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SECRETARY OF THE AIR FORCE

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Civil Engineering

AIR FORCE MILITARY CONSTRUCTION AND FAMILY HOUSING ECONOMIC ANALYSIS GUIDE

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This manual implements AFPD 32-10, Installations and Facilities and AFPD 32-60 Housing. It provides guidance on the preparation of Economic Analyses (EAs) required as part of the project justification process for Military Construction (MILCON), Military Family Housing (MFH), and Energy Conservation Investment Program/Federal Energy Management Program (ECIP/FEMP) projects. This manual also implements instructions and guidance outlined in Air Force Instruction (AFI) 65-501, *Economic Analysis*, and Air Force Manual (AFMAN) 65-506, *Economic Analysis.* Users should send comments and suggested improvements on AF Form 847, Recommendation for Change of Publication, through MAJCOMs to HQ USAF/CEC, 1260 Air Force Pentagon, Washington DC 20330-1260.

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Chapter 1

INTRODUCTION

1.1. Introduction. The Military Construction and Family Housing Economic Analysis Guide provides guidance on the preparation of Economic Analyses EAs) required as part of the project justification process for facility Improvement, Replacement, and New Construction projects. A thorough and well documented EA is a critical factor in project approval and subsequent Congressional appropriation. As such, the purpose of this manual is to assist in conducting and documenting the results of EAs. The procedures and methodologies presented in this manual are based on Air Force Instruction (AFI) 65-501, *Economic Analysis.*

1.1.1. This manual is specifically targeted to assist analysts in conducting and documenting EAs for:

- Military Construction Projects (MILCON).
- Military Family Housing Projects.
- Energy Conservation Investment Program/Federal Energy Management Program (ECIP/FEMP) Projects.

1.1.2. A separate section is provided for MILCON, Family Housing, and ECIP/FEMP EAs. These sections include step-by-step guidance on how to conduct EAs, from defining the project objective to documenting the results.

Chapter 2

MILITARY CONSTRUCTION PROJECTS

2.1. Purpose. This section of the Military Construction and Family Housing Economic Analysis Guide provides guidance on the preparation of Economic Analyses (EAs) which are required as part of the project justification process for Military Construction (MILCON) Improvement, Replacement, and New Construction projects. A thorough and well documented EA is a critical factor in project approval and subsequent Congressional appropriation. As such, the purpose of this manual is to assist in conducting and documenting the results of EAs. This manual supersedes the Military Construction Program Economic Analysis Manual, dated Feb 94.

2.2. Facilities Covered. The procedures and methodologies presented in this manual implement Air Force Instruction (AFI) 65-501, *Economic Analysis*, and Air Force Manual (AFMAN) 65-506, *Economic Analysis.* The information contained in this section is relevant to all MILCON projects including:

- Administrative facilities.
- Transient quarters.
- Bachelor quarters.
- Maintenance facilities.
- Warehouses.
- Child care facilities.
- Mission support facilities.

2.3. Requirement. According to AFI 65-501, an EA is required for all construction and major repair or renovation projects when:

2.3.1. Investment costs equal or exceed $2 million. (Investment refers to costs associated with the acquisition of real property, non-recurring services, and start-up operation and maintenance (O&M). These are usually one-time costs, although they may be spread over several years.)

2.3.2. Investment costs are less than $2 million but the principal justification for the MILCON project is economic.

2.3.3. The facility would improve organizational or operational efficiency, including consolidation of like organizations into one facility.

2.3.4. The project consists of the disposal or major revitalization of many facilities that are energy inefficient or require excessive maintenance and repair (M&R).
2.3.5. The project is a candidate for private sector development (PSD).
2.3.6. The project involves non-permanent buildings supporting short-term facility requirements and the investment costs exceed $1 million, or if annual recurring costs exceed $200,000.
2.3.7. An EA is initiated as early as practical during the project planning process. An early start allows sufficient time to collect all the necessary data to conduct a superior life cycle cost analysis, provides better information for early program decision making, and lays the foundation for superior program support documentation. However, before you are unnecessarily burdened by these demanding requirements of completing a full EA, conduct a preliminary EA (see attachment 6) to provide an accurate and timely project recommendation to the decision maker.
2.3.8. An EA is updated when significant developments occur that would invalidate or significantly alter the conclusions. Specifically, EAs should be updated:

- When there is a change in project scope.
- If there are major changes in the initial study assumptions.
- When new alternatives are identified that appear to satisfy the stated requirement.
- If projects are moved between fiscal years and changes in the unit costs for construction, renovation, or any other significant cost element exceed local price changes.

2.3.9. For the summer review of the budget, the EA has to be only approximately correct and developed within the last 2 years. However, for the Budget Estimate Submission (BES), the EA must exactly match the programmed amount and scope.
2.3.10. An EA is not required if:

- The costs of conducting the analysis clearly outweigh the potential benefits accruing to the decision maker.
- The Office of the Secretary of Defense (OSD) or higher authority directs a new or modified program and specifies how to accomplish the program goals.
- Legislation or a prior irrevocable management decision specifically exempts the project from an EA.
- There is only one method possible to accomplish the objective.
- The project corrects problems or violations involving health, safety, fire protection, pollution, or security, which are serious, urgent, or hazardous.

2.3.11. If an EA is not conducted due to one of the reasons specified above, a Request for Waiver from an Economic Analysis is prepared by the sponsoring activity for the project. Figure 2.1 presents the waiver format as outlined in AFMAN 65-506, *Economic Analysis*. The base financial analysis office, comptroller, and his or her functional counterpart, as well as the MAJCOM must concur that a waiver is appropriate.

Figure 2.1. Request for Waiver from an Economic Analysis.

An Economic Analysis was not prepared for this project for the following reasons:
_____ a. Project cost or benefits to be derived do not warrant the level of effort required to prepare a full and complete analysis. The factors supporting this decision are attached.
_____ b. There is only one method possible to accomplish the objective. Documentation of this condition is attached.
_____ c. The project and the method to accomplish it was directed by _____ as shown in the attached documentation.
_____ d. Project results from specifically directed legislation which directs the method of accomplishment, as documented in the attachment.
_____ e. The project corrects problems or violations involving health, safety, fire protection, pollution, or security which are serious, urgent, and hazardous.
_____ f. Other (List specific reasons why analysis was not prepared).

Coordination at base/installation level:
Base Level Financial Analysis: (Signature)
(Name/Office Symbol/DSN/Date)

Concurrence by other Base Level Office: (Signature)
(Name/Office Symbol/DSN/Date)

Concurrence by other Base Level Office: (Signature)

(As applicable) (Name/Office Symbol/DSN/Date)

Concurrence by Base Level FM: (Signature)
(Name/Office Symbol/DSN/Date)

Figure 2.1. Continued.

Coordination at MAJCOM Levels:
MAJCOM Financial Analysis Office: (Signature)
(Name/Office Symbol/DSN/Date)

MAJCOM Functional Office: (Signature)
(Name/Office Symbol/DSN/Date)

Other MAJCOM Office: (Signature)
(As applicable) (Name/Office Symbol/DSN/Date)

Source: AFMAN 65-506

2.4. Project Coordination. According to AFI 65-501, the primary responsibility for performing the EA lies with the Financial Management (FM) staff at the affected organizational level. Collateral responsibility lies with the Civil Engineering (CE) staff and the project user. Therefore, completing the EA requires close coordination between CE, FM, and the end user of the facility. The initiating CE office shall contact the local FM office early in the process for guidance in preparing the EA. Figure 2.2 presents the responsibility matrix. Figure 2.3 outlines the approval process for MILCON EAs.

Figure 2.2. Military Construction Program/Economic Analysis Responsibility Matrix.

TASK	COMPTROLLER	ENGINEER	USER
Identify Need/Project Objective			OPR
Determine if EA Required	OCR	OPR	
Initiate Economic Analysis		OPR	
Identify Alternatives	OCR	OPR	OCR
Identify Data Requirements			
Cost Data	OPR	OCR	OCR
Engineering Data		OPR	OCR
Formulate Assumptions	OPR		
Data Collection			
Cost Data	OPR	OCR	OCR
Engineering Data	OCR	OPR	OCR
Calculate Life Cycle Costs	OPR		
Calculate Benefits Analysis	OPR	OCR	OCR
Select Alternatives/Formulate Recommendations	OCR	OPR	OCR
Identify Changes in Scope		OPR	
Conduct Sensitivity Analyses	OPR		
Documentation			
Cost Data	OPR		
Engineering Data		OPR	
Certification	OPR	OCR	OCR

OCR = Office of Collateral Responsibility
OPR = Office of Primary Responsibility
Source: AFI 65-501

2.5. Defining the Project, Formulating Assumptions, and Identifying Alternatives. A clear, concise statement of the project objective is necessary in order to identify potential alternatives for the project. This section will assist the analyst in accurately identifying the problem, defining the project objective, formulating assumptions, and identifying alternatives to meet the need.

Figure 2.3. Economic Analysis Approval Process for MILCON.

Level	Civil Engineer (Functional)	Financial Management (Technical)
Base	Identification of requirement, data collection, and submittal (Base CE)	Analysis and documentation (Base FM)
MAJCOM	Functional review and submittal (MAJCOM/CEC)	Technical certification (MAJCOM/FMA)
Air Staff/SAF	Functional validation and submittal (AF/CEC)	Technical validation (SAF/FMCE)
SAF	Approval and submittal to Congress (SAF/MII)	Coordination (SAF/FMC)
OSD	Economic Analysis used in program budget review	
Congress	Reporting requirement to statutory cost limits for Improvement or Replacement project, based on justification of Economic Analysis	

Note: At each level of the above approval process, the cooperative effort between CE and FM offices must be completed and coordinated before the EA package is forwarded by the CE office to the next higher level or returned to the next lower level.

2.5.1. **Collecting and Reviewing Background Information.** The analyst will collect and review all written documentation available that could affect any project alternatives. This review will include the most current DD Form 1391, FY 19__ Military Construction Project Data, and the attached construction cost estimate for the proposed project, previous EAs, the Base Comprehensive Plan (BCP), and the Requirements and Management Plan (RAMP). Next, interviews are conducted with personnel involved in the project planning process and with the current facility users. The current facility users are a good source for identifying deficiencies in the existing facility. All information is collected in writing, including the source of the data, and the name, organization, title, and phone number of each point of contact (POC). The signed source documents are presented in Appendix C of the EA.

2.5.1.1. The interviews and background data that is collected will assist project planners in answering the following questions:

- What is the problem?
- What is the total requirement both in size (i.e., number of square feet) and capacity (i.e., number of people)?
- What is the size and capacity of the existing facility?
- What is the age of the existing facility?
- When was the existing facility last renovated?
- Does the project include any buildings on the National Register of Historic Places or other historically sensitive programs?
- Does the project require asbestos, radon, or lead-based paint remediation?
- Does the existing facility meet health, fire, safety, and security requirements?
- Are O&M costs for the existing facility excessive?
- Is the existing facility efficiently utilized?
- Does the existing facility meet the functional needs of the users?
- Does the existing facility meet the requirements laid out in the Americans with Disabilities Act (ADA) for handicapped accessibility?

2.5.1.2. Many of these issues can impact the scope and cost of the proposed project. For example, a facility that is on or under consideration for addition to the National Register of Historic Places cannot be demolished and demands unique architectural/engineering compliance requirements for renovation. Traditionally, renovation costs are more expensive for historic buildings because the sources for replacement materials are unique, hard to find, and costly. Additionally, it is very difficult to achieve enhanced energy efficiency if modern energy efficiency features are not permissible. Finally, the construction of a new facility next to existing historical buildings may require the adoption of similar exterior architectural features, thereby increasing the construction costs.

2.5.1.3. Asbestos, radon, or lead-based paint in the existing facility can lead to costly abatement procedures which may impact the project schedule. These costs may be incurred if the facility is renovated or demolished, depending on the scope and type of remediation required.

2.5.1.4. In older facilities it can be very expensive to correct any health, fire, safety, and security deficiencies, or to upgrade the facility to meet ADA standards. Older facilities also tend to be less energy efficient and require more maintenance and repairs to keep them operational.
2.5.1.5. When reviewing the current facility situation, it is very important to consider the user. Does the existing facility meet the needs of the user? Are the current working conditions affecting morale? Is an organization disjointed and spread over several facilities? Would the organization work more efficiently if it were consolidated into one facility? Could labor time be saved or duplicate functions be eliminated as a result of a consolidation? It is important to address these and other types of user concerns when trying to define the requirement.
2.5.1.6. The following are possible facility deficiencies and other concerns that may need to be addressed for the proposed MILCON project.
2.5.1.7. Current Facility Deficiencies:
- Space shortage.
- Space inadequacy.
- Inefficient layout/utilization.
- Structural deficiency.
- Utilities deficiency.
- Inefficient energy use.
- Security deficiency.
- Excessive O&M costs.
- Health violation.
- Fire safety violation.
- Safety violation.
- ADA violation.
- Asbestos present.
- Lead-based paint present.
- Radon present.
- Environmental clean-up required.
- Other deficiencies (specify).

2.5.1.8. Other Issues:
- Mission expansion or change.
- National Register of Historic Places.
- Facility user concerns.

2.5.2. **Defining the Project Objective.** From the information collected, a clear, concise statement of the project objective should be developed. Most frequently, a MILCON project is proposed to correct one or more of the following deficiencies:
- A new functional requirement resulting from a new mission or change in mission.
- A space shortage.
- An engineering deficiency.
- A health, safety, fire, or security problem.
- Excessive operation and maintenance costs.
- Functional inadequacy, including facilities that do not meet current Air Force standards.
- An inefficient condition, including inefficient use of energy or space.

2.5.2.1. When writing the project objective, it is important that the statement not be biased toward any alternative. Also, the project objective should be quantified to the extent possible. Once the project objective is clearly defined, the analyst will identify alternatives that satisfy the requirement. Figure 2.4 presents examples of project objectives for several facility types.

Figure 2.4. Sample Project Objectives for Selected MILCON Projects.

Visiting Officer Quarters:	To provide suitable quarters for 100 officers and distinguished visitors on TDY to Bolling AFB.
Bachelor Enlisted Quarters:	To provide suitable housing for the 120 enlisted military personnel due to arrive in FY95 to support the new air wing.

Warehouse: To provide 40,000 square feet of covered secure storage for war readiness materials, alternate mission equipment, communications scheme assets, and other base supplies and materials used to support the wing mission.

Figure 2.4. Continued.

Squadron Operations Facility:	To provide 960 square feet to accommodate the new mission requirements of the 605th Airlift Support Group and the addition of the 605th Maintenance and Aerial Port Squadrons to the existing HQ facility.
Parking Garage:	To provide 295 additional parking spaces to support daily faculty/staff requirements and special events.
Administrative Facility:	To consolidate the base procurement activities in order to facilitate employee interaction, eliminate duplicate functions, increase security, and improve the morale and productivity of the employees.

2.5.3. **Formulating Assumptions.** EAs are based on facts and data pertaining to the project in question. However, an EA deals with costs and benefits occurring in the future. Since the future is unpredictable, assumptions and sensitivity analyses are prepared to account for uncertainties. To avoid invalidation or bias of the analysis, assumptions based on realistic assessments or anticipated conditions should be made only by qualified individuals.

2.5.3.1. There are several common assumptions made when preparing an EA for a MILCON Project:

2.5.3.1.1. Economic Life of the Project. The economic life for MILCON projects is different for each facility type. However, the economic life of a renovated facility is normally less than a newly constructed facility.

2.5.3.1.2. Residual Value. Residual Value is the depreciated value of the facility. The start value for a replaced or newly constructed facility is defined as the total DD Form 1391 construction cost, including Contingency, and Supervision, Inspection, and Overhead (SIOH). It does not include demolition costs. Residual value is normally calculated using straight-line depreciation of the start value over the project's economic life.

2.5.3.1.3. Inflation. In a constant-dollar analysis, costs and benefits are estimated based on constant purchasing power of the dollar. Therefore, inflation adjustments are made only for those cost elements for which anticipated price increases exceed the general inflation rate. However, when historical data is used to estimate future costs, historical costs must be inflated to the base year (usually the project year) of the analysis. CE or FM staff may perform this task. It is critical that the source documents indicate the effective year for all cost/price information used in the analysis so that the analyst and reviewers know that appropriate escalation and discount values have been applied. The source and date of inflation indices must be documented.

2.5.3.1.4. Base Year. A constant dollar analysis requires that all costs be converted to a common, or base, year to permit equitable comparison of those values. Typically, the project year is defined as the base year for a given EA. Various tables, such as the "USAF Raw Inflation Indices" and the "DRI Energy Inflation Indices" found on the Financial Management Analysis Bulletin Board (FMABB), contain the factors used to make these conversions. See attachment 1 for the complete definition of and instructions for accessing the FMABB.

2.5.3.1.5. Discount Rate. The discount rate is used to account for the time value of money when comparing the cost of alternatives over several years. Most EAs performed to support Air Force MILCON programs should be priced in constant dollars and discounted at the interest rate published in the most recent President's Budget (PB). The PB is published in January or February of each year and includes both the constant and current-dollar discount rates to be used in EAs. SAF/FMCE will provide the annual discount rates on the FMABB. These discount rates reflect the latest values contained in the Office of Management and Budget (OMB) Circular A-94.

2.5.3.1.6. Cost Savings. Maintenance and Repair (M&R) and energy costs are usually lower for renovation and/or new construction projects than for Status Quo alternatives due to the increased efficiency of these facilities. Cost savings estimates are generally made relative to the current Status Quo values in the EA.

2.5.3.2. Additional assumptions may be required when project data is unavailable, when future costs are uncertain, or when a project involves unique circumstances.

2.5.4. **Identifying Alternatives.** For MILCON projects, there are typically five alternatives available to meet the objective:

- Status Quo.
- Improvement.
- New Construction or Replacement.
- Government Leasing.
- Private Sector Development.

2.5.4.1. The Status Quo alternative is considered the baseline for the EA. The Status Quo can be one or a combination of scenarios. Four common examples are:

2.5.4.1.1. The continued use and operation of existing facilities in their current condition.
2.5.4.1.2. The continued payment of Basic Allowance for Quarters (BAQ) and Variable Housing Allowance (VHA) to personnel living off base in private residential housing when there is insufficient dormitory space on base.
2.5.4.1.3. The continued payment of lodging per diem to personnel on TDY when there are insufficient transient quarters on base.
2.5.4.1.4. The continued use of temporary leased space in a privately owned facility off base.
2.5.4.2. The Improvement alternative involves renovating an existing facility to eliminate deficiencies and/or reduce future maintenance and repair costs, altering the facility to improve its operating efficiency, or constructing an addition to the facility to increase space. Various levels of improvements can be addressed as alternatives, from minimal correction of life-safety deficiencies to comprehensive "gut and rebuild" efforts. The actual work to be performed is explicitly documented in the EA.
2.5.4.3. The New Construction or Replacement alternative consists of the construction of a new facility in order to eliminate an existing shortage or deficiency, to meet a shortage or deficiency created by a new mission or mission change, or to replace a substandard facility. If new construction involves replacing an existing facility, then the disposal of the existing facility is addressed.
2.5.4.4. A Government Leasing alternative involves direct, long-term leasing by the Air Force of a suitable, privately owned facility off base. GSA handles long-term leases for general-purpose facilities. If leasing is used to replace an existing facility, then the disposal of the existing facility is addressed.
2.5.4.5. The Private Sector Development (PSD) alternative uses private sector resources and knowledge to provide facilities for the Air Force. At this time, PSD is only feasible in cases where no direct payment or guarantees are provided by the Air Force. However, new legislation is expected to be enacted to allow for direct payment and guarantees for family housing and possibly dormitories.
2.5.4.6. In the case of a transient or bachelor quarters requirement, a Direct Compensation alternative may also need to be considered. This will happen when:

- There is suitable housing off base for non-mission essential personnel within the allowable BAQ/VHA rates.
- There is suitable lodging available off base for TDY personnel within the allowable per diem.

2.5.4.6.1. A market analysis of the local hotel or housing market is normally conducted to assess the viability of a Direct Compensation alternative.
2.5.4.6.2. It is also important to remember that improved facilities are just one way of meeting a need. Other alternatives may include making operations more efficient so that a new facility is not required. For instance, a shortage of warehouse space may be compensated for by acquiring new handling and stacking equipment that allows more efficient use of vertical space (i.e., cubed footage) or instituting just-in-time parts provision procedures. Another solution may involve consolidating related functions to make better use of existing or new space. These innovative approaches to meeting space requirements can result in significant cost savings, and may offer the added benefit of improving operational efficiency and/or productivity.
2.5.4.6.3. The above-mentioned alternatives are the ones most frequently addressed in MILCON EAs. However, an analyst should always aggressively pursue all possible realistic alternatives, since the final decision can be no better than the available choices. Throughout the EA process, the analyst will continually consider accepting new alternatives and discarding old ones.
2.5.4.6.4. Occasionally, after a complete review of the facts and circumstances pertaining to the proposed project, the analyst may conclude that there is only one feasible alternative. In this case, a waiver or exemption from the requirement for an EA is required (see figure 2.1). This certificate must include all of the signatures required for a complete EA.
2.5.4.6.5. Cost is not a basis for infeasibility. If an alternative is selected based on cost, then an EA must be developed.
2.5.5. **Disposing of Existing Facilities.** If the alternative involves replacing the current facility either by means of new construction, Private Sector Development (PSD), or a long-term lease, the issue of what to do with the existing facility must be addressed. There are three common disposal practices:
2.5.5.1. Converting the facility to another use. This is normally only an option if an existing need could be met by the conversion. Conversion and operating costs are assumed to be borne by the new occupant and are not included in the economic analysis.
2.5.5.2. Demolishing the facility. This option is considered whenever the existing facility is substandard, if its site is required for a new facility, or if there is no other potential use for it. Facilities are a resource, however, so before demolition is selected, a review of all possible current or future uses needs to be conducted. The cost of demolition is included in the EA.
2.5.5.3. Placing the facility in protective storage. This option involves closing up the facility and preserving it for potential future use by providing periodic maintenance to preserve its structural integrity; "mothballing" and "pickling" are colloquial terms for protective storage. The O&M costs associated with protective storage are included in the EA.

2.6. Data Collection for the Economic Analysis. This section discusses the data collection requirements normally included in a MILCON Economic Analysis. The costs associated with each alternative under consideration must be quantified and included in the EA calculations. All costs the facility is expected to incur over the life of each alternative, except sunk costs, are included in the life cycle cost analysis. Sunk costs are expenditures which are incurred before the project has received final approval. These costs would not be recovered regardless of the alternative selected. Examples of sunk costs include: project planning, preliminary design, and preparation of the economic analysis itself. Design costs are considered sunk if they are obligated or spent prior to selection of an alternative. The amount of design costs that are considered sunk will vary based on the project.

2.6.1. **Construction and Other One-Time Costs.** Most one-time costs normally occur early in a project's life cycle. Construction costs are usually the most significant. However, all other one-time costs are also considered.

2.6.1.1. Construction/Improvement Costs. Construction/Improvement costs include design fees for the primary facility or building addition, demolition, site preparation, utilities, roads and pavements, contingencies, and Supervision, Inspection, and Overhead (SIOH). Since the largest percentage of the project cost is determined by the scope of the Improvement or New Construction project, it is imperative that all primary and support costs are considered in the EA. Equally important is the need for accurate and complete cost estimating capabilities. Parametric cost estimating systems, such as the Parametric Cost Engineering System (PACES), allow the user to quickly and accurately compile costs for multiple project construction or renovation alternatives.

2.6.1.1.1. Construction/Improvement costs are thoroughly documented on the DD Form 1391 and attachments. The DD Form 1391 and attachments for an EA include:

- The project title, project number, and alternative name.
- The scope of the estimate in square feet.
- A brief description of the costing methodology or estimating system used.
- Dated sources for variables, such as area cost factors and escalation factors.
- The base year of the project cost.
- Authority signature for the estimate.

2.6.1.1.2. The estimate shows all interim calculations so that the values can be tracked from the source data to the total project cost appearing on the DD Form 1391 and in the Life Cycle Cost Report. Clear documentation speeds review of the EA. In addition, a clearly documented DD Form 1391 can be easily updated when the source data changes or when the project is changed for a different program year.

2.6.1.1.3. When compiling project costs, special attention is also given to ensure that all costs associated with a renovation alternative, such as asbestos abatement, lead-based paint remediation, environmental compliance, etc., have been considered.

2.6.1.2. Other One-Time Costs. Accurate assessment and inclusion of other one-time costs is imperative to ensure a complete EA. Examples of one-time costs include:

- The moving and storage of furnishings and equipment when users are relocated.
- The disposal and replacement of furnishings and equipment.
- Lease payments made for temporary off-base space.
- Temporary contracting out of the requirement.
- Tenant build-out requirements involving renovations to the temporary space in order to make the facility meet the users' needs.

2.6.1.2.1. All attempts should be made to time facility replacement or improvement construction activities to correspond with the expected requirement. However, even with the best scheduling attempts, temporary accommodations may be required. Occasionally, contracting out the requirement may be feasible and economical. In other cases, users may require temporary accommodations. For renovation alternatives, this may involve moving the users into temporary leased space while the existing facility is being improved and, following completion of the project, moving into the completed facility. Lease rates are discussed below in paragraph 2.6.2.4. Moving and storage costs (drayage) can be obtained from the base transportation office. The Interstate Commerce Commission can also provide approximate moving costs based on weight, as well as requirements for cartons and custom-built crates. In addition, some tenant build-out, such as partitions, power, and telecommunications, may be required to meet the users' requirements.

2.6.1.2.2. The improvement or replacement of a dormitory can result in some unique one-time costs, such as:

- Reconnection fees associated with telephone and cable television service.
- The moving and storage of personal belongings for dormitory residents.
- BAQ/VHA payments made to personnel in temporary housing off base.

2.6.1.2.3. As with other MILCON projects, all attempts should be made to schedule or phase dormitory improvements or replacements so as to minimize these one-time costs.

2.6.2. **Recurring Costs.** Recurring costs are the repetitive costs required to operate and maintain a facility. They are generally calculated on an annual basis. Examples of recurring costs include:

- Maintenance and repair of the facility.
- Utilities, such as electricity, natural gas, steam, water, and sewer.
- Personnel costs, such as building management, lease management, custodial service, and security service.
- Lease costs.
- Miscellaneous costs, such as grounds maintenance, landscaping, and snow removal.

2.6.2.1. Maintenance and Repair Costs. Maintenance and Repair (M&R) Costs include both Annual M&R and Periodic M&R. Annual M&R expenses include preventive maintenance, unscheduled plumbing and electrical repairs, and minor structural repairs that are required to ensure a safe and efficient work or living environment. Periodic M&R expenses include major repairs to building components, such as roof systems, electrical systems, HVAC, plumbing fixtures, and interior finishes. These costs can be estimated based on the expected life of the building system.

2.6.2.1.1. When an existing facility is associated with the Status Quo alternative, Historical Annual M&R costs are used to project future Annual M&R costs in the EA. The analyst should collect and review at least 3 years of data in order to develop a valid estimate. The Work Information Management System (WIMS) maintenance records maintained by CE are the best source for the Annual M&R data. All historical costs are adjusted for inflation to the base year in the EA.

2.6.2.1.2. Renovation and replacement alternatives typically have lower Annual M&R costs than the Status Quo alternative. Therefore, the historical M&R cost data are normally adjusted downward by an assumed percentage (25 to 40 percent, based on engineering judgment) for the improvement and replacement alternatives. These assumptions must be clearly stated in the EA. The Building Age Multiplier (BAM) factors presented in figure 2.5 are used to adjust annual M&R costs over the life of the improved or new facility.

2.6.2.1.3. Periodic M&R schedules are based on the expected life of the equipment or fixtures. CE can provide the date the item was last replaced so that the analyst can project future schedules and costs under the Status Quo alternative. Renovation and new construction alternatives generally begin with all new equipment; hence, replacement schedules are based on the construction date. It is important to remember that scheduled intervals will often vary based on local conditions. For example, the salt air in marine environments corrodes and shortens the expected lives of exterior mechanical units, roof membranes and drainage systems, window frames, exterior doors, etc. Figure 2.6 displays the generally accepted useful lives of various equipment and fixtures.

Figure 2.5. Building Age Multiplier Factors.

Years	BAM
0-9	1.0
10-19	1.4
20-29	1.9
30-39	2.1
40-49	2.1
50+	1.65

Source: Oak Ridge National Laboratory Manual, 1987.

2.6.2.1.3. Periodic M&R schedules are based on the expected life of the equipment or fixtures. CE can provide the date the item was last replaced so that the analyst can project future schedules and costs under the Status Quo alternative. Renovation and new construction alternatives generally begin with all new equipment; hence, replacement schedules are based on the construction date. It is important to remember that scheduled intervals will often vary based on local conditions. For example, the salt air in marine environments corrodes and shortens the expected lives of exterior mechanical units, roof membranes and drainage systems, window frames, exterior doors, etc. Figure 2.6 displays the generally accepted useful lives of various equipment and fixtures.

Figure 2.6. Life Cycles of Selected Building Systems.

Roof Systems	20 years
Plumbing	30 years
Sprinklers (Fire Protection)	30 years
Electrical	20 years

HVAC	20 years
Elevators	20 years
Alarms/Intercom	20 years
Interior Finishes	10 years
Pavements and Walkways	15 years

Source: "Suggested Average Useful Life of Building Components," *MEANS Facility Maintenance Standards.*

2.6.2.1.4. Periodic M&R costs can be estimated from local prices or by using the cost of any recent replacement of similar items, including appropriate labor fees. If such cost data is unavailable, commercial sources, such as *R.S. Means* or *Dodge Cost Data* can be used and documented. Another possible source would be comparable maintenance and repair costs from another installation for a similar facility.

2.6.2.2. Utility Costs. Utility costs include the expenses associated with the provision of utility services, such as:

- Electricity.
- Natural gas or oil.
- Steam.
- Water.
- Sewage.
- Telecommunications.

2.6.2.2.1. Figure 2.7 presents an example of the methodology used to estimate annual electricity costs for all alternatives based on an area (square footage) basis; other energy-consuming utility costs can be similarly calculated. The analyst uses annual utility usage and facility size for similar facility types to estimate utility costs for the proposed facility. The most accurate estimates of utility costs are available when bases can meter utility usage at the facility level. Utility bills or Defense Utility Energy Reporting System (DUERS) reports provide total utility consumption figures for the facility. DUERS or WIMS can also provide the necessary area figures. CE is the best source for this data. If possible, usage rates from 3 previous years are averaged after adjusting them to the base year of the EA. Data Resources Inc. (DRI) Energy Inflation Indices are used to inflate energy costs to the base year. This data is available from the FMABB.

Figure 2.7. Calculation of Annual Electricity Costs on an Area Basis.

Status Quo (or comparable facility)

Three Year Average:

Year	Annual Cost	Inflation Index	Total Cost $ 1995			Avg Cost $ 1995
1990	70,550	1.109	78,240			
1991	67,023	1.049	70,307			
1992	70,374	1.028	72,344			
			220,891	÷	3	= 73,630

Status Quo Cost per Square Foot Calculation:

Avg Cost $ 1995		Total Area (SF)		Cost/SF $ 1995
73,630	/	83,000	=	0.887

Renovation

Status Quo Cost/SF $1995:		25% Estimated Savings		Cost/SF $1995		Net Square Ft:		Total Cost $1995
0.887	x	0.75	=	0.665	x	83,000	=	55,195

Replacement

Status Quo Cost/SF $1995:		30% Estimated Savings		Cost/SF $1995		Net Square Ft:		Total Cost $1995
0.887	x	0.70	=	0.621	x	78,000	=	48,438

Government Lease
Cost included in lease rate.

2.6.2.2.2. Non-energy-consuming utilities such as water, sewage, and telecommunications can also be calculated based on a three-year average. Since improvement or replacement usually will not influence these usage rates, status quo values can be used for all alternatives where the same users will move back into the facility. The analyst should inflate non-energy costs to the base year using the Air Force Raw Inflation Table for the O&M account on the FMABB maintained by SAF/FMC.
2.6.2.3. Personnel Costs. Personnel costs include the costs of staffing building services, such as building management, lease management, security, and custodial services. Personnel costs are calculated as the product of the number of personnel and their burdened salary. Different alternatives or alternative facility designs can result in dramatically different personnel costs. For example, a facility with a small number of exterior entrances would require fewer security personnel than a design with numerous entry points or multiple, unconsolidated facilities. Or, a bachelor quarters with exterior walkways would require fewer custodial personnel than bachelor quarters with interior corridors.
2.6.2.3.1. For transient quarters, personnel costs also include maid service and the front desk operation. Figure 2.8 presents an example for estimating annual personnel costs for a new bachelor quarters facility. Consult the FMABB for the most recent tables of Military and Civilian Compensation.
2.6.2.4. Lease Costs. Lease costs are associated with using off-base facilities on either a temporary or long-term basis. If there is an existing Air Force lease of similar space off base, then that lease rate per square foot is used to estimate future lease costs for either temporary space or a long-term requirement under a Government Lease Alternative. If there is not an existing Air Force lease, then the General Services Administration (GSA) lease rates for the appropriate geographic area are used. The base office responsible for real property management can normally provide the GSA space rates. For most facility types, Air Force leases are negotiated and managed by GSA. GSA rates are provided by functional space type (e.g. office, conference, storage, laboratory, industrial). GSA lease rates are typically gross leases--that is, the lease rate includes reimbursements for services like maintenance and utilities. Gross leases are also known as “full service” leases. The Air Force has authority to negotiate and manage leases directly for land and unique, special-purpose facilities.

Figure 2.8. Calculation of Annual Personnel Costs for a Bachelor Quarters.

Position	Grade	No.	FY95 Annual Composite Rate	Total Cost
Administrative Staff				
Manager	E-7	1	$49,452	$49,452
Assistant Manager	E-6	2	43,485	86,970
Desk watch	E-4	5	30,981	154,905
				291,327
Custodial Staff				
Custodian	E-3	4	26,176	104,704

Source: FMABB.

