on an IBM-PC or compatible microcomputer with approximately 640K of random access memory and a hard disk or disk drive capable of handling high-density diskettes. BLCC and QI are updated annually (on October 1) to include the current DOE energy price projections and federal discount rates.

Note: The BLCC and Quick Input programs are in the public domain, not subject to copyright. They can be freely copied and distributed. However, it is requested that attribution be given to the National Institute of Standards and Technology.

The author has made a concerted effort to produce computer programs that work as intended and are free from error. However, NIST makes no guarantee that BLCC and QI are free of errors and assumes no responsibility or liability for the accuracy of these programs or for the results which may come from their use.

Starting with BLCC version 4.2 and Quick Input version 2.1, the version number on the distribution diskette shows the year for which the FEMP discount rate and DOE energy price escalation rates are included. The most recent version of BLCC at the time of printing is BLCC 4.3-96. The most recent version of Quick Input is QI 2.2-96.

PREFACE

The NIST Building Life-Cycle Cost (BLCC) computer program is an economic analysis tool kit for evaluating the relative cost effectiveness of alternative buildings and building-related systems or components. Typically BLCC is used to evaluate design alternatives which have higher initial costs but lower operating-related costs over the project life than the lowest-initial-cost design, while providing comparative levels of service (e.g., occupant comfort, safety, and useable space). BLCC is especially useful for evaluating the costs and benefits of energy conservation and water conservation projects in buildings. BLCC can be used for evaluating projects in federal buildings, in the private sector, and at the state and local government levels. For the analysis of energy conservation investments in federal buildings (other than Department of Defense (DoD) facilities), BLCC complies with NBS Handbook 135, *Life-Cycle Costing Manual for the Federal Energy Management Program*. For DoD facilities, BLCC complies with the DoD Tri-Services memorandum of agreement on "Criteria/Standards for Economic Analyses/Life Cycle Costing for MILCON Design," dated March 1994. For other investments in federal buildings, BLCC complies with OMB Circular A-94 (revised), "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," October 29, 1992.

BLCC also complies with the American Society for Testing and Materials (ASTM) standard practices for building economics, including 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 for Investments in Buildings and Building Systems), and E1121 (Practice for Measuring Payback for Investments in Buildings and Building Systems).

While BLCC is intended primarily for use with buildings and building systems, it can be applied to almost any type of capital investment which is intended to reduce future operating-related costs. For example, it can be used to evaluate alternative automobile models in a fleet management program, or to evaluate alternative highway, bridge, or pipeline construction specifications that directly impact the life or maintenance requirements of those facilities.

BLCC is the main program in a set of five NIST computer programs providing computational support for the analysis of capital investments in buildings. The other programs in this series include:

- (2) *BLCC Quick Input (QI)*. QI provides a convenient method of setting up and solving relatively simple LCC problems that require the determination of the design alternative with the lowest LCC from two or more mutually exclusive alternatives. A number of project alternatives can be included in the same data file and evaluated simultaneously, although with less detail than is allowed with BLCC. BLCC input data files for each alternative can be generated from QI. QI is distributed on the same diskette as BLCC and the user's guide for QI is included in this report. (See section 6.)

- (3) *DISCOUNT--A Program for Discounting Computations in Life-Cycle Cost Analyses (version 3.4)*, NISTIR 4513, National Institute of Standards and Technology, January 1991.

The DISCOUNT program computes discount factors and related present values, future values, and periodic payment values of cash flows occurring at specific points. DISCOUNT is especially useful for solving life-cycle cost analysis problems which do not require the comprehensive summation and reporting capabilities provided by the BLCC program. DISCOUNT performs all of the functions of standard discounting tables, computing present values of future amounts, future values of present amounts, present and future values of periodic payments, periodic payments corresponding to present and future amounts, and corresponding discount factors. In addition, DISCOUNT computes the present value of periodic payments which increase at known rates over time, and the present value of energy costs which increase at rates projected by the U.S. Department of Energy for use in federal life-cycle cost analysis. DISCOUNT provides the added flexibility of accepting non-integer discount rates, time periods, and escalation rates in its computations. DISCOUNT runs on most IBM-PC and compatible microcomputers. The DISCOUNT program is included on the BLCC diskette.

- (4) *ERATES--A Program for Computing Time-of-Use, Block, and Demand Charges for Electricity Usage*, NISTIR 5186, National Institute of Standards and Technology, May 1993.

ERATES is a computer program for calculating monthly and annual electricity costs under a variety of electric utility rate schedules. Both kWh usage and kW demand can be included in these costs. Most typically these calculations will be used to support engineering-economic studies which assess the cost effectiveness of energy conservation measures or measures to shift electricity use from on-peak to off-peak time periods. With ERATES a user can set up time-of-use rate schedules, block rate schedules, and demand rate schedules and save these schedules to a disk file. ERATES can then use these schedules to compute monthly and annual electricity costs, given hourly or monthly kWh usage and kW demand data for a building or building system. ERATES is a menu-driven, interactive program, designed to be run on an IBM-PC or compatible microcomputer. ERATES can be used to create block rate and demand rate schedules which can be used with BLCC. ERATES is not intended for use by utilities in setting up or administering such schedules.

- (5) *EMISS--A Program for Estimating Local Air Pollution Emission Factors Related to Energy Use in Buildings*, NISTIR 5704, National Institute of Standards and Technology, October 1995.

EMISS allows you to create a data file of air pollution emission factors for a specific location which can be accessed by BLCC and used to compute the annual and life-cycle reductions in emissions (CO₂, SO₂, and NO_x) attributable to reductions in energy usage for a specific building or building system. No dollar value is placed on these emission reductions, but this information may be useful in choosing among alternatives or justifying the additional cost of a project.

Representatives of federal agencies and contractors to the federal government can order these programs, free of charge, from:

Advanced Sciences, Inc.
1525 Wilson Blvd, Suite 1200
Arlington, VA 22209-9998
(703) 243-4900

For others interested in obtaining BLCC and related programs, please contact one of the following organizations for price and ordering information:

FlowSoft
5 Oak Forest Court
Saint Charles, MO 63303
(314) 441-1022

Energy Information Services
PO Box 381
St. Johnsbury, VT 05819-0381
(802) 748-5148

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4650

NIST Handbook 135, *Life-Cycle Costing Manual for the Federal Energy Management Program*, newly revised 1995, provides an in-depth guide to understanding life-cycle costing and related methods of economic analysis as they are applied to federal buildings. It describes the required procedures and assumptions, defines and explains how to apply and interpret economic performance measures, gives examples of federal decision problems and their solutions, explains how to use the energy price indices and discount factors (which are updated annually in the following report), and provides work sheets and other computational aids and instructions for calculating the required measures.

The Annual Supplement to Handbook 135, *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis* (NISTIR 85-3273), provides updated energy price indices, discount rates, and discount factors in support of the methodology outlined in Handbook 135. This Supplement is updated each year on October 1 for use in the following fiscal year. This report is especially important if you are performing LCC analyses manually, i.e., without using the BLCC software. BLCC, Quick Input, and DISCOUNT are also updated each year on October 1 with the same underlying data used to compute the factors published in this supplement.

Note: For LCC analyses in the Department of Defense, NIST publishes a separate version of this report, called *Present Worth Factors for Life-Cycle Cost Studies in the Department of Defense*, NISTIR 4942, updated annually on October 1. The present worth factors for annually recurring costs in this report are based on mid-year discounting (as required by DoD), rather than on end-of-year discounting as the Annual Supplement to Handbook 135.

These NIST LCC publications can be ordered from:

Advanced Sciences, Inc.
1525 Wilson Blvd, Suite 1200
Arlington, VA 22209-9998
(703) 243-4900

NIST conducts LCC workshops, sponsored by DOE, at various locations around the country several times each year. The workshops include training and software for both BLCC and an energy analysis computer program called "A Simplified Energy Analysis Method" (ASEAM). You can obtain a schedule of workshops from the Office of Applied Economics, National Institute of Standards and Technology, Bldg. 226, Room B226, Gaithersburg, MD 20899, (301) 975-6132.

An introduction to the FEMPLCC methods is provided in three video training films in a series called "Least-Cost Energy Decisions:" (1) "An Introduction to Life-Cycle Cost Analysis;" (2) "Uncertainty and Risk;" and (3) "Choosing Economic Evaluation Methods." The video films and companion workbooks can be ordered from Video Transfer, Inc., 5709-B Arundel Avenue, Rockville, MD 20852, (301) 881-0270.

Further information on the Federal Energy Management Program can be obtained from the Federal Energy Management Program Staff, Office of the Assistant Secretary for Conservation and Renewable Energy, U.S. Department of Energy. Please direct communication to: FEMP, CE 10.1, U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585.

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NOTE REGARDING USE OF SI AND INCH-POUND UNITS

The BLCC and QI programs can use either SI or inch-pound units for energy and water amounts. The user can specify the units appropriate to the project being analyzed at the time that unit prices and annual usage amounts are entered. No conversion between units is conducted by the programs except in the analysis of air pollution emissions by BLCC. The user is responsible for assuring that the units selected and the price per unit match the energy and water usage data used in the analysis.

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1. INTRODUCTION

1.1 Overview

The NIST Building Life-Cycle Cost (BLCC) computer program is an economic analysis tool kit for evaluating alternative buildings and building-related projects, systems, or components that have different costs while providing an acceptable level of service (e.g., occupant comfort, safety, and useable space). Typically BLCC is used to evaluate alternative designs which have higher initial costs but lower operating-related costs over the project life than the lowest-initial-cost design. BLCC is especially useful for evaluating the costs and benefits of energy conservation and water conservation projects in buildings. With BLCC, the life-cycle costs of two or more alternative designs are computed and compared to determine which has the lowest life-cycle cost and is therefore most economical in the long run. BLCC can be used for evaluating alternative designs in both new and existing buildings. BLCC will also calculate comparative economic measures for the alternative designs, including Net Savings, Savings-to-Investment Ratio, Adjusted Internal Rate of Return, and Years to Payback. BLCC can evaluate federal, state, and local government projects as well as non-profit and for-profit projects in the private sector. While BLCC is oriented toward building-related design decisions, it can be used to evaluate alternative designs for almost any project type in which higher capital investment costs results in lower future operating-related costs.

Before using BLCC, you must identify appropriate design alternatives for the project to be evaluated, collect relevant cost, energy usage, and water usage data, and establish the economic environment (i.e., Base Date, Service Date, Study Period, Discount Rate, treatment of inflation, and tax status) in which the alternatives will be evaluated. Then, using a series of data entry forms displayed on the screen, you set up and save a separate data file of cost data and related parameters for each alternative. BLCC automatically performs LCC computations for each alternative as you save your input data file. Once you have created data files for two or more alternatives, you can use BLCC to identify the minimum life-cycle cost alternative and to calculate appropriate measures of economic performance. You can generate a yearly cash flow report, summary and detailed LCC analyses, and comparative economic analyses for designated design alternatives using menu-driven commands. You can specify whether the BLCC reports will be displayed to the screen, sent to the printer, or saved as a disk file for later retrieval by word processor.

BLCC has been improved each year since its first release in the early 1980's. Recent enhancements include (new features in version 4.3-96 are designated with "*"):

- Optional end-of-year or mid-year discounting convention*.
- LCC computations for the design of Department of Defense military construction (MILCON) projects, including the printing of the ECIP report*.
- Air pollutant emissions related to building or system energy usage reported in the detailed LCC analysis and comparative LCC analysis, based on local emission factors from the new NIST EMISS program*¹.

¹ Petersen, S., National Institute of Standards and Technology, *EMISS, A Program for Estimating Local Air Pollution Emission Factors Related to Energy Use in Buildings*, NISTIR 5704, October 1995

- Block rate and demand charge calculations for electricity costs, using rate schedules from the NIST ERATES program².
- Years to payback and annual energy savings computations for a project alternative relative to a specified base case.
- Optional units (including SI units) for energy types.
- Explicit data entry screens and computations provided for water conservation projects.

BLCC computational algorithms comply with the American Society for Testing and Materials (ASTM) standard practices for building economics, including 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 for Investments in Buildings and Building Systems) and E1121 (Practice for Measuring Payback for Investments in Buildings and Building Systems). For the economic analysis of energy conservation investments in federal buildings, BLCC complies with NBS Handbook 135, *Life-Cycle Costing Manual for the Federal Energy Management Program*. For Department of Defense military construction projects, BLCC complies with the criteria outlined in the DoD memorandum of agreement on "Criteria/Standards for Economic Analyses/Life Cycle Costing for MILCON Design," March 1994. For other investments in federal buildings, BLCC complies with OMB Circular A-94 Revised, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," October 29, 1992.

BLCC uses the U.S. Department of Energy's (DOE) most recent projections of energy price escalation rates. These DOE projections are needed for federal energy conservation analyses but can be used with other LCC analyses as well. These projections are updated yearly and released with the most recent version of BLCC at the beginning of the new federal fiscal year (October 1).

1.2 How to Use this Guide

BLCC was originally developed as an adjunct to the ASTM standard on life-cycle cost analysis in the early 1980's. Since then it has been through several revisions to improve the user interface and to add more analytical capabilities. Most of the data entry forms used in version 4.3 are similar to, or identical with those in version 3.0 and later. You can use your input data files from BLCC versions 3.0 and later with BLCC 4.3. However, you must update and resave the older data input files and recalculate the LCC for each alternative using BLCC 4.3 before you can use BLCC 4.3 to generate reports or perform a comparative analysis with those files. For experienced BLCC users, version 4.3 can be run with little additional preparation after installation. If you are not familiar with BLCC's capability to compute electricity costs using block rate and demand rate schedules, or water costs, be sure to read section 5. BLCC users should also read section 6 to learn about the capabilities of the Quick Input program that can be used instead of BLCC for many simple LCC problems.

If you are a first time BLCC user, it is recommended that you review section 3 to gain a basic understanding of BLCC's capabilities and the order in which the various steps of a BLCC analysis are undertaken. Look over examples of the six different types of BLCC reports provided in that

² Petersen, S., National Institute of Standards and Technology, *ERATES, A Computer Program for Calculating Time-of-Use, Block, and Demand Charges for Electricity Usage*, NISTIR 5186, May 1993.

section. It is essential that you keep the following requirement in mind when you are starting out: **You must create a separate input data file for each design alternative to be evaluated.** Thus, if you are evaluating four different levels of attic insulation to find which has the lowest LCC, you must create four input data files, one for each level. (The Quick Input program allows you to combine project alternatives in the same data file. See section 6 for information on this program.)

After installation (described in section 2), you start BLCC by entering the name of the executable program, BLCC4, at the DOS ready prompt. You can run BLCC4 with the demonstration files included on the BLCC diskette (DEMO1.DAT, DEMO2.DAT, etc.) to obtain an overview of the data entry forms and the various reporting functions. After starting BLCC4, select "Enter/Edit/Print Input Data" from the main menu and "Edit Existing Input File" from the secondary menu. Then select file "DEMO1.DAT" from the list of available files. From the file editing menu, select "All Data", and then page through the data entry forms. Press <PgDn> and <PgUp> to move forward and backward through the data entry forms. Press <Enter> or <Esc> to move forward or backward from a menu screen (i.e., a screen which requires selecting an option rather than entering data into a field). After the last screen you will be asked if you want to save the current data, review the data again, or exit without saving the file. If you do not make any changes to the data in these demonstration files, you can exit without resaving. If you have changed any data in the file, and want to save this file, select the save option; then provide a new filename when asked in order to preserve the original data in the demonstration file. Using these same demonstration files, you can display a summary or detailed LCC report, a listing of the input data, a cash-flow report, and a comparative economic analysis report by selecting these options from the main menu.

Section 4 provides examples of all of the data entry forms in BLCC and definitions of each variable that you must enter. The definition of each variable on each data entry form is located below the corresponding figure shown in section 4. Not all variables shown in section 4 apply to all types of analysis. For example, tax-related variables only appear when running the private-sector options.

Section 5 provides instructions on the use of block rate and demand rate calculations in BLCC version 4.0 and later. This feature requires that you use the NIST ERATES program to set up appropriate rate schedules before you run BLCC.

Section 6 provides an overview and instructions for running the BLCC "Quick Input" program. Whether you are a new or experienced BLCC user, you should read over this section and explore the features of this new program. QI can greatly simplify the task of creating data files for LCC analysis. You can enter cost data for many design alternatives into a single file, rather than having to create a separate file for each alternative. While the amount of cost data that you can enter for any single alternative is limited, you can use QI to generate BLCC input data files for those alternatives which require more intensive analysis. You can then enter more comprehensive cost data for those alternatives using BLCC and use its more detailed reporting capabilities.

1.3 BLCC Files and Filename Extensions

There are a number of different file types that are used with, or generated by, BLCC. A complete list of these file types, with filename extension, is shown in table 1.1. This list may be helpful in identifying files in your BLCC directory. The filename extensions are automatically assigned by the BLCC program. Do not include the extension when you enter a filename for saving a file.

Table 1.1 Filename extensions used with the BLCC program

<u>Filename Extension</u>	<u>File type</u>
BLK	Block rate files for kWh charges from ERATES
CFR	BLCC4 Annual Cash Flow Report
CMP	BLCC4 Comparative Economic Analysis Report
DAT	BLCC4 input data files
DEP	Depreciation table files (see section 4.9.4)
DMD	Demand rate files for kW demand charges from ERATES
DTS	BLCC4 Input Data Report
EMI	Air pollution emissions file from the EMISS program
EXE	Executable file (BLCC4)
FIL	Special data files for BLCC4
FLD	Report formatting files for BLCC4
LCC	BLCC4 life-cycle cost (output) files
LOW	BLCC4 Lowest LCC Report
RAN	ENCOST96.RAN only, DOE energy price escalation rates (see section 4.5.2)
SCR	Screen formatting files for BLCC4
SEQ	ENCOST96.SEQ only, map of data in ENCOST96.RAN
SUM	BLCC4 Summary LCC Report

2. INSTALLING BLCC

2.1 Installation

BLCC runs best when you install it on a hard disk. You can also run BLCC directly from a diskette if it has at least 720 kilobytes (KB) of data storage (i.e., a high density 5.25 inch or double-density 3.5 inch diskette, but not a double-density (360 KB) 5.25 inch diskette). However, BLCC loads and runs considerably more slowly when run from a diskette.

You will need approximately 1.2 MB of disk space to install all of the programs and files on the BLCC diskette. To install BLCC on a hard disk, use the following steps:

Important: Do not install BLCC in an existing directory containing an older version of BLCC predating BLCC 4.0 unless you delete all files in that directory first. If you want to use older BLCC input data files with this new version of BLCC, they can be accessed by specifying their directory location on the setup screen when running BLCC. In this guide, the BLCC directory name is assumed to be "`\BLCC4`". You can use any directory name that is acceptable to DOS.

- (1) Make a directory called "`\BLCC4`" on the disk drive where you intend to install BLCC (e.g., C:). To do this, type **MD \BLCC4** at the DOS ready prompt.
- (2) Insert the BLCC disk into the A (or B) drive and copy all of the files from the disk to the BLCC4 directory. To do this, type **COPY A:*. * (or COPY B:*. *)** at the DOS ready prompt.
- (3) Repeat step 3 if there is more than one BLCC diskette.
- (4) Type **BLCC4** at the ready prompt to start BLCC.

To run BLCC directly from a diskette, use the following steps:

(Note: These instructions are only valid when all of the supporting files listed below are on the same disk as BLCC4.EXE.)

- (1) Make a back-up copy of the BLCC diskette and save the original in a safe place.
- (2) Insert your back-up copy of the BLCC diskette into the A (or B) drive.
- (3) Make the A (or B) drive the current drive by typing **A:** (or **B:**) at the DOS ready prompt.
- (4) Type **BLCC4** at the DOS ready prompt to start BLCC.

If you run BLCC from a diskette rather than from a hard disk, space for file storage is limited and it is recommended that you save your input and output files to a second diskette in another drive. Section 2.2 shows how to do this.

The executable program BLCC4.EXE and the following supporting files must be available in the current directory to run BLCC:

MILPROJ.SCR	TAXREP.SCR	HELP.4	ENCOST96.SEQ
MILARC.SCR	TAXARC.SCR	COMPARE4.FLD	ENCOST96.RAN
MILREP.SCR	TAXPROJ.SCR	PRNTLCC4.FLD	DISRAT96.FIL
GENPROJ.SCR	ENESC.SCR	CASHFLW4.FLD	TITLES.FIL
GENARC.SCR	ENERGY.SCR	PRNTDAT4.FLD	UNITS.FIL
GENREP.SCR	MORT.SCR	ECIP.FLD	SETUP4.FIL
WATER.SCR			USAVG.EMI

If you intend to use the Quick Input program (see section 6), QI2.EXE must be available in the current directory. There is also a file called READ.ME with updated information about BLCC on the BLCC disk. Look at this file for information included after this user's guide was completed.

2.2 Setup

The first time you run BLCC, select the "Setup" option from the main BLCC menu. The setup screen is shown in figure 2-1. The setup screen allows you to specify several variables that are used in all subsequent BLCC analyses, until the setup variables are changed again.

```
Monitor (C=Color/M=Monochrome/E=B&W Emulation): C
Directory to save files: \BLCC4
DOE Energy Price Filename: ENCOST96
Emission Factor Filename: USAVG.EMI
Check Printer Status (Y/N): Y
Printer Port (e.g., LPT1):
```

Figure 2-1. BLCC setup variables.

The six setup variables are:

(1) The type of monitor you are using: C=color, M=monochrome, E=black and white emulation. For some non-color monitors that emulate, but do not actually display color, the screen display can be improved by selecting E from the setup screen.

(2) The directory or subdirectory for saving and retrieving project data files (*.DAT and *.LCC). It is recommended that you save data files for unrelated projects in different subdirectories. The directory name should be preceded by a back slash (\); e.g., \BLCC4. If this entry is left blank, data files will be saved and retrieved from the current directory; i.e., the directory from which BLCC is being run.

(3) The common filename of the DOE energy price escalation rate files on the BLCC disk (currently ENCOST96.SEQ and ENCOST96.RAN). Only the last two characters of the filename (the year, e.g., 96) can actually be entered in the field. This year is also used to specify the file with default discount rates for federal projects (currently DISRAT96.FIL).

(4) The filename of the emissions factors file to be used in calculating air pollution emissions related to the energy usage of the building or building system being evaluated. The default filename is USAVG.EMI, which contains national average emission factors. Note that the entire filename must be specified, including the extension. (At present there is no required filename extension for emission factor files.)

(5) Printer status check forced or not forced. If Y(es) is selected, the printer status will be checked to make sure the printer is available before sending a report to be printed. A warning will be issued if the printer is off line or out of paper. This check will not work properly with some network printers. In such a case, turn off the printer check by entering N(o).

(6) Printer port designator. Only LPT1:, LPT2:, or LPT3: can be entered. These are designators that DOS recognizes as printer devices. LPT1: is the default printer port.

After the set-up screen has been updated, press <PgDn> to save the set-up specifications shown on the screen and return to the main BLCC menu. Or press <Esc> to return to the main menu without saving any changes that you made here.

Note that the Quick Input program (QI) discussed in section 6 uses the same setup file as BLCC4. There is one variable in the setup file (the maximum number of QI records allowed) that is used by and can be changed by QI but not by BLCC.

2.3 Demonstration Files

There are several demonstration files on the BLCC disk for use in learning how to use the program. These files are:

DEMO1.DAT, DEMO2.DAT, DEMO3.DAT, DEMO4.DAT
DEMO1.LCC, DEMO2.LCC, DEMO3.LCC, DEMO4.LCC
DEMO.DEP, DEMO.BLK, DEMO.DMD
TESTMIL.DAT, TESTMIL.LCC, TESTMIL2.DAT, TESTMIL2.LCC

These demonstration files serve as the basis of the examples of BLCC reports used in this User's Guide. The four DEMO?.DAT files are data input files which contain the study parameters and cost data for four mutually exclusive design alternatives. You can view these files in the BLCC file edit mode, or use them as the basis for generating an Input Data Report or an Annual Cash Flow Report. Section 4 of this guide provides definitions of all BLCC input variables. The four DEMO?.LCC files contain the LCC calculation results automatically generated when the corresponding input data files were saved. Section 3.4 describes these reports. DEMO.DEP is an example file of a standard depreciation table for use with private-sector (taxable) analyses. Section 4.11 provides the format for this file. DEMO.BLK and DEMO.DMD are block rate and demand rate files, respectively, for electricity costs. These files are generated by the NIST ERATES program. The use of these files is described in section 5. The TESTMIL* files are used to generate the ECIP report example shown in section 3.5.3.

3. CONDUCTING A BLCC ANALYSIS

3.1 Getting Started

3.1.1 Preliminary Requirements

Life-cycle cost (LCC) analysis is an economic decision-making tool for choosing among alternative buildings or building systems *intended for the same purpose*, based on long-run cost performance. When design improvements increase the initial capital cost of a building or building system, but reduce future operating-related costs or extend the life of the building or system, an economic analysis is often required to justify the required additional investment. (Of course, when no additional investment is needed for these improvements, and no adverse consequences are anticipated, an economic analysis is not generally required to justify the improved design.) Life-cycle cost analysis sums, over a designated study period, all costs related to the owning and operating of a building or building system³, adjusted for the time-value of money. These costs include:

- (1) initial capital investment,
- (2) capital replacement costs,
- (3) resale (residual or salvage) value (a negative cost when the resale value is positive),
- (4) operating, maintenance, and repair (OM&R) costs,
- (5) energy and water costs (when itemized separately from other OM&R costs),
- (6) financing-related costs (when applicable), and
- (7) tax-related costs (when applicable).

LCC estimates are generally calculated in present-value dollars; that is, all future costs are discounted to present value and summed. LCC estimates can also be estimated as annualized costs; that is, the entire stream of costs over the study period are levelized to an equal annual amount, including an "interest" charge based on the discount rate. In BLCC, the summary and detailed LCC reports provide LCC costs of project alternatives in both present-value and annual-value terms⁴.

Before you can start an LCC analysis, you must first determine acceptable project alternatives that can perform the required functions of the building or building system being evaluated. The criteria for determining whether a project alternative is "acceptable" can include a number of factors: reliability, safety, conformance with building codes, occupant comfort, noise levels, and even visual aesthetics. Presumably each of the acceptable alternatives that you have identified will have different initial investment costs and future costs. LCC provides a systematic method for comparing project alternatives with different streams of costs in a time-equivalent manner.

³ In practice, only costs which are different need to be included in a LCC analysis of alternative buildings or building systems. Thus, if the annual maintenance cost is expected to be the same for each alternative heating system being evaluated for a particular application, there is no need to estimate such costs and include them in the LCC analysis.

⁴ Annualized costs computed in BLCC are allocated evenly to every year in the study period, even if there is a planning/construction period before the service date during which no costs other than capital investment costs are incurred.

The first step in performing the LCC analysis of these project alternatives is to establish the general study parameters for the project. These include:

- (1) the type of LCC analysis (e.g., federal, military construction, private sector, or general),
- (2) the treatment of inflation (constant or current dollars),
- (3) the Base Date (the date to which all future costs are discounted),
- (4) the Service Date (the date when the new building will be occupied or the new system will be put into service),
- (5) the Study Period (the life of the project, or in some cases, the number of years over which the investor has a financial interest in the project),
- (6) the Discount Rate (the investor's opportunity cost, or minimum acceptable rate of return), and
- (7) applicable tax rates (in private sector analyses which include taxes).

When two or more project alternatives are to be compared (or even when a single alternative is compared against an existing design), these general study parameters must be the same for each to assure that the comparison is valid. It is meaningless to compare the LCC of two or more alternatives if they are computed using different underlying assumptions.

Once you have established the general study parameters and identified the list of acceptable alternatives for a given project, you must quantify all project-related costs as they are affected by these alternatives and estimate the time at which these costs are expected to be incurred. You should differentiate between annually-recurring OM&R costs (costs which occur uniformly from year to year over the study period) and non-annually recurring OM&R costs because you will enter these separately into the BLCC input data file. You will not enter energy and water costs directly; instead you will enter annual usage amounts and unit prices; these factors are then used by BLCC to compute these costs. **You must specify all costs as though they were incurred on the base date of the study, usually the current date.** BLCC automatically adjusts these costs for price changes (if any) over the Study Period.

3.1.2 Steps in a BLCC Analysis

Now you are ready to begin the BLCC analysis. The following steps will provide a useful way to proceed:

- (1) Create a separate input data file for each alternative and save each file to the disk. The LCC for any alternative is automatically calculated when the input data file is saved. (See section 4 for a guide to creating/editing BLCC input data files.)
- (2) Print out the input data file Report and make sure that your input data were entered correctly. Use this report as documentation for your LCC report.
- (3) (Optional) Print out the Annual Cash Flow Report to make sure that the costs and their timing are correctly projected out year-by-year over the study period. If price escalation rates were included with the cost data, the cash flow analysis should show these costs adjusted for price escalation.
- (4) Print out a Detailed LCC Analysis Report for each alternative to be included as documentation for your LCC report.

- (5) Determine which alternative of those being considered has the lowest LCC, using the "Lowest LCC" option from the main menu. This is generally the most economic alternative. However, if there are non-quantitative consequences (positive or negative) related to any alternative, these generally should be included in the determination of which is "best" overall.
- (6) Perform a comparative analysis between the selected alternative and the base case (generally the existing condition or the lowest-first-cost alternative) to determine the overall Net Savings, Savings-to-Investment Ratio and Adjusted Internal Rate of Return for the selected alternative. Sometimes you may want to perform a comparative analysis between the alternative with the lowest LCC and the alternative with the next-lower investment requirement to determine the incremental Net Savings, Savings-to-Investment Ratio, and Adjusted Internal Rate of Return.

In the case where only one project alternative is being considered (say, installing a clock thermostat), two data input files are still required to conduct an economic analysis with BLCC: one for the base case (usually the existing situation) and one for the alternative being considered. The base case itself may have no initial investment cost, but will typically have higher operating-related costs than the alternative. The alternative will have a higher initial investment cost but will generally have lower operating-related costs. If the alternative has a lower LCC than the base case, it is considered to be cost effective relative to the base case.

Where several project alternatives are being considered for a particular application (whether two or more buildings for a given space requirement, different levels of insulation in roof assembly, or different heating and cooling systems for a new building), the LCC must be computed for each alternative. The alternative with the lowest LCC is generally the most economic choice. Additional measures of cost effectiveness (e.g., savings-to-investment ratio and adjusted internal rate of return) can be calculated for any given alternative relative to the base case or any other alternative, but the LCC measure itself is most useful in identifying the most cost-effective alternative for a given application.

3.2 The Main BLCC Menu

Enter **BLCC4** at the DOS ready prompt to start the program. The BLCC logo will appear on the screen. Press any key to display the Main BLCC menu, shown in figure 3-1. This menu shows the major functions of the BLCC program. Use the up/down cursor keys to highlight the desired function and press the <Enter> key. As each function is highlighted, a brief description of that function will be displayed at the bottom of the screen. Alternatively, simply press the highlighted character to select the desired menu item.

The first three selections on this menu lead to secondary menu choices, which are discussed in sections 3.3, 3.4, and 3.5, respectively. The Quick Input selection terminates BLCC and loads the Quick Input program, which is discussed in detail in section 6 of this guide. Setup is discussed in section 2.2 under installation procedures. The first time that you use BLCC, you should choose the Setup option first. The General Information option provides a short description of the BLCC program and how to use it. (As of yet, there are no help messages available with BLCC.) The Exit selection returns you to DOS.

```
Enter/Edit/Print Input Data
Individual Project Alternative Reports
Comparative Analysis Reports
Quick Input Program
Setup
General Information
Exit
```

Figure 3-1. Main BLCC menu.

3.3 Enter/Edit/Print Input Data

To use BLCC, you must first create a separate input data file for each project alternative to be evaluated. Select the first item from the main menu (Enter/Edit/Print Input Data) by using the cursor to highlight that menu choice and press <Enter> (or simply press the highlighted character, "E"). Figure 3-2 shows the secondary menu that will appear on the screen. To start in the file creation mode, select the first item (Create New Input File) from the secondary menu using the cursor key (or pressing the highlighted character "C").

```
Create New Input File
Edit Existing Input File
Print Input Data Report
```

Figure 3-2. Menu options for input data files.

The input data file for any project alternative contains the general assumptions for the LCC analysis; initial capital costs and resale value assumptions; operating, maintenance, and repair (OM&R) costs; capital replacement costs; and (where relevant) energy and water price and usage data and data related to taxes and financing. Section 4 of this guide provides detailed instructions for setting up input data files for BLCC analysis. After completing the last data entry form in the file creation mode, you will be asked if you want to save the file to the disk. If you wish to save this file, you must enter a DOS-convention filename (eight alphanumeric characters maximum). All input data files are automatically tagged with the filename extension "DAT".

Once you have created and saved an input data file for any project alternative, you can edit that file and save it under its old filename (replacing the old file) or under a new filename (leaving the old file unchanged). You can also print any input data file for documentation purposes by selecting "Print Input Data Report" from the secondary menu shown in figure 3-2. As with all BLCC reports, you can display this report to the screen, send it to the printer, or save it to an ASCII file in the designated project files directory for later retrieval. If the report is saved to the disk, you must provide a valid file name; a filename extension of "DTS" will automatically be assigned. An example of the input data report is shown for input data file DEMO1.DAT in table 3.1.

If you are going to edit an existing input data file, select "Edit Existing Input File" from the secondary menu; a list of the existing input data files in your designated project files directory will be displayed. (The project files directory is specified using the Setup utility accessed from the main menu.) Use the cursor keys to highlight the name of the existing file; then press <Enter> to begin. Several demonstration files have been included with the BLCC program; you can browse through these in the edit mode. If you change any of the input variables, save the file under a new name when prompted.

Whenever you save an input data file, the LCC computations are automatically performed and saved to the disk in an LCC output file. The default filename for the LCC output file is the same filename as the input file, but with the filename extension "LCC" automatically tagged. However, you can provide an alternative filename if desired. You can see a summary report of the LCC analysis at this point, or you can request it later from the main menu. Data input and LCC output files are both saved to the directory specified in the setup file.

IMPORTANT NOTE

You must make a separate input data file for each project alternative to be evaluated with BLCC. Don't try to combine several alternatives into a single input data file by using the "multiple components" option. (The Quick Input program, on the other hand, allows multiple alternatives to be included in the same file. See section 6.) After creating and saving an initial file for one project alternative, it is usually easier to modify that file in the edit mode and save it under a new name than to create a new file from scratch.

3.4 Individual Project Alternative Reports

You can generate three different types of BLCC reports for any single project alternative for which you have previously created and saved an input data file. These three report types are shown in figure 3-3, which is the secondary menu displayed when you select "Individual Project Alternative Reports" from the Main Menu.

```
Print Summary LCC Report
Print Detailed LCC Report
Print Annual Cash Flow Report
```

Figure 3-3. Report options for individual project alternatives.

3.4.1 Summary LCC Report

The Summary LCC Report is a brief summary of the LCC analysis for a single project alternative. This report provides only the present value and annual value for major cost categories and for the total LCC of that alternative. When you select "Print Summary LCC Report," a list of all input data files available in the designated project files directory is displayed. Select the filename for the project alternative to be reported by highlighting it with the cursor; then press <Enter>. Then select screen, printer, or disk file output. If you want to save the summary report to the disk, you must provide a valid filename. A filename extension of "SUM" will automatically be assigned by BLCC. An example of the Summary Report is shown for input data file DEMO1.DAT in table 3.2.

3.4.2 Detailed LCC Report

The Detailed LCC Report is a comprehensive summary of the LCC analysis for a single project alternative, including a summary of the economic analysis assumptions, phase-in of initial investment costs, the life-cycle costs for each cost category, and the total LCC. In addition, BLCC provides estimates of CO₂, SO₂, and NO_x emissions corresponding to the type and amount of energy used by the building or building system (based on factors in the emission factor file as noted in section 3.6). Both present-value and annual-value costs are shown for all life-cycle costs.

When you select "Print Detailed LCC Report," a list of all LCC output files available in the designated project files directory is displayed. (These are the files that were automatically created and saved at the time that the LCC calculations were performed.) Select one of these files by highlighting it with the cursor; then press <Enter>. Then select screen, printer, or disk file output. The report will automatically be generated and displayed/printed/saved to disk as requested. If the file is saved to the disk, you must provide a valid filename; a filename extension of "RPT" will automatically be assigned. An example of the Detailed LCC Report for input data file DEMO1.DAT is shown in table 3.3.

The annual-value amounts shown in both the summary and detailed LCC reports represent uniform annual amounts which are equivalent to the corresponding project costs, given the discount rate used in the analysis. The annual value calculation is based on a "uniform capital recovery" (UCR) factor applied to the present-value amount. The UCR is calculated as

$$UCR = d(1+d)^n / ((1+d)^n - 1),$$

where d is the discount rate and n represents the number of years in the study period (not in the service period, if less than the study period).

Table 3.1 Input Data Report for File DEMO1.DAT

 * N I S T B L C C : I N P U T D A T A L I S T I N G (ver. 4.3-96) *

FILE NAME: DEMO1
 FILE LAST MODIFIED ON 07-27-1995/12:57:21
 PROJECT NAME: Building 101
 PROJECT ALTERNATIVE: demo one
 COMMENT: (NONE)

GENERAL DATA:

 ANALYSIS TYPE: General LCC Analysis--Non-Federal, No Taxes
 BASE DATE FOR LCC ANALYSIS: JAN 1996
 STUDY PERIOD: 22 YEARS, 0 MONTHS INCLUDING PLANNING/CONSTRUCTION PERIOD
 PLANNING/CONSTRUCTION PERIOD: 2 YEARS, 0 MONTHS
 SERVICE DATE: JAN 1998
 DISCOUNT AND INTEREST RATES ARE Real (exclusive of general inflation)
 DISCOUNT RATE: 5.0%
 End-of-year discounting convention
 Escalation rates do not include general inflation

CAPITAL ASSET COST DATA:

 INITIAL COST (BASE YEAR \$) 10000
 EXPECTED ASSET LIFE (YRS/MTHS) 20/0
 RESALE VALUE FACTOR 10.00%
 AVG PRICE ESC RATE(PLAN/CONST) 0.00%
 AVG PRICE ESC RATE(SERVICE PD) 0.00%
 NUMBER OF REPLACEMENTS 1

COST-PHASING SCHEDULE BY YEAR OF CONSTRUCTION AND AT SERVICE DATE:

1	33.00%
2	33.00%
SERVICE DATE	34.00%

REPLACEMENTS TO CAPITAL ASSETS:

 REPLACEMENT NUMBER 1
 YEARS/MONTHS FROM SERVICE DATE 10/0
 INITIAL COST (BASE YEAR \$) 5000
 EXPECTED REPL. LIFE (YRS/MTHS) 10/0
 RESALE VALUE FACTOR 0.00%

OPERATING, MAINTENANCE, AND REPAIR COST DATA:

 ANNUAL RECUR OM&R COST (\$): 1000
 ESCALATION RATE FOR OM&R: 0.00%

NON-AN RECURRING OM&R COSTS (YRS/MTHS FROM SERVICE DATE; COST IN BASE YEAR \$):

Y/M	COST
10/0	1000
20/0	1000

Table 3.1 Input Data Report for File DEMO1.DAT (continued)

ENERGY-RELATED DATA:

 NUMBER OF ENERGY TYPES = 3
 DOE energy price escalation rates filename: ENCOST96
 DOE region (state code): 3 (MD)
 DOE rate schedule type: Residential
 Underlying gen. inflation rate used with DOE rates: 0.00%

	(A)	(B)	(C)
ENERGY TYPE:	Electricity	Distil. Oil	Natural Gas
BASE ANNUAL CONSUMPTION:	10000	2000	3000
UNITS:	kWh	Gallon	Therm
PRICE PER UNIT (\$):	0.100	1.000	1.000
ANNUAL DEMAND CHARGE (\$):	500.00	0.00	0.00
ESCALATION RATE METHOD:	DOE rates	DOE rates	DOE rates
1996	0.04	3.25	2.74
1997	0.16	2.95	2.50
1998	-0.18	1.97	1.63
1999	-0.07	1.67	1.16
2000	0.16	1.44	1.34
2001	0.58	1.17	1.32
2002	0.73	1.21	1.23
2003	0.46	1.39	0.87
2004	0.29	1.62	0.60
2005	0.18	1.47	1.23
2006	0.20	1.09	1.22
2007	0.74	1.08	0.66
2008	1.00	1.06	0.87
2009	0.99	1.17	1.36
2010	0.45	1.04	1.07
2011	-0.11	0.80	0.46
2012	-0.11	0.80	0.49
2013	-0.13	0.79	0.49
2014	-0.11	0.89	0.55
2015	-0.11	0.83	0.55
2016	-0.13	0.66	0.45
2017	-0.11	0.71	0.41
2018	-0.11	0.70	0.44

ENERGY TYPE:	Electricity	Distil. Oil	Natural Gas
ENERGY USE INDEXES BY YEAR:			
1998	100.00	100.00	100.00
1999	100.00	100.00	100.00
2000	100.00	100.00	100.00
2001	100.00	100.00	100.00
2002	100.00	100.00	100.00
2003	100.00	100.00	100.00
2004	100.00	100.00	100.00
2005	100.00	100.00	100.00
2006	100.00	100.00	100.00
2007	100.00	100.00	100.00
2008	100.00	100.00	100.00
2009	100.00	100.00	100.00
2010	100.00	100.00	100.00
2011	100.00	100.00	100.00
2012	100.00	100.00	100.00
2013	100.00	100.00	100.00
2014	100.00	100.00	100.00
2015	100.00	100.00	100.00
2016	100.00	100.00	100.00
2017	100.00	100.00	100.00

Table 3.1 Input Data Report for File DEMO1.DAT (continued)

WATER-RELATED DATA:

UNITS: 1000 gallons

	ANNUAL WATER USAGE		ANNUAL WATER DISPOSAL	
	Units/Yr	Price/Unit	Units/Yr	Price/Unit
@Summer Rates	1000	1.000	1000	1.000
@Winter Rates	1000	1.000	1000	1.000

WATER PRICE ESCALATION RATES &:

Year	Water Usage Rate(%)	Water Disposal Rate(%)
1996	0.00	0.00
1997	0.00	0.00
1998	0.00	0.00
1999	0.00	0.00
2000	0.00	0.00
2001	0.00	0.00
2002	0.00	0.00
2003	0.00	0.00
2004	0.00	0.00
2005	0.00	0.00
2006	0.00	0.00
2007	0.00	0.00
2008	0.00	0.00
2009	0.00	0.00
2010	0.00	0.00
2011	0.00	0.00
2012	0.00	0.00
2013	0.00	0.00
2014	0.00	0.00
2015	0.00	0.00
2016	0.00	0.00
2017	0.00	0.00
2018	0.00	0.00

Table 3.2 Summary LCC Report for File DEMO1.DAT

BLCC Summary for Building 101, Alternative: demo one

	PRESENT VALUE	ANNUAL VALUE
INITIAL COST (AS OF SERVICE DATE)	\$9,527	\$724
ANNUALLY RECURRING OM&R COSTS	\$11,304	\$859
NON-AN. RECURRING OM&R COSTS	\$899	\$68
ENERGY COSTS	\$83,968	\$6,379
WATER COSTS	\$45,214	\$3,435
REPLACEMENT COSTS	\$2,784	\$212
LESS: REMAINING VALUE	(\$342)	(\$26)
TOTAL LCC	\$153,354	\$11,650

Table 3.3 Detailed LCC Report for File DEMO1.DAT

 * N I S T B L C C : D E T A I L E D L C C A N A L Y S I S (ver. 4.3-96) *

PART I - INITIAL ASSUMPTIONS AND COST DATA

Project Name: Building 101
 Project Alternative: demo one
 Run date: 07-27-1995 12:59:37
 Run type: General LCC Analysis--Non-Federal, No Taxes
 Comment:
 Input data file: DEMO1.DAT, last modified: 07-27-1995/12:57:21
 LCC output file: DEMO1.LCC, created: 07-27-1995/12:57:22
 Base Date of Study: JAN 1996
 Service Date: JAN 1998
 Study period: 22.00 years (JAN 1996 through DEC 2017)
 Plan/constr. period: 2.00 years (JAN 1996 through DEC 1997)
 Service Period: 20.00 years (JAN 1998 through DEC 2017)
 Discount rate: 5.0% Real (exclusive of general inflation)
 End-of-year discounting convention

INITIAL CAPITAL ASSET COSTS (NOT DISCOUNTED)
 (ADJUSTED FOR PRICE CHANGES DURING PLAN/CONST. PERIOD, IF ANY)

	YEAR (Beginning)	Cost Phasing	Yearly Cost	Total Cost
	JAN 1996	33.0%	\$3,300	
	JAN 1997	33.0%	\$3,300	
AT SERVICE DATE:	JAN 1998	34.0%	\$3,400	
TOTAL INITIAL CAPITAL ASSET COSTS				\$10,000

ENERGY-RELATED COSTS

Energy Type	Units	Units/ Year	Price+ (\$/Unit)	Annual Cost Energy	Annual Cost Demand	Total P.V. Cost
Electricity	kWh	10,000	\$0.100	\$1,000	\$500	\$17,437
Distil. Oil	Gallon	2,000	\$1.000	\$2,000	\$0	\$27,129
Natural Gas	Therm	3,000	\$1.000	\$3,000	\$0	\$39,401

+Price and annual cost are as of base date (not adjusted for price escalation).

Table 3.3 Detailed LCC Report for File DEMO1.DAT (continued)

PART II - LIFE-CYCLE COST ANALYSIS
Discount Rate = 5.0% Real (exclusive of general inflation)

PROJECT ALTERNATIVE: demo one		RUN DATE: 07-27-1995/12:59:37	
	PRESENT VALUE (1996 DOLLARS)	ANNUAL VALUE (1996 DOLLARS)	
CASH REQUIREMENTS AS OF SERVICE DATE:			
DURING CONSTRUCTION	\$6,443	\$489	
AT SERVICE DATE	\$3,084	\$234	
SUBTOTAL	\$9,527	\$724	
OPERATING, MAINTENANCE & REPAIR COSTS:			
ANNUALLY RECURRING COSTS (NON-ENERGY)	\$11,304	\$859	
NON-ANNUALLY RECURRING COSTS	\$899	\$68	
SUBTOTAL	\$12,202	\$927	
ENERGY COSTS	\$83,968	\$6,379	
WATER COSTS	\$45,214	\$3,435	
REPLACEMENTS TO CAPITAL COMPONENTS	\$2,784	\$212	
RESALE VALUE OF ORIG CAPITAL COMPONENTS	\$342	\$26	
RESALE VALUE OF CAPITAL REPLACEMENTS	\$0	\$0	
TOTAL LIFE-CYCLE PROJECT COST	\$153,354	\$11,650	

* * * * *

PART III - EMISSIONS SUMMARY \a

Region: US Average Source Documentation: SRP

Energy Type	Annual Emissions	Life-cycle Emissions\b
Electricity:		
CO2 (Kg):	9,693.6	193,872
SO2 (Kg):	72.0	652
NOx (Kg):	29.2	584
Distil. Oil:		
CO2 (Kg):	20,311.5	406,230
SO2 (Kg):	30.5	610
NOx (Kg):	17.7	354
Natural Gas:		
CO2 (Kg):	15,844.0	316,880
SO2 (Kg):	0.1	1
NOx (Kg):	12.3	247
Total:		
CO2 (Kg):	45,849.1	916,982
SO2 (Kg):	102.6	1,264
NOx (Kg):	59.3	1,185

\a Based on emission factors from file USAVG.EMI
\b Includes effects of annual energy usage indices, if used.

3.4.3 Annual Cash Flow Report

The Annual Cash Flow Report is a year-by-year listing of all of the costs that occur over the study period, undiscounted, and by category (investment, OM&R, energy, etc.). These costs are adjusted for any rates of price increase included in the input data. When "Annual Cash Flow Report" is selected, a list of all BLCC input files available in the designated project files directory is displayed. Select one of these files by highlighting it with the cursor; then press <Enter>. Then select screen, printer, or disk file output. The report will automatically be generated and displayed/printed/saved to disk as requested. If the file is to be saved to the disk, you must provide a valid filename; a filename extension of "CFR" will automatically be assigned. An example of the Annual Cash Flow Report is shown for input data file DEMO1.DAT in table 3.4.

The annual cash flow amounts *are not* discounted to present value, but *do* include any price escalation designated in the input data file. If the analysis is performed in constant dollars, the cash flow amounts are reported in constant dollars. If the analysis is performed in current dollars, the cash flow amounts are reported in current dollars. Note that if the Base Date or the Service Date is designated as occurring in a month other than January, the years in the cash flow report begin with the month designated. For example, if both the Study Period and Service Date begin with July, each year in the cash-flow report begins with July and ends with the following June.

3.5 Comparative Analysis Reports

Once you have saved input data files for two or more project alternatives, you can generate two or three different types of comparative economic analysis reports for those alternatives. Figure 3-4 shows the secondary menu displayed when "Comparative Analysis Reports" is selected from the Main BLCC Menu.

Find Lowest LCC (up to 99 Alternatives) Comparative Measures (Alternative vs Base Case) ECIP report (MILCON analyses only)
--

Figure 3-4. Report options for comparative analyses.

3.5.1 Lowest LCC report

Use the "Find Lowest LCC" option to determine which of the design alternatives you are evaluating has the lowest life-cycle cost. A list of all LCC output files (*.LCC) in the designated project files directory will be displayed on the screen when you select this option. You must tag the filenames of all the design alternatives to be included in this report. To tag a filename, use the cursor keys to highlight the filename, then press the spacebar. The spacebar acts as a toggle switch to tag and untag the filename. Up to 99 files can be tagged for a "lowest LCC" analysis.