2.6.2.4.1. Leases for temporary space below the prospectus level can be implemented relatively quickly. The prospectus level is roughly $1.6 million in constant year FY94 dollars. Leases above the prospectus level require a longer approval process.
2.6.2.5. Miscellaneous Costs. Miscellaneous costs include grounds care and landscaping, trash removal, snow removal, and other building services provided under contract. Many building services could be estimated either under personnel costs, if the services are provided by base personnel, or under miscellaneous costs, if the services are provided by a contractor. For administrative facilities, the median cost per square foot for building services can be obtained from the Building Owners and Manager's (BOMA) Experience Exchange Report (BOMA International, Washington, DC, (202) 408-2662).
2.6.2.5.1. For a bachelor quarters facility, the primary cost element associated with a Direct Compensation (or Status Quo) alternative is BAQ/VHA payments. Both BAQ and VHA payments are based on grade; however, BAQ payments are uniform Air Force wide, whereas VHA is based on the geographic location of the military personnel. BAQ/VHA data can be obtained from the Financial Services Office.

2.6.2.5.2. For a transient quarters facility, the primary cost element associated with a Direct Compensation (or Status Quo) alternative is lodging per diem payments. The base billeting office can provide lodging per diem rates for the geographic area. Where there are no existing transient quarters, the billeting office can also provide the number of "Certificates of Non-Availability" that have been issued over the last 3 years.
2.6.2.5.3. BAQ/VHA or per diem payments may also be incurred when users need to find temporary accommodations off base during a Renovation or New Construction project for bachelor or transient quarters. These costs would be incurred in accordance with the construction schedule.
2.6.2.5.4. Figure 2.9 summarizes the suggested data sources for obtaining the data required to conduct a MILCON EA.
2.6.3. **Project Schedule.** The project schedule provides information about project phasing and facility occupancy under each alternative. Many costs associated with the existing situation continue to be incurred during the construction period. In general, cost savings, such as lower utility costs, cannot be realized until the new facility is occupied and the old facility has been disposed.
2.6.3.1. Where the project schedule allows for phased occupancy, costs such as Annual M&R and utilities are pro-rated. The occupancy or "move-in" date may vary for some alternatives due to different time factors associated with the construction period, approvals, and the solicitation process.

2.7. Conducting the Benefits Analysis. A benefits analysis takes into account many of the intangibles that are normally difficult to assess in an EA. Examples of benefits which might be considered are presented in figure 2.10. The list in figure 2.10 is by no means exhaustive, but it does include many of the benefits which are normally considered when evaluating MILCON projects.
2.7.1. The FM analyst is responsible for conducting the benefits analysis. However, input should be provided by a variety of installation functions including, but not limited to, the primary user or beneficiary of services from the facility, CE, services, security police, transportation, and other appropriate agencies. One effective approach is to convene a "roundtable" discussion with all participating organizations to determine benefit categories and weights, and to score each alternative. FM should prepare a source document for the benefits analysis showing participants, assumptions, rationale for benefit selection, and sources. This document must be signed and included in Appendix C of the EA.

Figure 2.9. Summary of Data Sources for MILCON Eas.

	Primary Source	**Other Sources**
Construction Costs	DD Form 1391	PACES, Means, Air Force Historical Cost
Annual M&R Costs	WIMS BCE (actual past M&R costs for a particular facility type or building)	DEMRC: Form 1133 BCE: RCS HAF LEE (SA) 7101
Periodic M&R Costs	WIMS BCE (same as above)	DEMRC: Individual facility jackets, Means or Dodge
Utility Costs	DUERS, WIMS	BCE: RCS HAF LEE (SA) 7101, MAJCOM consumption report
Miscellaneous Operations and Maintenance Costs	Base Contracting Office, Facilities Management Office, Base Transportation Office	Means, Dodge
Lease Costs	Base Real Property Office	Off-base real estate broker, GSA
BAQ/VHA	Financial Management Office	Housing Office
Per Diem	Base Billeting Office	

Discount Rates and Inflation Indices	FMABB

2.7.2. Each project will have its own set of benefits to assess. Each benefit is ranked in order of importance and is provided a "weight point." The next step is to estimate how well each alternative meets the objective. For example, a scale from 100 percent (Optimum Solution) to 0 percent (Does Not Meet Objectives) is used. Finally, the percentage estimate and the weight points assigned to each particular benefit are multiplied to determine the benefit value. The sum of the benefit values is the benefit score for that alternative. The alternative with the highest benefit score is the alternative which would yield the most benefit to the Air Force.
2.7.3. It is important to understand how the weight point rankings work mathematically. For example, if a weight point of 1 is assigned for security, 2 for morale, and 3 for health/safety, these rankings indicate that morale is valued twice as much as security, and health/safety 3 times as much as security. Hence, there may be situations where assigning a fractional weight point, such as 1.25 or 1.5, may be appropriate. Additionally, alternatives may have benefits with equal weights. Figure 2.11 presents an example of a benefits analysis conducted for a typical Air Force base.

2.8. Conducting the Economic Analysis and Analyzing the Results. The purpose of an EA is to determine the cost and benefits to the Air Force of each alternative that is being considered for satisfying the current objective. The analysis method generally uses a life cycle cost approach to determine the total net present value costs of each alternative. The Air Force normally uses a mid-year discounting convention. The evaluation of net present value provides the Air Force with a method of comparing the costs of alternatives with different economic lives.
2.8.1. The concept of present value is fundamental to the economic analysis. Present value calculations allow comparison of different dollar amounts received or expended during different time periods. Discounting is the technique used to determine the present value of future cash flows. The discounting process allows the analyst to take into account the fact that money received or expended today is worth more than the same amount of money received in the future, even after adjustment for inflation.

Figure 2.10. Benefits for Consideration For MILCON Projects.

Accessibility - The extent to which a service or facility is accessible to the users. This can include location, transportation, and parking issues.

Availability of Base Services/Activities - The location of the proposed project relative to the other services and activities on base.

Environmental Impact - The evaluation of the potential environmental impact of each of the alternatives under consideration to meet the objective.

Facility Adequacy - This criterion measures the extent to which a facility or service meets the needs of its user. Issues include: "Is there sufficient space/capacity?", "Is the layout compatible with the user?", "Are the utilities reliable?", etc.

Health/Safety - This criterion allows the analyst to assess the health and safety environments that would be provided under each alternative.

Historic Preservation - This factor needs to be addressed if the existing facility or a facility considered in one of the alternatives is of historic value and is likely to be altered or demolished.

Land Use Compatibility - The analyst should assess the suitability of the site selection or location of each of the alternatives relative to the adjacent facilities and the base comprehensive plan.

Maintenance - Newly constructed or improved facilities are easier to maintain and service. Many of these potential cost savings can be quantified and included in the life cycle cost analysis. Those benefits which cannot be quantified should be addressed here.

Mission/Operational Impact - Some alternatives will have a positive impact on the mission or operations of the affected organization. A new or improved facility may increase the productivity or efficiency of its workers. If these increases can be quantified, they should be included in the life cycle cost analysis.

Morale - Morale is important both to performance and retention of Air Force personnel.

Off-base Effects - Off-base socioeconomic effects may be a consideration if a substantial increase in assigned personnel is anticipated. The criterion can also be used if an alternative under consideration for the base would result in either an increase or decrease in dollars spent in the local community.

Security **-** Security refers to the ability of a facility to protect the resources it houses. Security requirements differ depending on the function performed and are often specified in Air Force regulations. If the security needs can be quantified across alternatives, then these costs should be included in the life cycle cost analysis.

Figure 2.11. Example Benefits Analysis.

	Status Quo			Improvement		Replacement	
	A	**B**	**C**	**D**	**E**	**F**	**G**
	Weight Pts.	**%**	**Benefit**	**%**	**Benefit**	**%**	**Benefit**
Mission/ Operational Impact	4.0	35	1.40	75	3.00	100	4.00
Health/Safety	2.0	30	.60	80	1.60	95	1.90
Security	1.5	20	.30	70	1.05	95	1.43
Maintenance	1.0	20	.20	80	.80	90	.90
Total Benefit Score			2.50		6.45		8.23

Scale: 100% Optimum Solution
0% Does not meet Objectives

2.8.2. Most EAs that are performed to support Air Force MILCON projects are priced in constant dollars and discounted at the rate prescribed in the President's Budget. This is based on current Office of Management and Budget (OMB) guidance outlined in OMB Circular A-94. The base year used in the EA is the program year for which initial funding is requested.
2.8.3. However, if future costs and benefits are collected in nominal (i.e. inflated) dollars, the analysis should then be conducted in inflated dollars. Since leases are often stated in inflated dollars, an analysis with a leasing alternative is an example of an EA in which inflated dollars may be appropriate. If the cost of a lease is stated in constant dollars, then the EA should be conducted in constant dollars.
2.8.4. The Air Force recommends using the PC-ECONPACK software package in the preparation of EAs for MILCON projects. PC-ECONPACK is available from the US Army Corps of Engineers. For information on how to use PC-ECONPACK, refer to the PC-ECONPACK User's Manual or hotline. For more information on obtaining PC-ECONPACK, see attachment 1.
2.8.4.1. The National Institute of Science and Technology’s Building Life Cycle Cost (BLCC) or DISCOUNT programs, developed for more general applications, are also acceptable for use in generating Economic Analyses for MILCON projects. However, it should be noted that the BLCC program does not provide reports formatted consistent with DoD report formats.
2.8.5. **Overview of PC-ECONPACK.** This section presents an overview of PC-ECONPACK and its application to MILCON EAs. PC-ECONPACK is a comprehensive program incorporating EA calculations, documentation, and reporting capabilities. It was developed and structured for use by non-economists for the preparation of complete, properly documented EAs in support of DoD funding requests. PC-ECONPACK is menu-driven and features interactive display screens which enable the user to select analysis parameters and to specify functions.
2.8.5.1. PC-ECONPACK version 4.0 is designed to be used on IBM personal computers and IBM compatible hardware equipped with at least 5 megabytes of storage available on one disk drive and 640K Random Access Memory (RAM). At a minimum, a ten megabyte hard disk is recommended for running PC-ECONPACK. The operating system needed to run PC-ECONPACK on a personal computer is Microsoft's Disk Operating System (DOS) version 2.2 or higher.
2.8.5.2. There are several advantages to using the PC-ECONPACK computer program to conduct EAs:
- Individuals having limited expertise in economic techniques can successfully produce EAs.
- Repetitive calculations can be revised easily and quickly.
- Sensitivity analyses can be conducted accurately and easily.
- Reports are generated in a standardized format that is accepted by the Air Force, OSD, and Congress.

2.8.5.3. Data entry and modification in PC-ECONPACK are straightforward, with the User's Manual providing step-by-step instructions. It is recommended, however, that the analyst organize the data as presented below in order to facilitate data entry:
- Project Title.

- Project Objective.
- Organization Title.
- Global Discounting Convention.
- Period of Analysis.
- Start Year.
- Discount Rate.
- Base Year.
- Analysis Type (Primary or Secondary).
- Cost Input (Dollars or Thousands).
- For Each Alternative list the alternative name, residual value parameters, and names, discounting conventions, and annual costs of expense items.
- Assumptions.
- Discussion of Alternatives.
- Source and Derivation of Costs and Benefits.
- Non-monetary Benefits.
- Discount Rate Sensitivity Analysis Parameters
- Results and Recommendations

2.8.5.4. PC-ECONPACK provides for two separate types of analyses: Primary and Secondary Analyses. A Secondary Analysis is used to determine which of two or more alternative courses of action would most economically fulfill an objective or requirement which is not currently being met. A Secondary Analysis does not include a Status Quo alternative. A Primary Analysis is used to determine whether an existing requirement can be satisfied better through an alternative. Each alternative is evaluated relative to the Status Quo.

2.8.6. **Net Present Value of Alternatives.** The Net Present Value (NPV) of an alternative is the sum of the discounted costs of that alternative across the analysis period. To determine the least costly approach for meeting the EA objective, the calculated NPVs of the alternatives under consideration should be compared. PC-ECONPACK presents the NPV for each alternative in the Executive Summary Report (ESR). The NPV can also be retrieved from the Life Cycle Cost Report (LCCR). The NPV is the last number under the column entitled Cumulative Net Present Value.

2.8.6.1. It is important to proofread the Life Cycle Cost Report to ensure that all the data input is correct. The analyst should:

- Check for any typographical errors in the data input.
- Check that the costs are being applied in the appropriate years.
- Check that the construction expenditures match the construction schedule and the DD Form 1391.
- Ensure that the appropriate cost elements have been included for each alternative.
- Ask -- Do the results make sense? Are they reasonable? Are there any surprises?

2.8.6.1.1. Any errors discovered are corrected and net present values are recalculated.

2.8.7. **Savings/Investment Ratio, Cost/Benefit Ratio, and Equivalent Uniform Annual Cost.** The Savings/Investment Ratio (SIR) is computed automatically for any Primary Analysis. The SIR is the ratio of future cost savings (or avoidance) to the discounted investment cost. The SIR is a comparison of the alternative to the Status Quo alternative. A SIR greater than 1 indicates that the value of the cost savings is greater than the value of the investment. SIR is a useful way to describe each alternative's "bang for the buck."

2.8.7.1. The Cost/Benefit ratio shows the decision maker the degree to which benefits are being attained relative to costs. The Cost/Benefit ratio for each alternative is calculated by dividing the net present value by the benefit score. The alternative with the lowest Cost/Benefit ratio is considered the most desirable solution.

2.8.7.2. PC-ECONPACK also calculates an Equivalent Uniform Annual Cost (EUAC) for each alternative. The EUAC is the amount of money which, if paid in equal annual installments over the life of a project, would pay for the project.

2.8.8. **Discount Rate and Cost Sensitivity Analyses.** At a minimum, all MILCON EAs should include a sensitivity analysis on the discount rate. A sensitivity analysis is conducted at plus and minus 25 percent of the currently prescribed discount rate found on the FMABB.

2.8.8.1. PC-ECONPACK addresses discount rate sensitivity analysis as a special case. The analyst can name the range of discount rates to be tested by designating the upper and lower limits. The results of the discount rate sensitivity analysis are presented in three parts:

- A graph depicting changes in NPV over the range of discount rates specified.
- A summary table that can be reviewed to see if the sensitivity analysis yielded any changes in the alternative rankings.
- A detailed report listing the NPVs by discount rate and alternative.

2.8.8.2. In addition, PC-ECONPACK allows the user to define additional cost sensitivity analyses, up to a maximum of 30. Any cost element which is significantly large and which is subject to uncertainty should be evaluated in the sensitivity analysis. The percentage range for any cost element should reflect the degree of uncertainty surrounding the cost used in the economic analysis.

2.8.9. **Residual Value Calculations.** The residual value accounts for the remaining monetary value, if any, of the proposed facility at the end of the term of analysis. Residual value should be included and quantified as a cost savings whenever the economic life of the facility in an alternative differs significantly from the term of analysis. The economic life of a facility varies by facility type and quality of construction. Figure 2.12 presents economic lives for several facility types. The economic life of a renovated facility should take into account functional obsolescence and be based on sound engineering judgment.

Figure 2.12. Economic Lives for Some Facility Types (Years).

	Class A	Class B	Class C
Quarters, dormitories	60	60	55
Auditoriums, theaters	50	50	45
Engineering, Industrial	55	55	50
Warehouses	55	55	50
Maint, Storage Hangars	--	--	40

Class "A" facilities have fireproofed structural steel frames with reinforced concrete or masonry floors and roof.
Class "B" facilities have reinforced concrete frames with concrete or masonry floors and roof.
Class "C" facilities have concrete or masonry exterior walls with wood or steel floors and roof.
Source: Marshall Valuation Service

2.8.9.1. For example, let's assume an EA has two alternatives for providing administrative office space:

- Improvement of an existing facility.
- New construction.

Continuing the example, then the new facility would have a useful life of 50 years, while the improved or renovated facility would have a useful life of only 30 years. When a term of analysis of 30 years is used, a residual value assigned under the new construction alternative reflects the cost advantage of the longer life.

2.8.9.2. PC-ECONPACK directly accounts for residual value on the alternative information screen for the Replacement alternative. The analyst should select "Yes" to the "Do you wish to include a residual (salvage) value (Y/N)?" prompt and select Residual Type 2, Straight Line Depreciation, as the type. The Start Value is the DD Form 1391 total construction cost minus the demolition costs (demolition plus contingency and SIOH) as seen in figure 2.13. An end-of-year discount convention is recommended for calculating residual value. A discounting convention for residual value can be selected under the Alternative Information data entry screen.

Figure 2.13. Residual Value Calculations.

RENOVATION COST:

Construction Cost $1995: 4,320,000

REPLACEMENT COST:

Construction Cost $1995: 5,570,000

Net Investment Cost:

Demolition Cost $1995	+	5% Contingency	=	Subtotal	+	6% SIOH	=	Total Demolition Cost $1995
190,000		9,500		199,500		11,970		211,470

Construction Cost $1995	-	Total Demolition Cost $1995	=	Net Investment Cost $1995

5,570,000	211,470	5,358,530

2.8.10. **Including a PSD Alternative.** The Private Sector Development (PSD) alternative uses private sector resources and knowledge to provide facilities and services for the Air Force. At this time, PSD is only feasible in cases where no direct payment or guarantees are provided by the Air Force. The cost elements for the economic analysis are generally limited to direct compensation to users (e.g., BAQ/VHA, per diem) and miscellaneous costs, such as moving expenses. However, the economics of the PSD alternative must also be reviewed to establish feasibility from the private sector point of view. For a transient quarters facility, PSD would be feasible only if the nightly room rate were lower than the lodging per diem amount users were willing to pay. Similarly, PSD would only be feasible for military family housing and bachelor quarters if the required rent to the developer was lower than the average BAQ/VHA received by the users. This feasibility check evaluates whether developers will respond to a PSD opportunity and whether the selected developer would be able to perform.

2.8.10.1. To estimate the rates that a private sector developer would bid in response to a PSD opportunity, one approach is to contact reputable private sector developers. The specific requirement should be described only in the most general terms. Care must be taken to avoid giving a potential RFP respondent (for PSD or Military Construction) any unfair advantage. One should be skeptical of the results since informal contacts with developers often result in unrealistic quotes. Another approach to estimating the rates charged under a PSD alternative is to perform a pro forma analysis. A pro forma analysis uses estimates of a developer's financing, construction, and operating costs to calculate the rate at which he will make an adequate return. Development and analysis of a reliable pro forma requires familiarity with private sector financial investment analysis techniques.

2.8.10.2. **Including a Government Lease Alternative.** A Government Lease Alternative involves direct, long-term leasing or the guaranteed rental by the Air Force of a suitable, privately owned facility off base. When working with an alternative involving a lease, it is important to be aware of the provisions of the lease. A lease which is constant over the term of the analysis will generally have inflation already built in. Thus, a current-dollar analysis should be conducted. However, a lease whose rate is structured to rise each year with the general rate of inflation can be included in a constant-dollar analysis.

2.8.10.3. A current-dollar analysis is conducted if the costs of a leasing alternative are collected in inflated dollars. In a current-dollar analysis, inflation factors are applied to costs which are not already collected in inflated dollars. Do not mix constant and current dollars in the same analysis. The discount rate used in a current-dollar analysis is based on the yearly projections of interest rates on US treasury securities with a maturity comparable to the period of analysis. These discount rates are available from the FMABB.

2.8.11. **Formulating Recommendations.** The net present value results account for quantifiable costs. When reviewing the results and formulating recommendations, non-quantifiable costs and benefits should also be evaluated. The cost/benefit ratio quantifies these issues but the analyst reviews all the results and makes a final recommendation. At this point, the viability of each alternative is once again addressed. In general, the alternative with the lowest NPV is recommended. A recommendation for an alternative other than the alternative with the lowest NPV is made only with the support of an extremely persuasive benefits analysis.

2.8.11.1. For example, an economic analysis for transient quarters could demonstrate that continuing to pay per diem to transient personnel is the most cost-effective alternative. However, if off-base lodging is remote and a significant number of the transients are distinguished visitors, the benefits analysis may demonstrate that construction of new quarters satisfies the objective far more effectively. Hence, the economic analysis could recommend a New Construction alternative.

2.9. Documenting the Results of the Economic Analysis. An EA must be documented to allow complete replication by reviewers. This section provides guidance on how to compile an EA. An EA contains:

- Certificate of Satisfactory Economic Analysis*.
- DoD Executive Summary*.
- Table of Contents*.
- Executive Summary Report.
- Project Objective. This includes alternatives, assumptions and results and recommendations.
- Life Cycle Cost Report. This includes alternative data and the source and derivation of costs and benefits.
- Benefits Analysis.
- Cost Sensitivity Analyses.
- Discount Rate Sensitivity Analysis.
- Appendices.

(* Items are created using a word processor or spreadsheet program.)

2.9.1. PC-ECONPACK can be used to generate most of the EA. PC-ECONPACK reports are generated in standardized formats which summarize the essential components of a comprehensive EA. Six different reports can be generated:

2.9.1.1. Executive Summary. The Executive Summary includes several pages containing a brief discussion of each alternative, assumptions, NPV, and EUAC for each alternative.
2.9.1.2. Graphs of the Cumulative NPV of each alternative.
2.9.1.3. Life Cycle Cost Report. This report provides an overview of all the detailed costs and benefits for each alternative on a year-by-year basis.
2.9.1.4. Cost Sensitivity Analysis Report. This report is used for any sensitivity analyses that may be warranted.
2.9.1.5. Discount Rate Sensitivity Analysis Report.
2.9.1.6. Input Listing. This is a line-by-line listing of all the data entered for the EA (not to be included in the EA documentation).
2.9.1.7. Text can be entered into five text blocks:

- Assumptions.
- Discussion of Alternatives.
- Source and Derivation of Costs and Benefits.
- Results and Recommendations.
- Non-Monetary Benefits.

2.9.1.8. For more information on creating PC-ECONPACK reports, refer to the PC-ECONPACK User's Manual. Attachment 3 contains a sample EA utilizing PC-ECONPACK for a selected MILCON project.
2.9.2. **Certificate of Satisfactory Economic Analysis.** A Certificate of Satisfactory Economic Analysis is attached to the front of each completed EA. The certificate is normally a two-page document. The first page includes:

- Name of the installation and MAJCOM.
- Project title.
- Project number.
- Objective.
- Project cost.
- Alternatives considered.
- Summary of analysis results.
- Certification.

2.9.2.1. The second page, or "signature page" presents the signatures of the reviewers and evaluators certifying that they have reviewed and concur with the EA findings. The signatures of the following personnel are required:

- Installation FM Analyst.
- Installation FM.
- Installation CE.
- MAJCOM/FMA Evaluator.
- MAJCOM FMA.
- MAJCOM CE.

2.9.2.2. These signatures do not need to be physically included on a single sheet of paper, but all signatures are required on the final EA before transmittal to HQ USAF and SAF. If more than one signature sheet is used, indicate the installation/MAJCOM, project title, project number, scope/cost, and objective on each sheet.
2.9.2.3. PC-ECONPACK cannot generate the Certificate of Satisfactory Economic Analysis; it is produced as a separate document and is attached to the front of the EA. A completed Certificate of Satisfactory Economic Analysis is included in the sample EA presented in attachment 3.
2.9.3. **Department of Defense Executive Summary.** A Department of Defense (DoD) Executive Summary follows the Certificate of Satisfactory Economic Analysis. This Executive Summary is a clear and concise, one-page summary of the EA and its conclusions. Figure 2.14 presents the format for the Executive Summary. PC-ECONPACK cannot generate the DoD Executive Summary. It is produced as a separate document and is included in the EA. A completed sample is located in the sample EA in attachment 3.
2.9.4. **Table of Contents.** A Table of Contents outlining the organization of the EA is placed after the DoD Executive Summary. PC-ECONPACK cannot generate a Table of Contents; it is produced as a separate document and is included in the EA.
2.9.5. **Executive Summary Report.** The PC-ECONPACK Executive Summary Report provides an overview of the EA. It includes the project objective, the description of the alternatives, a listing of the assumptions, and a summary of the results and recommendations.
2.9.5.1. Project Objective. The project objective is clearly stated early in the EA. Refer to figure 2.4 for examples of project objectives.

2.9.5.2. Alternatives. Detailed descriptions of each of the alternative addressed in the EA are also included in the EA Executive Summary Report. Figure 2.15 presents a checklist by alternative of the information that is included in the project description. Justification for alternatives that were considered but dismissed as infeasible are also presented in this section.

Figure 2.14. DoD Executive Summary.

INSTALLATION/MAJCOM:
PROJECT TITLE (include FY):
PROJECT NUMBER:
OBJECTIVE:
PROJECT COST:

ALTERNATIVES EXAMINED	NET PRESENT VALUE	BENEFIT SCORE	COST/BENEFIT RATIO
1. STATUS QUO			
2. RENOVATION			
3. REPLACEMENT			
4. DIRECT COMPENSATION			

ANALYSIS METHOD:

CONCLUSION:

Figure 2.15. Description of Alternatives Checklist for MILCON Eas.

STATUS QUO
Square footage of existing facility
Age of facility
Capacity of facility
Current condition
Date of last renovation
Location

RENOVATION
Number of square feet to renovate
Capacity of renovated facility
Renovation schedule
Extent of renovations
Location

NEW CONSTRUCTION
Square footage of new facility
Capacity of new facility
Location
Construction schedule
Disposal of existing facility

GOVERNMENT LEASE
Number of square feet to lease
Capacity of lease space
Lease term
Location
Disposal of existing facility

PSD
Number of square feet
Capacity
Location
Construction schedule
Disposal of existing facility
Legislative authority

2.9.5.3. Assumptions. According to AFI 65-501, all EAs must include a list of the assumptions made. These assumptions must be clearly stated so evaluators can understand the level of uncertainty and risk inherent in the EA results. It is also important to include the source for each assumption made. This section of the Executive Summary Report is not to be used to describe the derivation and source of every cost element in the analysis--that information is included in the Source and Derivation of Costs and Benefits section of the Life Cycle Cost Report.2.9.5.4. Results and Recommendations. This section of the EA presents a comparison of the results for each alternative. It addresses the NPV, SIR, Benefit Score, and Cost/Benefit Ratio for each alternative. A short paragraph summarizes the cost and discount rate sensitivity analyses indicating whether or not the alternative rankings are sensitive to reasonable changes in costs and/or assumptions. The conclusion paragraph includes the results of the life cycle cost analysis, the benefits analysis, the sensitivity analyses, and any non-quantifiable issues related to the proposed project. Based on the conclusion, a recommendation is made.
2.9.5.5. At the conclusion of the PC-ECONPACK Executive Summary Report, a graph depicting the cumulative net present values of each alternative is attached. This graph is produced by PC-ECONPACK.
2.9.6. **Life Cycle Cost Report.** The PC-ECONPACK Life Cycle Cost Report provides a detailed description of the costs and benefits associated with each alternative.
2.9.6.1. Alternative Data. The Life Cycle Cost Report provides a printout for each alternative of the:

- Life cycle cost tables by cost element and year.
- Total costs by year.
- Discount rate factors by year.
- Present value costs by year.
- Cumulative NPV costs by year.
- Cumulative NPV costs by cost element.
- Percentage of NPV for each cost element.

2.9.6.2. Source and Derivation of Costs and Benefits. At the end of the Life Cycle Cost Report there is a text block to be used for discussing the source and derivation of the costs and benefits. Each data element included in the analysis is discussed separately in this section. Since many cost elements may be the same across alternatives, this approach can avoid the redundancy which would occur if the cost elements are addressed by alternative.

2.9.6.3. Frequently, interim calculations for construction, utilities, M&R, BAQ/VHA, and other estimates, as well as adjustments for inflation, need to be made prior to entering the figures into PC-ECONPACK. The methodology used for these interim calculations can be presented in a table or chart such as the one shown in figure 2.7. Tables and charts can facilitate the review of the EA for evaluators. **It is very important to include the source and any interim calculations conducted for all estimates and data used in the EA.** Therefore, this section will refer the reader to the appropriate signed source documents in Appendix C and interim calculations in Appendix D of the EA. Any assumptions that were used in the derivation of the cost estimate are also reiterated here. For example, the derivation of Annual M&R costs might read like this:

> *Annual M&R costs for the existing facility were based on historical data provided by the Planning Department of the Civil Engineering Squadron (Appendix C). The data were adjusted for inflation to FY95 dollars (Appendix D). Annual M&R costs for the renovation alternative were assumed to be 10 percent less than the Status Quo alternative. Annual M&R costs for the new construction alternative were assumed to be 15 percent less than the Status Quo alternative. These assumptions were based on interviews with CE personnel and are documented in the CE Source Document dated 29 April 19XX. (Appendix C).*

2.9.7. **Benefits Analysis.** In the EA, the benefits analysis is presented in a separate section. This section explains the methodology used to develop the benefit score used in the calculation of the Cost/Benefit Ratio. The discussion on benefits analysis includes:

- An explanation of the methodology and rationale used to calculate the benefit score and weights.
- A description of each benefit category that is addressed in the analysis and a discussion of the results and rankings of each of the alternatives based on the benefit score.
- A chart or table similar to figure 2.11 summarizing the calculation of the benefit score.

2.9.7.1. PC-ECONPACK version 4.0 has added a fifth text block which can be used for the benefits analysis documentation.

2.9.8. **Cost Sensitivity Analyses.** The PC-ECONPACK Cost Sensitivity Analysis is included in the EA. If the results of any sensitivity analysis indicate a change in the alternative rankings, then this fact is highlighted and the implications are discussed in the EA.

2.9.9. **Discount Rate Sensitivity Analysis.** This section includes the PC-ECONPACK printouts pertaining to the discount rate sensitivity analysis. For the discount rate sensitivity analysis, PC-ECONPACK provides a NPV versus Discount Rate graph, a summary table from which the analyst can determine whether changes in the discount rate changed the original ranking of the alternatives, and a detailed report listing the NPVs for each discount rate value used in the analysis. All of these charts and graphs are included in this section of the EA.

2.9.10. **Appendices.** The EA appendices include the following:

- Appendix A - DD Form 1391 for the Renovation alternative. The Military Construction Project Data form for renovation of the existing facility is presented, which includes the project cost.
- Appendix B - DD Form 1391 for the New Construction alternative. The Military Construction Project Data form for the new construction of a facility is presented. This form includes the project cost.
- Appendix C - Source Documents. All of the signed source documents and supporting data are presented, including the name and phone number of POCs.
- Appendix D - Interim Calculations. All of the worksheets used in calculating utility, maintenance, moving, temporary leases, personnel costs, BAQ/VHA for military personnel, per diem for TDY personnel, and other estimates, as well as inflation/escalation adjustments are presented.

Chapter 3

MILITARY FAMILY HOUSING PROJECTS

3.1. Introduction. This section of the Military Construction and Family Housing Economic Analysis Guide provides guidance on the preparation of Economic Analyses (EAs) required as part of the project justification process for Family Housing Improvement, Replacement, and New Construction projects. This manual supersedes the Family Housing Economic Analysis Manual, dated Feb 94.

3.1.1. The procedures and methodologies presented in this manual implement Air Force Instruction (AFI) 65-501, *Economic Analysis*, and Air Force Manual (AFMAN) 65-506, *Economic Analysis*.

3.1.2. The Family Housing Economic Analysis Section is divided into five remaining parts outlining the steps in the EA process:

- Defining the Project, Formulating Assumptions, and Identifying Alternatives.
- Collecting Project Data.
- Conducting the Benefits Analysis.
- Conducting the EA and Analyzing the Results.
- Documenting the EA Results.

3.1.3. A Sample Economic Analysis for a Family Housing project is presented in attachment 4.

3.2. Requirement. EAs for Family Housing projects are mandated by Congress in Section 2812 of the FY91 National Defense Authorization Act, and Section 2802 of the FY93 Defense Authorization Act. According to the legislation, an EA is required:

- For all Family Housing replacement projects (Section 2802).
- For improvement projects when the most expensive unit exceeds $50,000 with adjustments for the area cost factor taken into account (Section 2812).
- For Family Housing New Construction projects with a total cost of over $2 million.

3.2.1. An EA should be initiated as early as practical during the project planning process and should be updated as significant developments occur which would invalidate or significantly alter the conclusions. Specifically, EAs should be updated:

- When there is a change in scope greater than plus or minus 25 percent, without a change in unit cost.
- If there are major changes in initial study assumptions.
- When new alternatives are identified that appear to satisfy the stated requirement.
- If projects are moved between fiscal years and changes in the unit costs for construction, renovation, or any other significant cost element exceed local price changes.

3.3. Project Coordination. According to AFI 65-501, the primary responsibility for performing the EA lies with the Financial Management (FM) staff at the affected organizational level. Collateral responsibility lies with the Civil Engineering (CE) staff and the project user. Hence, completing the EA requires close coordination between the CE and FM organizations. The initiating CE office shall contact the local FM office early in the process for guidance in preparing the EA. Figure 3.1 presents the responsibility matrix for Family Housing EAs. Figure 3.2 outlines the approval process for Family Housing Eas.

3.4. Defining the Project, Formulating Assumptions, and Identifying Alternatives. A clear, concise statement of the project objective is necessary in order to identify potential alternatives The objective for Family Housing projects is normally to correct non-conformance with current Air Force Whole House/Neighborhood standards or to alleviate a housing deficit. This section will assist the analyst in fully defining the project objective, formulating assumptions, and identifying alternatives.

Figure 3.1. Responsibility Matrix for Family Housing Eas.

TASK	COMPTROLLER	ENGINEER	USER
Identify Need/Project Objective			OPR
Determine if EA Required	OCR	OPR	
Initiate Economic Analysis		OPR	

Identify Alternatives	OCR	OPR	OCR
Identify Data Requirements			
Cost Data	OPR	OCR	OCR

Figure 3.1. Continued.