Table 3.4 Annual Cash Flow Report File DEM01.DAT

 * N I S T B L C C C A S H F L O W A N A L Y S I S (version 4.3-96) *

PROJECT NAME: Building 101
 PROJECT ALTERNATIVE: demo one
 COMMENT:
 RUN DATE: 07-27-1995 13:01:34
 INPUT DATA FILE: DEM01.DAT, LAST MODIFIED 07-27-1995/12:57:21
 STUDY PERIOD: 22.00 YEARS (JAN 1996 THROUGH DEC 2017)
 PLAN/CONSTR. PERIOD: 2.00 YEARS (JAN 1996 THROUGH DEC 1997)
 SERVICE PERIOD: 20.00 YEARS (JAN 1998 THROUGH DEC 2017)
 ANALYSIS TYPE: General LCC Analysis--Non-Federal, No Taxes
 All costs in constant 1996 dollars (i.e., excluding general inflation)
 End-of-year cashflow convention used.

INITIAL CAPITAL COSTS
 (AS INCURRED DURING PLANNING/CONSTRUCTION PERIOD AND AT SERVICE DATE)

YEAR BEGINNING	TOTAL (BY YEAR)
JAN 1996	3,300
JAN 1997	3,300
JAN 1998	3,400
TOTAL	10,000

CAPITAL INVESTMENT COSTS

YEAR BEGINNING	INIT CAPITAL INVESTMENT	CAPITAL REPLACEMENTS	CAPITAL DISPOSAL	TOTAL CAP. INVESTMENT
JAN 1996	3,300	0	0	3,300
JAN 1997	3,300	0	0	3,300
JAN 1998	3,400	0	0	3,400
JAN 1999	0	0	0	0
JAN 2000	0	0	0	0
JAN 2001	0	0	0	0
JAN 2002	0	0	0	0
JAN 2003	0	0	0	0
JAN 2004	0	0	0	0
JAN 2005	0	0	0	0
JAN 2006	0	0	0	0
JAN 2007	0	5,000	0	5,000
JAN 2008	0	0	0	0
JAN 2009	0	0	0	0
JAN 2010	0	0	0	0
JAN 2011	0	0	0	0
JAN 2012	0	0	0	0
JAN 2013	0	0	0	0
JAN 2014	0	0	0	0
JAN 2015	0	0	0	0
JAN 2016	0	0	0	0
JAN 2017	0	0	1,000	-1,000
TOTAL	10,000	5,000	1,000	14,000

Table 3.4 Annual Cash Flow Report File DEM01.DAT (continued)

OPERATING-RELATED COSTS DURING SERVICE PERIOD:

YEAR BEGINNING	OPERATING-RELATED COSTS				TOTAL OPER. COST
	ANNUAL	NON-ANNUAL	ENERGY	WATER	
JAN 1998	1,000	0	6,379	4,000	11,379
JAN 1999	1,000	0	6,951	4,000	11,951
JAN 2000	1,000	0	7,029	4,000	12,029
JAN 2001	1,000	0	7,107	4,000	12,107
JAN 2002	1,000	0	7,187	4,000	12,187
JAN 2003	1,000	0	7,255	4,000	12,255
JAN 2004	1,000	0	7,318	4,000	12,318
JAN 2005	1,000	0	7,397	4,000	12,397
JAN 2006	1,000	0	7,469	4,000	12,469
JAN 2007	1,000	1,000	7,529	4,000	13,529
JAN 2008	1,000	0	7,602	4,000	12,602
JAN 2009	1,000	0	7,695	4,000	12,695
JAN 2010	1,000	0	7,766	4,000	12,766
JAN 2011	1,000	0	7,802	4,000	12,802
JAN 2012	1,000	0	7,838	4,000	12,838
JAN 2013	1,000	0	7,874	4,000	12,874
JAN 2014	1,000	0	7,916	4,000	12,916
JAN 2015	1,000	0	7,957	4,000	12,957
JAN 2016	1,000	0	7,989	4,000	12,989
JAN 2017	1,000	1,000	8,021	4,000	14,021
TOTAL	20,000	2,000	150,081	80,000	252,081

SUM OF ALL CASH FLOWS

YEAR BEGINNING	CAPITAL INVESTMENT	OPERATING COSTS	TOTAL COST
JAN 1996	3,300	0	3,300
JAN 1997	3,300	0	3,300
JAN 1998	3,400	11,379	14,779
JAN 1999	0	11,951	11,951
JAN 2000	0	12,029	12,029
JAN 2001	0	12,107	12,107
JAN 2002	0	12,187	12,187
JAN 2003	0	12,255	12,255
JAN 2004	0	12,318	12,318
JAN 2005	0	12,397	12,397
JAN 2006	0	12,469	12,469
JAN 2007	5,000	13,529	18,529
JAN 2008	0	12,602	12,602
JAN 2009	0	12,695	12,695
JAN 2010	0	12,766	12,766
JAN 2011	0	12,802	12,802
JAN 2012	0	12,838	12,838
JAN 2013	0	12,874	12,874
JAN 2014	0	12,916	12,916
JAN 2015	0	12,957	12,957
JAN 2016	0	12,989	12,989
JAN 2017	-1,000	14,021	13,021
TOTAL	14,000	252,081	266,081

All project alternatives to be included in the Lowest LCC Report must be mutually exclusive. That is, only one (presumably the most economic) of the alternatives will be selected for implementation. In addition, you must have specified the same underlying economic assumptions (e.g., Base Date, Study Period, Service Date, and Discount Rate) for each alternative. If these are not the same, BLCC will advise you of the problem and return you to the main menu. You must go back to the input data files in the file edit mode and make the required changes. If you have used different energy prices or energy price escalation rates for a given energy type in any of the files, BLCC will warn you of this situation, but you will be allowed to continue with the analysis if you wish to do so.

The lowest LCC report shows the initial cost and LCC of each alternative, displayed in ascending order of initial cost. The alternative with the lowest LCC is flagged. The report will automatically be generated and displayed, printed, or saved to disk as you request. If you want to save the file to the disk, you must provide a valid filename; a filename extension of "LOW" will automatically be assigned by BLCC. An example of the Lowest LCC Report is shown in table 3.5 for input data files DEMO1.DAT, DEMO2.DAT, DEMO3.DAT, and DEMO4.DAT.

Table 3.5 Lowest LCC Report for input files DEMO1.DAT, DEMO2.DAT, DEMO3.DAT and DEMO4.DAT

COMPARATIVE PRESENT-VALUE COSTS OF ALTERNATIVE PROJECTS
(Shown in ascending order of initial cost, * = lowest LCC)

PROJECT ALTERNATIVE	LCC FILENAME	INITIAL COST (PV)	LIFE CYCLE COST (PV)
demo one	DEMO1	\$9,527	\$153,354
demo two	DEMO2	\$10,479	\$141,083
demo three	DEMO3	\$11,432	\$132,742
demo four	DEMO4	\$14,290	\$128,291*

3.5.2 Comparative economic measures

Use the "Comparative Measures" option to calculate comparative measures of economic performance for one design alternative relative to a specified "base case." Tag the filenames of the two alternatives to be compared (the same as for the "find lowest LCC" option, except that only two filenames can be tagged). The alternative with the lower initial cost is automatically considered to be the "base case;" the alternative with the higher initial cost is automatically considered to be the "alternative case." As with the "Find Lowest LCC" option, the two alternatives to be compared must be mutually exclusive and have the same underlying economic assumptions. The report will automatically be generated and displayed, printed, or saved to disk as you request. If you want to save the file to the disk, you must provide a valid filename; a filename extension of "CMP" will automatically be assigned by BLCC.

In general, if a project alternative is to be considered cost effective on a life-cycle cost basis, it must have a lower LCC than the base case, Net Savings greater than 0, an SIR greater than 1.0, and an AIRR greater than the minimum acceptable rate of return (i.e., the discount rate). These are all consistent measures of economic analysis; that is, they will all show that a given project alternative is either cost effective or not cost effective relative to the specified base case.

An example of the Comparative Analysis Report is shown in table 3.6 for input data files DEMO1.DAT and DEMO3.DAT. Note that the SIR calculation in this example, which is a General LCC Analysis, has only the initial investment in the denominator. Similarly, note that the AIRR is computed as the return on initial investment, i.e., project costs up to the service date. The SIR and AIRR are computed in the same way for the Private-Sector LCC Analysis as well. But for Federal and MILCON LCC Analyses, the SIR and AIRR are computed using total present-value investment, which includes initial investment as well as capital replacements and the resale value of the capital components and any capital replacements (usually as a negative amount). For Federal and MILCON Analyses, the SIR and AIRR will change if you specify a capital replacement as a non-annually recurring OM&R cost, while the SIR and AIRR will not change under this circumstance for the General and Private-Sector Analyses. The SIR and AIRR calculation procedures used in BLCC for federal and MILCON projects are required by the economic analysis criteria of the Federal Energy Management Program, as specified in the Code of Federal Regulations 10 CFR Part 436.

Payback as a measure of economic performance is not generally consistent with these LCC measures. This is because it generally ignores all costs and savings that occur after payback has been reached. In addition, investors often specify payback requirements which are arbitrary in length (e.g., three years) and insensitive to the life of the project, and therefore inconsistent with the long-term cost-effectiveness criteria of LCC analysis. However, both discounted and simple (undiscounted) payback are now included with the comparative analysis report because this criterion is frequently requested by investors. In general, discounted payback is a more acceptable measure of performance than simple payback because the time-value of money is included in the calculations. BLCC reports the year (starting with the service date) in which simple payback and discounted payback are achieved; that is, the year during which cumulative savings first exceed cumulative costs. The payback period is expressed as an integer number of years; part years are not included. BLCC will also print a warning if the payback is negated in later years; that is, if cumulative costs exceed cumulative savings at the end of any year once payback has been achieved.

If you wish to evaluate a single project alternative to determine whether or not it is economically justified, you must compare it against a "do-nothing" base case. An input data file must be created for the do-nothing case as well as for the project. The do-nothing case will not generally have an initial cost, but will likely have operating-related costs and possibly capital replacement costs occurring during the study period. You must use the same Base Date, Service date, Study Period, and Discount Rate for both the base case and the alternative. For example, to evaluate the cost effectiveness of storm windows added to existing single-pane windows, you must set up an input data file for the existing windows and a separate input data file for the storm windows over the existing windows. The base case will have no capital investment costs but will have higher annual energy usage over the period of analysis than the alternative case.

You must take special care when undertaking an analysis of interdependent building systems (or components). For example, evaluating several different levels of thermal insulation in the building envelope to determine which has the lowest LCC and then evaluating several different heating systems to determine which has the lowest LCC can lead to incorrect results if you do not recognize the interdependence between these systems. This is because the efficiency and fuel cost of the heating system will determine, in part, the cost effectiveness of each level of insulation, and the level of insulation will determine the annual heating requirements of the building and thus the cost effectiveness of each of the heating system alternatives considered. Neither system can be properly evaluated without knowing the specifications of the other.

Table 3.6 Comparative Analysis Report for Input Files DEMO1.DAT and DEMO3.DAT

 * N I S T B L C C: COMPARATIVE ECONOMIC ANALYSIS (ver. 4.3-96) *

PROJECT: Building 101
 BASE CASE: demo one
 ALTERNATIVE: demo three

PRINCIPAL STUDY PARAMETERS:

 ANALYSIS TYPE: General LCC Analysis--Non-Federal, No Taxes
 STUDY PERIOD: 22.00 YEARS (JAN 1996 THROUGH DEC 2017)
 PLAN/CONSTR. PERIOD: 2.00 YEARS (JAN 1996 THROUGH DEC 1997)
 SERVICE PERIOD: 20.00 YEARS (JAN 1998 THROUGH DEC 2017)
 DISCOUNT RATE: 5.0% Real (exclusive of general inflation)
 BASE CASE LCC FILE: DEMO1.LCC
 ALTERNATIVE LCC FILE: DEMO3.LCC

COMPARISON OF PRESENT-VALUE COSTS

	BASE CASE: demo one	ALTERNATIVE: demo three	SAVINGS FROM ALT.
INITIAL INVESTMENT ITEM(S):	-----	-----	-----
CASH REQUIREMENTS AS OF SERVICE DATE	\$9,527	\$11,432	-\$1,905
SUBTOTAL	\$9,527	\$11,432	-\$1,905
FUTURE COST ITEMS:			
ANNUAL AND NON-AN. RECURRING COSTS	\$12,202	\$9,942	\$2,261
ENERGY-RELATED COSTS	\$83,968	\$72,266	\$11,702
WATER COSTS	\$45,214	\$36,172	\$9,043
REPLACEMENTS TO CAPITAL	\$2,784	\$3,341	-\$557
RESALE VALUE AT END OF STUDY	-\$342	-\$410	\$68
SUBTOTAL	\$143,827	\$121,310	\$22,517
TOTAL P.V. LIFE-CYCLE COST	\$153,354	\$132,742	\$20,612

NET SAVINGS FROM ALTERNATIVE demo three COMPARED TO ALTERNATIVE demo one

Net Savings = P.V. of Future Cost Savings	\$22,517
- Increased Initial Invest.	\$1,905
Net Savings:	----- \$20,612

Note: the SIR and AIRR computations include only differential initial costs as investment costs.

(continued on next page)

Table 3.6 Comparative Analysis Report for Input Files DEMO1.DAT and DEMO3.DAT (continued)

SAVINGS-TO-INVESTMENT RATIO (SIR)
FOR ALTERNATIVE demo three COMPARED TO ALTERNATIVE demo one

$$\text{SIR} = \frac{\text{P.V. of Future Cost Savings}}{\text{Increased Capital Investment}} = 11.82$$

ADJUSTED INTERNAL RATE OF RETURN (AIRR)
FOR ALTERNATIVE demo three COMPARED TO ALTERNATIVE demo one
(Reinvestment rate = 5.00%; Study period = 22 years)

$$\text{AIRR} = 17.47\%$$

ESTIMATED YEARS TO PAYBACK (FROM BEGINNING OF SERVICE PERIOD)

Simple Payback occurs in year 2
Discounted Payback occurs in year 2*

ENERGY SAVINGS SUMMARY

Energy type	Units	Annual Consumption			Life-Cycle Savings
		Base Case	Alternative	Savings	
Electricity	kWh	10,000	8,500	1,500	30,000
Distil. Oil	Gallon	2,000	1,750	250	5,000
Natural Gas	Therm	3,000	2,500	500	10,000

EMISSIONS REDUCTION SUMMARY

Energy type	Annual Emissions		Annual Reduction	Life-Cycle Reduction
	Base Case	Alternative		
Electricity:				
CO2 (Kg):	9,693.6	8,239.5	1,454.0	29,080.7
SO2 (Kg):	72.0	61.2	10.8	97.9
NOx (Kg):	29.2	24.8	4.4	87.6
Distil. Oil:				
CO2 (Kg):	20,311.5	17,772.6	2,538.9	50,778.9
SO2 (Kg):	30.5	26.7	3.8	76.3
NOx (Kg):	17.7	15.5	2.2	44.3
Natural Gas:				
CO2 (Kg):	15,844.0	13,203.3	2,640.7	52,813.4
SO2 (Kg):	0.1	0.1	0.0	0.2
NOx (Kg):	12.3	10.3	2.1	41.1
Total:				
CO2 (Kg):	45,849.1	39,215.5	6,633.6	132,672.9
SO2 (Kg):	102.6	88.0	14.6	174.3
NOx (Kg):	59.3	50.6	8.7	173.1

* The simple payback and discounted payback in this example are the same because they are short and because only the integer year is printed. In general, the discounted payback period is longer than the simple payback period.

Interdependent analyses require a simultaneous analysis of both (or multiple) systems, in which various *combinations* of system specifications (e.g., a specific insulation level and a specific heating system) are compared to determine which combination has the lowest LCC. In order to make the number of comparisons manageable, first conduct LCC analyses of each individual system independently to determine the "robustness" of the lowest-LCC-solution for that system as changes are made to the other system specifications. (For example, as the heating system efficiency is improved, how does this effect the lowest-LCC level of attic insulation?) Use this information to determine the combinations that are most likely to be cost effective. In some cases, you can use the Quick Input program to set up a large number of combinations of system alternatives for initial screening, and then generate BLCC input data files for the most likely candidates for a more detailed BLCC analysis.

Special note regarding the calculation of the SIR for prioritizing independent projects.

Once you have established the best project alternative from among two or more mutually exclusive alternatives, you may be required to rank this project alternative against other independent (non-mutually exclusive) projects in order to allocate limited funding to those projects in a cost-effective manner. This is generally accomplished by ranking the independent projects in decreasing order of their SIR and then allocating the funding to the highest ranked projects. (Of course, only projects with an SIR greater than 1.0 should be included in the ranking exercise.) When you perform a LCC analysis of mutually exclusive project alternatives, you must use the same base date, service date, and study period for each alternative. (BLCC will not let you compare mutually exclusive alternatives with different dates or study periods.) However, you do not need to use the same base date, service date, and study period for each independent project in order to use the SIR ranking procedure. Moreover, when using the SIR ranking procedure, you should recalculate the SIR for each independent project based on its own life if project replacements were used to extend the original LCC analysis of this alternative to the end of the common study period used in the evaluation of several mutually exclusive alternatives. You must still define a base case in order to calculate the SIR for a project, and this base case must have the same base date, service date, and study period as the project being evaluated. Note that BLCC will calculate the SIR of project alternatives, but does not have the ability to rank independent projects by their SIR.

3.5.3 ECIP report (MILCON only)

The "ECIP report" option shown in figure 3-4 can only be used for energy-related MILCON (military construction) projects. ECIP (Energy Conservation Investment Program) is a Department-of-Defense-funded program for the retrofitting of existing DoD energy systems. ECIP projects are prioritized for funding in decreasing order of their savings-to-investment ratio (SIR).

To use the ECIP option, you must first create BLCC input files for both a base case and a project alternative, as with any conventional BLCC analysis. The BLCC input file with the lower initial investment cost is automatically selected as the base case file, as in the "comparative measures" report shown above. There are some restrictions on the cost data that you can include in the BLCC input files used to generate an ECIP report:

- (1) The BLCC input file cannot include multiple components for the project alternative.

- (2) The BLCC input file cannot include capital replacement costs. (There is no place for capital replacement costs on the ECIP report.) In general, when computing an SIR of a single project for ranking purposes relative to other projects, you should not include project replications that may have been used to compare the LCC of multiple, mutually exclusive, alternatives. Component replacements, if any, should be entered as non-annually recurring OM&R costs.
- (3) Residual values, if any, are not included in the ECIP report. The BLCC comparative analysis will not agree with the ECIP analysis if a residual value is included in the data file for either the base case or the alternative. Otherwise, the BLCC ECIP report and the BLCC comparative economic analysis should give identical results.

A sample of the BLCC ECIP report is shown in table 3.7, based on files TESTMIL.DAT, TESTMIL.LCC, TESTMIL2.DAT, and TESTMIL2.LCC included on the BLCC diskette. The BLCC version of the ECIP report shows both the actual and discounted capital investment costs that are incurred during the planning/construction phase of the project. (These are the same if all of the investment costs are incurred on the base date). The SIR and AIRR measures are computed using the discounted present value of the capital investment costs. If the beneficial occupancy date (BOD, or service date) is later than the base date, operating-related costs are assumed to be incurred only during the occupancy (service) period. The SIR and AIRR shown in the BLCC ECIP report would not agree with the BLCC comparative analysis report if capital investment costs occurring after the base date were not discounted to the base date. If you do not want to base the SIR on discounted investment costs, use the same date for both the base date and BOD.

In a BLCC analysis, the initial investment cost is assumed to include SIOH (supervision, inspection, and overhead), design cost, salvage value of existing equipment, and public utility company rebates, if any. These cost categories are specifically identified in an ECIP report. Therefore, to generate an ECIP report from BLCC input data files you must specify the percent of the project's initial investment cost (before salvage value of existing equipment and utility rebate adjustments, if any) to be allocated to SIOH and design. Default values of 6% and 10%, respectively, are provided. You must also specify the absolute amount of the salvage value from existing equipment and the utility rebate, if any. These data are entered, along with project identification data included in the ECIP report, in the data entry screen shown in figure 3.5. The (net) construction cost, SIOH, design, salvage value of existing equipment, and rebate are identified separately in the ECIP report. Summed together, these items will be identical to the difference in the initial investment costs between the project alternative and base case in the corresponding BLCC files.

Installation name: _____
 Location: _____
 Project number: _____
 Project title: _____
 Fiscal Year: _____
 Prepared by: _____
 SIOH (as percent of construction cost) 6 %
 Design (as percent of construction cost) 10 %
 Salvage value of existing equipment \$ _____
 Public Utility Company Rebate \$ _____

Figure 3.5 Additional data requirements for an ECIP report

Table 3.7 Sample ECIP report generated by BLCC

Energy/Water Life Cycle Cost Analysis Summary

Installation: test site
 Location: Maryland
 Project Title: Building 101
 Base Date: JAN 1996
 Discount rate: 4.10%
 BLCC input data files: Project: TESTMIL.DAT

Preparation Date: 07-27-1995
 Region No. 3
 Project No. A-123
 Fiscal Year: 1996
 Economic Life: 20 years
 BOD: JAN 1996(a)
 Prepared by: srp
 Base Case: TESTMIL2.DAT

1. Investment			
A. Construction Cost		\$9569	
B. SIOH		\$574	
C. Design Cost		\$957	Funding Amount:
D. Total Cost (1A + 1B + 1C)		\$11100	\$11100
E. Salvage Value of Existing Equipment		\$100	
F. Public Utility Company Rebate		\$1000	Present Value:(b)
G. Total Investment (1D - 1E - 1F)		\$10000	\$10000

2. Energy and Water Savings (+) or Cost (-)						
Analysis Date Savings, unit costs, & discounted savings						
Date of NISTIR 85-3273-X used for discount factors: october 1995						
Fuel	Unit Cost	Savings	Annual	Discount	Discounted	
	\$/MBtu	MBtu/Yr	Savings	Factor	Savings	
-----	(1)	(2)	(3)	(4)	(5)	
A. Electric	\$556.700	17.1	\$9500	14.055	\$133525	
B. Dist oil	\$0.000	0.0	\$0	0.000	\$0	
C. Resid oil	\$0.000	0.0	\$0	0.000	\$0	
D. Nat Gas	\$0.000	0.0	\$0	0.000	\$0	
E. Coal	\$1.000	-100.0	-\$100	14.211	-\$1421	
F. Demand Savings			\$9500	13.744	\$130569	
G. Subtotal		-82.9	\$18900		\$262673	
			Annual	Discount	Discounted	
	\$/Mgal	Mgal/yr	Savings	Factor	Savings	
H. Water use	\$1000.00	2.0	\$2000	13.744	\$27488	
Water disp	\$1000.00	2.0	\$2000	13.744	\$27488	
Subtotal			\$4000		\$54977	
I. Total			\$22900		\$317650	

3. Non-Energy Savings (+) or Cost (-)					
A. Annually Recurring (+/-)					
			-\$100		
(1) Discount Factor (Table A)				13.744	
(2) Discounted Savings/Cost (3A x 3A1)					-\$1374
B. Non-Annually Recurring (+/-)					
Item	Savings (+)	Occurrence	Factor	Discounted	Savings or Cost
	Cost (-)	(from BOD)	(Table A-1)		
	(1)	(2)	(3)	(4)	
a.	-\$1000	10	0.669		-\$669
b.	-\$1000	15	0.547		-\$547
d. Total					-\$1216
C. Total Non-energy Savings (+)/Cost(-) (3A(2)+3Bd(4))					-\$2591
4. First year savings (2I3 + 3A5 + 3Bd1/Yrs Economic Life)					
					\$22700
5. Simple Payback Period (1G/4)					
					0.44 years
6. Total Discounted Savings (2I5 + 3C)					
					\$315059
7. Savings to Investment Ratio (SIR = 6 / 1G)					
					31.51
8. Adjusted Internal Rate of Return (AIRR)					
					23.70%

(a) BOD = Beneficial Occupancy Date (Service Date)
 (b) Present value is less than actual cost when investment costs are incurred after base date.

The investment cost reported in the BLCC-generated ECIP report is the difference in initial capital cost of the project alternative relative to the base case (just as in the case of the "comparative measures" report shown in table 3.6). It is this difference in investment costs that must be justified by the economic analysis. For example, if you are replacing a non-functional heating system and you have more than one choice, the choice with the lowest initial cost is generally the base case, and the LCC analysis is used to justify a higher performance system. The SIR of the higher performance system should be based on the savings and additional cost of that system relative to the base case system. But funding may be needed for the entire system. It is important that these two objectives (replacing a system and selecting a high-performance system) not be confused.