Engineering Data	OCR	OPR	OCR
Formulate Assumptions	OPR		
Data Collection			
Cost Data	OPR		OCR
Engineering Data		OPR	OCR
Calculate Life Cycle Costs	OPR		
Calculate Benefits Analysis	OPR	OCR	OCR
Select Alternative/Formulate Recommendations	OCR	OPR	OCR
Identify Changes in Scope		OPR	
Conduct Sensitivity Analyses	OPR		
Documentation			
Cost Data	OPR		
Engineering Data	OPR		
Certification	OPR	OCR	OCR

OCR = Office of Collateral Responsibility
OPR = Office of Primary Responsibility

Source: AFI 65-501.

Figure 3.2. Economic Analysis Approval Process for Family Housing.

Level	Civil Engineer (Functional)	Comptroller (Technical)
Base	Identification of requirement, data collection, and submittal (Base CE)	Analysis and documentation (Base FM)
MAJCOM	Functional review and submittal (MAJCOM/CEH)	Technical certification (MAJCOM/FMA)
Air Staff/SAF	Functional validation and submittal (AF/CEH)	Technical validation (SAF/FMCE)
SAF	Approval and submittal to Congress (SAF/MII)	Coordination (SAF/FMC)
OSD	Economic Analysis used in program budget review	
Congress	Approval waiver to statutory cost limits for Improvement project, or approve Replacement project, based on justification of Economic Analysis	

Note: At each level of the above approval process, the cooperative effort between CE and FM offices must be completed and coordinated before the EA package is forwarded by the CE office to the next higher level or returned to the next lower level.

3.4.1. **Collecting Background Information and Defining the Project Objective.** The analyst will collect and review all written documentation available that could affect any project alternatives. This review will include the most current DD Form 1391 and the attached construction cost estimate for the proposed project, previous EAs, Base Comprehensive Plan (BCP), Housing Community Plan (HCP), and the most recent Housing Market Analysis (HMA). Next, interviews are conducted with personnel who are involved in the project planning process. All information is collected in writing,

including the source of data, and the name, organization, title, and phone number of each point of contact (POC). The signed source documents must be presented in Appendix C of the EA.

3.4.1.1. The interviews and background data collection should answer the following questions:

- What is the problem?
- What were the results and date of the most recent HMA?
- What is the total or phased number of units to be improved or replaced?
- What is the square footage and layout, including number of bedrooms, of the existing and proposed housing?
- Was the existing housing built under the Wherry or Capehart programs, or 1970's vintage Appropriated Program (or other)?
- What is the age of the existing Family Housing units?
- When was the existing Family Housing last renovated?
- Does the project include any buildings on the National Register of Historic Places or other historically sensitive programs?
- Does the project require asbestos, radon, or lead-based paint remediation?

3.4.1.2. Many of these issues can impact the scope and cost of the proposed project. For example, a housing unit which is on or under consideration for addition to the National Register of Historic Places cannot be demolished and demands unique architectural/engineering compliance requirements for unit renovation. This may make compliance with Whole House guidelines very difficult, and could give a false indication of associated costs. In general, renovation costs are more expensive for historic buildings because the replacement materials are unique, hard to find, and costly. Additionally, it is very difficult to achieve enhanced energy efficiency if modern energy efficiency features are not permissible. Finally, the construction of new units next to existing historical units may require the adaptation of similar exterior architectural features, thereby increasing unit construction costs.

3.4.1.3. Asbestos, radon, or lead-based paint in current housing can lead to costly removal procedures and may impact the project schedule. These costs may be incurred if the units are renovated or demolished (depending on the remediation method required).

3.4.2. **Defining the Project Objective.** From the information collected, a clear, concise statement of the project objective should be developed. The statement of the objective must not be biased toward any alternative. For example, a Family Housing project objective might read as follows:

To provide housing that meets USAF standards for 100 enlisted military families at Anywhere AFB.

3.4.2.1. Once the project objective is clearly defined, assumptions can be formulated, and alternatives can be identified to satisfy the requirement.

3.4.3. **Assumptions.** EAs are based on facts and data pertaining to the project. However, an EA deals with costs and benefits occurring in the future. Because the future is unpredictable, assumptions and sensitivity analyses are prepared to account for these uncertainties. To avoid invalidation or bias of the analysis, assumptions should be made only by qualified individuals and should be based on realistic assessments or anticipated conditions.

3.4.3.1. There are several common assumptions made when preparing an EA for Family Housing:

3.4.3.1.1. Economic Life of the Project. The economic life for improved housing is normally 25 years and for new or replaced housing is 40 years.

3.4.3.1.2. Project Phasing. Family Housing projects can involve the improvement or replacement of hundreds of units. Frequently, the construction is phased due to limited funding or construction scope. Hence, improvement or replacement may be spread over many months or years. If construction activities are phased over several years, construction costs should be allocated in the EA according to the construction schedule. Savings of the various expenses due to partial occupation during the construction year should also be taken into account.

3.4.3.1.3. Residual Value. Residual Value is the depreciated value of facilities. At the end of a 25-year analysis period there would be no residual value for improved Family Housing. The start value for replaced or newly constructed Family Housing is defined as the total DD Form 1391 construction cost, including Contingency, and Supervision, Inspection, and Overhead (SIOH), less total demolition costs. Residual value is normally calculated using straight-line depreciation of the start value over the project's economic life (usually 40 years).

3.4.3.1.4. Inflation. In a constant-dollar analysis, costs and benefits are estimated based on constant purchasing power of the dollar. Hence, inflation adjustments are made for only those cost elements for which price increases are expected to exceed the general inflation level. However, when historical data is used to estimate future costs, historical costs must be inflated to the base year (usually the project year) of the analysis. This can be performed by the CE or FM staff but it is critical that the effective year for all cost/price information be indicated on source documents and in the analysis. This will ensure that the analyst and reviewers know that appropriate escalation and discount values have been applied. The source and date of inflation indices must be documented.

3.4.3.1.5. Base Year. A constant-dollar analysis requires that all costs be converted to a common or base year to permit equitable comparison of those values. Typically, the project year is defined as the base year for a given EA. Various tables, such as the "USAF Raw Inflation Indices" and the "DRI Energy Inflation Indices" found on the Financial Management Analysis Bulletin Board (FMABB) contain the factors used to make these conversions.
3.4.3.1.6. Discount Rate. The discount rate is used to account for the time value of money when comparing the cost of alternatives over several years. Most EAs performed to support Air Force Family Housing programs should be priced in constant dollars and discounted at the interest rate published in the most recent President's Budget (PB). The PB is published in January or February of each year and includes both the constant and current-dollar discount rates to be used in conducting EAs. SAF/FMCE will provide the annual discount rates on the FMABB. These discount rates reflect the latest values in Office of Management and Budget (OMB) Circular A-94.
3.4.3.1.7. Cost Savings. Maintenance and Repair (M&R) and energy costs are generally lower for Improvement or Replacement alternatives than for the Status Quo alternative due to the increased efficiency of improved or replaced facilities. Cost savings estimates are generally made relative to the current Status Quo values in the EA.
3.4.3.1.8. Additional assumptions may be required when project data is unavailable, when future costs are uncertain, or when a project involves unique circumstances.
3.4.4. **Identifying Alternatives.** There are typically five alternatives available to meet the objective:

- Status Quo.
- Improvement.
- Replacement or New Construction.
- Direct Compensation.
- Government Leasing.

3.4.4.1. The Status Quo alternative is considered the baseline for the EA. The Status Quo can be one or a combination of scenarios. Two common examples are:

- The continued use and operation of existing Family Housing in its current condition; or
- The continued payment of Basic Allowance for Quarters (BAQ) and Variable Housing Allowance (VHA) to families living off base in private residential housing.

3.4.4.2. The Improvement alternative involves improvements to the current housing. Various levels of improvements can be addressed as alternatives, including Whole House/Whole Neighborhood revitalization projects that may involve the reconfiguration of existing units. The goal of an Improvement project is to extend the life of the current housing, to reduce future M&R costs, and to improve the ambiance of the housing and associated neighborhood.
3.4.4.3. The Replacement or New Construction alternative involves the construction of new Family Housing to meet the current need. New housing may be required to eliminate an existing shortage, to satisfy a shortage created by a new mission or mission change, or to replace inadequate housing.
3.4.4.4. The Direct Compensation alternative allows (non-mission-essential) personnel to live off base and compensates them directly in the form of BAQ/VHA. This alternative must always be considered in each EA conducted. However, if an HMA conducted within the previous 3 years concluded that suitable housing is not available in the local market, this fact should be stated with the results and considered when formulating recommendations and conclusions.
3.4.4.5. Government Leasing involves direct, long-term leasing or guaranteed rental by the Air Force of suitable, privately developed housing on or off base. At this time, however, neither the leasing nor guaranteed rental program is a viable alternative for providing Family Housing, although new legislation may make one or both options more attractive.
3.4.4.6. The above-mentioned alternatives are the ones most frequently addressed in Family Housing EAs. However, an analyst should always aggressively pursue all possible realistic alternatives since the final decision can be no better than the available choices. Throughout the EA process, the analyst should continually consider accepting new alternatives and discarding old ones.
3.4.4.7. Occasionally, after a complete review of the facts and circumstances surrounding the current housing deficit, the analyst may conclude that there is only one feasible alternative. For example, if the most recent HMA concluded that there is an insufficient quantity of acceptable housing off base to meet the future requirements, and the current on-base housing is filled, then the only feasible alternative would be new construction. In this case, a waiver or exemption from the requirement for an EA is prepared. The exemption or waiver documentation includes a Certificate of Exemption from an Economic Analysis and an Executive Summary which addresses why only one alternative is feasible. The Certificate of Exemption from an Economic Analysis must include all of the signatures required for a complete EA.
3.4.4.8. It is important to note that cost is not a basis for infeasibility. If an alternative is selected based on cost, then an EA must be developed.

3.5. Collecting Project Data. This section discusses the data collection requirements normally included in an EA for Family Housing. The costs associated with each alternative under consideration must be quantified and included in the EA

calculations. All costs the housing is expected to incur over the life of each alternative, with the exception of sunk costs, are included in the life cycle cost analysis. Sunk costs are expenditures which are incurred before a project receives final approval. These costs would not be recovered regardless of the alternative selected. Examples of sunk costs include project planning, design, and preparation of the economic analysis itself.

3.5.1. **One-Time Costs.** Many one-time costs normally occur early in a project's life cycle. Construction costs are usually the most significant; however, all other one-time costs must also be considered.

3.5.1.1. Construction Costs. Construction and improvement costs include construction labor and materials, demolition, site preparation, utilities, roads and pavements, Contingency, as well as Supervision, Inspection, and Overhead (SIOH). Since the largest percentage of the project cost is determined by the scope of the Improvement or Replacement project, it is imperative that all primary and support costs are included in the EA. Equally important is the need for accurate and complete cost estimating. Parametric cost estimating systems, such as the Parametric Cost Engineering System (PACES), allow the user to run multiple scenarios for Improvement alternatives, while Replacement alternatives are calculated with the Tri-Service Cost Model and documented on the DD Form 1391.

3.5.1.1.1. Construction/Improvement costs are thoroughly documented on the DD Form 1391 and attachments. The DD Form 1391 and attachments for an EA include:

- The project title, project number, and alternative name.
- The scope of the estimate in square feet.
- A brief description of the costing methodology or estimating system used.
- Dated sources for variables, such as area cost factors and escalation factors.
- The base year of the project cost.
- CE Authority signature for the estimate.

3.5.1.1.2. The estimate shows all interim calculations so that the values can be tracked from the source data to the total project cost appearing on the DD Form 1391 and in the Life Cycle Cost Report. Clear documentation speeds review of the EA. In addition, a clearly documented DD Form 1391 can be easily updated when the source data changes or when the project is changed for a different program year.

3.5.1.1.3. It is also important to ensure that Whole House/Neighborhood standards are applied equally for the respective Improvement and Replacement alternatives. More precisely, a proper EA cannot be achieved when the project alternatives differ in scope. Special attention should also be given to ensure all costs associated with the Improvement alternative have been considered, such as demolition, asbestos or lead-based paint remediation, environmental compliance, etc.

3.5.1.2. Other One-Time Costs. The accurate capture of other one-time costs is imperative to ensure a complete EA. Examples of other one-time costs for Family Housing projects include:

- The moving and storage of household goods when families are relocated due to construction.
- BAQ/VHA payments made to personnel in temporary off-base housing.
- Reconnection fees associated with telephone, cable television, gas, and electric utilities.

3.5.1.2.1. All attempts should be made to time housing replacement or improvement construction activities to correspond with expected vacancies. However, even with the best scheduling attempts, some military personnel may be subjected to multiple moves. For instance, a family might have to move into temporary housing while their unit is being improved. During this time, the costs for storage of the member's household goods may also be incurred. When the temporary housing is located off base, the Air Force pays BAQ/VHA, which must also be accounted for in the EA. A second move would be necessary to relocate the family from the temporary housing into a newly renovated or replaced unit. Additional moves may be required to facilitate complicated construction and/or personnel schedules.

3.5.1.2.2. Moving and storage costs (drayage) can be obtained from the base transportation office. This data is frequently based on historical averages by grade. Moving costs can also be calculated based on the average weight of household goods and the price per pound for the move.

3.5.1.2.3. Telephone, cable television, and gas companies normally charge a fee for the connection or reconnection of these services. Initial cable and telephone connection fees are the responsibility of the service member. However, the Air Force is responsible for any reconnection fees incurred by members as a result of moves required for military construction projects. The installation CE is the best source for this data.

3.5.2. **Recurring Costs.** Recurring costs are the repetitive costs required to operate and maintain Family Housing. They are generally calculated on an annual basis. Examples of recurring costs include:

- Maintenance and repair of housing units.
- Utilities, such as electricity, water, sewage, natural gas, and refuse collection.
- Miscellaneous costs, such as grounds maintenance, landscaping, and snow removal.
- Long term payments of BAQ/VHA.

3.5.2.1. Maintenance and Repair Costs. Maintenance and Repair (M&R) costs include both Annual M&R and Periodic M&R. Annual M&R expenses include preventive maintenance, unscheduled plumbing and electrical repairs, and minor

structural repairs that are continually incurred to ensure a safe and healthy living environment. Periodic M&R expenses include major repairs, such as roof, HVAC, appliance, flooring, fixtures, and carpet replacement that can be estimated based on the expected life of the equipment or fixture.

3.5.2.1.1. Historical Annual M&R costs associated with the Status Quo alternative should be used to project future costs in the EA. The analyst should collect and review at least 3 years of data in order to develop a valid estimate. Work Information Management System (WIMS) maintenance records maintained by CE are the best source for the Annual M&R data. All historical costs should be adjusted for inflation to the base year in the EA.

3.5.2.1.2. Annual M&R costs for the Improvement and Replacement alternatives are expected to be less than the Status Quo alternative. Hence, the historical M&R cost data is normally adjusted downward by an assumed percentage (25 to 40 percent, based on engineering judgment) for the Improvement and Replacement alternatives. Annual M&R costs over the life of improved and replaced units are assumed to increase 10 percent every 5 years through year 25. These assumptions should be clearly stated in the EA.

3.5.2.1.3. Periodic M&R schedules are based on the expected life of the equipment or fixture. CE can provide the date the item was last replaced so that the analyst can project future schedule and costs under the alternative. The Improvement and Replacement alternatives generally begin with all new equipment, and replacement schedules are based on the construction date. These schedules, coupled with the availability of local estimates for such items, lend themselves to good estimates of the associated expenses over the life of the housing. It is important to remember that scheduled intervals will often vary based on local conditions. Figure 3.3 displays the generally accepted useful lives of various equipment and fixtures.

Figure 3.3. Table of Useful Lives.

Plumbing	40 years
Electrical	30 years
Windows	25 years
Exterior Doors	25 years
Roof	20 years
Ceilings	20 years
HVAC	20 years
Appliances	10 years
Floor Covering	10 years
Exterior Paint	10 years
Interior paint	4 years

Source*: Means Facilities Maintenance Standards*, R.S. Means Corporation.

3.5.2.1.4. Periodic M&R costs can be estimated based on local prices or recent replacement of similar items and should include appropriate labor fees. If such cost data is unavailable, then commercial sources such *as R. S. Means, Dodge Cost Data*, or *National Construction Estimator* can be used and documented. Another possible source would be comparable maintenance and repair costs from another installation with a similar Family Housing program.

3.5.2.2. Utility Costs. Utility costs include the expenses associated with the provision of utility services such as:

- Electricity.
- Natural gas or oil.
- Water.
- Sewage.
- Refuse collection.

3.5.2.2.1. Figure 3.4 presents an example of the methodology used to estimate annual electricity costs for all alternatives based on an area (square footage) basis; other energy-consuming utility costs can be similarly calculated. The most accurate estimates of utility costs are available when bases can meter utility usage at the neighborhood level. Total consumption for Family Housing can be taken from utility bills or Defense Utility Energy Reporting System (DUERS) reports. DUERS or WIMS can also provide the necessary area figures. CE is the best source for this data. Usage rates from 3 previous years should normally be averaged after adjusting them to the base year of the EA. Data Resources, Inc. (DRI) Energy Inflation Indices are used to inflate energy costs to the base year. This data is available on the FMABB.

3.5.2.2.2. Non-energy-consuming utilities costs, such as water and sewage, can also be calculated based on a three-year average. Since improvement or replacement will not usually impact these usage rates, Status Quo values can be used for all alternatives where the same size families will occupy the housing units. Some utilities, such as refuse collection, are provided on a per-unit basis as demonstrated in figure 3.5. Non-energy costs are inflated to the base year using the Air Force Raw Inflation Table for the O&M account on the FMABB.

Figure 3.4. Calculation of Annual Electricity Costs on an Area Basis.

Status Quo

Three Year Average:

Year	Annual Cost	Inflation Index	Total Cost $ 1995				Avg Cost
1990	535,226	1.109	593,566				
1991	531,867	1.049	557,928				
1992	523,768	1.028	538,434				
			1,689,928	÷	3	=	563,309

Avg Cost $ 1995	/	Total Area	=	Cost/SF $ 1995	x	Avg Net Square Ft	=	Unit Cost $ 1995	x	Number of Units	=	Total Cost $ 1995
563,309		1,592,000		0.354		1,029		364		64		23,296

Improvement

Status Quo Cost/SF $1995:	x	35% Estimated Savings	=	Cost/SF $1995	x	Average Net Square Ft:	=	Unit Cost $1995	x	Number of Units	=	Total Cost $1995:
0.354		0.65		0.230		1,269		292		64		18,688

Replacement

Status Quo Cost/SF $1995:	x	40% Estimated Savings	=	Cost/SF $1995	x	Average Net Square Ft:	=	Unit Cost $1995	x	Number of Units	=	Total Cost $1995
0.354		0.60		0.212		1,273		270		64		17,280

Figure 3.5. Calculation of Refuse Collection Costs on a Unit Basis.

Unit Cost $1992:	x	Inflation Index:	=	Unit Cost $1995:	x	Number of Units	=	Total Cost $1995:
100.00		1.073		107		64		6,848

3.5.2.3. Other Costs. Include in the analysis for Improvement alternatives all recurring or one-time costs for separately programmed improvement or maintenance and repair work related to the housing units and associated neighborhood. The associated neighborhood is defined as the housing area or facilities directly associated with the family housing units, such as access roads and their sidewalks, parking spaces, walkways between roads/parking and housing units, landscaping adjacent to housing units, and utility branch lines servicing the housing unit.

3.5.3. **BAQ/VHA Payments.** The primary cost element associated with the Direct Compensation alternative is BAQ/VHA payments. Both BAQ and VHA payments are based on grade; however, BAQ payments are uniform across the Air Force, and VHA is based on the geographic location of the military personnel. BAQ/VHA data can be obtained from the Financial Management Office.

3.5.3.1. To calculate the BAQ/VHA costs, the number of military personnel by grade who would be assigned to the housing must be determined. BAQ/VHA costs are the product of the number of personnel requiring off-base housing by grade, and the associated BAQ/VHA rate. Figure 3.6 shows the calculation of monthly BAQ/VHA payments.

Figure 3.6. Calculation of Monthly BAQ and VHA Costs.

Grade	**Units**	**x**	**(BAQ**	**+**	**VHA)**	**=**	**Total Cost**
E-5	24		$406.50		$9.48		$9,983.52
E-6	20		$425.40		$12.89		$8,765.80
E-7	10		$489.30		$46.85		$5,361.50
E-8	6		$526.80		$68.73		$3,573.18
E-9	4		$571.50		$75.29		$2,587.16
TOTAL							$30,271.16

3.5.3.2. BAQ/VHA payments may also be incurred when personnel need to find temporary housing off base during an Improvement or Replacement project. These costs would be incurred in accordance with the construction schedule.
3.5.4. Figure 3.7 presents the suggested data sources for obtaining the data required to conduct a Family Housing EA.

Figure 3.7. Summary of Data Sources for Family Housing Eas.

	Primary Source	**Other Sources**
Construction Costs	DD Form 1391	PACES, Means, Tri-Services Cost Model, Local Cost Data
Annual M&R Costs	WIMS BCE (actual past M&R costs for a particular facility type or building)	DEMRC: Form 1133 BCE: RCS HAF LEE (SA) 7101
Periodic M&R Costs	WIMS BCE (same as above)	DEMRC: Individual facility jackets, Means or Dodge
Utility Costs	DUERS, WIMS	BCE: RCS HAF LEE (SA) 7101, MAJCOM consumption report
Miscellaneous Operations and Maintenance Costs	Base Contracting Office, Facilities Management Office, Base Transportation Office	Means, Dodge
Lease Costs	Base Real Property Office	Off-base real estate broker, GSA
BAQ/VHA	Financial Management Office	Housing Office
Discount Rates and Inflation Indices	FMABB	

3.5.5. **Project Schedule.** The project schedule provides information about project phasing and housing occupancy under each alternative. Many costs associated with the existing situation continue to be incurred during the construction period. In general, cost savings, such as lower utility costs, cannot be realized until the new housing is occupied and the old housing has been disposed.
3.5.5.1. Where the project schedule allows for phased occupancy, costs such as Annual M&R and utilities are pro-rated. The occupancy or "move-in" date may vary for some alternatives due to different time factors associated with the construction period, approvals, and the solicitation process.

3.6. Conducting the Benefits Analysis. A benefits analysis takes into account many of the intangibles that are normally difficult to assess in an EA. Examples of benefits which might be considered are presented in figure 3.8. The list in figure 3.8 is by no means exhaustive, but it does include many of the benefits that are normally considered when evaluating MFH projects.
3.6.1. The FM analyst is responsible for conducting the benefits analysis. However, input should be provided by a variety of installation functions, including CE, services, security police, transportation, and housing, as well as the current occupants. One effective approach is to convene a "roundtable" discussion with all participating organizations to determine benefit categories and weights, and to score each alternative. FM should prepare a source document for the benefits analysis showing participants, assumptions, rationale for benefit selection, and sources. This document must be signed and included in Appendix C of the EA report.
3.6.2. Each project will have its own set of benefits to assess. Each benefit is ranked in order of importance and is provided a "weight point." The next step is to estimate how much each alternative meets the objective. For example, a scale from 100 percent (Optimum Solution) to 0 percent (Does Not Meet Objectives) is used. Finally, the percentage estimate and the

weight points assigned to each benefit are multiplied together to determine the benefit value (seen in parentheses in the figure). The sum of the benefit values is the benefit score for that alternative. The alternative with the highest benefit score is the alternative that would yield the most benefit to the Air Force. Figure 3.9 presents a recommended example of a benefits analysis conducted for a typical Air Force base.

Figure 3.8. Benefits for Consideration for MFH Projects.

Availability of base services/activities **-** The location of the proposed MFH project relative to the other services and activities on base.

Efficiency/Comfort- The extent to which the housing meets Air Force standards and the needs of the occupants. Issues include the quality of units, size, layout, comfort, number of bedrooms, etc.

Health/Safety **-** The health and safety environments that would be provided under each alternative. Older housing may have lead-based paint, asbestos, radon, and other unsafe conditions.

Historic Preservation **-** Addressed if the existing housing considered in one of the alternatives is of historic value and is likely to be altered or demolished.

Maintenance **-** Newly constructed or improved housing is easier to maintain and service. Many of these potential cost savings can be quantified and included in the life cycle cost analysis. Those benefits which cannot be quantified should be addressed here.

Mission/Operational Impact **-** Some alternatives will have a positive impact on the mission or operations of the installation. Having military personnel on base, for example, can enhance mission readiness.

Morale/Retention **-** Morale is important both to performance and retention of Air Force personnel.

Off-base Effects **-** Off-base socioeconomic effects may be a consideration if a substantial increase in assigned personnel is anticipated. The criterion can also be used if an alternative under consideration for the base would result in either an increase or decrease in dollars spent in the local community.

Privacy **-** Evaluates the level of privacy each Family Housing alternative provides for military families.

Security **-** Security refers to how safe military families feel in their homes. This can include improved locks, better lit neighborhoods, security gates, etc.

Figure 3.9. Example Benefits Analysis.

		Alternatives		
Benefits	**Weight Points**	**Status Quo**	**Improvement**	**Replacement**
1. Security/Safety	3.0	60% (1.80)	80% (2.40)	100% (3.00)
2. Morale/Retention	2.5	20% (0.50)	60% (1.50)	90% (2.25)
3. Efficiency/Comfort	2.0	20% (0.40)	60% (1.20)	90% (1.80)
4. Privacy	1.0	30% (0.30)	60% (0.60)	90% (0.90)
TOTAL BENEFIT SCORE		3.00	5.70	7.95

SCALE: 100% Optimum Solution
0% Does Not Meet Objectives

3.6.3. It is important to understand how the weight point rankings work mathematically. For example, if a weight point of 1 is assigned for security, 2 for morale, and 3 for health/safety, this indicates that morale is valued twice as much as security, and health/safety 3 times as much as security. Hence, there may be situations where assigning a fractional weight point, such as 1.25 or 1.5, may be appropriate. Additionally, alternatives may have benefits with equal weights.

3.7. Conducting the Economic Analysis and Analyzing the Results. The purpose of an EA is to determine the cost and benefits to the Air Force of each alternative that is being considered for satisfying the current Family Housing requirement. The analysis method generally uses a life cycle cost approach to determine the total net present value costs of each alternative. The Air Force normally uses a mid-year discounting convention. The evaluation of net present value provides the Air Force with a method of comparing the costs of alternatives with different economic lives.

3.7.1. The concept of present value is fundamental to the economic analysis. Present value calculations allow the comparison of different dollar amounts received or expended during different time periods. Discounting is the technique used to determine the present value of future cash flows. The discounting process allows the analyst to take into account the fact that money received or expended today is worth more than the same amount of money received or spent in the future, even after adjustment for inflation.
3.7.2. Most EAs performed to support Family Housing programs will be priced in constant dollars and discounted at the discount rate prescribed in the President's Budget. This is based on current OMB guidance as outlined in OMB Circular A-94. The base year to use in the EA is the program year for which funding is requested. The analysis includes 25 years plus the construction period.
3.7.3. However, if future costs and benefits are collected in nominal (i.e., inflated) dollars, the analysis should then be conducted in inflated dollars. Since leases are often stated in inflated dollars, an analysis with a leasing alternative is an example of an EA in which inflated dollars may be appropriate. Should the cost of a lease be stated in constant dollars, then the EA should be conducted in constant dollars. Do not mix constant and current dollars in the same analysis.
3.7.4. The Air Force recommends using the PC-ECONPACK software package in the preparation of EAs for Family Housing. PC-ECONPACK is available from the US. Army Corps of Engineers. For information on how to use PC-ECONPACK, refer to the PC-ECONPACK User's Manual or call the hotline. For more information on obtaining PC-ECONPACK, see attachment 1.
3.7.5. **Overview of PC-ECONPACK.** This section presents an overview of PC-ECONPACK and its application to Family Housing EAs. PC-ECONPACK is a comprehensive program incorporating EA calculations, documentation, and reporting capabilities. It is structured so that it can be used by non-economists to prepare complete, properly documented EAs in support of DoD funding requests. PC-ECONPACK is menu-driven and features interactive display screens that enable the user to select analysis parameters and specify functions.
3.7.5.1. PC-ECONPACK is designed to be used on IBM personal computers and IBM-compatible hardware equipped with at least 5 megabytes of storage available on one disk drive and 512K Random Access Memory (RAM). At a minimum, a ten megabyte hard disk is recommended for running PC-ECONPACK. The operating system needed to run PC-ECONPACK on a personal computer is Microsoft's Disk Operating System (DOS) version 2.2 or higher.
3.7.5.2. There are several advantages to using the PC-ECONPACK computer program to conduct EAs:

- Individuals having limited expertise in economic techniques can successfully produce EAs.
- Repetitive calculations can be revised easily and quickly.
- Sensitivity analyses can be conducted accurately and easily.
- Reports are generated in a standardized format accepted by the Air Force, OSD, and Congress.

3.7.5.3. Data entry and modification in PC-ECONPACK are straightforward, with the User's Manual providing step-by-step instructions. It is recommended, however, to organize the data as presented in figure 3.10 in order to facilitate data entry. PC-ECONPACK also allows the user to input text information. Paragraph 3.8 provides more information on how to use PC-ECONPACK to generate EAs.
3.7.5.4. PC-ECONPACK provides for two separate types of analyses: Primary and Secondary Analyses. The Secondary Analysis should be used to evaluate Family Housing projects. A Secondary Analysis is used to determine which of two or more alternative courses of action would most economically fulfill an objective or requirement which is not currently being met. The net present value (NPV) of costs are calculated for each of the alternatives and the rank order identified.
3.7.6. **Net Present Value of Alternatives.** To determine the least costly approach to meeting the EA objective, the analyst will compare the calculated NPVs of the alternatives under consideration. With PC-ECONPACK, the NPV for each alternative is presented in the Executive Summary Report (ESR). The NPV can also be retrieved from the Life Cycle Cost Report (LCCR). The NPV would be the last number under the column titled "Cumulative Net Present Value."
3.7.6.1. It is important to proofread the Life Cycle Cost Report to ensure that all the data input is correct. The analyst should:

- Check for any typographical errors in the data input.
- Check that the costs are being applied in the appropriate years.
- Check that the construction expenditures match the construction schedule.
- Ensure that the appropriate cost elements have been included for each alternative.
- Ask -- Do the results make sense? Are they reasonable? Are there any surprises?

3.7.6.2. Any errors discovered should be corrected and new net present values should be calculated.
3.7.6.3. PC-ECONPACK also calculates an Equivalent Uniform Annual Cost (EUAC) for each alternative. The EUAC is the amount of money which, if paid in equal annual installments over the life of a project, would pay for the project.
3.7.7. **Cost/Benefit Ratio.** The cost/benefit ratio shows the decision maker the degree to which benefits are being attained relative to costs. The cost/benefit ratio for each alternative is calculated by dividing the net present value by the benefit score. The alternative with the lowest cost/benefit ratio is considered the most cost-effective solution.

3.7.8. **Scope Sensitivity Analysis.** To minimize EA revisions each time the scope of a project changes, "the OSD Comptroller has agreed to the preparation of EAs which reflect sensitivity analysis for scope changes of plus or minus 25 percent with a corresponding change in total cost." Since there is a possibility that the number of units will change during the review process, the FM analyst should perform a scope sensitivity analysis to reduce the likelihood of future revisions of the same EA.

Figure 3.10. Recommended Organization of Data for Input into PC-ECONPACK.

Project Title
Project Objective
Organization Title
Global Discounting Convention
Period of Analysis
Start Year
Discount Rate
Base Year
Analysis Type (Primary or Secondary)
Cost Input (Dollars or Thousands)

For Each Alternative:
Alternative Name
Residual Value Parameters
Expense Item Name
Expense Item Discounting Convention
Expense Item Annual Costs

Assumptions
Discussion of Alternatives
Source and Derivation of Costs and Benefits
Non-monetary Benefits
Scope Sensitivity Analysis Parameters
Discount Rate Sensitivity Analysis Parameters
Results and Recommendations

3.7.8.1. To perform the scope sensitivity analysis in PC-ECONPACK, the analyst enters into the cost sensitivity analysis menu (menu item [7] of the Data Entry and Modification screen), and selects the Improvement alternative. The analyst then reviews each separate expense item, determines if they would vary with a corresponding change in the number of units, and selects those expense items accordingly. As a suggestion, anything "on site" should vary with a change in the number of units. Next, the analyst selects the Replacement alternative, and determines if each separate expense item would vary with a corresponding change in the number of units. These expense items are selected accordingly. The upper limit of the expense items are varied by 25 percent.
3.7.8.2. The goal of the Scope Sensitivity Analysis is to see if the ranking of alternatives would change if the number of units varied by plus or minus 25 percent. Since the cost sensitivity analysis menu in PC-ECONPACK does not allow the lower limit to vary by 25 percent (it automatically decreases the lower limit to 100 percent), the analyst must do the following: After entering all costs in PC-ECONPACK, select the "Cost Sensitivity Analysis Report" as one of the reports to be printed.
3.7.8.3. The report "Table of Percent Changes Where Alternatives' NPVs are Equal" will display three columns. Column One displays percent changes for the least costly alternative. Column Two displays percent changes for the higher cost alternative. Column Three shows the NPV when the changes in Column One and Column Two yield the same NPV. Any change in the alternative listed in Column Two above the amount corresponding to Column One will change the ranking of the alternatives.
3.7.9. **Discount Rate Sensitivity Analysis.** At a minimum, all Family Housing EAs should include a sensitivity analysis on the discount rate. A sensitivity analysis should be conducted at plus and minus 25 percent of the currently prescribed rate found on the FMABB.
3.7.9.1. PC-ECONPACK addresses discount rate sensitivity analysis as a special case. The analyst can name the range of discount rates tested by designating the upper and lower limits. PC-ECONPACK recomputes the entire EA for each alternative for up to 60 different discount rates within the designated range. The results of the discount rate sensitivity analysis are presented in three parts:

- A graph depicting changes in NPV over the range of discount rates specified.
- A summary table which can be reviewed to see if the sensitivity analysis yielded any changes in the alternative rankings.
- A detailed report listing the NPVs by discount rate and alternative.

3.7.10. **Residual Value Calculations.** Residual Value is the expected value of an asset at any point in time before the end of its economic life. PC-ECONPACK directly accounts for residual value on the alternative information screen for the Replacement alternative. The analyst should select "Yes" to the "Do you wish to include a residual (salvage) value (Y/N)?" prompt and select Residual Type 2, Straight Line Depreciation, as the type. The Start Value is the DD Form 1391 total construction cost minus the demolition costs (demolition plus contingency and SIOH) as can be seen in figure 3.11. The Economic Life is usually 40 years and the Beginning Year is the year of construction. An end-of-year discount convention is recommended for calculating residual value. A discounting convention for residual value can be selected under the 'Alternative Information' data entry screen.

Figure 3.11. Residual Value Calculations.

IMPROVEMENT COST:

Construction Cost $1995: 5,111,000

REPLACEMENT COST:

Construction Cost $1995: 6,160,000

Net Investment Cost:

Demolition Cost $1995	+	5% Contingency	=	Subtotal	+	5.5% SIOH	=	Total Demolition Cost $1995
203,000		10,150		213,150		11,723		224,873

Construction Cost $1995	-	Total Demolition Cost $1995	=	Net Investment Cost $1995
6,160,000		224,873		5,935,127

3.7.11. **Formulating Recommendations.** The net present value results account for quantifiable costs. When reviewing the results and formulating recommendations, non-quantifiable costs and benefits should also be evaluated. The cost/benefit ratio quantifies these issues, but the analyst must review all the results and make a final recommendation. At this point, the viability of each alternative is once again addressed. For example, continuing to provide BAQ/VHA to personnel may be the most cost-effective alternative. However, a recent Housing Market Analysis may have concluded that there is insufficient housing in the private market for personnel. Hence, another alternative may be preferable.

3.7.11.1. A consideration at this time is the 70 Percent Rule. When improvement initial costs are estimated to exceed 70 percent of replacement initial costs, replacement may be considered in lieu of improvement, unless there is prevailing justification to retain the existing units. A complete EA still must be prepared to assess the full life cycle costs of each alternative, including careful consideration of the benefits of each alternative. The conclusions in the Executive Summary of the EA must contain one of the statements indicated below.

- For Replacement: "The improvement/replacement initial costs ratio is ___% and there is no prevailing justification to retain the existing units. It is therefore recommended that the Replacement alternative be approved."
- For Improvement: "The improvement/replacement initial costs ratio is ___%; however, improvement of the existing units is proposed on the basis that _____. It is therefore recommended that the Improvement alternative be approved."

3.8. Documenting the Results of the Economic Analysis. An EA must be documented to allow complete replication by reviewers. This section provides guidance on how to compile an EA. An EA contains:

- Certificate of Satisfactory Economic Analysis*.
- DoD Executive Summary*.
- Table of Contents*.
- Executive Summary Report, including the project objective, alternatives, assumptions, and results and recommendations.
- Life Cycle Cost Report., including alternative data and the source and derivation of costs and benefits.

- Benefits Analysis.
- Scope Sensitivity Analysis.
- Discount Rate Sensitivity Analysis.
- Appendices.

(* Items must be created in a word processor or spreadsheet program.)

3.8.1. PC-ECONPACK can be used to generate most of the EA. PC-ECONPACK reports are generated in standardized formats which summarize the essential components of a comprehensive EA. Six different reports can be generated:

3.8.1.1. Executive Summary: This report consists of several pages containing a brief discussion of each alternative, assumptions, NPV, and EUAC for each alternative.

3.8.1.2. Graphs of the Cumulative NPV of each alternative.

3.8.1.3. Life Cycle Cost Report: This report provides an overview of all the detailed costs and benefits for each alternative on a year-by-year basis.

3.8.1.4. Cost Sensitivity Analysis Report: This report is used for the Scope Sensitivity Analysis and other sensitivity analyses that may be warranted.

3.8.1.5. Discount Rate Sensitivity Analysis Report.

3.8.1.6. Input Listing: This is a line-by-line listing of all the data entered for the EA (not to be included in the EA documentation).

3.8.2. Text can be entered into five text blocks:

- Assumptions.
- Discussion of Alternatives.
- Source and Derivation of Costs and Benefits.
- Results and Recommendations.
- Non-Monetary Benefits.

3.8.3. For more information on creating PC-ECONPACK reports, refer to the PC-ECONPACK User's Manual. Attachment 4 contains a sample EA that utilized PC-ECONPACK for a Family Housing project.

3.8.4. **Certificate of Satisfactory Economic Analysis.** A Certificate of Satisfactory Economic Analysis is attached to the front of each completed EA. The certificate is normally a two-page document. The first page includes:

- Name of the installation and MAJCOM.
- Project title.
- Project number.
- Objective.
- Project cost.
- Alternatives considered.
- Summary of analysis results.
- Certification.

3.8.4.1. The second page, or "signature page" presents the signatures of the reviewers and evaluators certifying that they have reviewed and concur with the EA findings. The signatures of the following personnel are required:

- Installation FM Analyst.
- Installation FM.
- Installation CE.
- MAJCOM/FMA Evaluator.
- MAJCOM FMA.
- MAJCOM CEH.

3.8.4.2. These signatures do not need to be physically included on a single sheet of paper, but all signatures are required on the final EA before transmittal to HQ USAF. If more than one signature sheet is used, indicate the installation/MAJCOM, project title, project number, scope/cost, and objective on each sheet.

3.8.4.3. PC-ECONPACK cannot generate the Certificate of Satisfactory Economic Analysis; it is produced as a separate document and attached to the front of the EA. A completed Certificate of Satisfactory Economic Analysis is included in the sample EA presented in attachment 4.

3.8.5. **Department of Defense Executive Summary.** A Department of Defense (DoD) Executive Summary follows the Certificate of Satisfactory Economic Analysis. This Executive Summary is a clear and concise one-page summary of the EA and its conclusions. Figure 3.12 presents the format for the Executive Summary. PC-ECONPACK cannot generate the DoD Executive Summary; it is produced as a separate document and included in the EA. A completed sample may be found in attachment 4.

3.8.6. **Table of Contents.** A Table of Contents outlining the organization of the EA follows the DoD Executive Summary. PC-ECONPACK cannot generate a Table of Contents; it is produced as a separate document and included in the EA.

3.8.7. **Executive Summary Report.** The PC-ECONPACK Executive Summary Report provides an overview of the EA. It includes the project objective, the description of the alternatives, a listing of the assumptions, and a summary of the results and recommendations.

Figure 3.12. DoD Executive Summary.

INSTALLATION/MAJCOM:
PROJECT TITLE (include FY):
PROJECT NUMBER:
OBJECTIVE:
PROJECT COST:

ALTERNATIVES EXAMINED	NET PRESENT VALUE	BENEFIT SCORE	COST/BENEFIT RATIO
1. STATUS QUO			
2. IMPROVEMENT			
3. REPLACEMENT			
4. DIRECT COMPENSATION			

ANALYSIS METHOD:

CONCLUSION:

3.8.7.1. Project Objective. The project objective is clearly stated early in the EA. For Family Housing projects, the objective is normally **"To provide ___ [insert number and indicate Enlisted or Officer] Family Housing units meeting Air Force standards."**
3.8.7.2. Alternatives. A detailed description of each alternative addressed in the EA is included in the EA Executive Summary Report. Figure 3.13 presents the information that is included in the description, by alternative. Justification must be provided for alternatives that were considered but dismissed as infeasible.

Figure 3.13. Description of Alternatives Checklist.

STATUS QUO

Number of units
Age of units
Housing composition by grade and bedrooms
Current condition
Date of last renovation

IMPROVEMENT

Number of units to demolish
Number of units to renovate
Renovation schedule
Extent of renovations
Project composition by grade and bedrooms

REPLACEMENT

Number of units to demolish
Number of units to construct
Location
Construction schedule
Project composition by grade and bedrooms

DIRECT COMPENSATION

Number of personnel/families to receive BAQ/VHA

3.8.7.3. Assumptions. According to AFI 65-501, all EAs include a list of the assumptions made. These assumptions must be clearly stated so that evaluators can understand the level of uncertainty and risk inherent in the EA results. It is also important to include the source for each assumption made. This section of the Executive Summary Report is not to be used to describe the derivation and source of every cost element in the analysis. That information is included in the Source and Derivation of Costs and Benefits section of the Life Cycle Cost Report.
3.8.7.4. Results and Recommendations. This section presents a comparison of the results for each alternative. It addresses the NPV, the benefit score, and the cost/benefit ratio for each alternative. A short paragraph should summarize the scope sensitivity analysis. The conclusion paragraph includes the results of the life cycle cost analysis, the benefits analysis, the sensitivity analyses, and any non-quantifiable issues related to the proposed project. The sensitivity analyses are discussed,

indicating whether or not the alternative rankings are sensitive to reasonable changes in costs and/or assumptions. Based on the conclusion, a recommendation is proposed.

3.8.7.5. At the conclusion of the PC-ECONPACK Executive Summary Report, a graph depicting the cumulative net present values of each alternative is attached. This graph is produced by PC-ECONPACK.

3.8.8. **Life Cycle Cost Report.** The PC-ECONPACK Life Cycle Cost Report provides a detailed look at the costs and benefits associated with each alternative.

3.8.8.1. Alternative Data. The Life Cycle Cost Report provides a printout for each alternative of the:

- Life cycle cost tables by cost element and year.
- Total costs by year.
- Discount rate factors by year.
- Present value costs by year.
- Cumulative NPV costs by year.
- Cumulative NPV costs by cost element.
- Percentage of NPV for each cost element.

3.8.8.2. Source and Derivation of Costs and Benefits. At the end of the Life Cycle Cost Report there is a text block to be used for discussing the source and derivation of the costs and benefits. Each data element included in the analysis is discussed separately in this section. Since many cost elements may be the same across alternatives, this approach can avoid the redundancy which would occur if the cost elements were addressed by alternative.

3.8.8.2.1. Frequently, interim calculations for construction, utility, M&R, BAQ/VHA, and other estimates, as well as adjustments for inflation, need to be made prior to entry into PC-ECONPACK. The methodology used for these interim calculations can be presented in a table or chart such as the one shown in figure 3.4. Tables and charts can facilitate the review of the EA for evaluators. **It is very important to include the source and any interim calculations conducted for all estimates and data used in the EA.** Therefore, this section shall refer the reader to the appropriate signed source documents in Appendix C and interim calculations in Appendix D of the EA. Any assumptions which were used in the derivation of the cost estimate is also reiterated here. For example, the derivation of Annual M&R costs might read like this:

> *Annual M&R costs for the existing housing units were based on historical data provided by the Planning Department of the Civil Engineering Squadron (Appendix C). The data were adjusted for inflation to FY95 dollars (Appendix D). Annual M&R costs for the Improvement alternative were assumed to be 10 percent less than the Status Quo alternative. Annual M&R costs for the Replacement alternative were assumed to be 15 percent less than the Status Quo alternative. These assumptions were based on interviews with CE personnel and are documented in the CE Source Document dated 29 April 19XX. (Appendix C).*

3.8.9. **Benefits Analysis.** In the EA, the benefits analysis is presented in a separate section. This section explains the methodology used to develop the benefit score used in the calculation of the cost/benefit ratio. The discussion on benefits analysis includes:

- An explanation of the methodology and rationale used to calculate the benefit score and weights.
- A description of each benefit category addressed in the analysis and a discussion of the results and rankings of each of the alternatives based on the benefit score.
- A chart or table similar to figure 3.9 summarizing the calculation of the benefit score.

3.8.9.1. PC-ECONPACK version 4.0 has added an additional text block which can be used for the benefits analysis documentation.

3.8.10. **Scope Sensitivity Analysis.** For the scope sensitivity analysis, the PC-ECONPACK Cost Sensitivity Analysis should be included in the EA. If the results of any sensitivity analysis indicate a change in the alternative rankings, then this fact should be highlighted and the implications should be discussed in the EA. Note that the PC-ECONPACK software will insert the title "Cost Sensitivity Analysis" on this report. This title is hard-coded in the system and cannot be modified by the user.

3.8.10.1. The analyst addresses the results of this scope sensitivity analysis in the DoD Executive Summary. Specifically, the summary must indicate whether the ranking of alternatives would change if the number of units were varied by plus or minus 25 percent. Suggested statements would be:

> "A scope sensitivity analysis for Alternatives X (the initially least cost alternative) and Y (the initially higher cost alternative) has been conducted reflecting changes of plus and minus 25 percent of the proposed project scope. The results indicate that if the scope of Alternative X increases by 25 percent, the ranking of alternatives will not reverse unless the scope of Alternative Y increases by less than ___ percent. Conversely, if the scope of Alternative X decreases by 25 percent, the ranking of alternatives will not reverse unless the scope of Alternative Y decreases by more than ___ percent. Therefore, within the range of this analysis, the ranking of alternatives remains unchanged."

(NOTE: If the analysis indicates that the ranking of alternatives reverses, determine where between the limits of plus and minus 25 percent this reversal occurs and change the last sentence to: "Therefore, the ranking of alternatives reverses with a ___ percent change in the scope of Alternative X.)

3.8.11. **Discount Rate Sensitivity Analysis.** This section should include the PC-ECONPACK printouts pertaining to the discount rate sensitivity analysis. For the discount rate sensitivity analysis, PC-ECONPACK provides an NPV versus Discount Rate graph, a summary table from which the analyst can determine whether changes in the discount rate changed the original ranking of alternatives, and a detailed report listing the NPVs for each discount rate value used in the analysis. All of these charts and graphs are included in this section of the EA.

3.8.12. **Appendices.** The appendices of the EA include the following:

- Appendix A - DD Form 1391 for the Improvement alternative. The Military Construction Project Data form for improvement of existing housing must be presented, and must include the PACES report illustrating project composition.
- Appendix B - DD Form 1391 for the Replacement alternative. The Military Construction Project Data form for new construction or replacement of existing housing are presented and include the Tri-Service Cost Model illustrating project composition.
- Appendix C - Source Documents. All of the signed source documents and supporting data are presented including the name and phone number of POCs.
- Appendix D - Interim Calculations. All of the worksheets used in calculating utility, maintenance, moving, BAQ/VHA, and other estimates, as well as inflation/escalation adjustments are presented.

Chapter 4

ENERGY CONSERVATION INVESTMENT PROGRAM/FEDERAL ENERGY MANAGEMENT PROGRAM (ECIP/FEMP)

4.1. Introduction. This section of the manual provides guidance for the preparation of Economic Analyses (EAs) which are required as part of the project justification process for projects falling under the Energy Conservation Investment Program and the Federal Energy Management Program (ECIP/FEMP). ECIP/FEMP are DoD centrally managed programs. The ECIP is a Military Construction (MILCON) funded program for retrofitting existing Department of Defense energy systems and buildings in order to make them more energy efficient and to provide substantial savings in operating costs. The FEMP is similar to ECIP but it uses Operation and Maintenance funds—$300,000 or less for new work, and $3 million or less for repair type work. All ECIP/FEMP projects require that an EA be performed prior to the project being approved; FEMP projects require an EA to be submitted to the Air Staff if the expected cost is more than $300,000.

4.1.1. **Background.** The Presidential Executive Order 12759, issued on April 17, 1991, and recent directives from DoD have placed renewed emphasis on the energy conservation program. ECIP/FEMP funding levels vary based on congressional appropriations and current budget constraints. Hence, well-documented and justified energy projects can assist the Air Force in obtaining ECIP/FEMP funds. The purpose of this guidance manual is to assist analysts in the preparation of ECIP/FEMP EAs.

4.1.1.1. Public Law 102-486, the Energy Policy Act of 1992," makes each military service responsible for identifying and accomplishing all energy conservation measures with a 10-year or less payback. All facility energy conservation construction projects costing $300,000 or more are administered as MILCON projects.

4.1.1.2. By definition, an ECIP/FEMP project must result in an overall energy cost savings. That is, ECIP/FEMP projects are proposed to correct inefficient use of energy and reduce operating costs due to that inefficient use. ECIP/FEMP projects are prioritized on the basis of the greatest life cycle payback as determined by the savings-to-investment ratio (SIR). Additional consideration can be given to projects that substitute a renewable energy for nonrenewable energy. Figure 4.1 summarizes the 14 types of ECIP/FEMP projects.

4.1.2. **Project Coordination.** The primary responsibility for performing ECIP/FEMP EAs lies with the Civil Engineering (CE) staff at the affected organizational level, as can be seen in figure 4.2. Collateral responsibility lies with the Financial Management (FM) staff and the end user. Therefore, completing the EA requires close coordination between CE, FM, and the end user of the facility.

4.1.2.1. ECIP/FEMP EAs require approval from the MAJCOM. Hence, it is important that ECIP/FEMP EAs are well-documented and justified. Figure 4.3 presents the ECIP/FEMP project approval process.

Figure 4.1. Energy and Water Conservation Project Types.

EMCS or HVAC Controls Projects which centrally control energy systems with the ability to automatically adjust temperature, shed electrical loads, control motor speeds, or adjust lighting intensities.

Steam and Condensate Systems Projects to install condensate liens, cross connect lines, distribution system loops, repair or install insulation, and repair or install stream flow meters and controls.

Boiler Plant Modifications Projects to update or replace central boilers or ancillary equipment to improve overall plant efficiency. This includes fuel switching or dual fuel conversions.

Heating, Ventilation, Air Conditioning (HVAC) Projects to install more energy efficient heating, cooling, ventilation, or hot water heating equipment. This includes the HVAC distribution system (ducts, pipes, etc.).

Weatherization Projects improving the thermal envelope of a building. This includes building insulation (walls, roof, foundation, doors), windows, vestibules, earth berms, shading, etc.

Lighting Systems Projects to install replacement lighting systems and controls. This includes daylighting, new fixtures, lamps, ballasts, photocells, motion sensors, IR sensors, light wells, highly reflective painting, etc.

Energy Recovery Systems Projects to install heat exchangers, regenerators, heat reclaim units, or recapture energy lost to the environment.

Electrical Energy Systems Projects that will increase the energy efficiency of an electrical device or system or reduce cost by reducing peak demand.

Solar Systems Any project utilizing solar energy. This includes solar heating, cooling, hot water, industrial process heat, photovoltaics, wind energy, biomass, geothermal energy, and passive solar applications.

Facility Energy Improvements Multiple category projects or those that do not fall into any other category.

Water Conservation Retrofit Projects to install low-flow fixtures, control devices, or more water-efficient equipment.

Leak Detection/Repair Projects to repair water leaks in water main and plumbing systems.

Water Efficient Landscape Projects to install xeriscape, subsurface/drip irrigation, irrigation management systems, etc.

Water Reuse Projects for grey water reuse and wastewater treatment for reuse.

Figure 4.2. ECIP/FEMP Economic Analysis Responsibility Matrix.

TASK	COMPTROLLER	ENGINEER	USER
Identify Need/Project Objective		OPR	OCR
Identify Alternatives	OCR	OPR	OCR
Identify Data Requirements			
Cost Data	OCR	OPR	OCR
Engineering Data		OPR	OCR
Formulate Assumptions	OCR	OPR	
Data Collection			
Cost Data		OPR	OCR
Engineering Data		OPR	OCR
Calculate Life Cycle Costs	OCR	OPR	
Select Alternative/Formulate Recommendations	OCR	OPR	OCR
Identify Changes in Scope		OPR	
Documentation			
Engineering Data		OPR	

OCR = Office of Collateral Responsibility
OPR = Office of Primary Responsibility

Figure 4.3. Approval Process for ECIP/FEMP Projects.

Base: Identification of requirement, data collection, and submittal (Base CE).
MAJCOM: Functional review and submittal (MAJCOM/CE).
Air Staff/SAF: Functional validation and submittal (AF/CEC/CEO).
SAF: Approval and submittal to Congress (SAF/MII).
OSD: Economic Analysis used in program budget review.

Congress: Approval waiver to statutory cost limits for Improvement project, or approve Replacement project, based on justification of the Economic Analysis.

4.2. Defining the Project, Formulating Assumptions, and Identifying Alternatives. The analyst should collect and review all written documentation available that could affect any project alternatives. This review will include the most current DD Form 1391 and the attached construction cost estimate for the proposed project, previous EAs, the Base Comprehensive Plan (BCP), energy studies, and relevant floor plans. Next, interviews are conducted with the personnel involved with the project planning process and with current facility users. The current facility users are a good source for identifying deficiencies in the existing facility. All information is collected in writing, including the source of the data, and the name, organization, title, and phone number of each point of contact (POC).

4.2.1. Other concerns which should be addressed at this time include possible asbestos, radon, or lead-based paint problems which can cause costly abatement procedures and impact the project schedule. In addition, a facility on the National Register of Historic Places cannot be demolished and demands unique architectural/engineering compliance requirements for renovation. These requirements traditionally make renovation more costly and may make enhanced energy efficiency an impossible or nearly impossible goal.

4.2.2. **Defining the Project Objective.** From the information collected, a one-sentence description of the proposed project is developed. A clear, concise project definition is necessary in order to define potential alternatives for the project (called discrete portions by the LCCID software). Figure 4.4 presents sample ECIP/FEMP project objectives.

Figure 4.4. Sample ECIP/FEMP Project Descriptions.

***Steam and Condensate Systems*:** Replace 21,000 LM of High Temperature Hot Water Lines (HTHW) connecting the central heat plant to the industrial area of the base with a shallow trench system.

***Steam and Condensate Systems*:** Install two centimeters of insulation on all base steam and condensate lines in Warehouses 2 and 3.

***EMCS*:** Install a new EMCS in 26 buildings, and replace EMCS equipment in 12 water well stations, 6 water storage tanks, and 10 sanitary pump stations.

***HVAC*:** Replace existing chillers with new high-efficiency chillers and central plant piping extensions.

4.2.3. **Formulating Assumptions.** EAs are based on facts and data pertaining to the project in question. However, an EA deals with costs and benefits occurring in the future. Since the future is unpredictable, assumptions are made to account for uncertainties. To avoid invalidation or bias of the analysis, assumptions based on realistic assessments or anticipated conditions should be made only by qualified individuals. Since these assumptions are fundamental to the integrity of the EA, clarification of the assumptions is an essential part of the EA process.

4.2.3.1. There are several common assumptions made when preparing an EA for ECIP/FEMP projects:

- Economic Life of the Project: The economic life of an ECIP/FEMP project varies for each project type as can be seen in figure 4.5. The maximum life cycle is 25 years.
- Salvage Value: The salvage value is the residual value of existing equipment removed as a result of the retrofit project. This salvage value is the estimated market value and can be determined by contacting several local salvage yards. The information released should be limited to that required to get a fair estimate and should not bias source selection.

Figure 4.5. Life Cycles of Selected Energy Conservation Project Types.

Energy Monitoring and Control Systems (EMCS)	10	Years
Steam and Condensate Systems	15	Years
Boiler Plant Modifications	20	Years
Heating, Ventilation, Air Conditioning (HVAC)	20	Years
Weatherization	25	Years
Lighting Systems	15	Years
Energy Recovery Systems	20	Years
Electrical Energy Systems	20	Years
Solar Systems		
Active	10	Years
Passive and Photovoltaic	20	Years
Facility Energy Improvements	20	Years
Water Conservation Retrofit	5	Years
Leak Detection/Repair	25	Years

Water Efficient Landscape	15	Years
Water Reuse	25	Years

Source: US Army ECIP Guidance, 23 June 1991.

- Inflation: In a constant-dollar analysis, costs and benefits are estimated based on the constant purchasing power of the dollar. Therefore, inflation adjustments are made only for those cost elements for which price increases are anticipated to exceed the general inflation level. However, when historical data is used to estimate future costs, historical costs must be inflated to the date of analysis (DOA). This can be performed by CE or FM staff. It is critical that the analysis date be indicated on all source documents and in the analysis so that the analyst and reviewers know that the appropriate escalation and discount values have been applied. The source and date of the inflation indices must also be documented.
- Base Year: A constant-dollar analysis requires that all costs be converted to a common or base year to permit equitable comparison of those values. Typically, the project year is defined as the base year for a given EA. The most recent NISTIR 4942-2, *Present Worth Factors for Life-Cycle Cost Studies in the Department of Defense*, is used to obtain inflation indices for ECIP/FEMP projects.
- Discount Rate: The discount rate is used to account for the time value of money when comparing the cost of alternatives over multiple years. EAs performed to support Air Force ECIP/FEMP projects are priced in constant dollars and discounted by a market-based rate that is revised annually. The most recent NISTIR 4942-2, *Present Worth Factors for Life-Cycle Cost Studies in the Department of Defense*, is used to obtain discount rates for ECIP/FEMP projects.
- Cost Savings: By definition, an ECIP/FEMP project must save energy; therefore, there will always be an overall energy cost savings. Cost savings may include increases in the use of one fuel and a decrease in the use of another. Cost savings also include items such as electrical demand savings and operator/maintenance savings. Cost savings are made relative to the Status Quo values in the EA.

4.2.3.2. Additional assumptions may be required when project data is unavailable, when future costs are uncertain, or when a project involves unique circumstances. All ECIP/FEMP submittals will include copies of the life cycle analyses with supporting documentation showing the basic assumptions made in arriving at projected costs and savings.

4.2.4. **Identifying Alternatives.** There are typically three potential alternatives to meet an ECIP/FEMP objective:

- Status Quo.
- Retrofit.
- New Construction.

4.2.4.1. The Status Quo alternative is considered the baseline for the EA and is used only to allow calculation of the project's energy savings. In the case of an ECIP/FEMP project, the Status Quo is the continued use and operation of existing facilities in their current condition.

4.2.4.2. The Retrofit alternative involves renovating the existing facility to eliminate and/or reduce future energy costs by reducing fuel consumption or converting to a more efficient fuel. Various levels of improvements can be addressed as alternatives, including minimal correction of deficiencies (such as recaulking windows) to comprehensive “gut and rebuild” efforts (such as remodeling interior design to take a thicker insulation standard). This option must also consider any costs incurred due to construction requirements arising from historical or regulatory demands. The actual work to be performed is explicitly documented in the EA.

4.2.4.3. The New Construction alternative consists of the construction of a new facility in order to produce an overall energy savings. If new construction involves replacing an existing facility, then disposal of the existing facility is addressed. New construction is sometimes cheaper than a retrofit because energy conservation can be built into the facility, while retrofit may require additional engineering to support the conservation measures. For example, if thicker insulation is required to meet certain standards, the required space can be part of the design for new construction, while for a retrofit project, significant renovations may be required. This option must also consider any costs incurred due to construction requirements arising from historical or regulatory demands.

4.2.4.4. The above-mentioned alternatives are the ones most frequently addressed in an ECIP/FEMP EA. However, the analyst should always aggressively pursue all possible realistic alternatives since the final decision can be no better than the available choices. It is not unusual for ECIP/FEMP EAs to address only the Status Quo and one other alternative.

4.3. Data Collection for the Economic Analysis. This section discusses the data collection requirements normally included in an ECIP/FEMP EA. The costs associated with each alternative under consideration must be quantified and included in the EA calculations. All costs the facility is expected to incur over the life of each alternative, except sunk costs, are included in the life cycle cost analysis. Sunk costs are expenditures which are incurred before a project has received final approval. These costs would not be recovered regardless of the alternative selected. Examples of sunk costs include: project planning, preliminary design, conducting the energy audit, and preparation of the economic analysis.

4.3.1. **Construction and Other One-Time Costs and Savings.** Most one-time costs occur early in a project's life cycle. Construction or retrofit are usually the most significant. However, all one-time costs are also considered.
4.3.1.1. Construction Costs. Since the largest percentage of the project cost is determined by the scope of the Retrofit or New Construction project, it is imperative that all primary and support costs are included in the EA. Construction or retrofit costs include site preparation, utilities, roads and pavements, SIOH, and design costs.
4.3.1.1.1. Construction or retrofit costs can be calculated using *R.S. Means* estimating publications or approved parametric models such as PACES. When compiling project costs, special attention is given to ensure that all costs associated with a Retrofit alternative, such as asbestos abatement, lead-based paint remediation, and environmental compliance, have been considered. Accurate and complete construction or retrofit cost estimates are essential to the integrity of the EA.
4.3.1.1.2. Construction/Improvement costs are thoroughly documented on the DD Form 1391 and attachments. The DD Form 1391 and attachments for an EA include:

- The project title, project number, and alternative name.
- The scope of the estimate in square meters.
- A brief description of the costing methodology or estimating system used.
- Dated sources for variables, such as area cost factors and escalation factors.
- The base year of the project cost.
- CE Authority signature for the estimate.

4.3.1.1.3. The estimate shows all interim calculations so that the values can be tracked from the source data to the total project cost appearing on the DD Form 1391 and in the Life Cycle Cost Report. Clear documentation speeds review of the EA. In addition, a clearly documented DD Form 1391 can be easily updated when the source data changes or when the project is changed for a different program year.
4.3.1.2. Other One-Time Costs. Accurate assessment and inclusion of other one-time costs are imperative to ensure a complete EA. Examples of other one-time costs for an ECIP/FEMP project include:

- The moving and storage of furnishings and equipment when the users are relocated.
- Disposal and replacement of furnishings and equipment.
- Temporary contracting out of the requirement.
- Lease payments for temporary off-base space.
- Tenant build-out requirements that involve renovations to temporary space to ensure the space meets the needs of the users.

4.3.1.2.1. All attempts should be made to time construction/retrofit activities to minimize the costs associated with the above items. However, even with the best scheduling attempts, temporary displacement of some personnel, equipment and/or supplies may occur. This will require either contracting out for the requirement or moving the operations to temporary space.
4.3.1.2.2. When moving to or from some permanent or temporary space, moving and storage costs will be incurred. Moving and storage (drayage) costs can be obtained from the base transportation office. The Interstate Commerce Commission can also provide approximate moving costs based on weight and requirements for cartons and custom-built crates.
4.3.1.2.3. Lease costs are associated with using off-base facilities on either a temporary or long-term basis. If there is an existing Air Force lease of similar space, then that lease rate per square meter is used to estimate the lease costs for the temporary space. If there is not an existing Air Force lease, then the General Services Administration (GSA) lease rates for the appropriate geographic area are used. Tenant build-out costs, such as partitions, power, and telecommunications hook-ups, may also be incurred for the temporary space.
4.3.1.2.4. For each temporary building included in a project, separate documentation is required showing a minimum 10-year continuing need for active building retention after retrofit, the specific retrofit action applicable, and an economic analysis supporting the specific retrofit. Temporary buildings in ECIP/FEMP projects are documented in the installation's annual real property utilization survey (AR 405-70).
4.3.1.3. One-Time Savings. The replacement of one system with another may generate a need to dispose of the old equipment. This obsolete equipment may have some residual value, which can be estimated by contacting local salvage yards. The salvage value is a credit that is recouped during the construction period.
4.3.1.3.1. In addition, some projects may result in public utility company rebates which would further offset investment costs. These are moneys that public utility companies give for certain energy conservation improvements, such as converting to a renewable fuel.
4.3.2. **Energy Savings/Costs.** By definition, ECIP/FEMP projects must save energy; therefore, there will be an overall energy cost savings. At least 20 percent of the total discounted dollar savings in the EA should result directly from energy (Giga joules) savings. Project documentation shall be in metric units in support of goals established under Executive Order 12770 "Metric Usage in Federal Government Programs" dated July 25, 1991. These savings may include increased use of

one fuel and decreased use of another. Care should be taken when computing energy savings to ensure that energy savings are not duplicated between projects or portions of projects. The actual cost of the energy purchased for use at the facility is used (rather than stock fund prices) as the basis for energy cost analysis. Purchased energy is defined as being generated offsite. For special cases where electric power or steam is obtained from on-site sources, the actual average gross energy input to the generating plant is used. For the purposes of calculating energy savings, the conversion factors are presented in figure 4.6.

Figure 4.6. Conversion Factors for the Calculation of Energy Savings.

Purchased Electric Power	3,413 BTU/KWh	3.6 MJ/KWh
Purchased steam	1,340 BTU/lb	1.41 MJ/lb
Distillate Fuel Oil	138,700 BTU/gal	38.6 MJ/L
Residual Fuel Oil	Use average thermal content of residual fuel oil at each specific location.	
Natural Gas	1,031,000 BTU/1000 cu. ft.	38.85 MJ/cu. m
LPG, Propane, Butane	95,000 BTU/gal	24.6 MJ/L
Bituminous Coal	24,580,000 BTU/Short Ton	28,593 MJ/metric ton
Anthracite Coal	25,400,000 BTU/Short Ton	29,546 MJ/metric ton

The term "coal" does not include lignite. When lignite is involved, the Bureau of Mines average value for the source field is used. When refuse derived fuel (RDF) is involved, the heat value is the average of the RDF being used or proposed. When the average fuel oil heating value is accurately known through laboratory testing for a specific military installation, that value may be used in lieu of the amount specified above.

4.3.2.1. Additional consideration can be given to projects that substitute renewable energy for nonrenewable energy. Full energy credit may be taken for conversion from fossil fuels or electric power to solar, wind, RDF, or geothermal energy, less the calculated average yearly standby requirement.

4.3.2.2. Figure 4.7 presents an example of the methodology used to estimate annual electricity costs and savings for the Status Quo and Retrofit alternatives based on an area (square meter) basis. Other energy-consuming utility costs can be similarly calculated. The most accurate estimates of utility costs are available when bases can meter utility usage at the facility level. Total consumption for the facility can be taken from utility bills or Defense Utility Energy Reporting System (DUERS) reports. DUERS or WIMS can also provide the necessary area figures. CE is the best source for this data. If possible, usage rates from 3 previous years are averaged after adjusting them to the base year of the EA. Appropriate inflation indices can be obtained from NISTIR 4942-2, *Present Worth Factors for Life-Cycle Cost Studies in the Department of Defense.*

4.3.2.3. Potential savings estimates can be made based on engineering judgment or by consulting engineering handbooks, such as *ASHRAE Fundamentals*. Another possible source is the recorded savings from other facilities on base or other installations which have already been retrofitted with similar energy conservation measures.

4.3.3. **Non-Energy Savings/Costs.** Two major categories of non-energy savings/costs are used in ECIP/FEMP EAs. These categories are as follows:

- Annual Recurring Savings/Cost.
- Non-Recurring Savings/Costs.