If the entire cost of the project alternative must be justified, then the initial capital cost of the base case should be entered as zero. This is generally the case with the retrofit of functional equipment made entirely for reasons of energy or water use efficiency. In some cases, the total amount of funding requested may include the base funding as well, i.e., the entire cost of the project, not just its additional cost relative to the base case. Make sure you understand the objective of the analysis before creating the BLCC files used to generate the ECIP report.

Sometimes the investment cost and energy savings data for an energy conservation project may be provided to the analyst without the corresponding cost data for a base case. BLCC cannot accommodate this type of analysis directly. BLCC requires that the base case be treated explicitly in the analysis to ensure that the comparative analysis is performed properly and to make it easier to compare multiple alternatives. BLCC requires at least two data input files, one for the base case and one for the alternative. If data are only available for the project alternative, use the following strategy:

Set up a base case file with the initial investment cost set to zero. Any cost savings (e.g., energy savings) attributable to the project should be included in the base case file as a positive cost in the corresponding cost category. Then set up a data file for the project alternative which includes the initial investment cost and any negative cost savings (e.g., increased maintenance costs) as a positive cost in the corresponding cost category. Save each data file and the LCC will automatically be computed and saved as well. The BLCC comparative analysis and ECIP report based on these two LCC analyses will show the investment cost and the net operating-related savings attributable to the project alternative.

3.6 Air Pollutant Emissions Calculations

A new feature in BLCC is the capability of estimating annual and life-cycle CO₂, SO₂, and NO_x emissions coincident with the energy use of the building or building system being evaluated. The economic cost of these emissions is not estimated, but the emission estimates are included with the LCC analysis to provide additional data related to the project alternatives being considered.

The emission factors used in this analysis are read from a data file specified in the setup file. Emission factor files always have the filename extension "EMI". At present, the emission factor file disseminated with BLCC is USAVG.EMI, which contains emission factors for electricity, distillate and residual fuel oil, natural gas, LPG, and coal, based on national average data. An additional data file, UNITS.FIL, contains conversion factors which convert energy usage data from user-designated units (e.g., gallons, kWh, kilograms, etc.) in BLCC data input files to units consistent with the

emissions factors in the emissions file (million Btu). The unit conversion factors in UNITS.FIL are shown in table 3.8. This file is not modified by BLCC and should not be modified by the user. The conversion factors represent the number of units for each unit type show are contained in one million Btu.

The NIST EMISS program can be used to create or modify emission factors files to reflect local emission data for the electricity and fossil fuels consumed at the building site. EMISS contains default data, including emission factors for electricity generation by region and state and the sulfur content and energy content of fossil fuels. This will allow you to create an emissions factor file for a specific location that can be used indefinitely, or until the underlying emissions data change. When creating an emissions factor file with EMISS, you can specify factor units as either Kg/10⁶ Btu or Kg/10⁹ J. BLCC can use either set of units in calculating emissions, which it reports in only in Kg or Mg. For information on obtaining the EMISS program, see the preface to this report.

The emissions estimates for a project alternative are calculated at the same time that the LCC analysis is calculated; that is, at the time that the input data file is saved. The emission calculations are saved along with the LCC calculations in the LCC output file for each alternative, and the calculations are reported with the detailed LCC report for that alternative. Comparative emissions estimates are also reported in the comparative analysis report for two alternatives, as shown at the bottom of table 3.6. Note that emissions are only calculated for electricity, fuel oil, natural gas, LPG, and coal; not for central steam, chilled water, and "other" energy types that can be included in the BLCC input file.

Table 3.8 UNITS.FIL data format

units	per 1,000,000 Btu by fuel type					
"	elec	dist	resid	natgas	lpg	coal"
"kwh "	293	293	293	293	293	293
"gal "	0	7.145	6.864	0	10.923	0
"therm"	10	10	10	10	10	10
"MBtu "	1	1	1	1	1	1
"pound"	0	0	0	0	46.315	95.2
"MJ "	1055	1055	1055	1055	1055	1055
"GJ "	1.055	1.055	1.055	1.055	1.055	1.055
"Liter"	0	27.05	25.98	0	41.349	0
"Kg "	0	0	0	0	21.014	43.19
"ft3 "	0	0	0	970.87	397.46	0
"m3 "	0	0	0	27.47	11.247	0

4. CREATING AND EDITING DATA FILES

4.1 Overview

When creating or modifying an input data file for life-cycle cost analysis, you enter economic assumptions and cost data by choosing among options from a screen menu and by entering appropriate values into defined data fields displayed on the screen. BLCC requests input data in the order shown in table 4.1. A series of data entry forms corresponding to these data requirements are displayed to the screen in the BLCC file creation and editing modes. Section numbers in table 4.1 show where each of these data entry forms is discussed in this user's guide. You can move forward and backward through the data entry forms shown on the screen by pressing the page up <PgUp> or page down <PgDn> keys. Select menu choices by highlighting the desired choice using the cursor keys and then pressing the enter key <Enter>; to back up from a menu choice to a previous screen, press the escape key <Esc>. If at any time you wish to restart the file creation process from the beginning with a "clean slate," press <F9>.

Note, however, that in some cases you cannot exit a screen input form until certain mandatory data fields are properly completed. This is also true when trying to delete a row of input data. In these cases, a message at the bottom of the screen will tell you the allowable parameters of the data field. Even if you do not intend to save the input data, you must fill in the field with an allowable response before you can continue.

When creating a new input data file, the program automatically sends you to each relevant data entry form and asks that you fill out all the requested information. In general, only data fields which are required for the analysis are displayed on a data entry form. Thus tax-related data fields are only displayed for Private-Sector LCC Analyses which include tax computations. Data entry forms for financing are not displayed for Federal or MILCON LCC Analyses.

When editing an existing input data file, BLCC allows you to skip to whichever data level you desire. The file editing menu, shown in figure 4-1a, corresponds to the data file structure presented in table 4.1. Highlight the data type to be edited and press <Enter>. The data entry forms related to that data type will appear on the screen. After making any changes to those forms, press <F10> to go to the end of the file; then save the file. Use a new filename if you do not want to write over the old file. If you do not press <F10>, you will continue through the later data input forms until you press <F10> or you reach the file save menu.

If the input data file has the capital asset data broken down by major component (up to six components are allowed, each with its own OM&R and capital replacement schedule), the file editing menu looks like the menu shown in figure 4-1b. If you select "Component-Related Data," a second menu appears, as shown in figure 4-2. You can choose to review or edit all components or a selected component. The capital cost data entry form for the selected component appears first, followed by the OM&R and capital replacement forms. After data entry is completed for the selected component, control is returned to the component menu (figure 4-2). Select "Components Finished--Move On" to leave the component editing mode.

Table 4.1 Input Data File Structure and Section References

Type of Analysis (e.g., Federal, General, Private Sector, MILCON) (4.2)

Project-Level Data:

General LCC assumptions (4.3)

Tax-related data (Private-Sector Analysis only) (4.9.1)

Component-related data:

Capital Investment Data

Initial cost, life, resale (residual) value, escalation rates (4.4.2)

Cost phasing (if Service Date begins later than Base Date) (4.4.3)

Depreciation data (Private-Sector Analysis with taxes) (4.9.2, 4.9.3, 4.9.4)

Annually Recurring OM&R Costs (4.4.4)

Non-annually Recurring OM&R Costs (4.4.4)

Capital Replacements

Timing, cost, resale value (4.4.5)

Depreciation data (Private-Sector LCC Analysis with taxes) (4.9.2, 4.9.3, 4.9.4)

Energy-related Data (not component specific):

Types, annual usage, unit costs (4.5.1)

Price escalation rates (4.5.2)

Annual energy use indices (optional) (4.5.3)

Monthly kWh usage and maximum kW demand (optional) (5.1)

Block rate and demand rate files (optional) (5.2)

Water-related Data (not component specific):

Usage and disposal amounts and costs (4.6.1)

Price escalation rates (4.6.2)

Annual usage indices (optional) (4.6.3)

Financing Data (Non-Federal LCC Analysis only; not component specific):

Temporary construction financing (if Service Date begins later than Base Date) (4.7)

Permanent financing at Service Date (4.7)

```
All Data
General Project Data
Capital Asset Data
AnnUally Recurring OM&R
Non-Annually Recur OM&R
Replacement Data
Energy-Related Data
Water-Related Data
Financing Data
```

Figure 4-1a. File editing menu (capital assets combined).

```
All Data
General Project Data
Component-Related Data
Energy-Related Data
Water-Related Data
Financing Data
Save File/Compute LCC & Emissions
EXit without Saving
```

Figure 4-1b. File editing menu when capital components are broken out.

```
All Components
Component #1: comp1
Component #2: comp2
Component #3: comp3
Component #4: comp4
Component #5: comp5
Component #6: comp6
Components Finished--Move On
```

Figure 4-2. File editing menu for capital components.

In this section, each of the data entry forms will be shown, with the definition of each input variable and the range of acceptable responses (usually in parenthesis at the end of the definition). Data entry forms related to tax analysis in Private-Sector LCC Analyses are shown at the end of this section. Keep in mind the following conventions, which apply to all the data input forms:

If your response is above or below the allowable range for an input variable, the allowable range will be displayed at the bottom of the screen.

If the input variable requested is mandatory, you will not be allowed to continue until you enter a valid response.

Enter percentages as percentages, not as decimals (e.g., 7.0, not 0.07).

Do not include \$ or % signs with your entries.

Do not use commas for marking off thousands or millions.

Enter all cost data in base-year dollars. BLCC will automatically adjust prices to future-year values using price escalation rates entered by the user.

If **month/year** is requested (e.g., Base Date or Service Date), enter the calendar month (by number) and calendar year. Thus June 1993 is entered as 6/1993.

If **years/months elapsed from the service date** are requested (e.g., time of replacement), enter the number of years and months elapsed from the service date, separated by a "/", or enter the number of years only. Thus "10/6" means 10 years and six months after the service date; "10" and "10/0" both mean 10 years exactly after the service date. Entering the timing of non-annually-recurring costs by years and months elapsed from the service date allows you to change the service date without having to change the timing of all these costs.

Note: Entering "0/6" for the time of a non-annually recurring cost will cause that cost to be discounted from the end of sixth month of the first year, and it will show up in the cash flow report as occurring in the first year. Similarly, entering "11/6" will cause it to be discounted from the end of the sixth month in the twelfth year, and it will show up in the cash flow report as occurring in the twelfth year. Entering "11/0" for the time of a capital replacement cost will cause that cost to be discounted from the end of the eleventh year, and it will show up in the cash flow report as occurring in the eleventh year.

4.2 Beginning a New Input Data File

To begin creating a new input data file, select "Enter/Edit/Print Input Data" from the main menu, and select "Create New Input File" from the secondary menu. Figure 4-3 shows the first data entry form that appears. Choose the type of analysis that you wish to perform with BLCC. Once you select the analysis type, **you cannot change it without restarting the file creation process**, since data entered for one analysis type may not satisfy the analysis criteria of another.

- | |
|---|
| <ul style="list-style-type: none"> (1) Federal Analysis--Energy Conservation Projects (2) Federal Analysis--Projects Subject to OMB A-94 (3) Private Sector--Buildings with Tax Analysis (4) Private Sector--Owner-Occupied Houses (5) General LCC Analysis--Non-Federal, No Taxes (6) MILCON Design--Energy-related Projects (7) MILCON Design--Non-energy-related Projects |
|---|

Figure 4-3. Types of analysis that can be performed by BLCC.

Definitions:

- (1) **Federal Analysis--Energy Conservation Projects:** FEMP (Federal Energy Management Program) projects related to energy conservation or renewable energy projects in federal facilities.
- (2) **Federal Analysis--Projects Subject to OMB A-94:** Federal projects subject to OMB Circular A-94 (most other federal government construction projects, but not water resource projects).
- (3) **Private Sector--Buildings with Tax Analysis:** Projects such as commercial and industrial buildings and residential rental properties with full tax analysis.
- (4) **Private Sector--Owner-Occupied Houses:** Projects where only mortgage interest and property taxes are tax-deductible from federal and state income tax.
- (5) **General LCC Analysis:** LCC projects which do not need to conform to federal rules and do not require income tax analysis. Use this for any non-federal project not requiring income tax and property tax calculations, including state and local government projects.
- (6) **MILCON Design--Energy-related Projects:** Department of Defense studies in which energy costs are relevant, subject to DoD's Criteria/Standards for Economic Analysis/Life Cycle Costing for MILCON Design (March 1994).
- (7) **MILCON Design--Non-energy-related Projects:** Department of Defense studies in which energy costs are NOT relevant, subject to DoD's Criteria/Standards for Economic Analysis/Life Cycle Costing for MILCON Design (March 1994).

If you choose either MILCON design option, the present-value analysis will be computed slightly differently than for the other options. All annually recurring costs (OM&R and energy costs) are discounted from the middle of the year in a MILCON LCC Analysis, whereas these same costs are discounted from the end of the year for the other analysis types. MILCON LCC Analyses also use slightly different terminology for certain variables: "Base Date" is called "Date of Study" and "Service Date" is referred to as "Beneficial Occupancy Date."

For all federal projects (including MILCON projects), BLCC performs the LCC analysis in constant dollars and thus you should always enter the discount rate and price escalation rates in real terms (excluding inflation). For Private-Sector LCC Analyses (taxable and owner-occupied house), BLCC performs the analysis in current dollars and thus you should always enter the discount rate and price escalation rates in nominal terms (including inflation). (If you do not want to include taxes in a Private-Sector LCC Analysis, use the General LCC Analysis type instead.) Current dollars and nominal rates are used with Private-Sector LCC Analyses because income tax liabilities are based on current dollar amounts, not constant dollar amounts. Regardless of whether the analysis is performed in constant or current dollars, you must enter all cost data in base-year dollars.

If you choose a General LCC Analysis, you will be requested to specify whether the analysis is to be performed in constant dollars (excluding general inflation) or in current dollars (including general inflation) as shown in figure 4-4. If you specify that the analysis is to be performed in constant dollars, enter the discount rate, mortgage interest rate, and all price escalation rates in real terms (i.e., excluding general inflation). If you specify that the analysis is to be performed in current dollars, enter these rates in nominal terms (i.e., including general inflation). Once you have declared the use of constant or current dollars and have moved on to the first data entry form, you cannot return and change this declaration without reinitializing the file creation process. This is to assure that the discount rate and all price escalation rates are consistent with the constant dollar/current dollar declaration.

```
A General LCC Analysis can be performed in CONSTANT DOLLARS or
CURRENT DOLLARS. Select the method you wish to use:

Constant dollar analysis (Exclude general inflation)
Current dollar analysis (Include general inflation)

Use cursor to highlight selection, then press <Enter>.
```

Figure 4-4. Declaration of constant dollar or current dollar analysis.
(General LCC Analysis only)

For Federal LCC Analyses related to energy conservation, including energy-related military construction (MILCON) studies, BLCC will default to the DOE discount rate required by FEMP. The DOE discount rate is updated each October for the coming fiscal year and published by NIST in *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis*, NISTIR 85-3273. In fiscal year 1996 the DOE discount rate for energy-related investments in the federal government (including military construction) is 4.1% (real). For Federal LCC Analyses (but not MILCON LCC Analyses) unrelated to energy conservation, BLCC uses the discount rate required by OMB Circular A-94 as the default value. The DISRAT95.FIL file contains the most current (FY 95) DOE and OMB discount rates. This file, which was new with version 4.0, is updated each October and included with the most recent version of BLCC. For non-energy-related MILCON design studies, the appropriate discount rate can be obtained from the Cost Engineering Branch, Directorate of Military Programs, Headquarters, U.S. Army Corps of Engineers, in Washington, D.C.

In October 1992, OMB Circular A-94 was extensively revised, and two different types of discount rates were identified for non-energy-related federal investments: (1) a rate to be used for public investment and regulatory analysis, currently set at 7% real; and (2) a rate for cost-effectiveness, lease-purchase, internal government investment, and asset sale analyses, set to vary with the length of the study period, based on real interest rates on Treasury notes and bonds. These latter rates have been specified by OMB for the year beginning January 1995 as follows:⁵

Study Period:	<u>3 years</u>	<u>5 years</u>	<u>7 years</u>	<u>10 years</u>	<u>30 years</u>
Discount Rate:	4.2%	4.5%	4.6%	4.8%	4.9%

These latter rates are appropriate for economic analysis of non-energy-related investments in federal buildings intended to reduce future operating costs. For study periods other than those shown here, OMB A-94 requires that you use linear interpolation to get the correct rate. BLCC will automatically make this interpolation and provide the resulting discount rate as the default rate. Changing the study period will automatically change the default discount rate.

4.3 Project-Level Data

The first data entry form is for general project-level data and assumptions, as shown in figure 4-5.

Project Name: Building 101 _____
 Project Alternative: demo one
 Base Date of Study (Month/Year): 1/1996 (e.g., 3/1996)
 Service Date (Month/Year): 1/1998 (e.g., 3/1996)
 Study Period Length (Years/Months from Base Date): 22/0 (e.g., 20/0)
 Discount rate: 5.00% (real, excluding inflation)
 End-of-year or Mid-year discounting (E/M): E
 Comment: _____

Figure 4-5. General project data entry form.

Definitions of project-level data:

Project Name--The common name of the project for which two or more mutually exclusive project alternatives are to be evaluated. The same project name should be used for each alternative. (If the project name is not exactly the same for each alternative, the comparative economic analysis will be reported with the longer project name.)

Project Alternative--The name of the project alternative to be evaluated. A distinct name should be assigned to each project alternative to be evaluated since the comparative analysis will list the costs of each project alternative under this name. This field is limited to 12 characters so that it can appear at the top of a column in several of the report formats. More information about this alternative can be included in the Comment line below (optional).

⁵ The Treasury note and bond rates to be used as discount rates for internal government investment are scheduled to be published by OMB each year in March as Appendix C to OMB Circular A-94. The rates shown here are current as of March 1994.

Base Date--The month (1-12) and calendar year at which the study period begins, separated by a "/". The year must be between 1995 and 2000. If you do not enter the month, it is assumed to be January. All cost data must be entered in constant dollars as of this date. All costs will be discounted back to the Base Date. (Note: For Private-Sector LCC Analysis the month cannot be entered; it is assumed to be January. This is to force the months used in the analysis to be consistent with the tax year (January-December)).

Service Date--The month (1-12) and calendar year when the building or system/component is expected to be put into service. (Separate the month and year with a "/".) The Service Date can be the same as the Base Date or up to nine years later. The time elapsed between the Base Date and the Service Date (if any) is the "planning/construction period." The timing of OM&R costs, energy costs, and replacement costs is calculated from the Service Date, not from the Base Date, if this occurs earlier than the Service Date. Note that for Private-Sector LCC Analyses the month cannot be entered; it is assumed to be January. (In previous versions of BLCC the Service Date was referred to as the Occupancy Date.)

Study Period Length (years/months)--The number of years over which the project-related costs are to be evaluated. The Study Period begins with the Base Date. Thus if the Service Date is later than the Base Date, the Study Period will be longer than the Service Period. (Integer between 2 and 99)

Discount rate (%)--Used to convert cash flows occurring at different points in time to present value (as of the base date) and its equivalent annual value. Use the nominal (i.e. inclusive of inflation), after-tax discount rate for Private-Sector LCC Analyses or for General LCC Analyses designated as using current dollars. Use a real (i.e., exclusive of inflation) discount rate for Federal LCC Analysis (including MILCON LCC Analyses) and General LCC Analysis designated as using constant dollars. (0 to 25)

End-of-year or Mid-year discounting (E/M)--If end-of-year discounting is selected, all annually recurring costs (including energy and water costs) will be discounted from the end of the year in which they occur; if mid-year discounting is selected, all annually recurring costs will be discounted from the middle of the year. E is the default setting except for MILCON projects. This selection has no affect on one-time costs, which are discounted from the time that they are actually incurred (year and month).

Comment--Additional information to identify this project alternative, since the title field is small. (Up to 50 characters)

4.4 Component-related Data

4.4.1 Specification of Major Systems/Components (optional)

Once you have entered the project level data, you must specify whether this project alternative is to be divided into major systems or components (e.g., land, building, HVAC equipment, etc.) or whether it should be evaluated as a single system or component. At the prompt shown in figure 4-6, type "Y" if you wish to enter cost data for individual capital components, or "N" if you do not. By

subdividing the project alternative into several capital components, you can assign initial costs, resale values, OM&R costs, capital replacement costs, and depreciation schedules (Private-Sector LCC Analysis with full tax analysis only) individually to each component. In general, this is only recommended when a comprehensive LCC analysis of a large project is being undertaken, or when each component has a different depreciation schedule. Note: BLCC always assigns annual energy and water usage costs and financing costs to the overall project alternative and not to specific systems or components.

Extremely Important Note: Do not divide the project into separate components for the purpose of evaluating different (mutually exclusive) project alternatives. You must have a separate input data file for each project alternative.

```
Do you wish to break out cost data by capital component (Y/N)?

For how many components do you wish to set up
separate cost schedules (1-6)?
```

Figure 4-6. Breaking out capital component cost schedules.

If you answer "Y" to breaking out capital components, you will be prompted to enter the number of components. You can specify up to six capital components for any project. You must provide a unique name to each component, as shown in figure 4-7. When editing this file at a later point, you can rename any of the components, delete one or more of them, or add another (up to a total of six components) from this data entry form.

```
Component #1: name1
Component #2: name2
Component #3: name3
```

Figure 4-7. Enter/edit names of capital components.

4.4.2 Capital Investment Data

Figure 4-8 shows the data entry form for entering capital investment data and related factors. You must specify these data for each component or for the overall project alternative if it is not subdivided into components. (If this analysis requires tax-related data, there will be several additional data entry forms and some additional data fields for tax-related data entries. These screens and data fields are shown separately in section 4.9, "Tax-related Data.")

Initial Cost (Base-Year Dollars):	\$10000
Expected Life (from Service Date), Years/Months):	20/0
Resale Value Factor (% of Initial Cost):	10.0 %
Price Escalation Rate before Service Date:	0.0 %/year
Price Escalation Rate after Service Date:	0.0 %/year

Figure 4-8. Data entry form for capital investment data.

Definitions of capital investment cost variables:

Initial Cost (\$)--The total installed cost of the component, unadjusted for price escalation during the planning/construction period (if any). If the Service Date is later than the Base Date, BLCC uses the Cost-Phasing Schedule and the Average Price Escalation Rate before Service Date (discussed below) to determine the actual component cost incurred in each year of the planning/construction period and at the Service Date. (0 to 999,999,999)

Expected Life (years/months)--The useful life of the component (in years and months) anticipated by the investor. This is intended to be a realistic assessment of the component life, independent of the study period or depreciation life assigned to the component for income tax purposes (if any). (2 to 99)

Resale Value Factor (% of initial cost)--This is the percent of the initial component cost which you expect the component to retain as resale (residual or salvage) value at the end of the study period or at the end of the component life (whichever comes first), unadjusted for price escalation. This factor is intended to reflect the change in component value due to wear, deterioration, or obsolescence, but not to price escalation during the study period. In computing the actual resale value of the component, BLCC uses the Average Price Escalation Rate after Service Date (see below) to adjust for price changes during the Service Period. BLCC treats the resale value as a negative cost element in the life-cycle cost equation, even if the investor does not intend to dispose of the property at the end of the Study Period. (-100 to +200)

Price Escalation Rate before Service Date (%)--If the Service Date occurs later than the Base Date, this is the average annual rate at which the cost of this component increases during the interim (the "planning/construction period"). BLCC does not make an adjustment to component costs phased in during the first year of the planning/construction period since it assumes that initial costs are incurred on the first day of each year in that time period. All initial costs phased in after the first year and through the Service Date are adjusted using this rate. If the study is performed in constant dollars (Federal LCC Analyses and designated general LCC Analyses), this rate should not include general inflation, but instead reflect only real rates of change during this period. (-5 to +20)

Price Escalation Rate after Service Date (%)--This is the average annual rate at which the cost of this type of capital component is expected to change throughout the service period. BLCC uses this variable to adjust this component's replacement cost from base-year dollars to its cost at the time of replacement, and to establish the resale value of this component and any of its replacements. If the study is performed in constant dollars (Federal LCC Analyses

and designated general LCC analyses), do not include general inflation in this rate, but instead include only real rates of price change expected after the Service Date. (-5 to +20)

4.4.3 Cost Phasing of Initial Investment Costs

For all LCC analyses except MILCON Analyses, if the Service Date occurs later than the Base Date, you can specify the percentage of the initial capital costs to be allocated to each year in the planning/construction period and to the Service Date. If these factors do not add up to 100%, BLCC will automatically assign the unallocated percentage to the Service Date. The Cost Phasing data entry form is shown in Figure 4-9. (0 to 100 for each year, with total for all years plus the Service Date equal to 100.)

Plan/Const Year	Percent
-----	-----
1	<u>33.00</u>
2	<u>33.00</u>
Service Date:	<u>34.00</u>

Figure 4-9. Data entry form for cost phasing of initial costs.

The years shown in figure 4-9 (1 and 2) begin with the month designated for the Base Date. If the elapsed time between the Base Date and the Service Date contains a partial year (e.g., one year and six months rather than two years), the last year shown on the schedule (e.g., 2 in figure 4-9) will be a partial year. BLCC discounts the portion of initial costs allocated to each year from the first month in that year to the Base Date.

For MILCON Analysis only, if the Beneficial Occupancy Date is later than the Date of Study, you will be asked to enter the Midpoint of Construction, month and year (e.g., 1/1996). BLCC computes all initial project costs as of this date and discounts them to present value from this date. This procedure is suggested by the DoD "Memorandum of Agreement on Criteria/Standards for Economic Analysis/Life Cycle Costing for MILCON Design," (March 1994). The Midpoint of Construction must be between the Date of Study and the Beneficial Occupancy Date.

4.4.4 Operating, Maintenance, and Repair (OM&R) Costs

Specify Operating, Maintenance, and Repair (OM&R) Costs (other than energy costs) separately for each component if capital assets are subdivided into components. Otherwise specify OM&R costs for the overall project alternative. There are two types of OM&R costs, annually recurring costs (ARCs) and non-annually recurring costs (NARCs):

- (1) Annually-recurring OM&R costs occur in approximately the same amount every year over the service period or change at a relatively constant rate over the service period. Two data entries are needed, as shown in figure 4-10.

Amount (Base-Year Dollars):	\$1000
Annual rate of increase:	0.00%

Figure 4-10. Data entry form for annually-recurring OM&R costs.

Definitions related to annually-recurring OM&R costs:

Amount (\$)--The annually-recurring OM&R cost in base-year dollars. (0-9,999,999)

Annual Rate of Increase (%)--The average annual rate at which both annually-recurring OM&R costs and non-annually-recurring OM&R costs are expected to change over the study period. For Federal or General LCC Analyses in constant dollars, enter the real rate (net of general inflation); otherwise enter the nominal rate (including general inflation). (-5 to +20)

- (2) Non-annually-recurring OM&R costs (NARCs) must be specified individually for each occurrence. For each NARC, specify a pair of data entries as shown in figure 4-11. You can enter up to 40 pairs of entries (50 for Private-Sector LCC Analysis with taxes). If the time of occurrence for any NARC extends beyond the end of the study period, BLCC will not include that NARC in the LCC computations. NARCs do not need to be specified in chronological order. Non-capital replacement costs (minor replacement costs which are funded out of current accounts) should be included as NARCs rather than as capital replacements. For Private-Sector LCC Analysis you can only specify the year of occurrence; the NARC is assumed to be incurred at the end of the designated year.

Ys/Ms	Cost	Ys/Ms	Cost	Ys/Ms	Cost	Ys/Ms	Cost
-----	-----	-----	-----	-----	-----	-----	-----
10/0	1000						
20/0	1000						
_____	_____						

Figure 4-11. Data entry form for non-annually-recurring OM&R costs.

Definitions related to non-annually-recurring OM&R costs:

Years/Months from Service Date--The number of years and months elapsed from the service date to the time at which the NARC is incurred (e.g., 10/6 for 10 years and six months). (0/1 to 99/0)

Amount (\$)--The corresponding non-annually-recurring OM&R cost occurring at the time specified, in base-year dollars. (0 to 9,999,999)

4.4.5 Capital Replacement Costs

Next, BLCC will request information regarding capital replacements, as shown in figure 4-12. Capital replacements are assumed to be funded from capital accounts rather than current accounts. If this is a Private-Sector LCC Analysis (including taxes), these replacements will have their own depreciation schedules. *Replacements funded from operating accounts rather than from capital accounts should be entered as Non-Annually Recurring OM&R costs.* You can specify up to eight capital replacements (four for Private-Sector LCC Analysis) for the overall capital asset, or for each capital component if these have been designated separately. Note that for Private-Sector LCC Analysis, you can only enter the year of occurrence; the capital replacement is assumed to be incurred at the end of the designated year.

Replacement:	#1	#2	#3	#4
Years/Months (from Service):	<u>10/0</u>	_____	_____	_____
Initial Cost (base-year \$):	\$ <u>5000</u>	\$ _____	\$ _____	\$ _____
Expected Life (years/months):	<u>10/0</u>	_____	_____	_____
Resale Value Factor:	<u>0.0%</u>	_____%	_____%	_____%

Figure 4-12. Data entry form for capital replacement costs.

Definitions related to capital replacement costs:

Years/Months (from service date)--The elapsed time from the service date to the time at which the replacement cost is expected to be incurred (e.g., 5/6 for five years and six months). If you enter a date beyond the end of the study period, the replacement cost data will be saved in the input file but ignored in the LCC analysis. (2/1 to 99/0)

Initial Replacement Cost (base-year dollars)--The installed cost of the replacement, in base-year dollars. BLCC will calculate the actual replacement cost using the Average Price Escalation Rate before Service Date (if any) and the Average Price Escalation Rate after Service Date assigned to the original capital component. (0-9,999,999)

Expected Life (years/months)--The expected useful life of the replacement, in years and months. (1 to 99)

Resale Value Factor (% of initial replacement cost)--The percent of the initial replacement cost remaining at the end of the study period (or at the end of the expected useful life of the replacement, whichever is less) in base-year dollars, i.e., unadjusted for inflation or price escalation. BLCC uses the Average Price Escalation Rate before Service Date (if any) and the Average Price Escalation Rate after Service Date along with this factor to compute the actual resale value. (0 to 200)

4.5 Energy-related Data

Energy costs are assumed to be annually recurring costs starting with the Service Date and incurred throughout the Service Period of the LCC study. You may specify up to four individual energy types and different annual price escalation rates for each energy type. In addition, you can set up a schedule of Annual Energy Usage Indices for each energy type (optional) to change the annual energy consumption from year to year, starting with the Service Date. BLCC calculates total energy costs from both direct energy costs (i.e., those costs that are directly proportional to annual energy consumption) and indirect costs (i.e., demand-related or other fixed charges that are not proportional to annual energy consumption).

4.5.1 Main Energy Data Entry Form

You enter energy-related variables on several data entry forms displayed in the file creation/edit mode. The main data entry form sets up the types of energy to be evaluated and related variables, as shown in figure 4-13. You can enter data for up to four energy types on this form. Additional forms for entering energy price escalation rates, Annual Energy Usage Indices (optional), and monthly kWh and maximum kW demand (optional) are discussed below.

	(A)	(B)	(C)	(D)
Energy Type Code (1-9)*:	<u>1</u>	<u>2</u>	<u>4</u>	—
Units Code (1-12)**:	<u>1</u>	<u>2</u>	<u>3</u>	—
Base Annual Consumption (units/yr):	<u>10000</u>	<u>2000</u>	<u>3000</u>	_____
Price/unit (base-year dollars):	<u>\$ 0.100</u>	<u>\$ 1.000</u>	<u>\$ 1.000</u>	\$ _____
Annual Demand-related Charge:	<u>\$ 500</u>	<u>\$ 0</u>	<u>\$ 0</u>	\$ _____
Escalation Type Code (1-3)***:	<u>2</u>	<u>2</u>	<u>2</u>	—

Figure 4-13. Main data entry form for energy-related data.

Definitions related to energy data:

Energy Type Codes--Choose one of the following codes:

1 = Electricity	4 = Natural Gas	7 = Central Steam
2 = Distillate Fuel Oil (#1, #2)	5 = Liquefied Petroleum Gas	8 = Chilled Water
3 = Residual Fuel Oil (#4, #5, #6)	6 = Coal	9 = Other

Unit Codes--Choose one of the following codes:

1 = kWh	4 = MBtu (million Btu)	7 = GJ (gigajoule)	10 = ft ³
2 = gallon	5 = pound	8 = liter	11 = m ³
3 = therm	6 = MJ (megajoule)	9 = kg (kilograms)	12 = MWh

Note: If you set up two columns with the same energy type, they must both have the same unit code. (1-12)

Base Annual Consumption (in designated units)--The base annual energy consumption of the specified energy type (unadjusted by the Annual Energy Usage Indices, if any). (0-99,999,999)

Price per unit--The price per designated unit to be used in calculating direct energy costs for the project. Enter the price as of the Base Date of the analysis. (.001-999.999)

Instructions for using a block rate schedule for electricity prices (\$/kWh) with monthly kWh or MWH usage are provided in section 5. If a block rate schedule is to be used for electricity prices, the Base Annual Consumption and Price per Unit should be set to zero, and the Unit Code must be either 1 or 12.

Annual Demand (or Other Fixed) Charge (dollars/year)--These are the annual costs (usually the sum of monthly charges) for this energy type that are not calculated in proportion to energy usage. Fixed monthly customer charges and charges for peak power demand are examples of these charges. Enter the cost at rates as of the Base Date. Except for MILCON analyses, the escalation rates used for energy costs are also used for these demand charges. (0-99,999,999)

Instructions for using a demand rate schedule with monthly kW or MW demand for electricity are provided in section 5. If a demand rate schedule is used, the annual demand charge here should be set to zero. A demand rate schedule can be used only when a block rate schedule for kWh prices is used.

Escalation Type Code--A code which you use to specify how you will enter the energy price escalation rates for each energy type that you included in the analysis:

- 1 = You will enter energy price escalation rates from your own sources.
- 2 = BLCC will automatically retrieve annual energy price escalation rates from ENCOSTXX.RAN, a disk file with DOE projections of energy price escalation rates that is distributed with BLCC. (XX represents the year in which the file is released, e.g., ENCOST96.RAN was released for fiscal year 1996.) These rates vary by energy type, rate type, and region.
- 3 = BLCC automatically retrieves the annual energy price escalation rates as with code type 2. You can then overwrite these rates in any year, using your own estimates.

4.5.2 Energy Price Escalation Rates

After you have completed the main energy data entry form and pressed <PgDn>, BLCC displays the forms for entering energy price escalation rates. A separate form is displayed for each energy type you designated to be used in this analysis, and the format of that form depends on the escalation type code that you entered for that energy type.

Escalation Type Code = 1 If energy price escalation rates are to be entered by the user (Escalation Type Code 1), you can specify up to 50 pairs of discrete escalation rates and the number of years of duration for each rate. The data entry form for user's projected escalation rates is shown in figure 4-14. To delete a pair, move the cursor to either field in the pair to be deleted and press <F1>. To insert a new pair, move the cursor to the desired point and press <F2>; then type in the new values. Press <PgDn> when finished. (If all 50 pairs are already specified, you cannot insert another pair without deleting the last pair first.) Note that the total number of years for which escalation rates are entered must be one year more than the length of the study period.

Enter in pairs: Number of YEARS (duration) and corresponding RATE (%).									
(Enter up to 23 pairs; total years must add to at least 23)									
Yrs	Rate	Yrs	Rate	Yrs	Rate	Yrs	Rate	Yrs	Rate
---	-----	---	-----	---	-----	---	-----	---	-----
10	2.00								
13	1.00								
---	-----								

Figure 4-14. Data entry form for user's projected energy price escalation rates.

Definitions related to energy price escalation rates:

Years--The number of consecutive years that the corresponding energy price escalation rate is to be applied, starting with the Base Date. The number you enter must be an integer. Note that for each energy type, the sum of these years must equal or exceed the study period plus one year (as shown on the form). (1 to 100)

Energy Price Escalation Rate (%)--The average annual rate of price increase for this energy type over the corresponding years (duration). If the analysis is being performed in real terms (Federal and designated General LCC Analyses), you should enter this rate in real terms (i.e., excluding general inflation). If the analysis is being performed in nominal terms (i.e., Private-Sector and designated General LCC Analyses), you should enter this rate in nominal terms (i.e., including general inflation). (-10 to +20)

Figure 4-15 shows two pairs of energy price escalation rates for electricity. For the first 10 years after the beginning of the study period, the price of electricity is assumed to increase at 2% per year in real terms; for the remaining 13 years the price is expected to increase at 1% per year in real terms. (These rates are shown for demonstration purposes only; they are recommended for use in your LCC analysis.)

Escalation Type Codes = 2 or 3 If DOE projected Energy Price Escalation rates are to be retrieved from the disk (Escalation Type Codes 2 or 3), the data entry form shown in figure 4-15 will appear before the escalation rates are shown. These additional data are needed to identify the DOE rates specific to the analysis.

Rate Schedule Type* (1-3): <u>1</u>
State Abbreviation (2-char): <u>DC</u>
General Inflation Rate (projected for study period): <u>5.00%</u>

Figure 4-15. Data required for DOE energy price escalation rates.

Definitions related to DOE Energy Price Escalation Rates:

Rate Schedule Type--The type of utility rate schedule used for the project. Choose one:
1 = residential 2 = commercial 3 = industrial

State Abbreviation (2 characters)--The official U.S. Postal Service abbreviation for the state in which the project is to be located. This code is used to determine in which of the (currently) four DOE regions the project will be located.

General Inflation Rate--The projected rate of general price inflation over the study period. (Only required for analyses conducted in current dollars.) BLCC uses this rate to convert DOE projections of energy price increases from real rates (as they are retrieved from the file) to nominal (market) rates. It is not used for any other purpose in the BLCC analysis. The general inflation rate that you enter here should be consistent with the general inflation rate implicit (but undeclared) in your nominal discount rate, price escalation rates, and mortgage interest rates, if any. (0 to 10)

If you choose to use DOE escalation rates for a selected energy type and they are not available for the rate schedule type specified, you have three options:

- (1) Return to the data entry form shown in figure 4-15 and select another rate schedule type (e.g., residential or industrial). However, this will be applied to all of the energy types included in this analysis.
- (2) Return to the main energy menu (figure 4-13), change the Escalation Type Code to 1, and enter your own rates; or
- (3) Indicate that you want to substitute the DOE escalation rates for another energy type. Figure 4-16 shows the data entry form that allows you to do this. In this example, DOE escalation rates are not available for LPG delivered under commercial rate schedules. Figure 4-16 shows how you can force the DOE escalation rates for natural gas to be used for LPG.

No DOE energy price escalation rates are available for Commercial rates with the following energy type(s):

Energy type #1 (LPG):	<u>4</u>
-----------------------	----------

Enter the code from the list of energy types shown below that most closely corresponds to the energy type shown above. Or enter 0 if you want to enter your own escalation rates. Then press <PgDn> to continue.

Codes for energy types with DOE escalation rates (Commercial rates):
 1=Electricity; 2=Distil. Oil; 3=Residual Oil;
 4=Natural Gas; 6=Coal;

Figure 4-16. Assignment of DOE escalation rates to energy types without DOE rates.

When the DOE escalation rates are retrieved using Escalation Type Code 2, the rates are displayed on the screen as shown in figure 4-17. This display is for information purposes only. You cannot change these rates without designating Escalation Type Code 3.

DOE Projected Energy Price Escalation Rates for Distil. Oil (Net of general inflation)									
Rate type = Residential; DOE Region = 3; Projection File: ENCOST93									
Year	Rate	Year	Rate	Year	Rate	Year	Rate	Year	Rate
----	-----	----	-----	----	-----	----	-----	----	-----
1993	0.59	2003	1.66	2013	1.72				
1994	1.77	2004	1.51	2014	1.69				
1995	2.24	2005	1.38						
1996	2.91	2006	1.30						
1997	2.97	2007	1.28						
1998	2.95	2008	1.21						
1999	2.99	2009	1.04						
2000	2.59	2010	1.33						
2001	2.16	2011	1.78						
2002	1.93	2012	1.75						

Figure 4-17. DOE energy price escalation rates displayed for inspection.

If DOE escalation rates are retrieved for user modification (Escalation Type Code 3), the rates will be displayed on a data entry form like that shown in figure 4-18. Note that this form is similar to that shown in figure 4-14, in that the duration (in years) and rate are shown as pairs, and the total duration must be at least as long as the study period. Since the DOE escalation rates are different for each year, the default duration is 1 for each year. To delete a pair, move the cursor to either field in the pair to be deleted and press <F1>. To insert a new pair, move the cursor to the desired point and press <F2>; then type in the new values. Press <PgDn> when finished.

Enter in pairs: Number of YEARS (duration) and corresponding RATE (%). (Enter up to 22 pairs; total years must add to at least 22)									
Yrs	Rate	Yrs	Rate	Yrs	Rate	Yrs	Rate	Yrs	Rate
---	---	---	---	---	---	---	---	---	---
<u>1</u>	<u>2.24</u>	<u>1</u>	<u>2.59</u>	<u>1</u>	<u>1.72</u>				
<u>1</u>	<u>1.33</u>	<u>1</u>	<u>2.46</u>	<u>1</u>	<u>1.69</u>				
<u>1</u>	<u>1.49</u>	<u>1</u>	<u>2.15</u>						
<u>1</u>	<u>1.30</u>	<u>1</u>	<u>1.97</u>						
<u>1</u>	<u>1.84</u>	<u>1</u>	<u>2.06</u>						
<u>1</u>	<u>2.67</u>	<u>1</u>	<u>2.50</u>						
<u>1</u>	<u>3.07</u>	<u>1</u>	<u>2.92</u>						
<u>1</u>	<u>2.90</u>	<u>1</u>	<u>2.31</u>						
<u>1</u>	<u>2.96</u>	<u>1</u>	<u>1.78</u>						
<u>1</u>	<u>2.88</u>	<u>1</u>	<u>1.75</u>						

Figure 4-18. User modifies DOE's energy price escalation rates.

Note that only 50 Energy Price Escalation Rates can be entered on the form. If each rate is given a duration of one year, as in the case when DOE rates are used, and the study period exceeds 50 years, BLCC will assign the rate for the fiftieth year to all subsequent years.

4.5.3 Annual Energy Usage Indices

You can specify the pattern of annual energy usage for each energy type as constant or variable. If you expect the energy usage for the building or building system/component to be approximately the same from year to year (which is the general case in most energy analyses), specify **N** to the question "Do you want to enter a schedule of Annual Energy Usage Indices (Y/N)?" If you expect the annual usage to change in some predictable manner (e.g., an anticipated switch in heating fuels in the year 2000, so that one type of fuel is used less and another type more after that point), specify **Y**. You can then specify up to 50 discrete pairs of Annual Energy Usage Indices and the number of years of duration for each, separately for each energy type, as shown in figure 4-19. As with the energy price escalation rates, you can delete a pair by moving the cursor to either field in that pair and pressing <F1>, or insert a pair by pressing <F2> at the desired field.

Figure 4-19 shows that for the first 10 years of the service period the annual energy usage for electricity will be the same as the Annual Energy Consumption specified for that energy type in the main energy data entry form. For the next 10 years the annual energy consumption will be 10% higher than the Annual Energy Consumption specified in that form.

Annual Energy Usage Indices for Electricity									
Starting with first year of service period (1995); 100% = base index									
Enter in pairs: Number of YEARS (duration) and corresponding INDEX.									
(Enter up to 20 pairs; total years must add to at least 20)									
Yrs	Index	Yrs	Index	Yrs	Index	Yrs	Index	Yrs	Index
---	-----	---	-----	---	-----	---	-----	---	-----
<u>10</u>	<u>100.00</u>								
<u>10</u>	<u>110.00</u>								
---	-----								

Figure 4-19. Data entry form for Annual Energy Usage Indices.

Definitions related to Annual Energy Usage Indices:

Years--The number of consecutive years that a corresponding Annual Energy Usage Index is to be used. For each energy type, the sum of these duration periods must equal or exceed the service period. Note: These duration periods begin with the service date (since energy consumption calculations begin with the service date), while the duration periods for energy price escalation rates begin with the start of the study period (since all prices are entered in base-year dollars.) (0 to 99)

Index (%)--This is the percentage of the Base Annual Energy Consumption for the designated energy type to be used during the corresponding years. For example, if you specify base annual electricity usage as 10,000 kWh in the main energy data entry form and an Annual Energy Usage Index for electricity of 110 for years 11 through 20, the annual kWh usage for those latter years will be calculated as 11,000. An index of 100% for any year leaves the Base Annual Energy Consumption unchanged in that year. (0 to 999)

4.6 Water-related Data

BLCC calculates water-related costs in a similar fashion to energy-related costs. Explicit water-related data entry screens were introduced with the BLCC version 4.3 because water conservation has been included along with energy conservation as a designated goal for the Federal Energy Management Program for federal buildings. Water usage has been subdivided into two categories, water usage and water disposal (e.g., sewer charges), since these are often itemized separately. In addition, BLCC allows separate entries for water usage and disposal at summer rates and at winter rates. Water usage/disposal is assumed to begin with the Service Date. As with energy usage, you can set up an optional schedule of annual usage indices to change the amount of water consumption from year to year, if appropriate to the analysis. At present, there is no provision for block rates as is allowed with electricity costs.

Note: If water usage and disposal costs are not based on usage and disposal amounts, you cannot estimate the cost savings attributable to water conservation measures using BLCC.

4.6.1 Main Water Data Entry Form

You enter water-related variables on three data entry forms displayed in the BLCC file creation/edit mode. The main water data form sets up the units, amounts, and prices, as shown in figure 4-20. If an annual usage or disposal amount is entered on this form for either summer or winter rates, a non-zero unit price must be entered in the corresponding price field. No fixed charges are included in the water analysis. The annual consumption amount must be entered in the same units as the price. However, the units are not actually used in the computations. If the same price is used for the entire year, you do not have to break out summer and winter usage and disposal amounts.

Water Consumption and Price Data				
Units designator: L (L=1000 liters; G=1000 gallons; F=cubic feet; M=Cubic meters)				
	Annual Water Usage		Annual Water Disposal	
	Units/yr	Price/unit	Units/yr	Price/unit
At summer rates:	1000	1.000	1000	1.000
At winter rates:	1000	1.000	1000	1.000
Enter prices in base-year dollars.				

Figure 4-20. Main data entry form for water-related costs.

Definitions related to water data:

Unit designator--Choose one of the following four water unit codes:

- L = 1000 liters
- G = 1000 gallons
- F = cubic feet
- M = cubic meter

These units are not actually used in the cost calculations. But the annual amounts and prices per unit are assumed to be designated in the unit selected.

Annual water usage, units/yr (as designated above)--the base annual consumption at the corresponding unit price for water usage. If annual water usage or disposal is indexed to reflect changes in the annual amount, the 100% index corresponds to the amount entered here.

Annual water disposal, units/yr (as designated above)--the base annual water disposal amount at the corresponding unit price for water disposal. If annual disposal is indexed to reflect changes in the annual amount, the 100% index corresponds to the amount entered here.

Price per unit, usage--The price per unit, as of the beginning of the study period, for water usage.

Price per unit, disposal--The price per unit, as of the beginning of the study period, for water disposal.

4.6.2 Water Price Escalation Rates

After you have completed the main water data entry form and pressed <PgDn>, BLCC displays the form for entering water price escalation rates. There are no default escalation rates for water prices (as there are in the case of energy prices). Water price escalation rates are entered separately for water usage and water disposal prices, but the data entry fields are only displayed if the corresponding usage and/or disposal price(s) have been entered in the main water data screen. (That is, if you do not designate a price for water disposal, no data entry fields will be displayed for escalation rates for water disposal prices.)

Figure 4-21 shows the data entry form for price escalation rates for both water usage and water disposal. Up to five different pairs of escalation rates and corresponding duration periods can be entered for water usage and for water disposal. The first rate entered begins with the Base Date (since all prices are entered as of the Base Date), even though water usage and disposal do not begin until the Service Date. The sum of years (25 years in this example) for each set of escalation rates must equal or exceed the length of the study period plus one year (as shown on the form, 23 in this example). Rates in years beyond the end of the study period will be saved but not used in the LCC calculations. In figure 4-21, escalation rates are entered for five year intervals, increasing over time for water usage and decreasing over time for water disposal. (These rates are shown for demonstration purposes only; they are not for use in an actual LCC analysis.)

You can delete a year/rate pair by locating the cursor on either element of the pair and pressing <F1>. You can insert a year/rate pair by locating the cursor on the line at which the pair is to be inserted and press <F2>. (If all five pairs are already specified, you cannot insert another pair without first deleting the last pair. If an invalid entry has been made, you must correct the invalid entry before the pair can be deleted or moved.)

Enter pairs: Number of integer YEARS rate applies and RATE (%).			
(Enter up to 5 pairs; total years must add to at least 23)			
Water Usage		Water Disposal	
-----		-----	
Years	Rate (%)	Years	Rate (%)
5	0.0	5	3.0
5	1.0	5	2.0
5	2.0	5	1.5
5	3.0	5	1.0
5	3.5	5	0.5

Figure 4-21. Data entry form for water price escalation rates.