Figure 4.7. Calculation of Annual Electricity Savings for a Proposed ECIP/FEMP Project.

Status Quo

Three Year Average:

Year	**Annual Cost**	**Inflation Index**	**Total Cost $ 1995**			**Avg Cost $ 1995**
1990	70,550	1.109	78,240			
1991	67,023	1.049	70,307			
1992	70,374	1.028	72,344			
			220,891	÷	3 =	$73,630

Status Quo Cost per Square Meter Calculation:

Avg Cost $ 1995		**Total Area (SM)**		**Cost/SM $ 1995**
73,630	/	7,711	=	9.5486

Figure 4.7. Continued.

Retrofit

Status Quo Cost/SM $ 1995	x	30% Estimated Saving	Cost/M $ 1995	x	Net Square M:	=	Retrofit Total Cost $ 1995
9.5486	x	0.70	6.684	x	7,246	=	$ 48,432

Estimated Annual Savings

Status Quo Total Cost	-	Retrofit Total Cost	=	Annual Savings
$ 73,630	-	$ 48,432	=	$25,198

4.3.3.1. Annual Recurring Savings/Costs. The primary component of recurring cost savings is usually maintenance and repair costs. Maintenance and repair (M&R) costs include both annual and periodic M&R. Annual M&R includes preventive maintenance, and plumbing, electrical, and minor structural repairs required to ensure a safe and efficient working or living environment. Annual M&R costs/savings for Retrofit or New Construction alternatives are usually less than those incurred under the Status Quo alternative. Therefore, the historical M&R cost data are normally adjusted downward by an assumed percentage (25 to 40 percent, based on engineering judgment) for the Retrofit and New Construction alternatives. Annual M&R costs over the life of the retrofit or new facility are assumed to increase 10 percent every 5 years throughout the life cycle of the alternative or until equivalent to the Status Quo alternative.

4.3.3.2. Nonrecurring Savings/Costs. Nonrecurring costs/savings include unscheduled maintenance and repair (M&R) expenses and expenses that occur on a nonregular basis. Unscheduled M&R includes major repairs to components, such as replacing the AC motor in an HVAC system. Cost schedules are based on the expected life of the equipment or fixture. The date the item was last replaced is available from CE for projecting future schedules and costs under the Status Quo alternative. Renovation and new construction generally begin with all new equipment; hence replacement schedules are based on the construction date. It is important to remember that scheduled intervals will often vary based on local conditions. For example, the salt air in marine environments corrodes and shortens the expected lives of exterior mechanical units while other exterior mechanical units may be damaged in dusty environments.

4.3.3.2.1. Unscheduled M&R costs are estimated based on local prices or by using the cost of any recent replacement of similar items, including appropriate labor fees. If such cost data is unavailable, commercial source such as *R.S. Means* or *Dodge Cost Data* can be used and documented. Another possible source would be comparative maintenance and repair cost/ savings from another installation for a similar facility.

4.3.3.2.2. Figure 4.8 summarizes the data sources used in collecting ECIP/FEMP cost and savings data.

Figure 4.8. Summary of Data Sources for ECIP/FEMP Projects.

	PRIMARY SOURCE	**OTHER SOURCES**
Construction Costs	DD Form 1391	PACES, *Means,* Air Force Historical Cost
Annual M&R Costs	WIMS BCE (actual past M&R costs for a particular facility type or building)	DEMRC; PACES; Form 1133 BCE: RCS HAF LEE (SA) 7101
Periodic M&R Costs	WIMS Utility Bills	BCE: RCS HAF LEE (SA) 7101, MAJCOM consumption report
Miscellaneous Operations and Maintenance Costs	Base Contracting Office, Facilities Management Office, Base Transportation Office	*Means, Dodge*
Savings Calculations	ASHRAE Handbooks of	Engineering Handbooks

	Fundamentals	

Figure 4.8. Continued.

Lease Costs	Base Real Property Office	Off-base real estate broker, GSA
Inflation Indices and Discount Rates	NISTIR 4942-2, *Present Worth Factors for Life-Cycle Cost Studies in the Department of Defense*	

4.4. Conducting the Economic Analysis and Analyzing the Results. The purpose of an ECIP/FEMP EA is to determine the Savings-to-Investment Ratio (SIR) for each alternative or discrete action that is being considered for satisfying the objective to reduce energy-related costs. The SIR is the ratio of the present value savings to the present value costs of an energy conservation measure. A SIR of one indicates that the present value of savings is equal to the present value of investment. All SIR calculations and analyses will be based upon the useful life of the retrofit action, which is 5 to 25 years. For ECIP/FEMP projects to be considered, a SIR of at least 1.25 is required. The Air Force strongly recommends the use of Life Cycle Cost in Design (LCCID) to prepare the EA. The National Institute of Science and Technology's Building Life Cycle Cost (BLCC) or DISCOUNT programs, developed for more general applications, are also acceptable for use in generating Economic Analyses for energy conservation projects. However, it should be noted that the BLCC program does not provide reports formatted consistent with DoD report formats.

4.4.1. **Overview of the Life Cycle Cost in Design (LCCID) Model.** The Life Cycle Cost in Design (LCCID - pronounced EL SID') is a computer program intended to be used as a tool in the evaluation and ranking of design alternatives for new and existing projects. LCCID can calculate the life cycle costs and other economic parameters for a variety of energy conservation initiatives in DoD construction. The basic algorithms and reports in LCCID are based on the economic criteria of the Department of Energy (DOE), Department of Defense (DoD) and the Office of Management and Budget (OMB).

4.4.1.1. The specific criteria and other guidance embodied in LCCID are:

- OMB Circular A-94.
- Code of Federal Regulations, 10 CFR 435.
- Memorandum of Agreement on Criteria/Standards for Economic Analysis/Life Cycle Costing for MILCON Design, March 1994.
- DoD Energy Conservation Investment Program (ECIP) Guidance.

4.4.1.2. LCCID is a menu-driven, interactive program which can operate on several types of computer hardware. There is extensive on-line help to assist the first-time and infrequent users. LCCID is a public domain computer program available to any requester.

4.4.2. **Analyzing the Results.** The LCCID EA computer program used for ECIP/FEMP EAs produces a one-page summary report which is included in the ECIP/FEMP EA documentation. It includes eight parts:

- A summary of investment costs.
- A summary of energy savings.
- A summary of non-energy savings.
- Total net savings.
- Simple payback period.
- Total discounted savings.
- SIR
- First year dollar savings.

4.4.2.1. Figure 4.9 presents a sample LCCID ECIP/FEMP print-out for an EMCS project.

Figure 4.9. Sample LCCID ECIP/FEMP Printout.

ENERGY CONSERVATION INVESTMENT PROJECT/FEDERAL ENERGY MANAGEMENT PROGRAM (ECIP/FEMP)
LIFE CYCLE COST ANALYSIS SUMMARY

INSTALLATION & LOCATION: XYZ AFB. REGION NOS. 2 PROJECT NO. ABCD 968806
PROJECT TITLE: ECIP-INSULATE STEAM LINES FISCAL YEAR 1996
ANALYSIS DATE: 9-Feb-95 ECONOMIC LIFE 15 PREPARER: Wayne F. Myers
DISCRETE PORTION NAME: INSULATE WAREHOUSE STEAM DISTRIBUTION

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$ 350,000.		
B. SIOH (6.5%)	$ 22,750.		
C. DESIGN COST (8.3%)	$ 29,050.		
D. TOTAL COST (1A+1B+1C)	$ 401,800.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 401,800.

2. ENERGY SAVINGS (+) OR COST (-):

DATE OF NISTIR 4942-2 USED FOR DISCOUNT FACTORS OCT 1994

ENERGY SOURCE	COST $/GJ (1)	SAVINGS GJ/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTORS (4)	DISCOUNTED SAVINGS (5)
A. ELECT	$17.12	10.43	$179	12.2103	$ 2,180
B. DIST			$0	14.588	$0
C. RESID	$6.97	29,449	$205,325	16.1813	$3,322,428
D. NG			$0	13.8933	$0
E. PPG			$0	13.8993	$0
F. COAL			$0	12.6897	$0
G. SOLAR			$0		$0
H. OTHER			$0		$0
I. DEMAND SAVINGS					$0
J. TOTAL		29,459.43	$205,504		$3,324,608

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) $0.
(1) DISCOUNT FACTOR (TABLE E-2) 11.5902
(2) DISCOUNTED SAVING/COST (3A X 3A1) $0.

B. NON RECURRING SAVINGS (+) / COSTS (-) (Discount Factor from Table E-1)

ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCURRENCE (2)	DISCNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.				$0
b.				$0
c.				$0
d. TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2+3B4d) $0

4. TOTAL NET SAVINGS (2J3+3A+3B1d)	$205,504
5. SIMPLE PAYBACK (1G/4)	1.96
6. TOTAL NET DISCOUNTED SAVINGS (2J5 + 3C)	$3,324,608
7. SAVINGS TO INVESTMENT RATIO (SIR) (6/1G)	8.27
8. FIRST YEAR DOLLAR SAVINGS (2J3+3A+(3B1d/ECONOMIC LIFE))	$205,504

4.4.2.2. The investment section presents the construction cost, design, and SIOH. These values are given in constant dollars as of the date of analysis. Salvage value is the residual value of existing equipment removed as a result or the retrofit or replacement project and is subtracted from the investment costs. In some cases, public utility company rebates will also be provided to the installation.

4.4.2.3. Part 2 presents a table of the energy savings for the given discrete portion. Notice that savings are positive and costs are negative in this paragraph. Energy prices are always given in dollars per GJ and savings per fuel in GJ per year. The cost per GJ is the cost of energy at the installation on the date of analysis. For each fuel savings presented, complete documentation of all interim calculations must be attached to the ECIP/FEMP report to show and substantiate the energy

savings claimed. In addition to the fuel types provided in the DOE tables, renewable fuels such as solar energy and PPG fuels (propane) may be included. The fuels not in the DOE tables are discounted using UPW values for annual costs.

4.4.2.4. Part 3 lists the annual, one-time and other non-energy cost/savings for the given discrete portion. This section would include savings in M&R or operations.

4.4.2.5. Part 4 is the Total Net Savings per year.

4.4.2.6. Part 5 displays the estimated simple payback period for the project. This is calculated by dividing total investments by the annualized savings. The next paragraph adds total energy discounted savings to total discounted non-energy discounted savings to get the total net discounted savings. Dividing the total net discounted savings by the investment costs yields the SIR. If this number is less than 1.25, the project will be rejected. LCCID will indicate that the project does not qualify if this ratio is less than 1.

4.4.2.7. Part 8 is the First Year Dollar Savings which is the annualized value of all the energy and non-energy savings for the project. By definition, “First Year Dollar Savings” is the summation of the first year's energy and non-energy savings. One-time and non-annual, non-energy savings are converted to an annual value by dividing the total non-energy savings by the economic life of the discrete portion.

4.4.2.8. It is important to proofread the summary report to ensure that all the data input is correct. The analyst should:

- Check for any typographical errors in the data input.
- Check that cost/savings in fuel use are accurate.
- Check that the construction expenditures match the DD Form 1391 schedule.
- Ensure that the appropriate cost/savings elements have been included for each alternative.
- Ask -- Do the results make sense? Are they reasonable? Are there any surprises?

4.4.2.9. Any errors discovered are corrected and the analysis results are recalculated.

4.4.3. **Making Recommendations.** ECIP/FEMP projects are selected for inclusion based on two criteria: the savings-to-investment ratio and the payback period. Projects must have a SIR greater than 1.25 and a discounted payback period of 10 years or less to be considered. Those projects with the highest SIR and the fastest discounted payback should be given priority.

4.5. Documenting the Results of the Economic Analysis. It is important that an EA be documented to allow complete replication by reviewers. This section provides guidance on how to compile an ECIP/FEMP EA. An ECIP/FEMP EA contains:

- DD Forms 1391.
- Economic Analysis.

4.5.1. A sample ECIP/FEMP EA is provided in attachment 5.

4.5.2. **DD Forms 1391.** The ECIP/FEMP project submittal includes the DD Forms 1391 with the normal MILCON line-item detail. The DD Forms 1391 contain the notation "ECIP” or “FEMP" at the beginning of the title block and include the construction cost estimate, a brief description of the project requirements, the current situation, including any impact if the situation is not changed, and any additional comments concerning the project. Additional comments shall include: expected dollar savings per year, expected energy savings per year, and simple payback.

4.5.3. **Economic Analysis.** The economic analysis includes:

- Consideration of alternatives.
- Economic justification summary.
- LCCID ECIP/FEMP Summary Report.
- Savings validation/verification.

4.5.4. The economic analysis is included in Section 11 of the DD Forms 1391. Section 11C is the Consideration of Alternatives. In this section, a description of each of the alternatives or discrete portions addressed in the analysis is provided.

4.5.5. Following the Consideration of Alternatives is the Economic Justification Summary (11D). All of the supporting documentation consisting of basic assumptions and basic engineering and economic calculations showing how savings were determined are presented here. A list of the documents and data sources used is also provided.

4.5.6. The LCCID ECIP/FEMP Summary Report for each discrete portion is presented as 11E. The conclusion and recommendations should be documented on the DD Form 1391. Include a statement regarding whether or not the installation affected by the project is being considered for closure or realignment. If so, provide an explanation for why the project should still be considered.

4.5.7. The savings validation/verification is presented in section 11F. All ECIP/FEMP projects must include a savings validation on the DD Form 1391, or they may be rejected. This validation plan includes an accurate assessment of the project's savings and describes the procedures, methods, equipment, and documentation format that will be used to assess the efficiency of the new energy saving system. Also, if this is an EMCS project, it must include a signed statement from

the installation commander stating that appropriate resources will be committed to effectively operate the system over the life cycle of the investment.

4.6. Revalidation and Preparation of the Annual Report to the Office of the Deputy Assistant Secretary of Defense (Logistics). All projects must be revalidated prior to advertising to ensure that the contemplated benefits will still accrue. Projects may be considered valid if the SIR remains above 1.25. This will ensure that projects funded within the 25 percent variation allowance still achieve a positive return on investment over the life of the project. However, for programming purposes, ECIP/ FEMP projects with comparatively low SIRs are less likely to be funded than those with high ratios.

4.6.1. In the event that a project cost estimate changes by more than 25 percent of that furnished to the Congress (the original estimate attached with the DoD funding document) or the scope is reduced by 25 percent to allow award within the original estimate, notify the Deputy Assistant Secretary of Defense (Logistics) and the DoD Comptroller of the circumstances causing the change. Contracts or contract modifications may be awarded 21 days after submission to OSD, provided no objections exist. Contracts or contract modifications may be awarded prior to the 21-day period with OSD concurrence.

4.6.2. **Annual Report.** An annual report on the status of the ECIP/FEMP must be provided to the Office of the Deputy Assistant Secretary of Defense (Logistics) by February 15 of each year for incorporation into the Department of Energy's report to Congress. This report includes a project status list of all ECIP/FEMP projects for each of the past 5 years indicating:

- Original approved costs.
- Current working estimates.
- The original and current estimated savings, SIR, and payback periods.
- Whether or not the project has been awarded, completed, canceled, or deferred.

4.6.3. Computer-generated reports in Excel or Lotus 123 are preferred.

EUGENE A. LUPIA, Maj General, USAF
The Civil Engineer

GLOSSARY OF REFERENCES, ABBREVIATIONS, ACRONYMS, AND TERMS

References

AFI 65-501, *Economic Analysis*
AFMAN 65-506, *Economic Analysis*
Executive Order 12759
Executive Order 12770 "Metric Usage in Federal Government Programs" dated July 25, 1991
NISTIR 4942-2, *Present Worth Factors for Life-Cycle Cost Studies in the Department of Defense*
Public Law 102-946
Building Owners and Manager's (BOMA) Experience Exchange Report (BOMA International, Washington, DC, (202) 408-2662)
Code of Federal Regulations, 10 CFR 435
DoD Energy Conservation Investment Program (ECIP) Guidance
Dodge Cost Data
DRI Energy Inflation Indices
MEANS Facility Maintenance Standards, R.S. Means Corporation
Memorandum of Agreement on Criteria/Standards for Economic Analysis/Life Cycle Costing for MILCON Design, March 1994
OMB Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs
US Army ECIP Guidance, 23 June 1991
USAF Raw Inflation Indices

Abbreviations and Acronyms

ADA	Americans with Disabilities Act
AF	Air Force
AFB	Air Force Base
AFI	Air Force Instruction
AFMAN	Air Force Manual
BAM	Building Age Multiplier
BAQ	Basic Allowance for Quarters
BCE	Base Civil Engineer
BCP	Base Comprehensive Plan
BES	Budget Estimate Submission
BLCC	Building Life Cycle Cost
BOMA	Building Owners and Manager's Association
CE	Civil Engineering
DD	Department of Defense (as used on forms)
DOA	Date of Analysis
DoD	Department of Defense
DOE	Department of Energy
DOS	Disk Operating System
DRI	Data Resources Inc.
DUERS	Defense Utility Energy Reporting System
EA	Economic Analysis
ECIP/FEMP	Energy Conservation Investment Program/Federal Energy Management Program
EMCS	Energy Monitoring and Control Systems
ESR	Executive Summary Report
EUAC	Equivalent Uniform Annual Cost
FM	Financial Management
FMABB	Financial Management Analysis Bulletin Board
FY	Fiscal Year
GSA	General Services Administration
HCP	Housing Community Plan
HMA	Housing Market Analysis

HTHW	High Temperature Hot Water
HVAC	Heating, Ventilation, Air Conditioning
LCCID	Life Cycle Cost in Design
LCCR	Life Cycle Cost Report
M&R	Maintenance and Repair
MAJCOM	Major Command
MILCON	Military Construction
NPV	Net Present Value
O&M	Operation and Maintenance
OCR	Office of Collateral Responsibility
OMB	Office of Management and Budget
OPR	Office of Primary Responsibility
OSD	Office of the Secretary of Defense
PACES	Parametric Cost Engineering System
PB	President's Budget
POC	Point of Contact
PSD	Private Sector Development
RAM	Random Access Memory
RDF	Refuse Derived Fuel
SF	Square Feet
SIOH	Supervision, Inspection, and Overhead
SIR	Savings/Investment Ratio
TDY	Temporary Duty
U.S.C.	United States Code
VHA	Variable Housing Allowance
WIMS	Work Information Management System

Terms

***AIRR*--**The adjusted internal rate of return is the overall rate of return on an energy conservation measure. It is calculated by subtracting 1 from the nth root of the ratio of the terminal value of savings to the present value costs, where n is the number of years in the study period.

***Alternative*--A**n approach or program that is another possible way of fulfilling an objective, mission or requirement. (This includes the status quo).

***Analysis Period*--**Normally the construction period plus the shortest economic life of the alternatives being addressed.

***Assumption*--**An explicit statement describing present and/or future circumstances which may affect the outcome of an analysis.

***Base Year*--**The program year to which all costs are adjusted to permit equitable comparison of dollar values from different years.

***Benefit*--**A qualitative or quantitative measure of an alternative's effectiveness in meeting program objectives or needs.

***Benefits Analysis*--**An analysis which attempts to quantify the intangible aspects of an alternative that are normally difficult to assess in an EA. The analysis yields a benefit score which is used in the calculation of the Cost/Benefit Ratio.

***Break-even Point*--**The point between two alternatives at which they are equally cost-effective. It can be determined by plotting the alternatives' life-cycle costs on a graph.

***Build-to-Lease*--**A program for providing government facilities through private sector development. The government contracts with a private developer to have facilities built, with a guarantee that the government will lease the facilities for a certain period.

Burdened Salary--The true costs associated with paying personnel, including direct salaries, benefits, employer's share of social security payments, leave and holiday costs and non-cash benefits such as base housing. FMABB contains tables which include burdened salaries.

Business Case Analysis (BCA)--A tool to assist the Military Treatment Facility executive staff in making decisions regarding the provision of health care.

Constant Dollar Value--Value, cost or benefits estimated based on constant purchasing power of the dollar.

Cost/Benefit Ratio--Shows the decision maker the degree to which benefits are being attained relative to costs. The Cost/Benefit Ratio for each alternative is calculated by dividing the net present value by the benefit score.

Cost-Effective Alternative--That alternative which, when compared to all other alternatives, maximizes benefits when costs for each alternative are equal, or minimizes costs when benefits are equal for each alternative.

Current Dollar Value--Value, cost or benefits estimates including estimates of all expected future price changes.

Discount Rate--The parameter used to translate future costs or benefits into present worth. It is a measure of the time value of money. Values are derived from OMB Circular A-94, *Guidelines and Discount Rates for Benefit - Cost Analysis of Federal Projects.*

Discounting--The process of using a discount rate to determine the present value of costs and benefits.

Discounting Convention--Method of discounting costs, either at beginning-of-year, mid-year, end-of-year, or continuous.

Discrete Portion--A viable alternative capable of accomplishing the project objectives.

Energy Conservation Investment Program (ECIP)--The ECIP is a MILCON-funded program for construction investments greater than $300,000 to existing DoD energy systems and buildings in order to make them more energy efficient and to provide substantial savings in operating costs.

Economic Analysis (EA)--A systematic approach to the problem of choosing how to use scarce resources. An EA should provide as accurately and completely as possible a picture of monetary and non monetary costs and benefits associated with each alternative.

Economic Life--The period of time over which the benefits to be gained from a project may reasonably be expected to accrue to the Air Force. Useful life is another term for economic life.

Equivalent Uniform Annual Cost--The amount of money which, if paid in equal annual installments over the life of a project, would pay for the project. It is calculated by dividing the total net present value by the sum of the discount factors.

Federal Energy Management Program (FEMP)--an OSD operation and maintenance funded program for funding energy conservation projects which repair and/or retrofit existing facilities.

Financial Management Analysis Bulletin Board (FMABB)--the computer bulletin board designed for Air Force cost and financial analysts. FMABB has standard bulletin board features such as a message system. Updates to cost factors issued under AFI 65-503, *USAF Cost and Planning Factors,* are found in the form of bulletins (these factors are no longer printed; FMABB contains the official updates). Overseas analysts can access the same information over the Defense Data Network. Access is not limited to Air Force costs analysts, but is open to all Air Force and DoD employees, and contractors working on DoD projects. First time users must contact the system operator, Mr. Ray Scheuring, at DSN 225-5220 or commercial 703/695-5220 (hadmin@afcost.af.mil) to obtain the dialup number and arrange a password.

Inflation--The increase over time in costs of goods and services.

Investment Costs--Costs associated with acquisition of real property, nonrecurring services, and start-up operation and maintenance costs. These are usually one-time costs, although they may be spread over more than one year, such as construction costs.
LCCID--The Life Cycle Cost in Design is an economic analysis computer program used in conducting ECIP EAs.

Life Cycle Cost--The total cost to the government of a facility over its full life, including the cost of development, procurement, operation, support, and disposal.

Maintenance and Repair (M&R)--Actions taken by CE personnel to ensure that an adequate working or living environment is provided for occupants. Annual M&R includes those minor repairs that occur on a continual basis, such as repairing plumbing fixtures and broken windows which usually require the execution of an unscheduled Work Order. Periodic M&R includes the regularly scheduled replacement of major fixtures and equipment such as HVAC units, interior finishes, roofing systems, etc. that can be anticipated based on the economic life of the item.

National Register of Historic Places--The official national list of properties worthy of preservation for their significance in American history, architecture, archaeology, and culture. The Register is maintained by the Department of Interior (DOI). To qualify for the Register, a property must be professionally determined to meet the Criteria of Eligibility set forth in 36 CFR 60. Actions affecting properties on the Register must comply with Sect. 106 of the National Historic Preservation Act of 1966, as amended. Properties not currently on the Register but which meet the eligibility criteria are considered the same as Register properties.

Operation and Maintenance (O&M)--Activities and costs associated with the routine, recurring aspects of maintaining a facility. Examples include utilities, custodial services, repainting, and minor repairs.

Parametric Cost Engineering System (PACES)--A PC-based parametric cost estimating system which may be used to determine the costs of proposed renovation and replacement projects. The previously used system, the Tri-Service Automated Cost Engineering System (TRACES) is still in being, but is no longer in use by the Air Force.

PC-ECONPACK--A comprehensive software program incorporating EA calculations, documentation, and reporting capabilities. It is available from the US Army Corps of Engineers, Huntsville Division, P.O. Box 1600, ATTN: CEHND-ED-ES (ECONPACK), Huntsville, AL 35807-4301, phone: DSN 788-3389, COMM (205) 895-3389.

Present Value--Allows the comparison of different dollar amounts received or expended during different time periods. It is the net value of a flow of funds expressed as a single sum. It is calculated by multiplying the net cost figure for each year by the corresponding discount factor and totaling the results. The Air Force normally uses a mid-year discounting convention.

$$PV = \sum_{n=1}^{\infty} \frac{FV}{(1+r)^{n-.5}}$$

The formula for mid-year Present Value is:

Where:	PV	=	Present Value
	FV	=	Future Value
	r	=	discount rate
	n	=	period (years)

Primary Economic Analysis--Performed when the objective is to change the status quo (present method of operation) in order to achieve a financial savings to the Government.

Program Year--The fiscal year for which funding is being requested. For the EA, life cycle costs are ordinarily presented in program or base-year dollars for all alternatives.

Recurring Costs--Expenses such as utilities, supplies, personnel costs and other items incurred on a repeating basis.

Residual Value--The expected value of an asset at any point in time before the end of its economic life.

***Risk*--**The probability of an uncertain event occurring.

***Salvage Value*--**The estimated market value of selling existing equipment that has been removed as a result of the retrofit/construction project.

***Savings Investment Ratio (SIR)*--**The ratio of discounted future cost savings (or avoidance) to the discounted investment cost necessary to effect those savings. A SIR of 1 indicates that the present value of savings is equal to the present value of investment.

***Secondary Economic Analysis*--**Used to determine which of two or more alternative courses of action would most economically fulfill an objective or requirement which is not currently being met.

***Sensitivity Analysis*--**Conducted to determine the impact that changes in assumptions or parameters may have on the final conclusions. A sensitivity analysis should be performed on any cost element in which there is a level of uncertainty regarding its cost or estimate.

***Simple Payback*--**The estimated time in years required for the cumulative value of energy cost savings less future non-fuel costs to equal the investment costs of the building energy system, without consideration of future price changes or discount rates.

***Sunk Cost*--**The sum of past expenditures or irrevocably committed funds related to a project. Such costs are generally not relevant to economic decision-making as they reflect previous rather than present choices.

***Tri Services Cost Model*--**A model used to estimate new construction costs based on the type of facility, the size of the facility, the cost per square foot, and the area cost factor.

***Weight Point*--**Used in benefits analysis to rank the relative importance of each qualitative factor being assessed. Weight points can be whole or decimal values.

VALIDATION PROCEDURES

A2.1. Does the EA contain a Certificate of Satisfactory Economic Analysis and the associated signature page?

A2.2. Does the EA contain the DoD Executive Summary presenting the alternatives and the results of the analysis?

A2.3. PC-ECONPACK Executive Summary Report
A2.3.1. Is there a justified requirement?
A2.3.2. Were all possible alternatives examined?
A2.3.3. Has a satisfactory explanation been given for all alternatives considered infeasible?
A2.3.4. Has sufficient background and descriptive information been provided for each of the alternatives addressed in the EA?
A2.3.5. Are the assumptions reasonable and follow the guidelines presented in the MILCON EA Manual?
A2.3.6. Are the results of the EA and benefits analysis clearly presented?
A2.3.7. Has the analyst correctly interpreted the results of the EA?
A2.3.8. Are the recommendations reasonable and supported by the results of the EA?

A2.4. Life Cycle Cost Report
A2.4.1. Has PC-ECONPACK been used to conduct the analysis? If not, does the EA follow the procedures presented in the MILCON EA Manual and in accordance with AFI 65-501 and AFMAN 65-506?
A2.4.2. Have all data sources been explained and documented?
A2.4.3. Were the appropriate sources for the data used?
A2.4.4. Have the correct values been entered into PC-ECONPACK? (The PC-ECONPACK numbers should correlate with the background data sheets and/or the results of interim calculations).
A2.4.5. Has the data been applied to the correct years? (This is particularly important for construction costs, one-time costs, and periodic M&R costs).
A2.4.6. Has the appropriate discount factor from the President's Budget been used?
A2.4.7. Have all the costs that should be in the EA for each alternative been included?
A2.4.8. If PC-ECONPACK was not used, then is the math in the NPV calculations correct?
A2.4.9. Do the results make sense? Are there any surprises? Can the surprises be logically explained?

A2.5. Benefits Analysis
A2.5.1. Have all the appropriate benefits relative to the project been addressed?
A2.5.2. Have appropriate weights and percentages been assigned to each benefit category?
A2.5.3. Is the math correct in the benefit value calculation?
A2.5.4. Are the results reasonable?

A2.6. Sensitivity Analyses
A2.6.1. Has a scope sensitivity analysis been included in the EA and performed correctly?
A2.6.2. Has the appropriate costs been selected for variation in the scope sensitivity analysis?
A2.6.3. Has the discount rate sensitivity analysis been included in the EA and performed correctly?
A2.6.4. Are there other sensitivity analyses which should have been included in the EA?
A2.6.5. Has the analyst correctly interpreted the results of the sensitivity analyses?

A2.7. Appendices
A2.7.1. Have the DD Form 1391s been included in the appendices?
A2.7.2. Do the construction cost estimates on the DD Form 1391s appear reasonable? Is the math correct?
A2.7.3. Are all background data and source documents presented in the appendices?
A2.7.4. Are the methodology and results of all interim calculations presented?
A2.7.5. Are the interim calculations mathematically correct?
A2.7.6. Have the appropriate inflation indices been used and applied correctly?

SAMPLE ECONOMIC ANALYSIS FOR MILCON

(see attached)

ECONOMIC ANALYSIS

Enter (Name of Air Force Base), (State)/(MAJCOM)

Date

CERTIFICATE OF SATISFACTORY ECONOMIC ANALYSIS

INSTALLATION/MAJCOM: Anywhere Air Force Base, Any State / MAJCOM

PROJECT TITLE: Dormitory (320 PN)

PROJECT NUMBER: EFGH 123456

OBJECTIVE: Provide suitable cost-effective housing 320 unaccompanied enlisted personnel at Anywhere Air Force Base

PROJECT COST: $8,500,000

ALTERNATIVES CONSIDERED:

Status Quo (Direct Compensation)
New Construction
Improvement (Addition)

SUMMARY OF ANALYSIS RESULTS:

The New Construction alternative has the lowest NPV and is therefore the most cost-effective alternative. The Improvement alternative is the second most cost-effective.

The New Construction alternative has the lowest cost/benefit ratio, indicating that this alternative is the most desirable means of achieving the project objective.

Cost sensitivity analysis indicates that the New Construction alternative would remain the most cost-effective alternative across a reasonable range of changes in the expense items.

The New Construction alternative is recommended for implementation.

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CONTINUATION PAGE
CERTIFICATE OF SATISFACTORY ECONOMIC ANALYSIS

INSTALLATION/MAJCOM: Anywhere Air Force Base, Any State / MAJCOM

PROJECT TITLE: Dormitory (320 PN)

PROJECT NUMBER: EFGH 123456

OBJECTIVE: Provide suitable cost-effective housing for 320 unaccompanied enlisted personnel at Anywhere Air Force Base

PROJECT COST: $8,500,000

CERTIFICATION:

This economic analysis follows the guidelines and procedures contained in AFI 65-501 and AFMAN 65-506. Costs are based on CE Source Document dated 15 JAN 94.

Installation FM Analyst _____ _____
(Date)

Concurrence of Installation FM _____ _____
(Date)

Concurrence of Installation CE _____ _____
(Date)

MAJCOM/FMA Evaluator _____ _____
(Date)

Concurrence by MAJCOM FMA _____ _____
(Date)

Concurrence of MAJCOM CEH _____ _____
(Date)

DOD EXECUTIVE SUMMARY

INSTALLATION/MAJCOM: Anywhere Air Force Base, Any State / MAJCOM

PROJECT TITLE: Dormitory (320 PN)

PROJECT NUMBER: EFGH 123456

OBJECTIVE: Provide suitable cost-effective housing for 320 unaccompanied enlisted personnel at Anywhere Air Force Base

PROJECT COST: $8,500,000

ALTERNATIVES EXAMINED:	Net Present Value	Benefit Score	Cost/Benefit Ratio
Status Quo (Direct Compensation)	$18,186,067	11.8	1,541,192
New Construction	$16,236,790	22.0	738,036
Improvement (Addition)	$20,444,427	19.3	1,059,297

ANALYSIS METHOD:

All alternatives were examined using standard Air Force and DoD techniques and procedures for Economic Analysis. This economic analysis follows the guidelines and procedures contained in DODI 7041.3, AFI 65-501 and AFMAN 65-506.

CONCLUSION:

The New Construction alternative has the lowest NPV and is therefore the most cost-effective alternative. The Improvement alternative is the second most cost-effective.

The New Construction alternative has the lowest cost/benefit ratio, indicating that this alternative is the most desirable means of achieving the project objective.

Cost sensitivity analysis indicates that the New Construction alternative would remain the most cost-effective alternative across a reasonable range of changes in the expense items.

The New Construction alternative is recommended for implementation.

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Section 1

EXECUTIVE SUMMARY REPORT

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E X E C U T I V E S U M M A R Y R E P O R T PAGE 001

PROJECT TITLE : Provide Unaccompanied Personnel Housing
DISCOUNT RATE : 2.80%
PERIOD OF ANALYSIS: 31 YEARS
START YEAR : 1996
BASE YEAR : 1996

PROJECT OBJECTIVE : Provide suitable cost-effective housing for 320 unaccompanied enlisted personnel at Anywhere Air Force Base

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS:

The following alternatives were considered in this economic analysis:

Alternative 1: Status Quo (Direct Compensation)

This alternative provides funding in the form of Basic Allowance for Quarters (BAQ) for housing accompanied enlisted personnel off-base. Upon their arrival on-base, personnel are instructed to seek housing in the local community and are advised of the amount of BAQ they will receive each month to help defray the cost of housing.