Definitions related to water price escalation rates:

Years--The number of consecutive years (duration) that the corresponding water price escalation rate is to be applied, starting with the Base Date. This number must be an integer. (1-100)

Water price escalation rate--The average annual rate of price increase for water usage or water disposal (whichever is indicated) over the corresponding years (duration). If the analysis is being performed in real terms (Federal and designated General LCC Analyses), you should enter these rates in real terms (i.e., excluding general inflation). If the analysis is being performed in nominal terms (i.e., Private-Sector and designated General LCC Analyses), you should enter these rates in nominal terms (i.e., including general inflation). (-10 to +20)

4.6.3 Annual Water Usage and Disposal Indices

You can specify the pattern of annual water usage and annual water disposal as constant or variable. If you expect the water usage and/or disposal for the building or building system/component to be approximately the same from year to year (which is the general case in most LCC analyses), specify **N** to the question "Do you want to enter a schedule of annual water usage/disposal indices (Y/N)?" If you expect the annual usage and/or disposal amount to change in some predictable manner (e.g., an increase every five years of 10%) specify **Y**. You can then specify up to 5 discrete pairs of annual water usage and annual water disposal indices and the number of years of duration for each, as shown in figure 4-22. If water disposal prices and amounts are not included in the main water data entry form, no indices for water disposal amounts will be displayed.

As with the water price escalation rates, you can delete a pair by moving the cursor to either field in that pair and pressing <F1>, or insert a pair by pressing <F2> at the desired location. (If all five sets are used, you must delete the last pair before you can insert a new pair.) The usage and disposal indices begin with the Service Date rather than the Base Date. The sum of the years for each set must equal or exceed the length of the service period (as shown on the form). The same set of indices are applied to usage and disposal at both summer rates and winter rates. Indices for years beyond the end of the study period will be saved but not used in the LCC analysis.

Figure 4-22 shows that for the first 10 years of the service period, the annual water usage and annual water disposal will be the same as the annual water usage and disposal amounts specified in the main water data entry form. For the next 10 years the annual energy consumption will be 10% higher than the base amount. The indices for the additional 10 years shown will be saved but ignored in the calculations since they extend beyond the end of the study period.

Enter pairs: Number of integer YEARS index applies and INDEX. (Enter up to 5 pairs; total years must add to at least 20)					
Water Usage			Water Disposal		
-----	-----		-----	-----	
Years	Index		Years	Index	
10	100.00		10	100.00	
10	110.00		10	110.00	
10	120.00		10	120.00	
---	-----		---	-----	
---	-----		---	-----	

Figure 4-22. Data entry form for annual water usage/disposal indices.

Definitions related to Annual Water Usage and Disposal Indices:

Years--The number of consecutive years that a corresponding Annual Water Usage or Water Disposal Index is to be used. For each set of indices, the sum of these duration periods must equal or exceed the service period. Note: These duration periods begin with the service date. (0-99)

Index (%)--This is the percentage of the Base Annual Water Usage or Base Annual Water Disposal amounts to be used during the corresponding years. For example, if you specify base annual water usage as 10,000 liters per year in the main water data entry form and an Annual Water Usage Index of 110 for years 11 through 20, the annual water usage for those latter years will be calculated as 11,000 liters. An index of 100% for any year leaves the Base Annual Energy Consumption unchanged in that year. (0 to 999)

4.7 Finance-related Data

If financing arrangements are an integral part of the project economics, you can incorporate them into the BLCC analysis (General and Private-Sector LCC Analyses only). If there is a planning/construction period, you can specify temporary financing during that period. Temporary financing is assumed to expire as of the Service Date. Permanent financing begins with the Service Date; you can enter input data for one or two permanent mortgage loans. Data for temporary financing during the planning/construction period (if any) and for permanent financing are entered on separate data entry forms.

Note: BLCC cannot handle adjustable-rate mortgages (ARMs). However, since the underlying rate of general inflation is assumed to be constant throughout the study period, the assumption of a constant interest rate over the same period of time is reasonable.

Data requirements for temporary and permanent financing are essentially the same, except that you cannot enter the life of the loan for temporary financing. (It is assumed to end at the service date.) Figure 4-23 shows the data entry form for temporary financing. Figure 4-24 shows the data entry form for permanent financing.

If you wish to include financing in the BLCC analysis, answer **Y** to the question "Do you want to include financing in this LCC analysis (Y/N)?" If the service period begins at a later date than the Base Date, so that there is a planning/construction period before the service date, you can include construction financing by answering **Y** to the question "Include temporary financing during the planning/construction period (Y/N)?"

Percent of initial cost borrowed:	75.0%
Loan Type Code (2-3)*:	2
Annual Interest Rate**:	5.00%/yr
Number of Payments per year:	1
Points Paid (% of loan amount):	0.0%

Figure 4-23. Financing data during planning/construction period.

	Loan: #1	#2
Percent of initial cost borrowed:	<u>80.0%</u>	<u>10.0%</u>
Loan Type Code (1-3)*:	<u>1</u>	<u>2</u>
Annual Interest Rate**:	<u>5.00%/yr</u>	<u>5.00%/yr</u>
Number of Payments per year	<u>12</u>	<u>1</u>
Points Paid (% of loan amount):	<u>1.0%</u>	<u>0.0%</u>
Life of Loan:	<u>20 years</u>	<u>10 years</u>

Figure 4-24. Financing data for permanent financing at service date.

Definitions related to financing data:

Percent of Initial Cost Borrowed--This factor is multiplied by the initial project cost (including price escalation during construction, if any) to determine loan amounts for the project. During the planning/construction period, this factor is assumed to be the same in each year and is applied to the initial costs as they are phased in. For permanent financing, the sum of these factors for both loans cannot exceed 100%.

Loan Type Codes--BLCC can handle three loan types:

- 1 = fully amortized loan with periodic payments of equal amount (permanent financing only);
- 2 = interest only loan with periodic interest payments and repayment of principal at end of loan life; or
- 3 = both interest payments and principal repayment deferred to end of financing period.

Annual Interest Rate (%)--The annual interest rate of the loan, without compounding effects or loan placement costs considered (i.e., not the effective interest rate or "APR"). If the analysis is to be performed in constant dollars (General LCC Analysis only, since financing is not available with Federal and MILCON LCC Analyses), enter the annual

interest rate in real terms (i.e., net of general inflation). Otherwise enter the interest rate in nominal (market) terms. (0 to 25)

Number of Payments per Year--The number of equal payments made at periodic intervals through the year (e.g., 1 = annual payment; 12 = monthly payment). (1 to 12)

Points Paid (% of loan amount)--The loan placement fee (including all transaction costs paid by the borrower), assessed as a percentage of the loan amount (i.e., one "point" equals 1% of the loan amount). (0 to 6)

Life of Loan (Years)--The number of years over which the load will be repaid. The loan life can be longer or shorter than the study period. If it is longer, any remaining principal and accrued interest at the end of the study period are assumed to be paid at the end of the study period. (Integer between 2 and 40)

4.8 Saving a BLCC Input File

Once the data entry for a project alternative has been completed, you can save your project data to the disk, review these data in the file edit mode, or exit without saving. Figure 4-25 shows the menu which allows you to make this choice. You must save the data if you wish to compute the LCC for this alternative. BLCC automatically computes the LCC and corresponding air pollution emissions (if any) for this alternative when you save the input data and then saves these computations to an LCC output file. Each alternative will then have two files: an input data file and an LCC output file. Comparative analyses of project alternatives and the Detailed LCC Report are based on the LCC output file for each alternative, not the input data file.

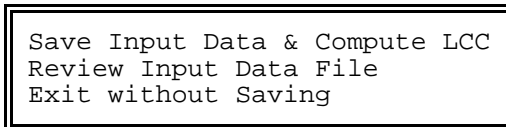


Figure 4-25. Menu displayed when data entry is complete.

To save the input data file, you must enter a DOS-convention filename (8 characters maximum) in the data field provided, as shown in figure 4-26. BLCC automatically assigns the filename extension "DAT". Press <Enter> when the filename has been entered. If this filename already exists in the same directory, a warning message will be shown. If you choose to use the same filename as that of an existing file, the existing file will be written over. If a default filename is shown, as is the case when you are editing an existing file, simply press <Enter> and the file will be saved under the default filename (after verifying that you wish to write over the existing file).

As soon as the input data file is saved, BLCC automatically performs the LCC calculations for that file. You must then enter a filename for the LCC output file in the field provided, as shown in figure 4-26. The default filename for the LCC output file is the same as the filename for the input data file; press <Enter> to use this name. BLCC automatically assigns the filename extension "LCC". Both

the input data file and the LCC output data file can have the same filename since they have different filename extensions. In general you should use the same filename for both files to make it easier to keep track of file pairs, but you can use different filenames if you have reason to.

```
Enter filename for saving Input Data File: DEMO1.DAT

Enter filename for saving LCC Output File: _____.LCC
Default file name = DEMO1
```

Figure 4-26. Data entry fields for filenames.

Once the LCC computations are completed and saved to the disk, you can immediately view the LCC summary report for that alternative. This report can be displayed to the screen, printed, or saved to the disk, at your option. Control is then returned to the main BLCC menu.

If you choose to review the input data file or edit any of the entries before saving the current file, the menu shown in figure 4-1 will appear. Use this menu to select which data entry form you want to review or edit. You can return to the file save menu at any time in the file review/edit mode by pressing <F10>.

4.9 Tax-related Data

For Private-Sector LCC Analysis, you will need to enter additional data related to tax rates in order to calculate after-tax life-cycle costs and measures of cost effectiveness. For Private-Sector LCC Analyses which are designated as "buildings with tax analysis" (i.e., for profit), data related to depreciation schedules are also required. If you are conducting a for-profit analysis, BLCC assumes that all capital-related costs (initial investment and capital replacements) are depreciable over time and all current expenditures (OM&R costs, including non-capital replacement and energy costs, and mortgage interest) are deductible in the year of occurrence. If you are conducting a Private-Sector LCC Analysis of owner-occupied homes, BLCC assumes that only property taxes and mortgage interest are tax deductible. For both of these analysis types, BLCC reduces the resale value of the project alternative by the computed capital gains tax liability, if any.

This section describes tax-related data entry fields for Private-Sector LCC Analysis. These fields are shown here rather than actual order of occurrence in order to streamline the user's guide and to provide a comprehensive source for tax-related variables.

4.9.1 Tax Rates and Depreciation Factors

After you enter the project level data (see section 4.2), the data entry form shown in figure 4-27 is displayed.

Marginal Federal Income Tax Rate:	<u>10.00%</u>
Marginal State Income Tax Rate:	<u>10.00%</u>
Property Tax Rate (nominal):	<u>10.00%</u>
Capital Gains Adjustment Factor:	<u>10.00%</u>
Depreciation Recapture Code(0-3):	<u>1</u>
Depreciation Basis Adjustment Factor:	<u>10.00%</u>

Figure 4-27. Data entry form for tax-related data.

Definitions of tax rates and depreciation factors:

Marginal Federal Income Tax Rate (%)--The federal income tax rate applied to the last dollar of income to the investor. (0 to 50)

Marginal State Income Tax Rate (%)--The state tax rate applied to the last dollar of income to the investor. If income taxes are imposed by local jurisdiction, you can include these in the economic analysis by replacing the state tax rate with a composite state and local rate. Note that BLCC computes a composite income tax rate from the marginal federal and state income tax rates, based on the assumption that state and local income taxes are deductible from federal income tax. Otherwise all tax deductions are assumed to be the same for both federal and state tax computations. (0 to 20)

Property Tax Rate (%)--The quoted (nominal) tax rate levied on this type of property at this location, without consideration of the assessment rate. Note that the Property Tax Rate is the same for all capital components and their capital replacements, but that the percentage of each component that is subject to this property tax rate (i.e., the assessment rate) can be specified separately for each component and replacement. (0 to 20)

Capital Gains Adjustment Factor (%)--The percentage of the capital gains that is taxed as ordinary income. Use 100% if there is no capital gains preference. At the end of the study period, if the resale value of the project is greater than its initial cost, the difference is assumed to be taxable as long-term capital gains. The effective capital gains tax may be lower than the ordinary income tax rate. (For example, at the time of this writing capital gains are taxed at 28% while ordinary income at the top bracket is taxed at 31%. In this case the Capital Gains Adjustment Factor is 90.32%.) For owner-occupied houses which are sold, the capital gains tax is usually deferred if another house is purchased and occupied within a specified amount of time. To defer capital gains taxes indefinitely, enter a zero for this factor. (0 to 100)

Depreciation Recapture Code--At the end of the study period, if the resale (or salvage) value of the project is greater than its depreciated book value (i.e., the remaining undepreciated portion of its actual cost as of the service date), the difference (up to the total amount of depreciation claimed) may be subject to a depreciation recapture tax. This depreciation recapture tax can be computed in one of several different ways, as designated by the following input codes:

0 = no depreciation recapture,
 1 = recapture as capital gain,
 2 = recapture as ordinary income, and
 3 = depreciation calculated at straight-line rates, recaptured as capital gains; any excess depreciation (due to accelerated calculation procedures), recaptured as ordinary income.

IRS rules for recapture vary with the type of property involved, method of depreciation used, and date of asset acquisition. If there is no capital gains preference (i.e., the Capital Gains Adjustment Factor is 100%), codes 1, 2, and 3 all produce the same results.

Depreciation Basis Adjustment Factor (%)--If an investment (or energy) tax credit is claimed for any component, this may reduce the original cost basis for depreciation calculations by a specific percentage of the tax credit. For example, if one half of the tax credit must be deducted from the original cost basis for depreciation, enter 50. If no investment tax credit is to be claimed for capital assets (as described below), enter 0. (0 to 100)

4.9.2 Tax-related data for capital components and replacements

Figure 4-28 shows the data entry form that is used to enter cost and related data for each capital component, or for the overall project alternative if individual components are not broken out. The first five fields in this figure are the same as those shown in section 4.4.2 for analysis without taxes. The last three fields require you to enter tax-related data specific to the capital components.

Initial Cost (base-year dollars):	<u>\$10000</u>
Expected Life (years):	<u>20</u>
Resale Value Factor (% of initial cost):	<u>10.0%</u>
Price Escalation Rate before Service Date:	<u>4.0 %/year</u>
Price Escalation Rate after Service Date:	<u>4.0 %/year</u>
Tax Credit Rate:	<u>0.0%</u>
Property Tax Assessment Rate:	<u>100.0 %</u>
Depreciation Code (0-4):	<u>4</u>

Figure 4-28. Data entry form for capital investment data with tax-related items.

Definitions of tax-related data for capital components and replacements:

Tax Credit Rate (% of initial cost)--The percent of the initial cost of the component (or overall project alternative, if no components are specified) which can be claimed as an income tax credit in the first year of the service period. If the tax credit is taken, the IRS may require you to reduce the depreciation basis of the component by some percentage of this credit. The percentage of the tax credit by which the depreciation basis is to be reduced can be specified using the Depreciation Basis Adjustment Factor, described in section 4.9.1. (0 to 20)

Property Tax Assessment Rate (%)--The percentage of the initial component cost to which the Property Tax Rate for the overall project is applied in order to calculate the actual property tax obligation. BLCC only calculates property taxes during the service period (i.e., not during the planning/construction period), and assumes that these taxes are paid at the end of each year, based on the assessed value of that component at that time. In computing the assessed value of the component for each year of the service period, BLCC decreases the initial component cost annually--in straight-line fashion--to its estimated resale value (unadjusted for price changes) at the end of the study period (or at the end of the component life, if this occurs before the end of the study period). It then adjusts these values for price changes using the "Average Price Escalation Rate after Service Date," before applying the Property Tax Assessment Factor to determine the amount to which the Property Tax Rate is applied. Note that this is necessarily an approximation technique; the actual assessment depends on the taxing authority's own assessment methods. (0 to 100)

Depreciation Code--The method to be used for depreciating each capital component is determined by the following codes:

- 0 = no depreciation calculated
- 1 = straight-line
- 2 = declining balance (accelerated)
- 3 = sum of years digits
- 4 = depreciation table

See section 4.9.4 for information regarding the depreciation table method.

Figure 4-29 shows the data entry form that is used to enter capital replacement data. The first four fields in this figure are the same as those shown in figure 4-12 for analysis without taxes. The last two fields have tax-related data specific to capital components. The definitions for these fields are the same as for capital components above.

Replacement:	#1	#2	#3	#4
Year (from service date):	<u>10</u>	—		
Initial Cost (base yr \$):	\$ <u>2000</u>	\$ _____	\$ _____	\$ _____
Expected Life (years):	<u>10</u>	—		
Resale Value Factor:	<u>10.0%</u>	_____ %	_____ %	_____ %
Property Tax Assess Factor:	<u>100.0%</u>	_____ %	_____ %	_____ %
Depreciation Code (0-4):	<u>1</u>	—		

Figure 4-29. Data entry form for replacement cost schedule with tax-related items.

4.9.3 Additional Depreciation Data

Projects with full tax analysis require you to input more information regarding depreciation if you have specified Depreciation Codes 1, 2, or 3. Figure 4-30 shows the form for entering depreciation data for capital investments and for capital replacements. You must enter these depreciation data separately for each component and each replacement, if relevant.

Depreciation Life: <u>10</u> Years Acceleration Rate (if needed): <u>0</u> % Salvage value (as % of initial cost): <u>0</u> % Additional first year depreciation (as % of initial cost): <u>0</u> %
--

Figure 4-30. Data entry form for additional depreciation data.

Definitions of additional depreciation data:

Depreciation Life (Years)--The number of years over which the component will be depreciated. (2-45)

Acceleration Rate--This is the ratio of allowable depreciation to straight-line depreciation that BLCC uses to calculate the depreciation allowance. For double declining balance, enter 200. This rate is only required and used when the Depreciation Method Code = 2. (100 to 300)

Salvage Value Factor (% of initial cost)--If the IRS depreciation rules require that salvage value be deducted from the initial asset cost before calculating depreciation, you must enter the Salvage Value Factor. Otherwise enter zero. The Salvage Value Factor is specified as a percentage of the initial component cost. Negative values are not allowed. Note: The Salvage Value Factor is specified only for depreciation purposes here; this is not the same as the Resale Value Factor. (0 to 50)

Additional First-Year Depreciation Factor--If additional first-year depreciation is allowed, enter this factor as a percentage of the actual component cost. BLCC deducts any additional first year depreciation from the original depreciation basis before the depreciation schedule is set up for this component and added to the first year of the depreciation schedule. (0 to 20)

4.9.4 Standard Depreciation Tables

When you create or modify an input data file that requires depreciation data, you can specify several types of depreciation calculations, including straight-line, sum-of-years digits, accelerated depreciation, and standard table computations. If you specify the standard table option, BLCC bases the depreciation computations on depreciation factors that it retrieves from a disk file that you have previously set up for this purpose. This allows you to use a standard depreciation table without having to re-enter it each time. (IRS publishes such tables for different classes of depreciable assets.) You can use the same depreciation table several times without re-entering the table. You can use the same table for both initial capital components and capital replacements.

Before running BLCC, you must create a file of depreciation factors using a text editor (or word processor in the text mode) and save it as an ASCII file. Files with depreciation factors must have the filename extension "DEP". This file must be accessible from the BLCC directory (not the data file directory specified in the "Setup" option). An example of a file containing a standard depreciation table is included on the BLCC disk as DEMO.DEP.

Depreciation table files have the following format:

```
n
factor 1
factor 2
.
.
factor n
```

where:

n = number of factors in file (i.e., the number of years over which the asset is to be depreciated), and
factor i = percent of asset cost allowed as depreciation in year i, i = 1 to n, in decimal form (e.g., 10% = .1). The sum of these factors must equal 1.0.

Figure 4-31 shows an example of a depreciation table file for use with BLCC. This file contains the number of years that an asset is to be depreciated and the percent (in decimal terms) of its depreciation basis that is allowed as depreciation in each of those years. Separate tables must be created for each depreciation schedule. Note that the Annual Cash Flow Report shows the computed depreciation amounts at the bottom of the report.

```
5
.2
.2
.2
.2
.2
```

Figure 4-31. Example of a data file containing a standard depreciation table.

5. ELECTRICITY COST CALCULATIONS USING ERATES FILES

BLCC can compute annual kWh costs using block rate schedules with monthly kWh data, rather than simply multiplying annual kWh usage by the price per unit. A file with block rate schedules created by the NIST ERATES program⁶ can be imported for this purpose. Block rate schedules assign different prices to different levels of kWh usage in a given month. Different price schedules can be in effect for different months of the year. For example, summer months may have different kWh rates than winter months.

BLCC can also compute annual demand charges using a demand rate schedule and monthly maximum kW demand data, rather than simply using the annual demand charge from the main energy data entry form. A file with demand rates created by the NIST ERATES program can be imported for this purpose. Demand charge schedules can be complex, especially when "ratchet" effects are considered. BLCC uses a simplified method which is explained later in this section.

5.1 Specifying Rate Schedules

To use a block rate (kWh) schedule and a demand rate schedule with BLCC, you must generate them in advance with the NIST ERATES program. Using ERATES, you can create a file of one or more monthly block rate schedules for kWh charges and assign them to specific months of the year. Figure 5-1 shows two block rate schedules generated with ERATES and their assigned months. The first is assigned to all months except May, June, July, August, and September; the second is assigned to these months. **You must save the block rate and demand rate files generated by ERATES in the same directory as BLCC4.EXE, not in the directory you designated for saving and retrieving BLCC data input files (using the set up utility).**

You can change the number of kWh in each usage block and the price for each block with the ERATES program. You can assign up to five usage blocks to each schedule; all kWh consumption above the highest block is charged at the rate shown for "all additional kWh." You can include as many as six monthly schedules in a single file, along with their assigned months. ERATES block rate files always have the filename extension "BLK". The two schedules shown in figure 5-1 were taken from file DEMO.BLK, included on the BLCC diskette for demonstration purposes.

To use block rates for calculating annual kWh costs, do the following: Declare electricity as an energy type in the main energy data entry form by entering a 1 for the energy type code, and declare kWh (or MWh) as the unit designator by entering a 1 (or 12) for the units code. Do not enter either an annual energy usage amount or a unit energy price (either a blank or a zero will do). When the main energy data entry form is completed, press <PgDn>. Then answer "Y" to the question, "Use block rates?" A list of block rate files in your current BLCC directory will appear on the screen. Tag the file to be used; the filename will be saved in your BLCC input data file.

⁶ National Institute of Standards and Technology, *ERATES, A Computer Program for Calculating Time-of-Use, Block, and Demand Charges for Electricity Usage*, NISTIR 5186, May 1993.

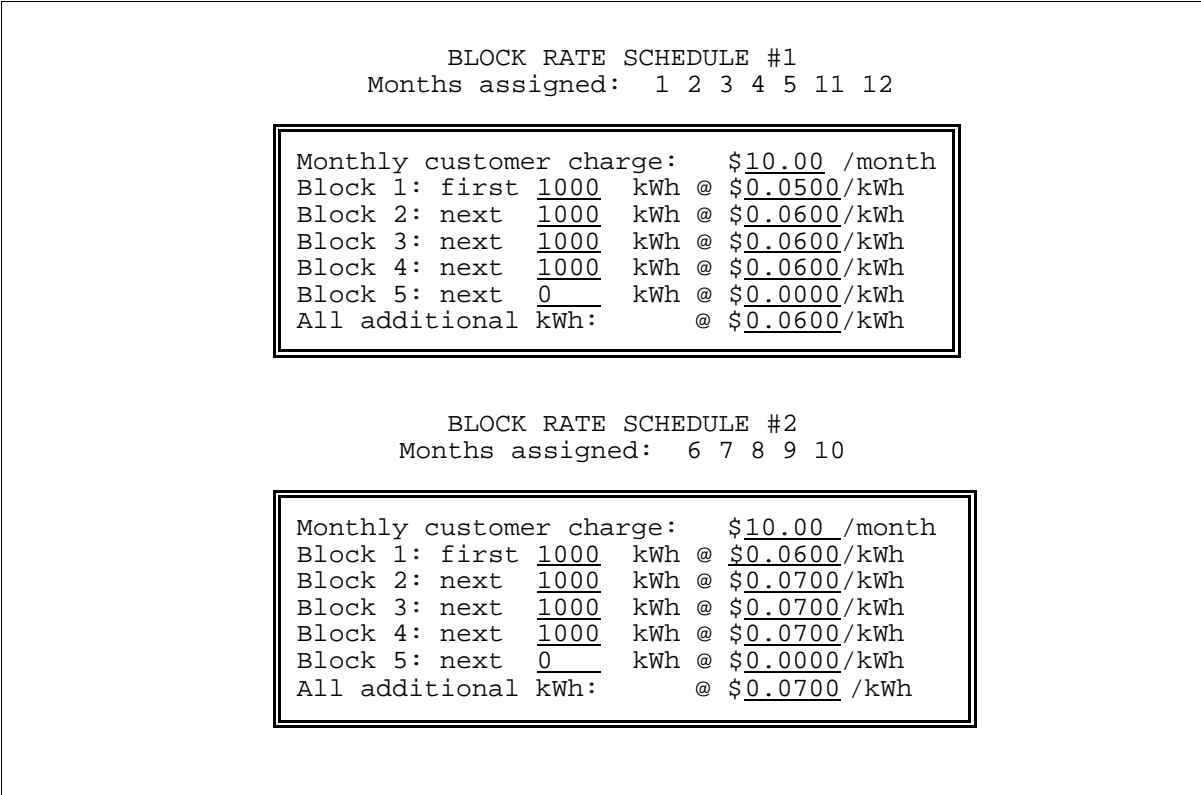


Figure 5-1. Block rate schedules from ERATES program.

Demand charges can be calculated using an ERATES demand rate file only if (1) you are using block rates for kWh charges, and (2) you specify a zero demand charge for electricity in the main energy data entry form. Then answer "Y" to the question "Use demand rates?" A list of demand rate files in your current BLCC directory will appear on the screen. Tag the file to be used; the filename will be saved in your BLCC input data file.

Figure 5-2 shows two demand charge schedules created with ERATES. These schedules are similar to those used for kWh block rates charges, in that the demand rates can also be entered in blocks of variable sizes and different schedules can be assigned to different months. The demand charge schedule, as set up by ERATES, will also determine whether the monthly charges are to be levied on the maximum demand for the corresponding month or on the maximum demand for the entire year. (This is intended to provide more flexibility in simulating the calculation of demand charges under a wide variety of rate structures.) ERATES demand rate files always have the filename extension "DMD". The demand charge schedule shown in figure 5-2 was taken from file DEMO.DMD, included on the BLCC diskette for demonstration purposes.

The ERATES demand rate schedule specifies the hours when peak demand is to be metered. This feature is intended to support the determination of peak demands using hourly kWh consumption data with ERATES. BLCC uses monthly maximum kW data and thus ignores the on-peak hour specifications. BLCC assumes that the monthly maximum kW specified in the BLCC input data file for this project alternative occurred during the appropriate on-peak hours.

5.2 Entering Monthly kWh and kW Data

Finally, enter the monthly kWh usage and maximum kW demand (if used) for each month of the year in the data entry form shown in figure 5-3. These kWh and kW become the nominal usage amounts for an Annual Energy Usage Index of 100% if these indices are used. (The Energy Usage Indices will adjust both the kWh usage and kW demand amounts by the same percentage.) The annual kWh usage will be computed and reported in the Detailed LCC and the Comparative LCC reports. If MWh units rather than kWh units were declared in the header file, then enter monthly usage and demand in MWh and MW, even though prices in the block rate and demand rate files are designated in kWh and kW. The MWh and MW data will be converted to kWh and kW before applying the kWh and kW prices.

Some utilities use a "ratchet" method when calculating demand charges, using the maximum kW demand in one month as the basis for calculating demand charges in subsequent months. If this is the case then enter the ratchet amount in the appropriate months after the ratchet base has been established, instead of the actual amount. For example, if the ratchet base of 100 kW is established in July and the demand charge is based on 90% of this amount for the next 12 months, then enter 100 for July and 90 for each of the subsequent months (including January through June since the objective is to set up a typical year of monthly kW demand amounts). Note that the rate per kW can vary from month to month, depending on the demand rate schedule assigned to that month when setting up the file in ERATES. If the ratchet amount is the same as the ratchet base for all 12 months, choosing the "annual maximum kW" option instead of the "monthly maximum kW" option when setting up the ERATES demand file will automatically base the monthly charge in each month on the maximum kW demand for the year, regardless of the kW demand amounts entered in the other 11 months.

Monthly and annual calculations of annual kWh costs and kW demand charges can be performed and displayed within the NIST ERATES program. This can be helpful when setting up the block rate and demand rate schedules for use with BLCC. By experimenting with different monthly kWh and kW profiles and different rate schedule assignments you can determine the cost consequences of changes to these input parameters. When setting up block rate and demand rate files with ERATES, it is recommended that you first perform sample cost calculations with ERATES, using typical kWh and kW demand profiles, before importing these files into BLCC.

DEMAND RATE SCHEDULE #1
Months assigned: 1 2 3 4 10 11 12

Enter on-peak demand hours (1-24)

First Period	Second Period
Start <u>6</u> Stop <u>9</u>	Start <u>14</u> Stop <u>22</u>

Block 1: first <u>100</u>	kW @ \$ <u>10.00</u> /kW
Block 2: next <u>100</u>	kW @ \$ <u>12.00</u> /kW
Block 3: next <u>0</u>	kW @ \$ <u>0.00</u> /kW
Block 4: next <u>0</u>	kW @ \$ <u>0.00</u> /kW
Block 5: next <u>0</u>	kW @ \$ <u>0.00</u> /kW
All additional kW:	@ \$ <u>15.00</u> /kW

DEMAND RATE SCHEDULE #2
Months assigned: 5 6 7 8 9

Enter on-peak demand hours (1-24)

First Period	Second Period
Start <u>6</u> Stop <u>20</u>	Start <u>0</u> Stop <u>0</u>

Block 1: first <u>100</u>	kW @ \$ <u>15.00</u> /kW
Block 2: next <u>100</u>	kW @ \$ <u>20.00</u> /kW
Block 3: next <u>0</u>	kW @ \$ <u>0.00</u> /kW
Block 4: next <u>0</u>	kW @ \$ <u>0.00</u> /kW
Block 5: next <u>0</u>	kW @ \$ <u>0.00</u> /kW
All additional kW:	@ \$ <u>25.00</u> /kW

Figure 5-2. Demand rate schedule from ERATES program.

Month	kWh	kW
January	<u>1000</u>	<u>10</u>
February	<u>1000</u>	<u>10</u>
March	<u>1500</u>	<u>12</u>
April	<u>1500</u>	<u>12</u>
May	<u>1500</u>	<u>15</u>
June	<u>2000</u>	<u>15</u>
July	<u>2000</u>	<u>15</u>
August	<u>2000</u>	<u>15</u>
September	<u>1800</u>	<u>12</u>
October	<u>1500</u>	<u>11</u>
November	<u>1500</u>	<u>10</u>
December	<u>1500</u>	<u>10</u>

Figure 5-3. Data entry form for monthly kWh and maximum kW demand data.

6. THE BLCC QUICK INPUT PROGRAM (Version 2.11)

6.1 Overview

The BLCC Quick Input Program (QI) provides a convenient method of setting up and solving relatively simple LCC problems that require the determination of the design alternative with lowest LCC from two or more mutually exclusive alternatives. For example, you may want to determine which of several alternative levels of roof insulation, or which of several different heating systems, is most cost effective for a particular building. With BLCC, you must set up a separate file for each alternative, calculate the LCC for each, and then compare their LCCs to determine which alternative has the lowest LCC. With QI, you can set up this problem in a single file that includes common "header" information (including the basic study parameters and unit energy costs) and line item entries for each alternative to be evaluated. After you save this file, you can, with a single key stroke, calculate the LCC for each alternative in the file, identify the alternative with the lowest LCC, and report this information along with the Net Savings, Savings-to-Investment Ratio, and Adjusted Internal Rate of Return for the lowest-LCC alternative. If you want to add more detail to any of the alternatives (for example, to add more non-annually recurring costs or replacements costs) or generate more comprehensive LCC reports, QI can generate input data files for a BLCC analysis.

QI can evaluate several different groups of projects, each with its own set of alternatives, in the same data file. The requirements for this multiple analysis are (1) that all of the projects must be evaluated in the same LCC context (i.e., using the same study period, service date, and discount rate); and (2) that the projects must be (approximately) functionally independent. This latter requirement means that none of the projects evaluated, at any of their alternative levels of implementation, significantly affects the energy savings or life-cycle costs of any of the other project alternatives included in the same QI file.

For example, adding attic insulation (especially at the higher levels) will have little or no effect on the cost or savings from double- or triple-pane windows and thus both groups of alternatives can be evaluated in the same QI analysis. However, installing a high-efficiency furnace will have a significant effect on the savings from adding insulation or insulated glass since the energy efficiency of the heating system determines, at least in part, the energy savings attributable to those latter modifications. Thus you cannot evaluate several different levels of heat pump efficiency, several different levels of attic insulation, and several different levels of window glazing as three different groups in the same QI file. Instead you must enter the combined cost and energy usage for each practical combination of these components/systems as a single line item, with all combinations listed under the same group code. The term "practical combination" implies that you have given some consideration to economic balance in the specification of each combination and that you omit obviously unbalanced combinations. For example, you would not expect to use single-glazed windows together with a high level of attic insulation. (See the discussion at the end of section 3.5 for more information on simultaneous analyses of interdependent systems.)

You can save and edit QI input data files much like BLCC input data files. Moreover, you can append additional project alternatives to the end of a QI data file, either in the QI edit mode, or by using a modified version of an energy analysis program such as the DOE ASEAM program (version 5.0). The data format needed to append data for additional alternatives directly to a QI input file is discussed in section 6.5.

While QI is fully compatible with BLCC from a computational standpoint, its data entry capabilities are somewhat limited, in keeping with its nature as a simplified analysis program. The following list provides some of these limitations and special assumptions that are different from those in BLCC:

The Base Date and the Service Date (Beneficial Occupancy Date) can only be specified by year. The month is assumed to be January.

Time-phasing of initial costs between the Base Date and the Service Date is not available. Instead, all initial costs are assumed to be incurred at the Service Date (except for MILCON LCC Analysis, where initial costs are discounted from the midpoint of construction).

You cannot enter escalation rates specific to individual cost items except for energy costs. However, for a General LCC Analysis you can enter the general inflation rate if you want to conduct the LCC analysis in current, rather than constant, dollars. In this case, the general inflation rate will be used to convert DOE energy price escalation rates (which do not include inflation) to their nominal (market) equivalents. The general inflation rate will also be used to increase OM&R costs and capital replacement costs to their actual cost level in the year of occurrence before discounting these costs back to present value.

You can enter only one capital replacement cost and only one non-annually recurring OM&R cost for each alternative in the QI file. However, for these two cost items, the *frequency of occurrence* is entered (in years/months from the Service Date) rather than entering the *time of occurrence* as in BLCC. Thus these costs will automatically recur at the stated time interval up to (but not including) the end of the study period. If you use QI to generate a BLCC input data file for any project alternative in the QI file, the timing of each replacement and non-annually-recurring OM&R cost will automatically be transferred to the BLCC file.

You cannot enter a residual (resale or salvage) value for the initial investment or its capital replacements, but you can force this value to be calculated. See section 6.3.3 for information on residual value calculations.

Input data related to energy calculations are identical to those in BLCC, except that Annual Energy Usage Indices cannot be entered. Block rate and demand rate files can be used with QI; however, as with BLCC this requires monthly data for kWh and maximum kW consumption for each alternative. DOE energy price projections are retrieved from the disk as in BLCC.

Explicit water conservation analysis is not included in QI.

Tax-related analyses cannot be performed with QI.

Financing analysis is not included in QI.

Mid-year discounting is not an option in QI as it is in BLCC. However, annually recurring costs in MILCON analyses are automatically discounted from mid-year

6.2 Installation

QI should be installed in the same directory as BLCC. This will generally be done at the time that you install BLCC, since they are both included on the BLCC diskette. If you want to install QI separately from BLCC, copy the following files from the BLCC diskette to the QI directory: QI2.EXE, ENCOST96.SEQ, ENCOST96.RAN, DISRAT96.FIL, SETUP4.FIL, and ENESC.SCR. Use the setup option as in BLCC to select the monitor type, data file directory, filename for DOE energy price escalation rates, the maximum number of project records that can be included in a single QI data file, and the printer port designator.

QI defaults to 200 records in a single file but will allow you to raise this number to 500. Raising the maximum number of records will require more random access memory than is available on some PCs, especially if you include monthly kWh usage and maximum monthly kW demand for each project alternative with the project data. If insufficient memory is available, the program may crash. To avoid losing data, it is helpful to save your data base frequently when adding large numbers of records (greater than 200). (Future versions of this program will test memory requirements during setup.) If you are appending data to a QI file from outside the program (see section 6.7), there is no limit to the number of records that can be included in the file. But only the maximum number of records specified in Setup will be read in when running QI and computing LCCs.

Table 6.1 provides a list of file types that are used with, or generated by, QI along with filename extensions. This list may be helpful in identifying files in your BLCC/QI directory. The filename extensions are automatically assigned by QI. Do not include the extension when you enter a filename for saving a file. The executable file for QI version 2.11 is QI2.EXE.

Table 6.1 Filename extensions used with Quick Input program (QI)

<u>Filename Extension</u>	<u>File type</u>
.EXE	Executable files (QI2)
.SCR	Screen formatting files for QI (and BLCC4)
.FIL	Special data files for QI (and BLCC4)
.SEQ	ENCOST96.SEQ only, map of data in ENCOST95.RAN
.RAN	ENCOST96.RAN only, DOE energy price escalation rates (see section 4.7.2)
.QI	QI input data files
.QID	Optional files for QI Input Data Report
.QLR	Optional files for QI LCC Report
.LST	Optional files for list of BLCC input data files generated by QI

6.3 Running QI

Type QI2 to begin the QI program. The main QI menu, shown in figure 6-1, will appear on the screen.

```
Create New QI file
Edit Existing QI file
Print QI Input File
LCC Calculations
Generate BLCC Input Files
SetUp
Exit to BLCC
Exit to DOS
```

Figure 6-1. Main Quick Input menu.

If you are using QI for the first time it is recommended that you run through the demonstration file DEMO.QI. Highlight the "Edit Existing QI file" bar and press <Enter>. You will see the existing QI files in your directory (only DEMO.QI if you are just starting). Highlight the file and press <Enter>. The file will be retrieved from the disk. The type of analysis that has been designated in the DEMO.QI file will automatically be shown. Press <Enter> and the data entry form for file header data will be displayed. Use <PgDn> and <PgUp> to move from screen to screen to review the data. You can then resave this data or return to the main menu without saving. From the main menu select LCC Calculations to generate an LCC report for this file.

6.3.1 Creating a New QI File

To create a QI data file for a project, use the cursor to highlight "Create New QI file" and press <Enter>, or simply press the letter C on the keyboard. When creating a new QI file, you must choose one of the five types of LCC analyses shown in Figure 6-2. Unlike BLCC, you can change the analysis type in the file edit mode. If you initially selected "General LCC Analysis" and you change to a Federal or MILCON LCC analysis you must also change the discount rate, inflation rate, and study period in the file header data to conform to the specific LCC requirements of the new analysis type; *this will not be done automatically*.

```
(1) General LCC Analysis--Non-Federal, No Taxes
(2) Federal Analysis--Energy Conservation Projects
(3) Federal Analysis--Projects Subject to OMB A-94
(4) MILCON Design--Energy-related Projects
(5) MILCON Design--Non-energy-related Projects
```

Figure 6-2. Types of LCC analyses performed by QI.

6.3.2 Common Data for LCC Analysis

Figure 6-3 shows the "file header" data entry form. QI uses the data in this form for evaluating all of the groups of project alternatives included in this file. The data entry requirements are similar to those in BLCC. Note, however, that the "Common Project Name" is the name of the overall analysis, not the name of an individual project alternative. (Project alternative names are entered on a later form along with corresponding cost and energy usage data.) You can only enter the year for the Base Date and Service Date; the month is assumed to be January. The Base Date must fall between 1995 and 2000. The Service Date more than nine years beyond the Base Date is not allowed.

You can enter the Study Period Length as a year or as a year/month pair, separated by a "/" (e.g., "10/6" for 10 years and 6 months; maximum = 99 years). Only enter a non-zero inflation rate when the LCC analysis is to be conducted in current dollars (including inflation). If you do include a non-zero inflation rate, you must specify the discount rate in nominal terms (including inflation). If the inflation rate is set to zero, specify the discount rate in real terms (net of general inflation). Federal and MILCON LCC Analyses should always be conducted in constant dollars (inflation set to zero) with a real discount rate, as in the BLCC program. (The discount rate must be between zero and 20; inflation rate between zero and 10.)

For MILCON LCC Analyses only, if the Service Date (Beneficial Occupancy Date) is later than the Base Date, you will be asked to enter the midpoint of construction, as in BLCC. However, in QI you can only enter the year, not the month and year.

COMMON PROJECT NAME: House Insulation				
BASE DATE OF STUDY (YEAR):1996 (e.g., 1993)				
SERVICE DATE (YEAR): 1996 (e.g., 1993)				
STUDY PERIOD LENGTH (YEARS/MONTHS FROM BASE DATE): 30 (E.G., 20/6)				
DISCOUNT RATE: 5 %				
INFLATION RATE: 0 % (0 for constant dollars with real discount rate)				
COMMON ENERGY DATA	#1	#2	#3	#4
ENERGY TYPE CODE:	<u>1</u>	<u>4</u>	<u>0</u>	<u>0</u>
UNITS CODE:	<u>1</u>	<u>3</u>	<u>0</u>	<u>0</u>
PRICE PER UNIT:	<u>\$0.10</u>	<u>\$1.00</u>	<u>\$0</u>	<u>\$0</u>
ESCALATION TYPE CODE:	<u>2</u>	<u>2</u>	<u>0</u>	<u>0</u>

Figure 6-3. Data entry form for QI header data.

The header data entry form includes the common energy data required for energy cost analysis of each of the project alternatives to be included in the QI file. Only the energy types that you specify here (by entering the Energy Type Code, Unit Code, price, and Escalation Type Code) will appear on the data entry form for the individual project alternatives. You may specify the same Energy Type Code in more than one column with a different Price per Unit, but you must use the same Units Code in each column having the same Energy Type Code. The Energy Type Codes, Unit Codes, and Escalation Type Codes are identical to those used in BLCC:

Energy Type Codes: 1=Electricity; 2=Distillate oil (#1 & #2);
3=Residual oil (#4, #5, & #6); 4=Natural Gas; 5=LPG
6=Coal; 7=Central Steam; 8=Chilled Water; 9=other

Unit Codes: 1=kWh; 2=gallon; 3=therm (100,000 Btu); 4=MBtu (million Btu);
5=pound; 6=MJ (megajoule); 7=GJ (gigajoule) 8=liter; 9=kilogram
10=cubic feet; 11=cubic meters; 12=MWh

Energy Escalation Type Codes: 1=user enters rates; 2=DOE rates from disk;
3=user modifies DOE rates

If you select an Energy Escalation Type Code of 1 for any energy type, you will need to enter your own energy price escalation rates into a form identical to the form used in BLCC for this purpose (see figure 4-13). If you enter an Energy Escalation Type Code of 3, the DOE rates will be retrieved and displayed so that you can modify them, again as in BLCC (see figure 4-18). Code 2 retrieves the DOE energy price escalation rates from the disk; however these are not displayed to the screen as in BLCC.

For Energy Escalation Type Codes 2 and 3 you must declare the Rate Type (residential, commercial, or industrial) and the State Abbreviation as in BLCC (see figure 4-15). If there are no DOE projections for the combination of energy type and rate schedule type specified, you will be able to select the DOE rates for another energy type for use for this energy type, or change the code to 1 and enter your own rates. The data entry form for BLCC shown in figure 4-16 is also used in the QI program for selecting alternative DOE energy price escalation rates.

For electricity usage with kWh or MWh units, leaving the price per unit blank or entering a zero will allow you to specify a block rate file and a demand rate file from the NIST ERATES program to be used in the energy cost computations. The prompt for these file declarations will appear immediately after you leave the header data entry form. If you specify a block rate file, you will need to enter monthly kWh or MWh usage for each project alternative in this file. If you specify a demand rate file, you must enter the monthly maximum kW or MW demand for each project alternative in this file. This procedure is similar to the use of block and demand rates in BLCC. See section 5 of this guide for more information on these procedures. You cannot specify electricity with a price per unit in one column and without a price per unit in another column in the same QI file.

6.3.3 Declaration of residual value computation method and investment costs definitions

Quick Input does not include data entry fields for residual (resale or salvage) value factors. Instead, QI can automatically recalculate the residual value for the initial investment or for capital replacements if their expected life extends beyond the end of the study period. These computations were automatically performed in QI 1.0; these computations are optional in QI 2.0 and later. Figure 6-4 shows the screen display that requests declarations from the user regarding the computation of residual values for the initial capital investment and for capital replacements.

```

Compute residual value* for initial capital investment if project life
extends beyond end of study period (Y/N)? Y

Compute residual value* for any capital replacement whose life extends
beyond end of study period (Y/N)? Y

Include capital replacements and residual values as investment-related
costs for computation of SIR and AIRR** (Y/N)? Y

```

Figure 6-4. QI calculation method declarations.

Residual value calculations are based on straight-line depreciation (i.e., prorated) over the expected life of the initial investment and replacements. (The term "depreciation" is used here from a physical standpoint, not a tax computation standpoint.) Thus if you specify a study period of 25 years in the header data (with the service date the same as the base date) and assign an expected life of 50 years to a given project alternative (as will be shown in the next section), a residual value factor of 50% $[(50-25)/50]$ for that project alternative will automatically be assigned in the QI LCC calculations. If a capital replacement with a ten year life is assumed to be incurred five years before the end of the study period, it will also be given a residual value factor of 50% $[(10-5)/10]$. If the LCC analysis is conducted in current dollars, the general inflation rate will be applied after the prorated residual value amount is calculated. (Note that if the Service Date is later than the Base Date, the prorated depreciation will be computed over the service period rather than over the entire study period.) If you use QI to generate a BLCC input data file for a project alternative, the calculated residual value factors will automatically be transferred to that file.

Figure 6-4 also shows a third declaration regarding investment-related costs when computing the savings-to-investment ratio (SIR) and adjusted internal rate of return (AIRR) on investment. If you declare that capital replacements and residual values should be included as investment related costs, these costs will appear in the denominator of the SIR and AIRR calculations as increased investment costs. If you declare that capital replacements and residual values should NOT be included as investment-related costs, these costs will appear in the numerator of the SIR and AIRR calculations as reduced operating-related savings. Note that in either case the LCC will not change; only the SIR and AIRR calculations will change. Inclusion of capital replacements and residual values as investment-related costs will generally produce lower SIR and AIRR calculations than their inclusion as operating-related costs. The rationale for choosing one method over the other hinges on whether the investor is interested in calculating the SIR and AIRR for all investment capital or only for initial investment capital. For energy-related LCC analysis in the federal government (FEMP and MILCON analyses), capital replacements and residual values are automatically assumed to be investment-related costs, in accordance with 10 CFR 436; in these cases this last declaration field will not appear on the screen.

6.3.4 Data Entry for Individual Project Alternatives

Once you have completed data entry forms for the header data, energy price escalation rates, and residual value calculations, the data entry form for the individual project alternatives appears on the screen. You will enter data specific to each of the project alternatives (and multiple projects, if

relevant) on this one form. Since the data form is wider than the screen, it automatically scrolls to the right to accommodate data related to energy usage. Use <Tab> and <Shift><Tab> to move right and left from field to field on the project data form. Use <Ctrl><End> to shift to the right edge of the form; use <Ctrl><Home> to shift back to the left edge of the form. If you enter more than 12 project alternatives, the data entry form will scroll downward as well. Use <Ctrl><PgDn> to move downward frame-by-frame (12 alternatives at a time) through the form; <Ctrl><PgUp> to move back upward.

You must enter all data for an individual project alternative on a single line in the project data form. **Enter all costs in base-year dollars.** You can delete any project alternative by moving the cursor to any field on its data entry line and pressing <F1>. You can force a new line for inserting an additional project alternative between two existing project alternatives by moving the cursor to the line where the new line is to appear and pressing <F2>.

ALT #	ALTERNATIVE NAME	GROUP CODE	LIFE (Y/M)	INITIAL COST (\$)	CAPITAL		ANNUAL
					REPLACEMENTS FREQ*	COST (\$)	OM&R COST (\$)
1	R-0 attic	A	30/0	0	0/0	0	0
2	R-11 attic	A	30/0	425	0/0	0	0
3	R-19 attic	A	30/0	625	0/0	0	0
4	R-30 attic	A	30/0	925	0/0	0	0
5	R-38 attic	A	30/0	1125	0/0	0	0
6	R-49 attic	A	30/0	1425	0/0	0	0
7	no strm door	B	0/0	0	0/0	0	0
8	storm door	B	15/0	150	15/0	130	0
9	single glass	C	30/0	2000	0/0	0	100
10	double glass	C	30/0	2500	15/0	300	125
11	triple glass	C	30/0	3000	15/0	400	150

Figure 6-5L. Left side of data entry form for project alternatives.

ALT #	CAPITAL		ANNUAL	NON-ANNUAL	OM&R	ANNUAL ENERGY USE		AN. ELEC.
	REPLACEMENTS FREQ*	COST (\$)	OM&R COST (\$)	FREQ*	COST (\$)	ELECTRIC (kWh)	NAT.GAS (therm)	DEMAND CHARGE (\$)
1	0/0	0	0	0/0	0	1465	625	0
2	0/0	0	0	0/0	0	1231	465	0
3	0/0	0	0	0/0	0	1177	440	0
4	0/0	0	0	0/0	0	1138	420	0
5	0/0	0	0	0/0	0	1123	415	0
6	0/0	0	0	0/0	0	1109	410	0
7	0/0	0	0	0/0	0	1465	625	0
8	15/0	130	0	7/6	20	1460	620	0
9	0/0	0	100	0/0	0	1465	625	0
10	15/0	300	125	5/0	100	1400	550	0
11	15/0	400	150	5/0	100	1380	525	0

*FREQ = Frequency of occurrence (in years/months)

Figure 6-5R. Right side of data entry form for project alternatives.