Alternative 2: New Construction

This alternative involves the construction of a new 64,000 square foot (SF) dormitory-type facility. The proposed construction will accommodate 320 unaccompanied enlisted personnel with a grade mix of E1 to E4. It will provide personnel with housing conducive to proper rest, relaxation, and personnel well-being. The facility will be designed and furnished to provide some degree of personal privacy. Construction will include reinforced concrete foundation and floor slabs, structural frame, masonry walls, and sloped metal roof. Construction will also include room-bath-room modules, laundries, storage, and lounge areas, demolition, asbestos removal/disposal, and necessary support.

Alternative 3: Improvement (Addition)

This alternative involves the construction of five 12,800 SF additions to existing facilities on-base supporting 320 personnel. The existing facilities on-base that would be expanded are buildings 223, 225, 229, 231, and 232. Expansion will be accomplished by additions to the ends of these buildings thereby gaining the necessary total SF. The addition will provide personnel with housing conducive to proper rest relaxation, and personal well-being. The addition will be designed and furnished to provide some degree of personal privacy. Construction will include reinforced concrete foundation and floor slabs, structural frame, masonry walls, and sloped metal roof.

E X E C U T I V E S U M M A R Y R E P O R T PAGE 002

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS (cont.):

Construction will also include room-bath-room modules, laundries, storage and lounge areas, demolition, asbestos removal/disposal, and necessary support.

ASSUMPTIONS OF THE ANALYSIS:

1. Anywhere AFB will retain the mission to house the 320 unaccompanied enlisted personnel.

2. The base year of the analysis is 1996, the first year for which costs differ across the alternatives.

3. The period of analysis is 31 years to coincide with the 30 year economic life of the facility proposed under the Improvement alternative, and to allow one year for construction of the additions.

4. The New Construction alternative is assigned a residual value using a 60 year economic life and straight line depreciation.

5. All non-energy costs developed from historical data have been adjusted using inflation indices contained in AFR 173-13, USAF Cost and Planning Factors, Atch 45, 15 Feb 94.

6. The construction time for the New Construction and Improvement alternatives is one year.

7. All costs are expressed in FY 96 constant dollars to coincide with the program year.

8. All costs except residual value occur throughout the year and are discounted using a "middle-of-year" discount convention. The residual value is discounted using an "end-of-year" discount convention. The real discount rate is 2.8% (FMABB).

9. Miscellaneous furniture will be replaced every ten years over the life of the project to coincide with the life expectancy for furniture (10 years).

10. Appliances will be replaced every fifteen years over the life of the project to coincide with the life expectancy for appliances (15 years).

RESULTS AND RECOMMENDATIONS:

	ALTERNATIVE NAME	NPV	EUAC	SIR	DPP
1	Status Quo (Direct Comp.)	$18,186,067	$873,177		
2	New Construction	$16,236,790	$779,586	1.30	16.1 YEARS
3	Improvement (Addition)	$20,444,427	$981,609	0.79	

E X E C U T I V E S U M M A R Y R E P O R T PAGE 003

NON-MONETARY BENEFITS:

A benefits analysis was performed for each alternative. This benefits analysis included seven factors which were difficult to assess in monetary terms for the EA:

- Health/Safety
- Aesthetics
- Adequacy
- Maintenance
- Security
- Accessibility
- Morale

Health/Safety is a criteria which evaluates the health and safety environments associated with each alternative. The New Construction and Improvement alternatives were rated superior to the Status Quo alternative because the new dormitory will comply with contemporary health and safety standards.

Aesthetics evaluates the impact of the appearance of the proposed site and facility under each alternative. The New Construction alternative will have a positive impact on the aesthetic quality of the base. The Addition alternative is rated inferior because the additions will reduce desirable greenspace adjacent to existing dormitories. The Status Quo alternative will have no impact on the aesthetic quality of the base.

Adequacy measures the extent to which the facility meets the needs of the unaccompanied personnel to be housed. The New Construction alternative is rated superior because the planned room-bath-room modules including kitchenette meets the current Air Force requirements. The Addition alternative would not include kitchenettes due to the constrained floorplates. The low rating for adequacy for the Status Quo alternative is based on observations of housing occupied by enlisted personnel off-base.

Maintenance evaluates the ease of maintaining the facility. This criteria accounts for potential cost savings which are not quantified and included as life cycle costs. In order to match the existing exterior closure, the Addition alternative would employ materials which may require more maintenance than materials planned for the New Construction alternative. The Status Quo alternative is given a high score because the Air Force is not responsible for maintaining private housing off-base.

Security evaluates the ability of the facility to protect the unaccompanied personnel from threats other than health/safety. The New Construction and Addition alternatives are rated superior because they move personnel into the relatively more secure on-base environment.

Accessibility evaluates the location and ease of parking for each alternative. The Status Quo alternative has a poor rating because the off-base housing is remote from duty stations and other on-base

NON-MONETARY BENEFITS (cont.):

facilities. The New Construction alternative would provide parking immediately adjacent to the dormitory. The Addition alternative would provide less than optimal parking.

Morale is a criteria which evaluates the impact of the facility under each alternative to the confidence and discipline of the unaccompanied personnel housed there. The New Construction alternative is rated superior because the quality of the units would be high.

Each benefit was ranked in order of importance and assigned a "weight point." Then each alternative was evaluated on how well the alternative met the objective. Finally, the weight point was multiplied by the objective score to produce a benefit value. The sum of the benefit values is the total benefit score for each alternative.

BENEFITS ANALYSIS TABLE

Status Quo alternative

Benefits	A Weight Points	B %Objective Met	C Benefit Value (AxB)
Health/Safety	5	70%	3.5
Aesthetics	1	70%	0.7
Adequacy	4	50%	2.0
Maintenance	3	100%	3.0
Security	4	20%	0.8
Accessibility	3	20%	0.6
Morale	2	60%	1.2
			=========
Total Benefit Score			11.8

New Construction alternative

Benefits	A Weight Points	B %Objective Met	C Benefit Value (AxB)
Health/Safety	5	100%	5.0
Aesthetics	1	100%	1.0
Adequacy	4	100%	4.0
Maintenance	3	100%	3.0
Security	4	100%	4.0
Accessibility	3	100%	3.0
Morale	2	100%	2.0
			=========
Total Benefit Score			22.0

Improvement alternative

E X E C U T I V E S U M M A R Y R E P O R T PAGE 005

NON-MONETARY BENEFITS (cont.):

Benefits	A Weight Points	B %Objective Met	C Benefit Value (AxB)
Health/Safety	5	90%	4.5
Aesthetics	1	60%	0.6
Adequacy	4	90%	3.6
Maintenance	3	80%	2.4
Security	4	100%	4.0
Accessibility	3	80%	2.4
Morale	2	90%	1.8
			=========
Total Benefit Score			19.3

The New Construction alternative has the highest total benefit score.

DISCUSSION:

The New Construction alternative has the lowest NPV and is therefore the most cost-effective alternative. The Improvement alternative is the second most cost-effective.

The Cost/Benefit Ratios are as follows:

ALTERNATIVE NAME	BENEFIT NPV	COST/BENEFIT SCORE	RATIO
Status Quo (Direct Compensation)	$18,186,067	11.8	1,541,192
New Construction	$16,236,790	22.0	738,036
Improvement (Addition)	$20,444,427	19.3	1,059,297

The New Construction alternative has the lowest cost/benefit ratio, indicating that this alternative is the most desirable means of achieving the project objective.

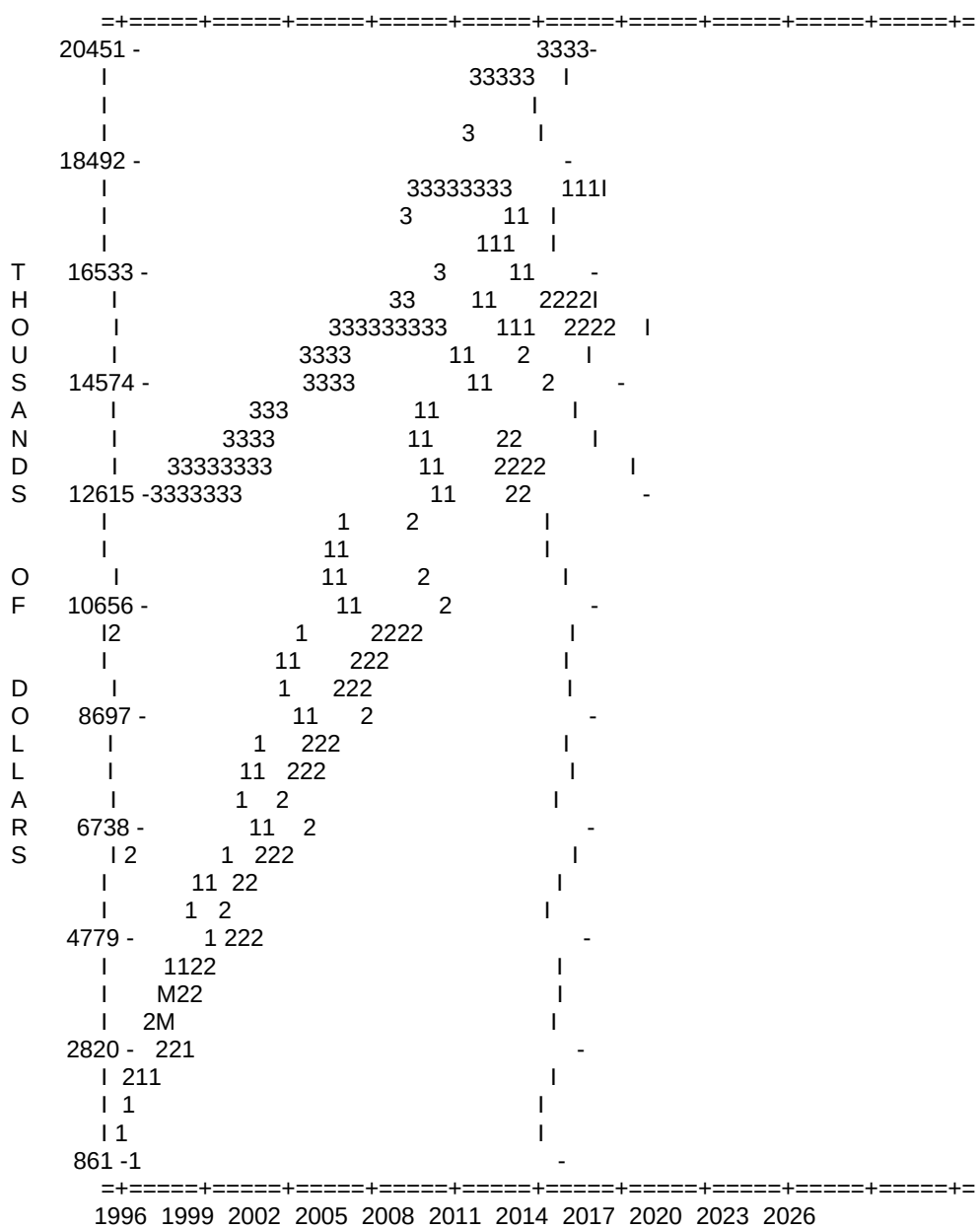
Cost sensitivity analysis indicates that the New Construction alternative would remain the most cost-effective alternative across a reasonable range of changes in the expense items.

The New Construction alternative is recommended for implementation.

ACTION OFFICER: Maj. A.B. Smith, (123) 456-7890
ORGANIZATION : FM, Anywhere Air Force Base

E C O N O M I C A N A L Y S I S G R A P H 1

CUMULATIVE NET PRESENT VALUE



LEGEND	DESCRIPTION
1	Status Quo (Direct Compensation)
2	New Construction
3	Improvement (Addition)
M	MERGING DATA

Section 2

LIFE CYCLE COST REPORT

L I F E C Y C L E C O S T R E P O R T PAGE 001

ALTERNATIVE 1: Status Quo (Direct Compensation)

YEAR	BAQ (01)	TOTAL ANNUAL OUTLAYS	MIDDLE OF YEAR DISCOUNT FACTORS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
1996	$873,178	$873,178	0.986	$861,204	$861,204
1997	$873,178	$873,178	0.959	$837,747	$1,698,951
1998	$873,178	$873,178	0.933	$814,929	$2,513,880
1999	$873,178	$873,178	0.908	$792,733	$3,306,613
2000	$873,178	$873,178	0.883	$771,141	$4,077,754
2001	$873,178	$873,178	0.859	$750,137	$4,827,891
2002	$873,178	$873,178	0.836	$729,705	$5,557,596
2003	$873,178	$873,178	0.813	$709,830	$6,267,426
2004	$873,178	$873,178	0.791	$690,496	$6,957,922
2005	$873,178	$873,178	0.769	$671,689	$7,629,611
2006	$873,178	$873,178	0.748	$653,394	$8,283,005
2007	$873,178	$873,178	0.728	$635,597	$8,918,602
2008	$873,178	$873,178	0.708	$618,285	$9,536,887
2009	$873,178	$873,178	0.689	$601,445	$10,138,332
2010	$873,178	$873,178	0.670	$585,063	$10,723,395
2011	$873,178	$873,178	0.652	$569,127	$11,292,522
2012	$873,178	$873,178	0.634	$553,626	$11,846,148
2013	$873,178	$873,178	0.617	$538,547	$12,384,695
2014	$873,178	$873,178	0.600	$523,878	$12,908,573
2015	$873,178	$873,178	0.584	$509,609	$13,418,182
2016	$873,178	$873,178	0.568	$495,729	$13,913,911
2017	$873,178	$873,178	0.552	$482,226	$14,396,137
2018	$873,178	$873,178	0.537	$469,092	$14,865,229
2019	$873,178	$873,178	0.523	$456,315	$15,321,544
2020	$873,178	$873,178	0.508	$443,886	$15,765,430
2021	$873,178	$873,178	0.495	$431,796	$16,197,226
2022	$873,178	$873,178	0.481	$420,035	$16,617,261
2023	$873,178	$873,178	0.468	$408,594	$17,025,855
2024	$873,178	$873,178	0.455	$397,465	$17,423,320
2025	$873,178	$873,178	0.443	$386,639	$17,809,959
2026	$873,178	$873,178	0.431	$376,108	$18,186,067

%NPV 100.00
$18,186,067
DISCOUNTING
CONVENTION M-O-Y

EQUIVALENT UNIFORM ANNUAL COST = $873,177 (2.80% DISCOUNT RATE, 31 YEARS)

L I F E C Y C L E C O S T R E P O R T PAGE 002

ALTERNATIVE 2: New Construction

YEAR	Construction (01)	Annual M&R (02)	Periodic M&R (03)	Utilities (04)	Misc O&M Trash Removal (05)
1996	$8,500,000	$0	$0	$0	$0
1997	$0	$49,757	$0	$61,971	$2,933
1998	$0	$49,757	$0	$61,971	$2,933
1999	$0	$49,757	$0	$61,971	$2,933
2000	$0	$49,757	$0	$61,971	$2,933
2001	$0	$49,757	$0	$61,971	$2,933
2002	$0	$49,757	$0	$61,971	$2,933
2003	$0	$49,757	$0	$61,971	$2,933
2004	$0	$49,757	$513,920	$61,971	$2,933
2005	$0	$49,757	$0	$61,971	$2,933
2006	$0	$49,757	$0	$61,971	$2,933
2007	$0	$49,757	$0	$61,971	$2,933
2008	$0	$69,660	$0	$61,971	$2,933
2009	$0	$69,660	$0	$61,971	$2,933
2010	$0	$69,660	$0	$61,971	$2,933
2011	$0	$69,660	$513,920	$61,971	$2,933
2012	$0	$69,660	$0	$61,971	$2,933
2013	$0	$69,660	$0	$61,971	$2,933
2014	$0	$69,660	$0	$61,971	$2,933
2015	$0	$69,660	$0	$61,971	$2,933
2016	$0	$69,660	$0	$61,971	$2,933
2017	$0	$94,538	$1,912,960	$61,971	$2,933
2018	$0	$94,538	$513,920	$61,971	$2,933
2019	$0	$94,538	$0	$61,971	$2,933
2020	$0	$94,538	$0	$61,971	$2,933
2021	$0	$94,538	$0	$61,971	$2,933
2022	$0	$94,538	$3,223,680	$61,971	$2,933
2023	$0	$94,538	$0	$61,971	$2,933
2024	$0	$94,538	$0	$61,971	$2,933
2025	$0	$94,538	$513,920	$61,971	$2,933
2026	$0	$94,538	$0	$61,971	$2,933
%NPV	51.63	8.13	23.73	7.57	0.36
	$8,383,442	$1,320,198	$3,852,204	$1,229,577	$58,194
DISCOUNTING CONVENTION	M-O-Y	M-O-Y	M-O-Y	M-O-Y	M-O-Y

L I F E C Y C L E C O S T R E P O R T PAGE 003

ALTERNATIVE 2: New Construction

YEAR	Furniture (06)	BAQ (07)	TOTAL ANNUAL OUTLAYS	MIDDLE OF YEAR DISCOUNT FACTORS	PRESENT VALUE
1996	$1,069,173	$873,178	$10,442,351	0.986	$10,299,158
1997	$0	$0	$114,661	0.959	$110,008
1998	$0	$0	$114,661	0.933	$107,012
1999	$0	$0	$114,661	0.908	$104,098
2000	$0	$0	$114,661	0.883	$101,262
2001	$0	$0	$114,661	0.859	$98,505
2002	$0	$0	$114,661	0.836	$95,820
2003	$0	$0	$114,661	0.813	$93,211
2004	$0	$0	$628,581	0.791	$497,072
2005	$0	$0	$114,661	0.769	$88,202
2006	$0	$0	$114,661	0.748	$85,801
2007	$936,457	$0	$1,051,118	0.728	$765,122
2008	$0	$0	$134,564	0.708	$95,283
2009	$0	$0	$134,564	0.689	$92,688
2010	$0	$0	$134,564	0.670	$90,163
2011	$0	$0	$648,484	0.652	$422,675
2012	$132,716	$0	$267,280	0.634	$169,466
2013	$0	$0	$134,564	0.617	$82,995
2014	$0	$0	$134,564	0.600	$80,735
2015	$0	$0	$134,564	0.584	$78,535
2016	$0	$0	$134,564	0.568	$76,396
2017	$936,457	$0	$3,008,859	0.552	$1,661,689
2018	$0	$0	$673,362	0.537	$361,746
2019	$0	$0	$159,442	0.523	$83,323
2020	$0	$0	$159,442	0.508	$81,053
2021	$0	$0	$159,442	0.495	$78,845
2022	$0	$0	$3,383,122	0.481	$1,627,423
2023	$0	$0	$159,442	0.468	$74,609
2024	$0	$0	$159,442	0.455	$72,577
2025	$0	$0	$673,362	0.443	$298,161
2026	$0	$0	$159,442	0.431	$68,677
%NPV	14.40	5.30			
	$2,337,491	$861,204			
DISCOUNTING CONVENTION	M-O-Y	M-O-Y			

L I F E C Y C L E C O S T R E P O R T PAGE 004

ALTERNATIVE 2: New Construction

YEAR	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$10,299,158	$0	$10,299,158
1997	$10,409,166	$7,909,216	$2,499,950
1998	$10,516,178	$7,563,387	$2,952,791
1999	$10,620,276	$7,230,529	$3,389,747
2000	$10,721,538	$6,910,192	$3,811,346
2001	$10,820,043	$6,601,942	$4,218,101
2002	$10,915,863	$6,305,356	$4,610,507
2003	$11,009,074	$6,020,030	$4,989,044
2004	$11,506,146	$5,745,568	$5,760,578
2005	$11,594,348	$5,481,592	$6,112,756
2006	$11,680,149	$5,227,733	$6,452,416
2007	$12,445,271	$4,983,637	$7,461,634
2008	$12,540,554	$4,748,959	$7,791,595
2009	$12,633,242	$4,523,368	$8,109,874
2010	$12,723,405	$4,306,543	$8,416,862
2011	$13,146,080	$4,098,174	$9,047,906
2012	$13,315,546	$3,897,960	$9,417,586
2013	$13,398,541	$3,705,613	$9,692,928
2014	$13,479,276	$3,520,852	$9,958,424
2015	$13,557,811	$3,343,407	$10,214,404
2016	$13,634,207	$3,173,016	$10,461,191
2017	$15,295,896	$3,009,427	$12,286,469
2018	$15,657,642	$2,852,395	$12,805,247
2019	$15,740,965	$2,701,685	$13,039,280
2020	$15,822,018	$2,557,068	$13,264,950
2021	$15,900,863	$2,418,325	$13,482,538
2022	$17,528,286	$2,285,244	$15,243,042
2023	$17,602,895	$2,157,617	$15,445,278
2024	$17,675,472	$2,035,248	$15,640,224
2025	$17,973,633	$1,917,944	$16,055,689
2026	$18,042,310	$1,805,520	$16,236,790

%NPV -11.12

$1,805,520

DISCOUNTING CONVENTION E-O-Y

EQUIVALENT UNIFORM ANNUAL COST = $779,586 (2.80% DISCOUNT RATE, 31 YEARS)

L I F E C Y C L E C O S T R E P O R T PAGE 005

PRIMARY ECONOMIC ANALYSIS

Present Alternative: Status Quo (Direct C
Proposed Alternative: New Construction

Project Year(s)	Recurring Annual Operating Costs Present Alternative	Proposed Alternative	Present Value Differential Cost	Present Value Factor	Present Value of Differential Cost
1996	$873,178	$1,942,351	-$1,069,173	0.986	-$1,054,512
1997	$873,178	$114,661	$758,517	0.959	$727,739
1998	$873,178	$114,661	$758,517	0.933	$707,917
1999	$873,178	$114,661	$758,517	0.908	$688,635
2000	$873,178	$114,661	$758,517	0.883	$669,879
2001	$873,178	$114,661	$758,517	0.859	$651,632
2002	$873,178	$114,661	$758,517	0.836	$633,885
2003	$873,178	$114,661	$758,517	0.813	$616,619
2004	$873,178	$628,581	$244,597	0.791	$193,424
2005	$873,178	$114,661	$758,517	0.769	$583,487
2006	$873,178	$114,661	$758,517	0.748	$567,593
2007	$873,178	$1,051,118	-$177,940	0.728	-$129,525
2008	$873,178	$134,564	$738,614	0.708	$523,002
2009	$873,178	$134,564	$738,614	0.689	$508,757
2010	$873,178	$134,564	$738,614	0.670	$494,900
2011	$873,178	$648,484	$224,694	0.652	$146,452
2012	$873,178	$267,280	$605,898	0.634	$384,160
2013	$873,178	$134,564	$738,614	0.617	$455,552
2014	$873,178	$134,564	$738,614	0.600	$443,143
2015	$873,178	$134,564	$738,614	0.584	$431,074
2016	$873,178	$134,564	$738,614	0.568	$419,333
2017	$873,178	$3,008,859	-$2,135,681	0.552	-$1,179,463
2018	$873,178	$673,362	$199,816	0.537	$107,346
2019	$873,178	$159,442	$713,736	0.523	$372,992
2020	$873,178	$159,442	$713,736	0.508	$362,833
2021	$873,178	$159,442	$713,736	0.495	$352,951
2022	$873,178	$3,383,122	-$2,509,944	0.481	-$1,207,388
2023	$873,178	$159,442	$713,736	0.468	$333,985
2024	$873,178	$159,442	$713,736	0.455	$324,888
2025	$873,178	$673,362	$199,816	0.443	$88,478
2026	$873,178	$159,442	$713,736	0.431	$307,431
Totals	$27,068,518	$15,207,068	$11,861,450		$8,527,199

L I F E C Y C L E C O S T R E P O R T PAGE 006

PRIMARY ECONOMIC ANALYSIS

Total present value of investment	$8,383,442
Plus: present value of existing assets to be used	$0
Less: present value of existing assets replaced	$0
Less: present value of terminal value of alternative	$1,805,520
Total present value of net investment	$6,577,922
Total present value of differential costs	$8,527,199
Plus: present value of cost of refurbishment or modification eliminated	$0
Less: status quo salvage value	$0
Total present value of savings	$8,527,199
Savings/Investment ratio	1.30
Discounted Payback Period	16.1 years

For Status Quo

Recurring Costs - Expense Item(s) 1

For Proposed Alternative

Recurring Costs - Expense Item(s) 2 3 4 5 6 7
Investment Costs - Expense Item(s) 1

L I F E C Y C L E C O S T R E P O R T PAGE 007

ALTERNATIVE 3: Improvement (Addition)

YEAR	Construction (01)	Annual M&R (02)	Periodic M&R (03)	Utilities (04)	Misc O&M Trash Removal (05)
1996	$10,729,790	$0	$0	$0	$0
1997	$0	$49,757	$0	$61,971	$2,933
1998	$0	$49,757	$0	$61,971	$2,933
1999	$0	$49,757	$0	$61,971	$2,933
2000	$0	$49,757	$0	$61,971	$2,933
2001	$0	$49,757	$0	$61,971	$2,933
2002	$0	$49,757	$0	$61,971	$2,933
2003	$0	$49,757	$0	$61,971	$2,933
2004	$0	$49,757	$540,800	$61,971	$2,933
2005	$0	$49,757	$0	$61,971	$2,933
2006	$0	$49,757	$0	$61,971	$2,933
2007	$0	$49,757	$0	$61,971	$2,933
2008	$0	$69,660	$0	$61,971	$2,933
2009	$0	$69,660	$0	$61,971	$2,933
2010	$0	$69,660	$0	$61,971	$2,933
2011	$0	$69,660	$540,800	$61,971	$2,933
2012	$0	$69,660	$0	$61,971	$2,933
2013	$0	$69,660	$0	$61,971	$2,933
2014	$0	$69,660	$0	$61,971	$2,933
2015	$0	$69,660	$0	$61,971	$2,933
2016	$0	$69,660	$0	$61,971	$2,933
2017	$0	$94,538	$2,014,720	$61,971	$2,933
2018	$0	$94,538	$540,800	$61,971	$2,933
2019	$0	$94,538	$0	$61,971	$2,933
2020	$0	$94,538	$0	$61,971	$2,933
2021	$0	$94,538	$0	$61,971	$2,933
2022	$0	$94,538	$3,393,280	$61,971	$2,933
2023	$0	$94,538	$0	$61,971	$2,933
2024	$0	$94,538	$0	$61,971	$2,933
2025	$0	$94,538	$540,800	$61,971	$2,933
2026	$0	$94,538	$0	$61,971	$2,933
%NPV	51.76	6.46	19.83	6.01	0.28
	$10,582,656	$1,320,198	$4,055,107	$1,229,577	$58,194
DISCOUNTING CONVENTION	M-O-Y	M-O-Y	M-O-Y	M-O-Y	M-O-Y

L I F E C Y C L E C O S T R E P O R T PAGE 008

ALTERNATIVE 3: Improvement (Addition)

YEAR	Furniture (06)	BAQ (07)	TOTAL ANNUAL OUTLAYS	MIDDLE OF YEAR DISCOUNT FACTORS	PRESENT VALUE
1996	$1,069,173	$873,178	$12,672,141	0.986	$12,498,372
1997	$0	$0	$114,661	0.959	$110,008
1998	$0	$0	$114,661	0.933	$107,012
1999	$0	$0	$114,661	0.908	$104,098
2000	$0	$0	$114,661	0.883	$101,262
2001	$0	$0	$114,661	0.859	$98,505
2002	$0	$0	$114,661	0.836	$95,820
2003	$0	$0	$114,661	0.813	$93,211
2004	$0	$0	$655,461	0.791	$518,329
2005	$0	$0	$114,661	0.769	$88,202
2006	$0	$0	$114,661	0.748	$85,801
2007	$936,457	$0	$1,051,118	0.728	$765,122
2008	$0	$0	$134,564	0.708	$95,283
2009	$0	$0	$134,564	0.689	$92,688
2010	$0	$0	$134,564	0.670	$90,163
2011	$0	$0	$675,364	0.652	$440,195
2012	$132,716	$0	$267,280	0.634	$169,466
2013	$0	$0	$134,564	0.617	$82,995
2014	$0	$0	$134,564	0.600	$80,735
2015	$0	$0	$134,564	0.584	$78,535
2016	$0	$0	$134,564	0.568	$76,396
2017	$936,457	$0	$3,110,619	0.552	$1,717,888
2018	$0	$0	$700,242	0.537	$376,186
2019	$0	$0	$159,442	0.523	$83,323
2020	$0	$0	$159,442	0.508	$81,053
2021	$0	$0	$159,442	0.495	$78,845
2022	$0	$0	$3,552,722	0.481	$1,709,007
2023	$0	$0	$159,442	0.468	$74,609
2024	$0	$0	$159,442	0.455	$72,577
2025	$0	$0	$700,242	0.443	$310,064
2026	$0	$0	$159,442	0.431	$68,677
%NPV	11.43	4.21			
	$2,337,491	$861,204			
DISCOUNTING CONVENTION	M-O-Y	M-O-Y			

L I F E C Y C L E C O S T R E P O R T PAGE 009

ALTERNATIVE 3: Improvement (Addition)

YEAR	CUMULATIVE NET PRESENT VALUE
1996	$12,498,372
1997	$12,608,380
1998	$12,715,392
1999	$12,819,490
2000	$12,920,752
2001	$13,019,257
2002	$13,115,077
2003	$13,208,288
2004	$13,726,617
2005	$13,814,819
2006	$13,900,620
2007	$14,665,742
2008	$14,761,025
2009	$14,853,713
2010	$14,943,876
2011	$15,384,071
2012	$15,553,537
2013	$15,636,532
2014	$15,717,267
2015	$15,795,802
2016	$15,872,198
2017	$17,590,086
2018	$17,966,272
2019	$18,049,595
2020	$18,130,648
2021	$18,209,493
2022	$19,918,500
2023	$19,993,109
2024	$20,065,686
2025	$20,375,750
2026	$20,444,427

EQUIVALENT UNIFORM ANNUAL COST = $981,609 (2.80% DISCOUNT RATE, 31 YEARS)

L I F E C Y C L E C O S T R E P O R T PAGE 010

PRIMARY ECONOMIC ANALYSIS

Present Alternative: Status Quo (Direct C
Proposed Alternative: Improvement (Addition)

Project Year(s)	Recurring Annual Operating Costs Present Alternative	Proposed Alternative	Present Value Differential Cost	Present Value Factor	Present Value of Differential Cost
1996	$873,178	$1,942,351	-$1,069,173	0.986	-$1,054,512
1997	$873,178	$114,661	$758,517	0.959	$727,739
1998	$873,178	$114,661	$758,517	0.933	$707,917
1999	$873,178	$114,661	$758,517	0.908	$688,635
2000	$873,178	$114,661	$758,517	0.883	$669,879
2001	$873,178	$114,661	$758,517	0.859	$651,632
2002	$873,178	$114,661	$758,517	0.836	$633,885
2003	$873,178	$114,661	$758,517	0.813	$616,619
2004	$873,178	$655,461	$217,717	0.791	$172,167
2005	$873,178	$114,661	$758,517	0.769	$583,487
2006	$873,178	$114,661	$758,517	0.748	$567,593
2007	$873,178	$1,051,118	-$177,940	0.728	-$129,525
2008	$873,178	$134,564	$738,614	0.708	$523,002
2009	$873,178	$134,564	$738,614	0.689	$508,757
2010	$873,178	$134,564	$738,614	0.670	$494,900
2011	$873,178	$675,364	$197,814	0.652	$128,932
2012	$873,178	$267,280	$605,898	0.634	$384,160
2013	$873,178	$134,564	$738,614	0.617	$455,552
2014	$873,178	$134,564	$738,614	0.600	$443,143
2015	$873,178	$134,564	$738,614	0.584	$431,074
2016	$873,178	$134,564	$738,614	0.568	$419,333
2017	$873,178	$3,110,619	-$2,237,441	0.552	-$1,235,662
2018	$873,178	$700,242	$172,936	0.537	$92,906
2019	$873,178	$159,442	$713,736	0.523	$372,992
2020	$873,178	$159,442	$713,736	0.508	$362,833
2021	$873,178	$159,442	$713,736	0.495	$352,951
2022	$873,178	$3,552,722	-$2,679,544	0.481	-$1,288,972
2023	$873,178	$159,442	$713,736	0.468	$333,985
2024	$873,178	$159,442	$713,736	0.455	$324,888
2025	$873,178	$700,242	$172,936	0.443	$76,575
2026	$873,178	$159,442	$713,736	0.431	$307,431
Totals	$27,068,518	$15,585,948	$11,482,570		$8,324,296

L I F E C Y C L E C O S T R E P O R T PAGE 011

PRIMARY ECONOMIC ANALYSIS

Total present value of investment	$10,582,656
Plus: present value of existing assets to be used	$0
Less: present value of existing assets replaced	$0
Less: present value of terminal value of alternative	$0
Total present value of net investment	$10,582,656
Total present value of differential costs	$8,324,296
Plus: present value of cost of refurbishment or modification eliminated	$0
Less: status quo salvage value	$0
Total present value of savings	$8,324,296
Savings/Investment ratio	0.79

SIR is less than one at end of period of analysis

For Status Quo

Recurring Costs - Expense Item(s) 1

For Proposed Alternative

Recurring Costs - Expense Item(s) 2 3 4 5 6 7
Investment Costs - Expense Item(s) 1

L I F E C Y C L E C O S T R E P O R T PAGE 012

SOURCE AND DERIVATION OF COSTS AND BENEFITS:

1. Construction cost: The construction cost for the New Construction alternative is based on the DD Form 1391 estimate dated March 15, 1994 and included in Appendix A.

2. Addition cost: The construction cost for the Improvement alternative is based on the DD Form 1391 estimate dated March 15, 1994 and included in Appendix B.

3. Annual maintenance and repair (M&R) costs for alternatives involving construction are estimated using historical average annual M&R costs of similar existing facilities on Anywhere AFB.

4. Annual M&R costs are escalated using BAM factors.

5. Periodic M&R costs for alternatives involving construction are based on historical costs for replacement of major subsystems for similar building types on Anywhere AFB.

6. Periodic M&R for the Improvement alternative includes a 5 percent adjustment for replacement of subsystems due to the new addition being attached to an existing facility, which would require workarounds in order to make replacements.

7. Utility costs are developed from historical averages for similar building types on Anywhere AFB. Energy-consuming utilities are inflated using DRI producer price indices.

8. Miscellaneous Operations and Maintenance (O&M) includes trash removal cost based on historical data for removal by volume and trash production per person.

Section 3

BENEFITS ANALYSIS

NON-MONETARY BENEFITS:

A benefits analysis was performed for each alternative. This benefits analysis included seven factors which were difficult to assess in monetary terms for the EA:

- Health/Safety
- Aesthetics
- Adequacy
- Maintenance
- Security
- Accessibility
- Morale

Health/Safety is a criteria which evaluates the health and safety environments associated with each alternative. The New Construction and Improvement alternatives were rated superior to the Status Quo alternative because the new dormitory will comply with contemporary health and safety standards.

Aesthetics evaluates the impact of the appearance of the proposed site and facility under each alternative. The New Construction alternative will have a positive impact on the aesthetic quality of the base. The Addition alternative is rated inferior because the additions will reduce desirable greenspace adjacent to existing dormitories. The Status Quo alternative will have no impact on the aesthetic quality of the base.

Adequacy measures the extent to which the facility meets the needs of the unaccompanied personnel to be housed. The New Construction alternative is rated superior because the planned room-bath-room modules including kitchenette meets the current Air Force requirements. The Addition alternative would not include kitchenettes due to the constrained floorplates. The low rating for adequacy for the Status Quo alternative is based on observations of housing occupied by enlisted personnel off-base.

Maintenance evaluates the ease of maintaining the facility. This criteria accounts for potential cost savings which are not quantified and included as life cycle costs. In order to match the existing exterior closure, the Addition alternative would employ materials which may require more maintenance than materials planned for the New Construction alternative. The Status Quo alternative is given a high score because the Air Force is not responsible for maintaining private housing off-base.

Security evaluates the ability of the facility to protect the unaccompanied personnel from threats other than health/safety. The New Construction and Addition alternatives are rated superior because they move personnel into the relatively more secure on-base environment.

Accessibility evaluates the location and ease of parking for each alternative. The Status Quo alternative has a poor rating because the off-base housing is remote from duty stations and other on-base

E X E C U T I V E S U M M A R Y R E P O R T PAGE 004

NON-MONETARY BENEFITS (cont.):

facilities. The New Construction alternative would provide parking immediately adjacent to the dormitory. The Addition alternative would provide less than optimal parking.

Morale is a criteria which evaluates the impact of the facility under each alternative to the confidence and discipline of the unaccompanied personnel housed there. The New Construction alternative is rated superior because the quality of the units would be high.

Each benefit was ranked in order of importance and assigned a "weight point." Then each alternative was evaluated on how well the alternative met the objective. Finally, the weight point was multiplied by the objective score to produce a benefit value. The sum of the benefit values is the total benefit score for each alternative.

BENEFITS ANALYSIS TABLE

Status Quo alternative

Benefits	A Weight Points	B %Objective Met	C Benefit Value (AxB
Health/Safety	5	70%	3.5
Aesthetics	1	70%	0.7
Adequacy	4	50%	2.0
Maintenance	3	100%	3.0
Security	4	20%	0.8
Accessibility	3	20%	0.6
Morale	2	60%	1.2
Total Benefit Score	11.8		

New Construction alternative

Benefits	A Weight Points	B %Objective Met	C Benefit Value (AxB)
Health/Safety	5	100%	5.0
Aesthetics	1	100%	1.0
Adequacy	4	100%	4.0
Maintenance	3	100%	3.0
Security	4	100%	4.0
Accessibility	3	100%	3.0
Morale	2	100%	2.0
Total Benefit Score	22.0		

Improvement alternative

E X E C U T I V E S U M M A R Y R E P O R T PAGE 005

NON-MONETARY BENEFITS (cont.):

Benefits	A Weight Points	B %Objective Met	C Benefit Value (AxB)
Health/Safety	5	90%	4.5
Aesthetics	1	60%	0.6
Adequacy	4	90%	3.6
Maintenance	3	80%	2.4
Security	4	100%	4.0
Accessibility	3	80%	2.4
Morale	2	90%	1.8
		=========	
Total Benefit Score			19.3

The New Construction alternative has the highest total benefit score.

Section 4

COST SENSITIVITY ANALYSIS

C O S T S E N S I T I V I T Y A N A L Y S I S PAGE 001

COST SENSITIVITY ANALYSIS NUMBER 01
TITLE ..... Test Changes for All Expense Items
ALLOWABLE CHANGE ..... 25.00 PERCENT

This sensitivity analysis checks for alternative 3 to be ranked least cost as a result of changes in the expense item(s) listed below:

ALTERNATIVE	EXPENSE ITEM(S)
2 - New Construction	1 - Construction
	2 - Annual M&R
	3 - Periodic M&R
	4 - Utilities
	5 - Misc O&M Trash Removal
	6 - Furniture
3 - Improvement (Additio	1 - Construction
	2 - Annual M&R
	3 - Periodic M&R
	4 - Utilities
	5 - Misc O&M Trash Removal
	6 - Furniture

The selected expense items are allowed to vary from a value of 100% less than their input value to 25.00% more than their input value.

ALTERNATIVE	NET PRESENT VALUE
2 - New Construction	$16,236,790
3 - Improvement (Additio	$20,444,427

C O S T S E N S I T I V I T Y A N A L Y S I S PAGE 002

TABLE OF PERCENT CHANGES WHERE ALTERNATIVES' NPVs ARE EQUAL

% CHANGE OF SELECTED EXPENSE ITEMS FOR New Construction (INITIALLY LEAST COST)	% CHANGE OF SELECTED EXPENSE ITEMS FOR Improvement (Additio (INITIALLY HIGHER COST)	NET PRESENT VALUE
-89.49	-100.00	$861,204
-86.49	-97.37	$1,376,637
-83.49	-94.74	$1,892,070
-80.49	-92.10	$2,407,504
-77.49	-89.47	$2,922,937
-74.49	-86.84	$3,438,370
-71.49	-84.21	$3,953,803
-68.49	-81.58	$4,469,236
-65.49	-78.94	$4,984,669
-62.49	-76.31	$5,500,103
-59.49	-73.68	$6,015,536
-56.49	-71.05	$6,530,969
-53.49	-68.42	$7,046,402
-50.49	-65.78	$7,561,835
-47.49	-63.15	$8,077,269
-44.49	-60.52	$8,592,702
-41.49	-57.89	$9,108,135
-38.49	-55.26	$9,623,568
-35.49	-52.62	$10,139,001
-32.49	-49.99	$10,654,434
-29.49	-47.36	$11,169,868
-26.49	-44.73	$11,685,301
-23.49	-42.10	$12,200,734
-20.49	-39.46	$12,716,167
-17.49	-36.83	$13,231,600
-14.49	-34.20	$13,747,034
-11.49	-31.57	$14,262,467
-8.49	-28.94	$14,777,900
-5.49	-26.30	$15,293,333
-2.49	-23.67	$15,808,766
0.51	-21.04	$16,324,199
3.51	-18.41	$16,839,633
6.51	-15.78	$17,355,066
9.51	-13.14	$17,870,499
12.51	-10.51	$18,385,932
15.51	-7.88	$18,901,365
18.51	-5.25	$19,416,798
21.51	-2.62	$19,932,232
24.51	0.02	$20,447,665
25.00	0.45	$20,532,066

EXPLANATION OF TABLE USE: FOR ANY NUMBER IN THE FIRST COLUMN, RANKING REVERSAL WILL OCCUR IF THE CHANGE IN EXPENSE ITEM(S) FOR THE OTHER ALTERNATIVE FALLS IN THE RANGE OF -100% TO THE CORRESPONDING NUMBER IN THE SECOND COLUMN. FOR EXAMPLE: FOR A CHANGE OF -29.49% IN THE SELECTED EXPENSE ITEMS OF ALTERNATIVE 2, ANY % CHANGE IN THE SELECTED EXPENSE ITEMS OF ALTERNATIVE 3 IN THE RANGE OF -100% TO -47.36% WILL RESULT IN ALTERNATIVE 3 HAVING A NPV LESS THAN THAT OF ALTERNATIVE 2.

Section 5

DISCOUNT RATE SENSITIVITY ANALYSIS

D I S C O U N T R A T E S E N S I T I V I T Y A N A L Y S I S 1 PAGE 001

Graph of Net Present Value ($ in thousands) vs. Discount Rate

DISCOUNT RATE (%)

LEGEND	DESCRIPTION
1	Status Quo (Direct C
2	New Construction
3	Improvement (Additio

D I S C O U N T R A T E S E N S I T I V I T Y A N A L Y S I S 1 PAGE 002

Summary of Alternative Rankings by Discount Rate

Discount Rate: 2.80 Lower Limit: 2.10 Upper Limit: 3.50

Discount Rate (%)	Alternative Ranking
2.10	2 1 3
2.20	2 1 3
2.30	2 1 3
2.40	2 1 3
2.50	2 1 3
2.60	2 1 3
2.70	2 1 3
2.80	2 1 3
2.90	2 1 3
3.00	2 1 3
3.10	2 1 3
3.20	2 1 3
3.30	2 1 3
3.40	2 1 3
3.50	2 1 3

* indicates a change in the alternative ranking occurred.

D I S C O U N T R A T E S E N S I T I V I T Y A N A L Y S I S 1 PAGE 003

Table of Net Present Value for each Discount Rate

Discount Rate = 2.10%		Discount Rate = 2.20%		Discount Rate = 2.30%	
Alt	NPV	Alt	NPV	Alt	NPV
2	$16,914,620	2	$16,813,146	2	$16,713,263
1	$19,954,589	1	$19,686,627	1	$19,423,965
3	$21,589,101	3	$21,414,728	3	$21,244,121

Discount Rate = 2.40%		Discount Rate = 2.50%		Discount Rate = 2.60%	
Alt	NPV	Alt	NPV	Alt	NPV
2	$16,614,946	2	$16,518,158	2	$16,422,886
1	$19,166,493	1	$18,914,083	1	$18,666,618
3	$21,077,195	3	$20,913,841	3	$20,753,990

Discount Rate = 2.70%		Discount Rate = 2.80%		Discount Rate = 2.90%	
Alt	NPV	Alt	NPV	Alt	NPV
2	$16,329,107	2	$16,236,790	2	$16,145,914
1	$18,423,984	1	$18,186,067	1	$17,952,763
3	$20,597,546	3	$20,444,427	3	$20,294,550

Discount Rate = 3.00%		Discount Rate = 3.10%		Discount Rate = 3.20%	
Alt	NPV	Alt	NPV	Alt	NPV
2	$16,056,458	2	$15,968,406	2	$15,881,719
1	$17,723,958	1	$17,499,553	1	$17,279,448
3	$20,147,837	3	$20,004,221	3	$19,863,610

Discount Rate = 3.30%		Discount Rate = 3.40%		Discount Rate = 3.50%	
Alt	NPV	Alt	NPV	Alt	NPV
2	$15,796,399	2	$15,712,399	2	$15,629,718
1	$17,063,538	1	$16,851,735	1	$16,643,943
3	$19,725,952	3	$19,591,150	3	$19,459,161

Section 6

APPENDICES

Appendix A

DD Form 1391 - New Construction

1. COMPONENT		2. DATE
AIR FORCE	**FY 1996 MILITARY CONSTRUCTION PROJECT DATA**	15 MAR 94

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
ANYWHERE AIR FORCE BASE, ANY STATE	**Dormitory (320 PN)**

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
4.18.96	721-312	EFGH 123456	8,500

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
DORMITORY				6,208
DORMITORY	SF	64,000	95	(6,080)
AUTOMATIC SPRINKLER PROTECTION	SF	64,000	2	(128)
SUPPORTING FACILITIES				1,400
UTILITIES	LS			(650)
PAVEMENTS	LS			(450)
SITE IMPROVEMENTS	LS			(300)
SUBTOTAL				7,608
CONTINGENCY (5 %)				380
TOTAL CONTRACT COST				7,988
SUPERVISION, INSPECTION, AND OVERHEAD (6 %)				479
TOTAL REQUEST				8,467
TOTAL REQUEST (ROUNDED)				8,500

10. DESCRIPTION OF PROPOSED CONSTRUCTION

A three-story structure with reinforced concrete foundation and floor slabs, structural frame, masonry walls, sloped metal roof, fire protection, and site improvements. Includes room-bath-room modules, laundries, storage and lounge areas, and necessary support.

Air Conditioning: 120 Tons Grade Mix: 320 E1-E4

11. REQUIREMENT: 1,627 PN ADEQUATE: 0 SUBSTANDARD: 1,139 PN

PROJECT Construct a dormitory.

REQUIREMENT This is a Level I Commander's Facility Assessment project. Properly designed and furnished quarters are essential for the proper rest and morale of enlisted personnel.

CURRENT SITUATION: There are currently not enough adequate base dormitories to meet the billeting requirements for unaccompanied enlisted personnel. at this installation. There are over 320 enlisted personnel living off-base due to a lack of on-base quarters. This project will significantly reduce the base dormitory deficiency..

IMPACT IF NOT PROVIDED: Substandard living conditions will persist and the morale, productivity, and career satisfaction of the enlisted force will continue to be degraded. In addition, personnel living on-base will continue to result in payments for BAQ/VHA allowances.

DD Form 1391, DEC 76 PREVIOUS EDITIONS MAY BE USED INTERNALLY PAGE NO 1 of 3

(CG using the Program, Design and Construction (PDC) System only.) UNTIL EXHAUSTED

1. COMPONENT		2. DATE
AIR FORCE	**FY 1996 MILITARY CONSTRUCTION PROJECT DATA**	15 MAR 94

3. INSTALLATION AND LOCATION

ANYWHERE AIR FORCE BASE, ANY STATE

4. PROJECT TITLE	5. PROJECT NUMBER
DORMITORY (320 PN)	EFGH 123456

ADDITIONAL:

This project meets the criteria/scope specified in Part II of Military Handbook 1190 "Facility Planning and Design Guide."

An economic analysis has been prepared comparing the alternatives of new construction, improvement, and the status quo. Based on the net present values and benefits of the respective alternatives, new construction was found to be the most cost effective over the life of the project. Fire protection systems for this project meet new standards established in MIL-HNBK 1008B, Fire Protection for Facilities. Cost for fire protection is shown separately since this new standard ins not yet reflected in the OSD approved unit cost factor for dormitories.

The estimates were performed using TRACES. TRACES uses a quantity method of parametric estimating. With a minimum of required information (size, building use, etc.), this method uses algorithms and default parameter information to establish quantities of materials, labor, and equipment and then links these quantities to a current price database (US Army Corps of Engineers Price Book). The system also uses location modifiers, i.e., seismic, weather, and climate zones, to make the design and estimate site specific. TRACES estimates projects through the use of parameters - project requirement, characteristics, and conceptual design.

TRACES uses the mid-point of the construction project (e.g. June 1994 for a 12 month project starting in January 1994) to apply escalation. TRACES uses Office of Management and Budget (OMB) escalation tables for Air Force projects. The OMB escalation tables are generally identical to USAF Raw Inflation Indices. The baseline for escalation is based on the date of the pricing data (currently January 1994) . Both the pricing data and escalation tables are periodically updated.

As a default, TRACES projects the mid-point of construction as a function of a start date and a construction period. The user can instead override this default to enter a mid-point for escalation. For this estimate, a mid-point of April 1996 was selected and the estimate is in FY 1996 dollars.

1. COMPONENT		2. DATE
AIR FORCE	**FY 1996 MILITARY CONSTRUCTION PROJECT DATA**	15 MAR 94

3. INSTALLATION AND LOCATION

ANYWHERE AIR FORCE BASE, ANY STATE

4. PROJECT TITLE	5. PROJECT NUMBER
DORMITORY (320 PN)	EFGH 123456

PAGE:
DATE: 02/15/1994 SYSTEM CONSTRUCTION COST REPORT TIME: 10:21:34

SYSTEM DESCRIPTION	MATERIAL	LABOR	EQUIPMENT	TOTAL	% TOTAL
FACILITY: DRM1					
01 SUBSTRUCTURE	101,334	90,080	10,654	202,069	4.0%
02 SUPERSTRUCTURE	517,900	392,618	26,606	937,125	18.8%
03 EXTERIOR CLOSURE	289,473	281,190	5,237	575,901	11.5%
04 ROOFING	145,947	34,174	3,223	183,345	3.7%
05 INTERIOR CONSTRUCTION	307,775	290,635	6,100	604,511	12.1%
06 INTERIOR FINISHES	290,647	293,388	5,570	589,606	11.8%
08 PLUMBING	236,577	221,909	5,119	463,605	9.3%
09 H.V.A.C	255,968	248,590	5,439	509,998	10.2%
11 ELECTRIC POWER	315,100	484,430	3,438	802,969	16.1%
12 ELECTRICAL SYSTEMS	45,446	71,170	430	117,047	2.3%
14 FURNISHINGS	8,451	1,062	29	9,543	0.2%
FACILITY TOTAL	$2,514,623	$2,409,251	$71,850	$4,995,725	100.0%
FACILITY: FIRE					
01 SUBSTRUCTURE	0	0	0	0	0.0%
10 FIRE PROTECTION	102,834	2,438	52	105,325	100.0%
FACILITY TOTAL	$102,834	$2,438	$52	$105,325	100.0%
FACILITY: Project					
99 CONTRACTOR OVERHEAD AND PROFIT	568,009	523,336	15,602	1,106,949	100.0%
FACILITY TOTAL	$568,009	$523,336	$15,602	$1,106,949	100.0%
TOTAL COST	$3,185,467	$2,935,026	$87,506	$6,208,000	100.0%
PERCENT OF TOTAL	51.3%	47.3%	1.4%		

Concurrence of Installation CE _____ _____
(Date)

DD Form 1391c, DEC 76 PREVIOUS EDITIONS MAY BE USED INTERNALLY PAGE NO 3 of 3
(CG using the Program, Design and Construction (PDC) System only.) UNTIL EXHAUSTED

Appendix B

DD Form 1391 - Improvement

1. COMPONENT		2. DATE
AIR FORCE	**FY 1996 MILITARY CONSTRUCTION PROJECT DATA**	15 MAR 94

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
ANYWHERE AIR FORCE BASE, ANY STATE	**Dormitory (320 PN) Improvement**

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
4.18.96	721-312	EFGH 123456	10.730

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
DORMITORY				10.730
DORMITORY	SF	64,000		2,146
				2,146
				2,146
				2,146
				2,146
SUBTOTAL				10,730
CONTINGENCY (0 %)				0
TOTAL CONTRACT COST				10,730
SUPERVISION, INSPECTION, AND OVERHEAD (0 %)				0
TOTAL REQUEST				10,730
TOTAL REQUEST (ROUNDED)				10,730

10. DESCRIPTION OF PROPOSED CONSTRUCTION

A 12,800 SF addition to each of the five existing dorms. Includes necessary support.

Air Conditioning: 120 Tons Grade Mix: 320 E1-E4

11. REQUIREMENT: 1,627 PN ADEQUATE: 0 SUBSTANDARD: 1,139 PN

PROJECT Construct additions for dormitory space.

REQUIREMENT Properly designed and furnished quarters are essential for the proper rest and morale of enlisted personnel.

CURRENT SITUATION: There are currently not enough adequate base dormitories to meet the billeting requirements for unaccompanied enlisted personnel. at this installation. There are over 320 enlisted personnel living off-base due to a lack of on-base quarters. This project will significantly reduce the base dormitory deficiency..

IMPACT IF NOT PROVIDED: Substandard living conditions will persist and the morale, productivity, and career satisfaction of the enlisted force will continue to be degraded. In addition, personnel living on-base will continue to result in payments for BAQ/VHA allowances.

DD Form 1391, DEC 76 PREVIOUS EDITIONS MAY BE USED INTERNALLY PAGE NO 1 of 4

(CG using the Program, Design and Construction (PDC) System only.) UNTIL EXHAUSTED

1. COMPONENT		2. DATE
AIR FORCE	**FY 1996 MILITARY CONSTRUCTION PROJECT DATA**	15 MAR 94

3. INSTALLATION AND LOCATION

ANYWHERE AIR FORCE BASE, ANY STATE

4. PROJECT TITLE	5. PROJECT NUMBER
DORMITORY Improvement	EFGH 123456

ADDITIONAL:

This project meets the criteria/scope specified in Part II of Military Handbook 1190 “Facility Planning and Design Guide.” An economic analysis has been prepared comparing the alternatives of new construction, improvement, and the status quo. Based on the net present values and benefits of the respective alternatives, improvement was less cost effective over the life of the project than new construction. Fire protection systems for this project meet new standards established in MIL-HNBK 1008B, Fire Protection for Facilities.

The estimates were performed using TRACES. TRACES uses a quantity method of parametric estimating. With a minimum of required information (size, building use, etc.), this method uses algorithms and default parameter information to establish quantities of materials, labor, and equipment and then links these quantities to a current price database (US Army Corps of Engineers Price Book). The system also uses location modifiers, i.e., seismic, weather, and climate zones, to make the design and estimate site specific. TRACES estimates projects through the use of parameters - project requirement, characteristics, and conceptual design

Algorithm and default parameter information was developed by preparing takeoffs for each building type on the quantity and material type used in typical military construction.

TRACES uses the mid-point of the construction project (e.g. June 1994 for a 12 month project starting in January 1994) to apply escalation. TRACES uses Office of Management and Budget (OMB) escalation tables for Air Force projects. The OMB escalation tables are generally identical to USAF Raw Inflation Indices. The baseline for escalation is based on the date of the pricing data (currently January 1994) . Both the pricing data and escalation tables are periodically updated.

As a default, TRACES projects the mid-point of construction as a function of a start date and a construction period. The user can instead override this default to enter a mid-point for escalation. For this estimate, a mid-point of April 1996 was selected and the estimate is in FY 1996 dollars.

1. COMPONENT		2. DATE
AIR FORCE	**FY 1996 MILITARY CONSTRUCTION PROJECT DATA**	15 MAR 94

3. INSTALLATION AND LOCATION

ANYWHERE AIR FORCE BASE, ANY STATE

4. PROJECT TITLE	5. PROJECT NUMBER
DORMITORY Improvement	EFGH 123456

PARAMETRIC MODELS PAGE: 1
DATE: 02/15/1994 SYSTEM CONSTRUCTION COST REPORT TIME: 10:08:13

PROJECT: DORMBB
PROJECT DESCRIPTION: DORMITORY IMPROVEMENT - Alternative 3
Add 12,800 sf additions to each of 5
dorms.
PROJECT COMMENT:

BUILDING TOTAL GROSS FLOOR AREA: 29,684 SF
GEOLOCATION: ANYWHERE AFB
ESTIMATED BY:
ESTIMATE DATE: 02/15/1994
REPORT FILE: DORMIMP.DOC_
COST DATABASE: NAT92R

ESCALATION MODIFIER: Mid-Point of Construction

1. COMPONENT		2. DATE
AIR FORCE	**FY 1996 MILITARY CONSTRUCTION PROJECT DATA**	15 MAR 94

3. INSTALLATION AND LOCATION

ANYWHERE AIR FORCE BASE, ANY STATE

4. PROJECT TITLE	5. PROJECT NUMBER
DORMITORY Improvement	EFGH 123456

PARAMETRIC MODELS PAGE: 2
DATE: 02/15/1994 SYSTEM CONSTRUCTION COST REPORT TIME: 10:08:13

SYSTEM DESCRIPTION	MATERIAL	LABOR	EQUIPMENT	TOTAL	% TOTAL
FACILITY: DRM1					
01 SUBSTRUCTURE	38,268	35,770	4,056	78,113	6.5%
02 SUPERSTRUCTURE	127,045	75,942	5,600	208,587	17.3%
03 EXTERIOR CLOSURE	126,385	126,562	2,305	255,253	21.1%
04 ROOFING	49,253	11,094	1,121	61,469	5.1%
05 INTERIOR CONSTRUCTION	66,397	53,562	1,121	121,082	10.0%
06 INTERIOR FINISHES	43,744	45,632	856	90,233	7.5%
08 PLUMBING	48,278	49,727	1,155	99,161	8.2%
09 H.V.A.C	46,359	55,462	1,166	102,988	8.5%
11 ELECTRIC POWER	61,437	89,420	597	151,456	12.5%
12 ELECTRICAL SYSTEMS	19,120	18,378	110	37,609	3.1%
14 FURNISHINGS	1,365	171	4	1,541	0.1%
FACILITY TOTAL	$627,637	$561,724	$18,096	$1,207,497	100.0%
SUPPORTING FACILITIES	$156,345	$139,925	$4,507	$300,778	100.0%
FACILITY GRAND TOTAL	$783,982	$701,650	$22,604	$1,508,275	100.0%
FACILITY: FIRE					
01 SUBSTRUCTURE	0	0	0	0	0.0%
10 FIRE PROTECTION	15,690	371	8	16,070	100.0%
FACILITY TOTAL	$15,690	$371	$8	$16,070	100.0%
FACILITY: Project					
99 CONTRACTOR O&P	326,106	286,284	9,221	621,612	100.0%
FACILITY TOTAL	$326,106	$286,284	$9,221	$621,612	100.0%
TOTAL COST	$1,125,779	$988,306	$31,833	$2,145,958	100.0%
PERCENT OF TOTAL	52.5%	46.1%	1.5%		

Concurrence of Installation CE _____ _____
(Date)

DD Form 1391c, DEC 76 PREVIOUS EDITIONS MAY BE USED INTERNALLY PAGE NO 4 of 4
(CG using the Program, Design and Construction (PDC) System only.) UNTIL EXHAUSTED

Appendix C

Source Documents

DEPARTMENT OF THE AIR FORCE
INSTALLATION CE
ANYWHERE AIR FORCE BASE, ANY STATE

15 JAN 94

MEMORANDUM FOR FM

FROM CE

SUBJECT: Civil Engineering Source Document for Economic Analysis, Project Number EFGH 123456

The data below are provided to support the Economic Analysis for Project Number EFGH 123456 FY 95 Dormitory (320 PN). Except where otherwise noted, all costs are in FY 1996 dollars.

1. Existing facilities data is shown below:

Building	SF	Annual M&R
212	30,825	$18,670
213	31,700	$18,890
214	31,350	$18,720
217	31,350	$18,890
218	25,347	$18,800
219	25,347	$18,800
221	25,347	$18,800
222	25,347	$18,800
223	18,000	$14,230
225	18,000	$14,230
227	18,000	$14,230
228	18,000	$14,230
229	18,000	$14,230
231	18,100	$13,900
232	19,854	$13,900
321	19,854	$15,480
322	19,854	$15,480
323	19,854	$15,480
Total	412,375	$295,760
Average Cost Per SF		$0.71721
Escalation Factor	1.084	
Average Cost, FY96$s		$0.77746

Annual M&R Cost $49,757 (64,000 SF x $0.77746)

2. Periodic Maintenance and Repair Data (FY96$s)

New Construction

Subsystem		Cost/SF
A-Roofing	$06.00	
B-Int. Walls & Doors, Windows, Ext. Closure	$50.37	
C-Walls/Floor Finishes, Paint, Coverings	$08.03	
D-Ceiling Finishes	$03.55	
E-HVAC		$20.34
F-Plumbing		$15.92
G-Electrical		$28.93

Replacement
A-2017, 2037
B-2022

C-2004,2011,2018,2025,2032,2039,2046
D-2017,2037
E-2017,2037
F-2037
G-2027

Addition (Improvement)

Subsystem		Cost/SF
A-Roofing	$06.32	
B-Int. Walls & Doors, Windows, Ext. Closure	$53.37	
C-Walls/Floor Finishes, Paint, Coverings	$08.45	
D-Ceiling Finishes	$03.74	
E-HVAC		$21.42
F-Plumbing		$16.76
G-Electrical		$30.45

Replacement
A-2017, 2037
B-2022
C-2004,2011,2018,2025,2032,2039,2046
D-2017,2037
E-2017,2037
F-2037
G-2027

3. Utilities data is the same for both alternatives

Electricity (FY93)	$0.0441 /Kwh	716.160 Kwh	
Steam (FY93)	$0.0047 /Kbtu		1,760,000 Kbtu
Water (FY93)	$2.46 /KGal		7,136 KGal
Sewage (FY86)	$0.4016 /Kgal		5,138 Kgal

4. Trash Removal costs are the same for both alternatives

Trash Removal (FY93)		
Annual Cubic Yards Per Unit	5.76	
Removal Cost Per Cubic Yard	$1.47	
Annual Cost Per Unit		$8.46
Number of Units (Personnel)	320	
Total Annual Cost	$2,707	

5. Furniture and appliance costs and life expectancies are as follows

Furniture			
Life:	10 years		
Cost:	Room Furniture		$585,600
	Common Area Furniture		$ 80,640
	Drapes, Beds, Covering		$157,760
	Pictures, Plants, Other	$ 61,120	
	Total Furniture	$885,120 (FY94$s)	

Appliances		
Life:	15 years	
Cost		$125,440 (FY94$s)

John X. Doe, Lt Col, USAF
Base Civil Engineer

Appendix D

Interim Calculations

WORKSHEET 1
Annual Maintenance Costs
FY 96 Program Year Dollars
Alternative: NEW CONSTRUCTION

Annual Maintenance

Annual Maintenance Cost per Square Foot	$0.77746
Number of Square Feet of Building Space	X 64,000
Total Annual Maintenance Cost	$49,757

Escalation Factor (Method 1 - Building Age Multiplier)

Year of Construction of Facility:	1996	
Building Age Multiplier During Years:	1997-2006	1.00
Building Age Multiplier During Years:	2007-2016	1.40
Building Age Multiplier During Years:	2017-2026	1.90
Building Age Multiplier During Years:	2027-2036	2.10
Building Age Multiplier During Years:	2037-2046	2.10

Calculations:

$49,757 X 1.00 = $49,757
$49,757 X 1.40 = $69,660
$49,757 X 1.90 = $94,538
$49,757 X 2.10 = $104,490
$49,757 X 2.10 = $104,490

WORKSHEET 2
Periodic Maintenance, Repair, and Replacement Costs
FY 96 Program Year Dollars
Alternative: ADDITION

Roofing
M&R Cost per Square Foot: $6.32
Square Feet of Space: 64,000
Subtotal M&R Cost: $404,480
Life Expectancy in Years: 20
Years M&R Would Be Required: 2017, 2037

Interior Walls and Doors, Windows, Exterior Closure
M&R Cost per Square Foot: $53.02
Square Feet of Space: 64,000
Subtotal M&R Cost: $3,393,280
Life Expectancy in Years: 25
Years M&R Would Be Required: 2022

Wall and Floor Finishes, Paint, Wall Coverings, Carpeting
M&R Cost per Square Foot: $8.45
Square Feet of Space: 64,000
Subtotal M&R Cost: $540,800
Life Expectancy in Years: 7
Years M&R Would Be Required: 2004, 2011, 2018, 2025, 2032, 2039, 2046

Ceiling Finishes
M&R Cost per Square Foot: $3.74
Square Feet of Space: 64,000
Subtotal M&R Cost: $239,360
Life Expectancy in Years: 20
Years M&R Would Be Required: 2017, 2037

HVAC
M&R Cost per Square Foot: $21.42
Square Feet of Space: 64,000
Subtotal M&R Cost: $1,370,880
Life Expectancy in Years: 20
Years M&R Would Be Required: 2017, 2037

Plumbing
M&R Cost per Square Foot: $16.76
Square Feet of Space: 64,000
Subtotal M&R Cost: $1,072,640
Life Expectancy in Years: 40
Years M&R Would Be Required: 2037

Electrical
M&R Cost per Square Foot: $30.45
Square Feet of Space: 64,000
Subtotal M&R Cost: $1,948,800
Life Expectancy in Years: 30
Years M&R Would Be Required: 2027

WORKSHEET 2A
Total Periodic Maintenance and Repair (M&R) Costs
FY 96 Program Year Dollars
Alternative: NEW CONSTRUCTION

YEAR	SUBSYSTEM	M&R COST ($)	TOTAL FOR YEAR(S)
2004	Walls/Floors, Paint, Carpet	513,920	513,920
2011	Walls/Floors, Paint, Carpet	513,920	513,920
2017	Roofing	384,000	
	Ceiling Finishes	227,200	
	HVAC	1,301,760	1,912,960
2018	Walls/Floors, Paint, Carpet	513,920	513,920
2022	Int Walls/Doors, Windows, Ext Closure	3,223,680	3,223,680
2025	Walls/Floors, Paint, Carpet	513,920	513,920
2027	Electrical	1,851,520	1,851,520
2032	Walls/Floors, Paint, Carpet	513,920	513,920
2037	Roofing	384,000	
	Ceiling Finishes	227,200	
	HVAC	1,301,760	
	Plumbing	1,018,880	2,931,840
2039	Walls/Floors, Paint, Carpet	513,920	513,920
2046	Walls/Floors, Paint, Carpet	513,920	513,920

WORKSHEET 2A
Total Periodic Maintenance and Repair (M&R) Costs
FY 96 Program Year Dollars
Alternative: ADDITION

YEAR	SUBSYSTEM	M&R COST ($)	TOTAL FOR YEAR(S)
2004	Walls/Floors, Paint, Carpet	540,800	540,800
2011	Walls/Floors, Paint, Carpet	540,800	540,800
2017	Roofing	404,480	
	Ceiling Finishes	239,360	
	HVAC	1,370,880	2,014,720
2018	Walls/Floors, Paint, Carpet	540,800	540,800
2022	Int Walls/Doors, Windows, Ext Closure	3,393,280	3,393,280
2025	Walls/Floors, Paint, Carpet	540,800	540,800
2027	Electrical	1,948,800	1,948,800
2032	Walls/Floors, Paint, Carpet	540,800	540,800
2037	Roofing	404,480	
	Ceiling Finishes	239,360	
	HVAC	1,370,880	
	Plumbing	1,072,640	3,087,360
2039	Walls/Floors, Paint, Carpet	540,800	540,800
2046	Walls/Floors, Paint, Carpet	540,800	540,800

WORKSHEET 3
Utility Costs
FY 96 Program Year Dollars
Alternative: NEW CONSTRUCTION

Electricity *	
Consumption per Square Foot (Kwh):	11.19
Square Feet of Space:	64,000
Annual Electricity Consumption (Kwh):	716,160
Cost per Kwh of Electricity:	$0.0455
Total Annual Electricity Cost:	$32,585
Steam (HTHW) *	
Consumption per Square Foot (Kwh):	27.5
Square Feet of Space:	64,000
Annual Steam Consumption (KBtu):	1,760,000
Cost per KBtu of Steam:	$0.0046
Total Annual Steam Cost:	$8,096
Water *	
Number of Units (Personnel):	320
Annual Water Use per Unit (KGal):	22.3
Total Annual Water Use (KGal):	7,136
Cost per KGal of Water:	$2.67
Total Annual Water Cost:	$19,053
Sewage Treatment **	
Total Annual Water Use (KGal):	7,136
Ratio of Sewage Treatment to Water Use:	.72
Total Annual Sewage Treatment (KGal):	5,138
Cost per KGal of Sewage Treatment:	$0.4353
Total Annual Sewage Treatment Cost:	$2,237
Total Utilities	**$61,971**

Note
*Costs for Electricity, and Steam are inflated from FY93 constant dollars to FY96 program years dollars using DRI producer price indices. Inflation of Water costs derived using raw inflation indices.
**Costs for Sewage Treatment are inflated from FY86 constant dollars of FY96 program year dollars using raw inflation indices.