Figure 6-5L shows the data entry form as it initially appears on the screen. Figure 6-5R shows this same form at its right-most margin. (Note that some of the fields are duplicated at the point of overlap of the two screens.) The total width of the project data form depends on the number of energy types you declared on the header data form and whether you specified that annual demand costs for electricity would be entered or calculated.

The example shown in figures 6-5L and 6-5R is for the evaluation of three independent "groups" of energy conservation measures in the same building, each having two or more mutually exclusive alternatives: five levels of attic insulation, a storm door option (with base case), and three levels of window glazing. These measures are being evaluated for implementation in a single-family house with electric air conditioning and gas heating in Maryland. Group code "A" is used for the attic insulation alternatives, group code "B" for the two door alternatives, and group code "C" for the window-related alternatives. These three different groups of measures are evaluated independently here; that is, the level of implementation of any one group (e.g., the level of attic insulation) is not expected to significantly affect the energy savings in the other groups. For this reason the base level of energy consumption is the same for all three groups, and the reduced energy consumption levels for each implementation level are stated relative to that base, without consideration of the effects of the other group alternatives. The results of this analysis are shown in section 6.5.

Definitions of data related to individual project alternatives:

Alternative name--Each project alternative should have a distinct name, up to 12 characters.

Group Code--An alphanumeric code (one or two characters, case insensitive) used to identify a specific alternative as belonging to a specific group of alternatives. QI assumes that all of the alternatives in a particular group are mutually exclusive, i.e., only one of them will be selected (presumably the alternative with the lowest LCC). If you are going to evaluate more than one group of project alternatives in a single QI file, assign a different Group Code to each set of project alternatives. In figure 6-5, all five alternatives are for the same project (attic insulation) and thus are all identified with the same code, shown here as "A". If you want to add a second group of project alternatives to this file (e.g., window treatments), tag each alternative in the second group with a second Group Code (e.g., "W" for windows). When QI performs the LCC calculations, it will flag the alternative with the lowest LCC in each group. You do not need to list project alternatives together by Group Code; you can enter them in any order. Alternatives with the same Group Code are listed together in the QI LCC report. As explained in section 6.1, each group of project alternatives evaluated in the same QI file must be functionally independent.

Life--The expected life of this alternative, in years (or years/months, separated by a "/"). If the life of a project alternative extends beyond the end of the study period, QI will optionally calculate its residual value based on its remaining life, as explained in section 6.1. If no residual value is expected, set the life of the project alternative equal to the service period (the time from the service date to the end of the study period).

Initial Cost--The initial investment cost of the project alternative.

Replacements (Frequency and Cost)--Enter both the frequency, in years (or years/months), and the cost of the capital replacements (if any) for each project alternative. QI will automatically calculate capital replacement costs at the end of each replacement cycle, based on the frequency specified, up until the end of the study period, with the residual value of the last replacement based on its remaining life (if any). For example, if you specify a frequency of 10 years for a replacement in an LCC analysis with a service period of 25 years, a replacement cost will be included at the end of both the 10th and 20th year. The remaining life of the second replacement will be used to calculate its residual value at the end of the study period, as discussed in section 6.1. The replacement cycle is independent of the life of the initial investment.

Annually Recurring OM&R--The operating, maintenance, and repair cost for each project alternative that is assumed to occur in approximately the same amount each year (unadjusted for inflation), from the service date through the end of the study period.

Non-Annually Recurring OM&R (Frequency and Cost)--The sum of operating, maintenance, and repair costs for each project alternative that is expected to be incurred regularly, but not annually, starting with the service date. The frequency in years (or years/months) is used to repeat this cost at the specified intervals until the end of the study period. For example, if a frequency of five years is entered and the service period is 25 years, the same cost will be repeated at the end of each five year interval (including at the end of the 25th year). No residual value is calculated for these costs.

Annual Energy Use--The annual amount of energy usage, by energy type, for each project alternative. (Appropriate units are established in the file header data.)

If you specified that block rates for electricity costs are to be used in the QI calculations, press <F3> to display the form for entering monthly kWh usage at any time while you are in the project data entry form. Figure 6-6 shows this form. As with the form for entering data for project alternatives, this form scrolls to the right to access the later months and scrolls downward if more than 12 project alternatives are included. Press <Esc> to return to the project data form.

If you specified that demand costs for electricity are to be calculated rather than entered, press <F4> to display the form for entering monthly maximum kW by project alternative at any time while you are in the project data entry form. Figure 6-7 shows this form. This form also scrolls to the right to access the later months and scrolls downward if more than 12 project alternatives are included. Press <Esc> to return to the project data form.

PROJECT ALTERNATIVE		MONTHLY KWH CONSUMPTION						
#	NAME	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY
1	R-0	500	500	450	350	350	400	500
2	R-11	450	450	425	325	325	375	475
3	R-19	425	425	415	315	315	360	450
4	R-30	415	415	410	310	310	355	440
5	R-38	410	410	405	305	305	350	430

Figure 6-6. Data entry form for monthly kWh usage by project alternative (left side only shown).

PROJECT ALTERNATIVE		MONTHLY KWH CONSUMPTION						
#	NAME	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY
1	R-0	10.5	10.4	8.2	7.2	7.4	7.5	9.0
2	R-11	9.5	9.4	7.2	6.5	6.7	7.1	8.0
3	R-19	9.0	8.9	7.0	6.3	6.3	6.7	7.5
4	R-30	8.8	8.8	6.8	6.2	6.2	6.5	7.3
5	R-38	8.7	8.7	6.7	6.2	6.2	6.4	7.2

Figure 6-7. Data entry form for monthly maximum kW demand by project alternative (left side only).

After completing the data entry for individual project alternatives, press <PgDn>. Data entry is complete and now it is time to save the file.

6.3.5 Saving a QI File

After you have completed data entry for all of the project alternatives and pressed <PgDn>, you will be asked for a valid DOS filename for saving this QI file to the disk. Do not include the directory or the filename extension. The extension "QI" is automatically appended to all QI data files. In the edit mode you can overwrite the original file by using the same filename, or save the data to a new file (thus leaving the old file unchanged) by entering a new filename. Once the file is saved, you are returned to the main QI menu.

6.4 Printing a QI Input File

As with BLCC, you should print out the QI data file to check for input errors and to provide it as documentation along with any LCC analysis that you perform with the Quick Input program. To print out the QI data file in report format, select this option from the main menu. You can send this report to the printer or a disk file. If you send the report to a disk file, you must specify a valid DOS filename; the extension "QID" will automatically be appended to the filename. Table 6.2 provides an example of this report corresponding to the data input shown in figure 6-3 through 6-5.

Table 6.2 QI Input Data Report

QI filename = DEMO.QI
 Analysis type = General LCC Analysis--Non-Federal, No Taxes
 Project name = House Insulation
 Base Date of Study = 1996
 Service Date = 1996
 Study Period = 30 years
 Discount rate = 5.0%
 Inflation rate = 0.00%
 Cap replacements and residual values (if any) included as investment costs.
 Residual values automatically calculated for capital components.
 Residual values automatically calculated for capital replacements.

Common energy data	#1	#2	#3	#4
Energy type:	Electric	Nat.Gas		
Units:	(kWh)	(therm)		
Price per unit:	\$0.100	\$1.000		
Escalation type code:	2	2		

Data for DOE escalation rates:
 DOE Escalation Rate File = ENCOST96
 Rate Schedule Type = 1
 State Abbreviation = MD

DOE Price escalation rates for Electric					
Year	Rate(%)	Year	Rate(%)	Year	Rate(%)
-----	-----	-----	-----	-----	-----
1996	0.0447	2006	0.1969	2016	-0.1278
1997	0.1573	2007	0.7422	2017	-0.1066
1998	-0.1789	2008	0.9985	2018	-0.1068
1999	-0.0673	2009	0.9882	2019	-0.1069
2000	0.1568	2010	0.4481	2020	-0.1070
2001	0.5821	2011	-0.1059	2021	-0.1285
2002	0.7349	2012	-0.1060	2022	-0.1072
2003	0.4650	2013	-0.1274	2023	-0.1073
2004	0.2859	2014	-0.1063	2024	-0.1290
2005	0.1757	2015	-0.1064	2025	-0.1076

DOE Price escalation rates for Nat.Gas					
Year	Rate(%)	Year	Rate(%)	Year	Rate(%)
-----	-----	-----	-----	-----	-----
1996	2.7355	2006	1.2239	2016	0.4451
1997	2.4983	2007	0.6572	2017	0.4090
1998	1.6288	2008	0.8702	2018	0.4412
1999	1.1570	2009	1.3645	2019	0.4394
2000	1.3423	2010	1.0680	2020	0.3702
2001	1.3246	2011	0.4564	2021	0.3352
2002	1.2308	2012	0.4893	2022	0.3008
2003	0.8747	2013	0.4870	2023	0.2998
2004	0.6024	2014	0.5536	2024	0.3321
2005	1.2312	2015	0.5510	2025	0.2980

(continued on next page)

Table 6.2 QI Input Data Report (continued)

Number of alternatives in file = 11
 Number of groups in file = 3

ALT #	ALTERNATIVE NAME	GROUP CODE	LIFE (Y/M)	INITIAL COST(\$)	CAPITAL REPLACEMENTS		ANNUAL OM&R	NON-ANNUAL OM&R	
					FREQ*	COST(\$)	COST(\$)	FREQ*	COST(\$)
1	R-0 attic	A	30/0	0	0/0	0	0	0/0	0
2	R-11 attic	A	30/0	425	0/0	0	0	0/0	0
3	R-19 attic	A	30/0	625	0/0	0	0	0/0	0
4	R-30 attic	A	30/0	925	0/0	0	0	0/0	0
5	R-38 attic	A	30/0	1125	0/0	0	0	0/0	0
6	R-49 attic	A	30/0	1425	0/0	0	0	0/0	0
7	no strm door	B	0/0	0	0/0	0	0	0/0	0
8	storm door	B	15/0	150	15/0	130	0	7/6	20
9	single glass	C	30/0	2000	0/0	0	100	0/0	0
10	double glass	C	30/0	2500	15/0	300	125	5/0	100
11	triple glass	C	30/0	3000	15/0	400	150	5/0	100

*FREQ = Frequency of occurrence (in years/months)

ALT #	ALTERNATIVE NAME	GROUP CODE	ANNUAL ENERGY USE		AN. ELEC.
			Electric (kWh)	Nat.Gas (therm)	DEMAND CHARGE(\$)
			---#1---	---#2---	-----
1	R-0 attic	A	1465	625	0
2	R-11 attic	A	1231	465	0
3	R-19 attic	A	1177	440	0
4	R-30 attic	A	1138	420	0
5	R-38 attic	A	1123	415	0
6	R-49 attic	A	1109	410	0
7	no strm door	B	1465	625	0
8	storm door	B	1460	620	0
9	single glass	C	1465	625	0
10	double glass	C	1400	550	0
11	triple glass	C	1380	525	0

6.5 LCC Calculations with QI

After you have saved the QI data file, you can perform an LCC analysis of all projects and alternatives by selecting "LCC Calculations" from the main menu. You can send the LCC report to the screen or printer, or save it to a disk file. If you save the report to a disk file, you must specify a valid DOS filename. Do not enter the directory or filename extension. A filename extension of "QLR" will automatically be appended to the filename.

Table 6.3 provides an example of the LCC analysis report generated by the Quick Input program. The report shown here corresponds to the input data shown in table 6.2. The LCC report includes the basic assumptions common to all of the alternatives examined and shows the LCC of each alternative included in the file. The groups are reported in the order that they are entered into the data file. The alternatives within each group are arranged in increasing order of investment cost. The project alternative with the lowest LCC in each group is flagged and the Net Savings, Savings-to-Investment Ratio, and Adjusted Internal Rate of Return for each alternative are reported relative to the base case for that group (i.e., the alternative with the lowest investment cost in that group).

In the example shown in table 6.3 three groups of alternatives are reported: the attic insulation, storm door, and windows. The R-30 attic insulation, no storm door option, and double glazing options are shown to have the lowest LCC within the corresponding group. This example is based on hypothetical input data and is not meant to provide guidance for these particular energy conservation investments.

6.6 Generating BLCC Input Data Files

If you require a more detailed LCC analysis of any of the project alternatives using BLCC, the Quick Input program can generate the requisite BLCC input data files directly from the QI data file. From the main Quick Input Menu select "Generate BLCC Input Files." A list of all QI data files in the designated project files directory will be displayed to the screen. Use the cursor to highlight the QI file that contains the project alternatives of interest and press <Enter> to retrieve that file. Enter a five-character name to serve as the root filename for the BLCC files to be generated. Each file generated by QI will have a unique 1 to 3 digit serial number added to the root filename, as well as the filename extension of "DAT" required for all BLCC input data files. For example, if you enter the root filename "ABCDE", the first file to be generated will be ABCDE001.DAT, the second will be ABCDE002.DAT, and so forth. Note that if you use the name of an existing set of BLCC input files with the same root filename, the existing files with the same serial numbers will be overwritten without warning.

A list of all of the project alternatives in the file will be displayed to the screen, along with its LCC and the unique BLCC filename that will be assigned to that file if it is generated. Use the cursor to highlight the name of each project alternative for which you want to generate a BLCC file; then press the spacebar to tag it. (Press the spacebar again to untag the same alternative.) When all desired alternatives are tagged, press <Enter>. QI will generate the BLCC input data files and save them to the directory specified in the Setup procedure. After these files have been generated, QI will print a list of the project alternatives for which BLCC files were generated, along with their corresponding filenames, for future reference.

Table 6.3 QI LCC Analysis Report

BLCC Quick Input Program (QI2.2-96) 08-09-1995/09:54:06

QI filename = DEMO.QI
 Analysis type = General LCC Analysis--Non-Federal, No Taxes
 Project name = House Insulation
 Base date of study = 1996
 Service date = 1996
 Study Period = 30 years
 Discount rate = 5.0%
 Annually recurring costs and energy costs discounted from end of year.
 DOE energy price escalation rate file = ENCCOST96

Number of alternatives in file = 11
 Number of groups in file = 3

Note: Project alternatives displayed in increasing order of investment cost

Group code: A -----Present-Value Costs-----				
Alternative Name	Investment Costs*	OM&R Costs	Energy Costs	Total Life-Cycle Costs
R-0 attic	\$0	\$0	\$13498	\$13498
R-11 attic	\$425	\$0	\$10265	\$10690
R-19 attic	\$625	\$0	\$9733	\$10358
R-30 attic	\$925	\$0	\$9313	\$10238<--MIN LCC
R-38 attic	\$1125	\$0	\$9200	\$10325
R-49 attic	\$1425	\$0	\$9088	\$10513

Comparative measures are only calculated for the alternative with lowest LCC relative to alternative with the lowest present-value investment cost.

Comparative economic measures for R-30 attic relative to R-0 attic:

NET SAVINGS = \$3260; SIR = 4.52; AIRR = 10.42%
 Ratio of present-value energy savings to total savings = 1.00

* Investment costs include capital replacements and residual values (if any).
 Residual values for initial capital investment are calculated when life extends beyond end of study period.
 Residual values for capital replacements are calculated when life extends beyond end of study period.

Group code: B -----Present-Value Costs-----				
Alternative Name	Investment Costs*	OM&R Costs	Energy Costs	Total Life-Cycle Costs
no strm door	\$0	\$0	\$13498	\$13498<--MIN LCC
storm door	\$213	\$30	\$13401	\$13643

Comparative measures are only calculated for the alternative with lowest LCC relative to alternative with the lowest present-value investment cost.

Can't compute comparative economic measures for an alternative against itself.

* Investment costs include capital replacements and residual values (if any).
 Residual values for initial capital investment are calculated when life extends beyond end of study period.
 Residual values for capital replacements are calculated when life extends beyond end of study period.

(continued on next page)

Table 6.3 QI LCC Analysis Report (continued)

Group code: C	-----Present-Value Costs-----			
Alternative Name	Investment Costs*	OM&R Costs	Energy Costs	Total Life-Cycle Costs
single glass	\$2000	\$1567	\$13498	\$17066
double glass	\$2644	\$2177	\$12053	\$16874<--MIN LCC
triple glass	\$3192	\$2561	\$11574	\$17328

Comparative measures are only calculated for the alternative with lowest LCC relative to alternative with the lowest present-value investment cost.

Comparative economic measures for double glass relative to single glass:

NET SAVINGS = \$191; SIR = 1.30; AIRR = 5.91%
 Ratio of present-value energy savings to total savings = 1.00

* Investment costs include capital replacements and residual values (if any). Residual values for initial capital investment are calculated when life extends beyond end of study period. Residual values for capital replacements are calculated when life extends beyond end of study period.

The BLCC files generated by QI will appear in the list of available input files when you run BLCC and select "Edit Existing File" from the Main BLCC Menu. Note that BLCC cannot display more than 200 filenames when retrieving a list of available input data files from a designated subdirectory. If you are creating large number of these files, you may want to use different subdirectories for different sets of files.

When generating BLCC input data files from QI, the LCC calculations are not automatically performed as they are when a BLCC file is saved within BLCC. This means that you cannot yet print a detailed LCC report for this project alternative or perform a comparative analysis with other alternatives. You must first use BLCC in the file edit mode to read each new file and then resave it (with or without editing). Resaving the data file will force the LCC computations and create the corresponding LCC output file.

6.7 Appending Data for Project Alternatives to QI File

The BLCC Quick Input program was designed to allow the importation of data for project alternatives from other energy analysis programs, such as the DOE ASEAM 5.0 program. Once you have created a QI file with common "header" data, you can append cost, frequency, and energy usage data for individual project alternatives to the end of that file, following the data format described in this section. You can then run QI and compute the LCC of each of the project alternatives in the QI file by selecting the "LCC Computations" option from the QI menu. In the Quick Input file edit mode, you can add or modify cost data for each alternative. You can generate BLCC input files for any of the project alternatives once they have been properly appended to the QI data file.

Generally, the process of appending data for individual projects to a QI data file is managed by several lines of computer code that you (or the programmer) add to the energy analysis program. This code must be able to perform the following functions:

- (1) Request the name of the QI data file to which the cost and energy usage data will be appended.
- (2) Open the designated QI file in the APPEND mode; that is, in a way that will not write over the existing file but will add the new data to the end of the file.
- (3) After the energy usage for each project alternative has been computed, write data to the QI data file in the format shown below.
- (4) Close the file.

The format required to append project data to the end of QI data file includes one to three lines of data. Each line starts with a line code (6, 7, or 8) which is used by QI to determine how the data in that line will be read. Only the first line (line code 6) is mandatory for each project alternative evaluated; the second and third lines, which are for monthly kWh and kW data, are optional. All numeric values except the line codes themselves are real numbers (i.e., they can include a decimal point).

The first line contains all of the data specific to a project alternative except monthly kWh and kW data (if any). This line includes the energy type code and annual energy usage amount, EnergyType(i) and AnnualUsage(i), repeated for each energy type used with this project alternative (i = 1 to NE). The line must have the following format:

```
6, AltName, GroupCode, Life, InitialCost, ReplFreq, ReplCost,
ArcCost, NarcFreq, NarcCost, NE, EnergyType(1), AnnualUsage(1)...
```

where:

6--the line code for the first data line

AltName (string variable)--the name of the project alternative

GroupCode (string variable)--the group identifier (1 or 2 characters) for that alternative

Life--expected life of this project alternative

InitialCost--the initial cost of this project alternative

ReplFreq--the frequency of capital replacements (in years)

ReplCost--the cost of the capital replacement

ArcCost--the annually recurring OM&R cost

NarcFreq--the frequency of non-annually recurring OM&R costs (in years)

NarcCost--the non-annually recurring OM&R cost

NE--the number of energy types included in this line (maximum = 4)

EnergyType(i)--the energy type code used in QI and BLCC (1-11) for energy type i

AnnualUsage(i)--the annual energy usage for energy type i, in units designated in the header file (use 0 for electricity if monthly kWh are to be entered)

The minimum data requirements for appending this line to a QI file are: the alternative name, group code, life, initial cost, number of energy types included in this line (NE), and the energy type code and annual energy usage for each. Write a zero for any other variable for which no value is available; do not skip any variables. Commas must be inserted after all string variables but are optional after numeric variables. Do not include a comma within a string variable unless the string is included in quotes (e.g., "ALT 1,X"). All costs must be in base-year dollars. The variable NE does not have to

be the same as the number of energy types included in the header file, but it cannot be greater than that number, and only energy types included in the header file can be included in this data line.

Note: It is the programmer's responsibility to make sure that the energy types and energy units declared in the header data are consistent with the energy types and energy units that are computed and added to the QI data file by the energy analysis program.

No demand charge for electricity can be included directly in this data line. However, demand charges can be calculated in QI by including monthly kW demand data for the project alternative and using a demand rate file from the NIST ERATES program. See the information for writing monthly maximum kW to line 3 immediately below.

Data lines 2 and 3 are optional; use them only if block rate and demand rate files are specified in the QI file and these monthly kWh usage and maximum kW can be calculated in the energy analysis program. Monthly kWh usage must be included if monthly maximum kW demands are to be included, but the latter are optional even if the former are included.

line 2: Write monthly kWh usage to a single line:

```
7, kwh(1), kwh(2), kwh(3), kwh(4), kwh(5), kwh(6), kwh(7), kwh(8), kwh(9), kwh(10), kwh(11), kwh(12)
```

where:

7--line code for monthly kWh amounts, and
kwh(m)--monthly kWh usage in month m, m = 1 to 12.

line 3: Write monthly maximum kW usage to a single line:

```
8, kw(1), kw(2), kw(3), kw(4), kw(5), kw(6), kw(7), kw(8), kw(9), kw(10), kw(11), kw(12)
```

where:

8--line code for monthly kW amounts, and
kw(m)--maximum monthly kW demand in month m, m = 1 to 12.

Example

For a project alternative named "Alt 1" with group code "A", having a life of 15 years, a first cost of \$5,000, no replacement or OM&R costs, and two energy types: annual electricity (code type 1) usage of 8,000 kWh, and annual natural gas (code type 4) usage of 50 GJ, line 1 would be appended as follows:

```
6, "Alt 1", A, 15, 5000, 0, 0, 0, 0, 0, 2, 1, 8000, 4, 50
```

If monthly kWh and maximum kW demand values are to be included, the number of annual kWh should be set to zero and lines 7 and 8 provide the monthly kWh and kW amounts. The three lines would then look like:

```
6, "Alt 1", A, 15, 5000, 0, 0, 0, 0, 0, 2, 1, 0, 4, 50  
7, 500, 500, 500, 500, 600, 1000, 1000, 1000, 800, 600, 500, 500  
8, 10, 10, 10, 10, 12, 15, 15, 13, 12, 10, 10
```

6.8 Special starting features for QI

QI can be started with a command line option. The command line option is passed with the QI execution command (e.g., **QI2 /r**). The following command line options are intended to provide a LCC interface to the DOE ASEAM 5.0 program and were coordinated with the ASEAM programming team. If the interface feature requested cannot be completed successfully, an exit code of "-1" is passed with program termination; otherwise an exit code of "0" (null) is passed. (The "/" symbol indicating that an option is being passed can be substituted with a "-" symbol (i.e., both "/r" and "-r" have the same effect). In the following command line options, the brackets around the filename indicate that the filename is optional; do not include the brackets in the command line.

/r [filename]

Calculates LCC for QI data file *filename.QI* and saves results to text file *filename.QLR* (overwriting old *filename.QLR* without warning). If no filename is included in command line, QI will prompt user for the filename. If *filename.QI* does not exist, the program will terminate with exit code "-1".

/n [filename]

QI starts directly in file creation mode, bypassing main menu. QI file is saved as *filename.QI*. If *filename.QI* already exists, the user has the option of overwriting the existing file or returning to DOS with exit code "-1", but not of changing the filename. The user can create file header information, but not actual project cost and energy usage data (line item data). (Project cost and energy usage data will be provided by the building loads program.) If no filename is included in the command line, the program will prompt the user for filename. (It is assumed that project-specific data will be appended to the QI file by the building loads program.)

/e [filename]

QI starts directly in file edit mode, bypassing the main menu. The QI file is saved as *filename.QI*. The existing *filename.QI* file is automatically overwritten with updated file data. If no filename is included in the command line, the program will prompt the user for the filename. The user cannot edit the project cost and energy usage data (line item data). It is assumed that project-specific data will be appended to the QI file by the building loads program.

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