WORKSHEET 3
Utility Costs
FY 96 Program Year Dollars
Alternative: ADDITION

Electricity *	
Consumption per Square Foot (Kwh):	11.19
Square Feet of Space:	64,000
Annual Electricity Consumption (Kwh):	716,160
Cost per Kwh of Electricity:	$0.0455
Total Annual Electricity Cost:	$32,585
Steam (HTHW) *	
Consumption per Square Foot (Kwh):	27.5
Square Feet of Space:	64,000
Annual Steam Consumption (KBtu):	1,760,000
Cost per KBtu of Steam:	$0.0046
Total Annual Steam Cost:	$8,096
Water *	
Number of Units (Personnel):	320
Annual Water Use per Unit (KGal):	22.3
Total Annual Water Use (KGal):	7,136
Cost per KGal of Water:	$2.67
Total Annual Water Cost:	$19,053
Sewage Treatment **	
Total Annual Water Use (KGal):	7,136
Ratio of Sewage Treatment to Water Use:	.72
Total Annual Sewage Treatment (KGal):	5,138
Cost per KGal of Sewage Treatment:	$0.4353
Total Annual Sewage Treatment Cost:	$2,237
Total Utilities	**$61,971**

Note
*Costs for Electricity, and Steam are inflated from FY93 constant dollars to FY96 program years dollars using DRI producer price indices. Inflation of Water costs derived using raw inflation indices.
**Costs for Sewage Treatment are inflated from FY86 constant dollars to FY96 program year dollars using raw inflation indices.

WORKSHEET 4
Miscellaneous Operations and Maintenance Costs
FY 96 Program Year Dollars
Alternative: NEW CONSTRUCTION

Trash Removal

Cost per Cubic Yard for Removal (FY93$):	$1.47
Inflation Index	1.084
Cost per Cubic Yard for Removal (FY96$):	$1.59
Annual Cubic Yards Generated per Unit:	5.76
Annual Cost per Unit:	$9.16
Number of Units (Personnel):	320
Total Annual Trash Removal Cost:	$2,931

Note
*Costs for trash removal are inflated from FY93 constant dollars to FY96 program year dollars using raw inflation indices.

WORKSHEET 4
Miscellaneous Operations and Maintenance Costs
FY 96 Program Year Dollars
Alternative: ADDITION

Trash Removal

Cost per Cubic Yard for Removal (FY93$):	$1.47
Inflation Index	1.084
Cost per Cubic Yard for Removal (FY96$):	$1.59
Annual Cubic Yards Generated per Unit:	5.76
Annual Cost per Unit:	$9.16
Number of Units (Personnel):	320
Total Annual Trash Removal Cost:	$2,931

Note
*Costs for trash removal are inflated from FY93 constant dollars to FY96 program year dollars using raw inflation indices.

WORKSHEET 5
Miscellaneous User Costs
FY 96 Program Year Dollars
Alternative: STATUS QUO

Basic Allowance for Quarters (BAQ)

Rate:		
	E1	$179.10 p/mo.
	E2	$210.30 p/mo.
	E3	$247.80 p/mo.
	E4	$252.30 p/mo.
		$880.50 / 4 = **$220.13**

Average Rate per Person (FY94)		$	220.13
Inflation Index	X		1.033
Average Rate per Person (FY 96)	=	$	227.39
Number of Personnel	X	$	320
Number of Months per Year	X		12
Annual BAQ Cost	=	$	873,177.60
Annual BAQ Cost (Rounded)	=	$	873,178

Variable Housing Allowance (VHA)

$0 for Anywhere Air Force Base

WORKSHEET 5
Miscellaneous User Costs
FY 96 Program Year Dollars
Alternative: NEW CONSTRUCTION

Furniture

Furniture Cost: $936,457
Life Expectancy in Years: 10
Years Replacement is Required: 1996, 2007, 2017, 2027, 2037

Appliances

Appliance Cost: $132,716
Life Expectancy in Years: 15
Years Replacement is Required: 1996, 2012, 2027, 2042

Note: Costs for furniture and appliances are inflated from FY94 constant dollars to FY96 program year dollars using USAF Raw Inflation Indices contained in AFR 173-13, *USAF Cost and Planning Factors*, ATCH 45, 15 Feb 94. Furniture and appliance costs were derived using the following method:

Room Furniture		$585,600
Common Area Furniture:		$ 80,640
Drapes, Beds, Coverings		$157,760
Pictures, Plants, Other		$ 61,120
		$885,120
Inflation	x	1.058
Total		**$936,457**

Appliances		$125,440
Inflation	x	1.058
Total		**$132,716**

WORKSHEET 5
Miscellaneous User Costs
FY 96 Program Year Dollars
Alternative: ADDITION

Furniture

Furniture Cost: $936,457
Life Expectancy in Years: 10
Years Replacement is Required: 1996, 2007, 2017, 2027, 2037

Appliances

Appliance Cost: $132,716
Life Expectancy in Years: 15
Years Replacement is Required: 1996, 2012, 2027, 2042

Note: The calculation for inflation uses an inflation index of 1.058 to inflate FY94 constant dollars to FY96 program year dollars. Furniture and appliance costs were derived using the following method:

Room Furniture		$585,600
Common Area Furniture:		$ 80,640
Drapes, Beds, Coverings		$157,760
Pictures, Plants, Other		$ 61,120
		$885,120
Inflation	x	1.058
Total		**$936,457**
Appliances		$125,440
Inflation	x	1.058
Total		**$132,716**

Utilities Inflation

Electricity

Cost per Kwh (FY93$):		$0.0441
DRI Inflation Index:	X	1.032
Cost per Kwh (FY96$):	=	$0.0455

Steam (HTHW)

Cost per KBtu (FY93$):		$0.0047
DRI Inflation Index:	X	0.988
Cost per KBtu (FY96$):	=	$0.0046

Water

Cost per Kgal (FY93$):		$2.46
Raw Inflation Index:	X	1.084
Cost per Kgal (FY96$):	=	$2.67

Sewage

Cost per Kgal (FY93$):		$0.4016
Raw Inflation Index:	X	1.084
Cost per Kgal (FY96$): =		$0.435

SAMPLE ECONOMIC ANALYSIS FOR MILITARY FAMILY HOUSING

(see attached)

ECONOMIC ANALYSIS

Enter (Name of Air Force Base), (State)/(MAJCOM)

Date

CERTIFICATE OF SATISFACTORY
ECONOMIC ANALYSIS

INSTALLATION/MAJCOM: Any Air Force Base, Any State / MAJCOM

PROJECT TITLE: FY 95 Replace Capehart Housing Phase 1

PROJECT NUMBER: ABCD 123456

OBJECTIVE: Provide 64 Enlisted Family Housing Units Meeting Air Force Standards

PROJECT COST: $6,160,000

ALTERNATIVES CONSIDERED:

1. Status Quo
2. Improvement
3. Replacement
4. Direct Compensation

SUMMARY OF ANALYSIS RESULTS:

The Status Quo alternative is the least costly alternative, yielding an NPV of $2.6 million, compared with $7.2 million for the Improvement alternative and $7.5 million for the Replacement alternative. The Status Quo alternative is unacceptable, however, because it does not repair the deteriorating structures and would force Air Force personnel to continue to live in inadequate housing. Furthermore, the benefits analysis shows that the Replacement alternative would yield the greatest benefit to Air Force personnel. An evaluation of costs and benefits together by means of the cost/benefit ratio also indicates that the Replacement alternative is the most cost-effective alternative. The improvement/ replacement initial cost ratio is 83.0% and there is no prevailing justification to retain the existing units. The sensitivity analysis conducted on the discount rate shows that the ranking of the alternatives will change if the discount rate goes below 3.20%. The sensitivity analysis conducted on plus and minus 25 percent of project scope shows no impact on the relative rankings of the alternatives. The Direct Compensation alternative is not feasible because a 1992 Housing Market Analysis concluded that there is a deficit of adequate housing for Air Force personnel off base. Therefore, it is recommended that the Replacement alternative be approved.

CERTIFICATION:

This economic analysis follows the guidelines and procedures contained in AFI 65-501 and AFMAN 65-506. Costs are based on CE Source Document dated 30 Oct 92, LG Source Document dated 25 Oct 92, and FM Source Document dated 26 Sep 92.

CONTINUATION PAGE
CERTIFICATE OF SATISFACTORY ECONOMIC ANALYSIS

INSTALLATION/MAJCOM: Any Air Force Base, Any State / MAJCOM

PROJECT TITLE: FY 95 Replace Capehart Housing Phase 1

PROJECT NUMBER: ABCD 123456

OBJECTIVE: Provide 64 Enlisted Family Housing Units Meeting Air Force Standards

PROJECT COST: $6,160,000

Installation FM Analyst: _____ _____
(Date)

Concurrence of Installation FM: _____ _____
(Date)

Concurrence of Installation CE _____ _____
(Date)

MAJCOM/FMA Evaluator: _____ _____
(Date)

Concurrence by MAJCOM FMA: _____ _____
(Date)

Concurrence of MAJCOM CEH: _____ _____
(Date)

DOD EXECUTIVE SUMMARY

INSTALLATION/MAJCOM: Any Air Force Base, Any State / MAJCOM

PROJECT TITLE: FY 95 Replace Capehart Housing Phase 1

PROJECT NUMBER: ABCD 123456

OBJECTIVE: Provide 64 Enlisted Family Hsg Units Mtg AF Standards

PROJECT COST: $6,160,000

ALTERNATIVES EXAMINED:	Net Present Value	Benefit Score	Cost/Benefit Ratio
1. Status Quo	$2,603,863	2.70	964,394
2. Improvement	7,236,088	5.70	1,269,489
3. Replacement	7,509,491	7.95	944,590
4. Direct Compensation	N/A	N/A	N/A

ANALYSIS METHOD:

All alternatives were examined using standard Air Force and DoD Economic Analysis techniques and procedures. This examination conforms to generally accepted cost analysis principles as specified in DODI 7041.3, AFI 65-501 and AFMAN 65-506.

CONCLUSION:

The Status Quo alternative is the least costly alternative, yielding an NPV of $2.6 million, compared with $7.2 million for the Improvement alternative and $7.5 million for the Replacement alternative. The Status Quo alternative is unacceptable, however, because it does not repair the deteriorating structures and would force Air Force personnel to continue to live in inadequate housing. Furthermore, the benefits analysis shows that the Replacement alternative would yield the greatest benefit to Air Force personnel. An evaluation of costs and benefits together by means of the cost/benefit ratio also indicates that the Replacement alternative is the most cost-effective alternative. The improvement/ replacement initial cost ratio is 83.0% and there is no prevailing justification to retain the existing units. The sensitivity analysis conducted on the discount rate shows that the ranking of the alternatives will change if the discount rate goes below 3.20%. The sensitivity analysis conducted on plus and minus 25 percent of project scope shows no impact on the relative rankings of the alternatives. The Direct Compensation alternative is not feasible because a 1992 Housing Market Analysis concluded that there is a deficit of adequate housing for Air Force personnel off base. Therefore, it is recommended that the Replacement alternative be approved.

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Section 2
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Section 1

EXECUTIVE SUMMARY REPORT

FILENAME: ANYAFBAS
DATE GENERATED: 22 FEB 1994
VERSION: PC V4.0

E X E C U T I V E S U M M A R Y R E P O R T PAGE 001

PROJECT TITLE : FY 95 Improve/Replace Capehart Housing Phase 1
DISCOUNT RATE : 4.50%
PERIOD OF ANALYSIS: 26 YEARS
START YEAR : 1995
BASE YEAR : 1995

PROJECT OBJECTIVE : Provide 64 Enlisted Family Housing Units Meeting Air Force Standards

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS:

ALTERNATIVE 1: STATUS QUO

These 64 units of Family Housing consist of 34 JNCO 3BR units, 10 JNCO 4BR units, 18 SNCO 3BR units, and 2 SNCO 4BR units, which no longer meet current living standards. Due to advancing age and continual deterioration, these units require extensive maintenance and repair. These units were constructed in 1959, under the Capehart Program, and have had no formal renovations. Kitchens are narrow and dark, and do not provide adequate cabinet and countertop space. Additionally, washing machines and dryers are located in the kitchens, causing a lack of ample work space for household chores. The bathroom tubs are very small and in poor condition, there is no counter space around the sinks, and the space between bathroom fixtures is extremely limited. The interior of exterior walls is constructed of uninsulated painted masonry block; interior partition walls are inferior grade wallboard. There is poor interior lighting in hallways, bathrooms, and bedrooms. The exteriors of these units lack landscaping and have no covered patios for protection from the sun. Continuation of the status quo will require Air Force members and their families to continue living in extremely outdated and unsatisfactory housing. The housing will continue to deteriorate with age, resulting in unacceptable maintenance and repair and utility costs, and extreme inconvenience to the occupants.

ALTERNATIVE 2: IMPROVEMENT

Improvement will include the renovation of all 64 existing Family Housing units, maintaining the current rank/bedroom composition, in order to alleviate the severe space problems in the kitchen, bathrooms and dining areas. The interior finishes will be upgraded, and adequate lighting provided. Support facilities, such as utility systems, patios, walks, parking, privacy fences and landscaping will be upgraded or replaced. Construction will be accomplished in three phases over a 12 month period. For purposes of this analysis, current residents would move to temporary off base housing in 1995, and return approximately four months later upon completion of the work.

E X E C U T I V E S U M M A R Y R E P O R T PAGE 002

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS (cont.):

ALTERNATIVE 3: REPLACEMENT

The Replacement alternative will have the same functional features as the Improvement alternative and will maintain the current rank/bedroom composition. The current 64 units would be demolished and 64 new units would be constructed on the same site. These new units will meet or exceed all of the current standards for energy efficiency. Construction phasing will be the same as for the Improvement alternative. For purposes of this analysis, current residents would move to temporary off base housing in 1995 and return approximately four months later upon completion of the work.

ALTERNATIVE 4: DIRECT COMPENSATION

This alternative involves demolishing the existing housing, moving all 64 families off base, and paying BAQ/VHA for the entire period of analysis. Direct compensation is not a feasible alternative as a result of a 1992 Housing Market Analysis, which concluded that there is a deficit of adequate housing in the community to meet Air Force needs.

ASSUMPTIONS OF THE ANALYSIS:

1. All values are in 1995 constant dollars.

2. This base will retain the mission to house its current compliment of military families for the period of this analysis.

3. Energy adjustments are based on "DRI Energy Inflation Indices". Other cost adjustments are based on "USAF Raw Inflation Indices" (FMABB).

4. Discount Rate is 4.5% (FMABB).

5. The economic life of improved housing is 25 years and 40 years for new housing.

6. Residual value will be calculated using Straight Line Depreciation.

7. Improvement or Replacement will be completed in three phases over a twelve month period. Annual M&R costs and all utility costs are estimated at 70% of Status Quo annual costs during the construction year (App C-1).

8. Each family will make two moves during the construction period, once to vacate the housing units to permit construction, and another upon completion of construction to re-occupy them (App C-2).

9. Annual Maintenance and Repair costs will initially be reduced by 15% for the Improvement alternative, and 20% for the Replacement alternative compared to Status Quo costs (App C-1). Annual M&R costs will then increase 10% every fifth year for 25 years.

E X E C U T I V E S U M M A R Y R E P O R T PAGE 003

ASSUMPTIONS OF THE ANALYSIS (cont.):

10. Status Quo energy consumption will be comparable to 1990-1992 energy consumption data, with costs adjusted for inflation (App C-1).

11. Electricity costs will be reduced by 35% for the Improvement alternative, and 40% for the Replacement alternative compared to Status Quo costs (App C-1).

12. Natural Gas costs will be reduced by 30% for the Improvement alternative, and 35% for the Replacement alternative compared to Status Quo costs (App C-1).

13. Non-Energy Consuming Utilities will remain constant for all alternatives (App C-1).

14. Moving costs are computed at maximum weight allowance for each grade (App C-2).

15. BAQ/VHA costs are estimated at full BAQ with dependents rate (App C-3).

RESULTS AND RECOMMENDATIONS:

ALTERNATIVE NAME	NPV	EUAC
1 Status Quo	$2,603,863	$168,167
2 Improvement	$7,236,088	$467,336
3 Replacement	$7,509,491	$484,993
4 Direct Compensation	$0	$0

NON-MONETARY BENEFITS:

ALTERNATIVE NAME	BENEFIT SCORE	COST/BENEFIT RATIO
1 Status Quo	2.70	964,394
2 Improvement	5.70	1,269,489
3 Replacement	7.95	944,590
4 Direct Compensation	N/A	N/A

E X E C U T I V E S U M M A R Y R E P O R T PAGE 004

DISCUSSION:

SCOPE SENSITIVITY ANALYSIS:

A scope sensitivity analysis has been conducted for the Improvement and Replacement alternatives reflecting changes of plus and minus 25% of the proposed project scope. The results indicate that if the scope of the Improvement alternative (the initially least cost alternative) increases by 25 percent, the ranking of the alternatives will not reverse unless the scope of the Replacement alternative (the initially higher cost alternative) increases by less than 18.70 percent. Conversely, if the scope of the Improvement alternative decreases by 25 percent, the ranking of the alternatives will not reverse unless the scope of the Replacement alternative decreases by more than 25.37 percent. Therefore, within the range of this analysis, the ranking of alternatives remains unchanged.

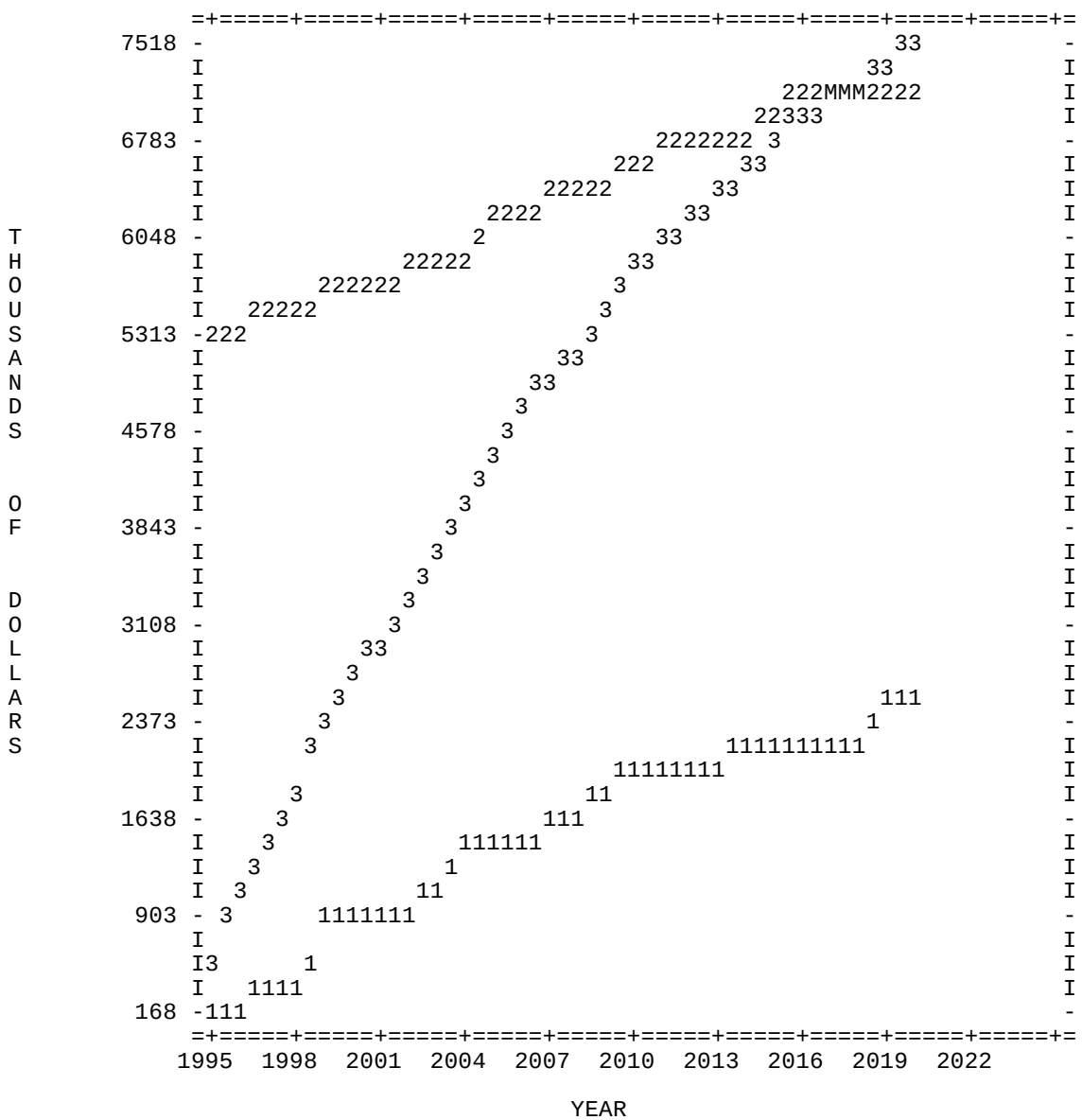
CONCLUSION:

The Status Quo alternative is the least costly alternative, yielding an NPV of $2.6 million, compared with $7.2 million for the Improvement alternative and $7.5 million for the Replacement alternative. The Status Quo alternative is unacceptable, however, because it does not repair the deteriorating structures and would force Air Force personnel to continue to live in inadequate housing. Furthermore, the benefits analysis shows that the Replacement alternative would yield the greatest benefit to Air Force personnel. An evaluation of costs and benefits together by means of the cost/benefit ratio also indicates that the Replacement alternative is the most cost effective alternative. The improvement/replacement initial cost ratio is 83.0% and there is no prevailing justification to retain the existing units. The sensitivity analysis conducted on the discount rate shows that the ranking of the alternatives will change if the discount rate goes below 3.20%. The sensitivity analysis conducted on plus and minus 25% of project scope shows no impact on the relative rankings of the alternatives. The Direct Compensation alternative is not feasible because a 1992 Housing Market Analysis concluded that there is a deficit of adequate housing for Air Force personnel off base. Therefore, it is recommended that the Replacement alternative be approved.

ACTION OFFICER: Maj. A. B. Smith, (123) 456-7890
ORGANIZATION : FM, Any Air Force Base

E C O N O M I C A N A L Y S I S G R A P H 1

CUMULATIVE NET PRESENT VALUE



LEGEND	DESCRIPTION
1	Status Quo
2	Improvement
3	Replacement
M	MERGING DATA

Section 2

LIFE CYCLE COST REPORT

L I F E C Y C L E C O S T R E P O R T PAGE 001

ALTERNATIVE 1: Status Quo

YEAR	PERIODIC M & R (01)	ANNUAL M & R (02)	ELECTRICITY (03)	NATURAL GAS (04)	NON-ENERGY UTILITIES (05)
1995	$98,338	$24,192	$23,296	$11,200	$15,360
1996	$0	$24,192	$23,296	$11,200	$15,360
1997	$0	$24,192	$23,296	$11,200	$15,360
1998	$0	$24,192	$23,296	$11,200	$15,360
1999	$480,772	$24,192	$23,296	$11,200	$15,360
2000	$0	$24,192	$23,296	$11,200	$15,360
2001	$0	$24,192	$23,296	$11,200	$15,360
2002	$0	$24,192	$23,296	$11,200	$15,360
2003	$98,338	$24,192	$23,296	$11,200	$15,360
2004	$348,167	$24,192	$23,296	$11,200	$15,360
2005	$0	$24,192	$23,296	$11,200	$15,360
2006	$0	$24,192	$23,296	$11,200	$15,360
2007	$98,338	$24,192	$23,296	$11,200	$15,360
2008	$0	$24,192	$23,296	$11,200	$15,360
2009	$461,544	$24,192	$23,296	$11,200	$15,360
2010	$0	$24,192	$23,296	$11,200	$15,360
2011	$98,338	$24,192	$23,296	$11,200	$15,360
2012	$0	$24,192	$23,296	$11,200	$15,360
2013	$0	$24,192	$23,296	$11,200	$15,360
2014	$0	$24,192	$23,296	$11,200	$15,360
2015	$98,338	$24,192	$23,296	$11,200	$15,360
2016	$0	$24,192	$23,296	$11,200	$15,360
2017	$0	$24,192	$23,296	$11,200	$15,360
2018	$0	$24,192	$23,296	$11,200	$15,360
2019	$828,939	$24,192	$23,296	$11,200	$15,360
2020	$0	$24,192	$23,296	$11,200	$15,360
%NPV	55.97	14.39	13.85	6.66	9.13
	$1,457,332	$374,583	$360,705	$173,414	$237,829
DISCOUNTING CONVENTION	M-O-Y	M-O-Y	M-O-Y	M-O-Y	M-O-Y

L I F E C Y C L E C O S T R E P O R T PAGE 002

ALTERNATIVE 1: Status Quo

YEAR	TOTAL ANNUAL OUTLAYS	MIDDLE OF YEAR DISCOUNT FACTORS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
1995	$172,386	0.978	$168,633	$168,633
1996	$74,048	0.936	$69,317	$237,950
1997	$74,048	0.896	$66,331	$304,281
1998	$74,048	0.857	$63,476	$367,757
1999	$554,820	0.820	$455,123	$822,880
2000	$74,048	0.785	$58,126	$881,006
2001	$74,048	0.751	$55,623	$936,629
2002	$74,048	0.719	$53,228	$989,857
2003	$172,386	0.688	$118,581	$1,108,438
2004	$422,215	0.658	$277,926	$1,386,364
2005	$74,048	0.630	$46,643	$1,433,007
2006	$74,048	0.603	$44,635	$1,477,642
2007	$172,386	0.577	$99,437	$1,577,079
2008	$74,048	0.552	$40,874	$1,617,953
2009	$535,592	0.528	$282,909	$1,900,862
2010	$74,048	0.505	$37,428	$1,938,290
2011	$172,386	0.484	$83,385	$2,021,675
2012	$74,048	0.463	$34,275	$2,055,950
2013	$74,048	0.443	$32,800	$2,088,750
2014	$74,048	0.424	$31,386	$2,120,136
2015	$172,386	0.406	$69,923	$2,190,059
2016	$74,048	0.388	$28,741	$2,218,800
2017	$74,048	0.371	$27,504	$2,246,304
2018	$74,048	0.355	$26,320	$2,272,624
2019	$902,987	0.340	$307,138	$2,579,762
2020	$74,048	0.325	$24,101	$2,603,863

EQUIVALENT UNIFORM ANNUAL COST = $168,167 (4.50% DISCOUNT RATE, 26 YEARS)

L I F E C Y C L E C O S T R E P O R T PAGE 003

ALTERNATIVE 2: Improvement

YEAR	PERIODIC M & R (01)	ANNUAL M & R (02)	ELECTRICITY (03)	NATURAL GAS (04)	NON-ENERGY UTILITIES (05)
1995	$0	$14,394	$13,082	$6,765	$10,752
1996	$0	$20,563	$18,688	$9,664	$15,360
1997	$0	$20,563	$18,688	$9,664	$15,360
1998	$0	$20,563	$18,688	$9,664	$15,360
1999	$98,338	$20,563	$18,688	$9,664	$15,360
2000	$0	$20,563	$18,688	$9,664	$15,360
2001	$0	$22,619	$18,688	$9,664	$15,360
2002	$0	$22,619	$18,688	$9,664	$15,360
2003	$98,338	$22,619	$18,688	$9,664	$15,360
2004	$0	$22,619	$18,688	$9,664	$15,360
2005	$382,434	$22,619	$18,688	$9,664	$15,360
2006	$0	$24,881	$18,688	$9,664	$15,360
2007	$98,338	$24,881	$18,688	$9,664	$15,360
2008	$0	$24,881	$18,688	$9,664	$15,360
2009	$0	$24,881	$18,688	$9,664	$15,360
2010	$348,167	$24,881	$18,688	$9,664	$15,360
2011	$98,338	$27,369	$18,688	$9,664	$15,360
2012	$0	$27,369	$18,688	$9,664	$15,360
2013	$0	$27,369	$18,688	$9,664	$15,360
2014	$0	$27,369	$18,688	$9,664	$15,360
2015	$480,772	$27,369	$18,688	$9,664	$15,360
2016	$0	$30,106	$18,688	$9,664	$15,360
2017	$0	$30,106	$18,688	$9,664	$15,360
2018	$0	$30,106	$18,688	$9,664	$15,360
2019	$98,338	$30,106	$18,688	$9,664	$15,360
2020	$79,110	$30,106	$18,688	$9,664	$15,360
%NPV	12.77	5.02	3.92	2.03	3.22
	$923,697	$363,477	$283,874	$146,798	$233,321
DISCOUNTING CONVENTION	M-O-Y	M-O-Y	M-O-Y	M-O-Y	M-O-Y

L I F E C Y C L E C O S T R E P O R T PAGE 004

ALTERNATIVE 2: Improvement

YEAR	RECONNECTION CHARGES (06)	MOVING COSTS (07)	BAQ/VHA (08)	IMPROVEMENT COST (09)	TOTAL ANNUAL OUTLAYS
1995	$7,552	$155,138	$128,832	$5,111,000	$5,447,515
1996	$0	$0	$0	$0	$64,275
1997	$0	$0	$0	$0	$64,275
1998	$0	$0	$0	$0	$64,275
1999	$0	$0	$0	$0	$162,613
2000	$0	$0	$0	$0	$64,275
2001	$0	$0	$0	$0	$66,331
2002	$0	$0	$0	$0	$66,331
2003	$0	$0	$0	$0	$164,669
2004	$0	$0	$0	$0	$66,331
2005	$0	$0	$0	$0	$448,765
2006	$0	$0	$0	$0	$68,593
2007	$0	$0	$0	$0	$166,931
2008	$0	$0	$0	$0	$68,593
2009	$0	$0	$0	$0	$68,593
2010	$0	$0	$0	$0	$416,760
2011	$0	$0	$0	$0	$169,419
2012	$0	$0	$0	$0	$71,081
2013	$0	$0	$0	$0	$71,081
2014	$0	$0	$0	$0	$71,081
2015	$0	$0	$0	$0	$551,853
2016	$0	$0	$0	$0	$73,818
2017	$0	$0	$0	$0	$73,818
2018	$0	$0	$0	$0	$73,818
2019	$0	$0	$0	$0	$172,156
2020	$0	$0	$0	$0	$152,928
%NPV	0.10	2.10	1.74	69.09	
	$7,388	$151,761	$126,028	$4,999,744	
DISCOUNTING CONVENTION	M-O-Y	M-O-Y	M-O-Y	M-O-Y	

L I F E C Y C L E C O S T R E P O R T PAGE 005

ALTERNATIVE 2: Improvement

YEAR	MIDDLE OF YEAR DISCOUNT FACTORS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
1995	0.978	$5,328,935	$5,328,935
1996	0.936	$60,169	$5,389,104
1997	0.896	$57,577	$5,446,681
1998	0.857	$55,098	$5,501,779
1999	0.820	$133,392	$5,635,171
2000	0.785	$50,455	$5,685,626
2001	0.751	$49,826	$5,735,452
2002	0.719	$47,681	$5,783,133
2003	0.688	$113,273	$5,896,406
2004	0.658	$43,662	$5,940,068
2005	0.630	$282,681	$6,222,749
2006	0.603	$41,347	$6,264,096
2007	0.577	$96,290	$6,360,386
2008	0.552	$37,863	$6,398,249
2009	0.528	$36,232	$6,434,481
2010	0.505	$210,661	$6,645,142
2011	0.484	$81,950	$6,727,092
2012	0.463	$32,901	$6,759,993
2013	0.443	$31,486	$6,791,479
2014	0.424	$30,129	$6,821,608
2015	0.406	$223,840	$7,045,448
2016	0.388	$28,653	$7,074,101
2017	0.371	$27,418	$7,101,519
2018	0.355	$26,238	$7,127,757
2019	0.340	$58,555	$7,186,312
2020	0.325	$49,776	$7,236,088

EQUIVALENT UNIFORM ANNUAL COST = $467,336 (4.50% DISCOUNT RATE, 26 YEARS)

L I F E C Y C L E C O S T R E P O R T PAGE 006

ALTERNATIVE 3: Replacement

YEAR	PERIODIC M & R (01)	ANNUAL M & R (02)	ELECTRICITY (03)	NATURAL GAS (04)	NON-ENERGY UTILITIES (05)
1995	$0	$13,548	$12,096	$6,317	$10,752
1996	$0	$19,354	$17,280	$9,024	$15,360
1997	$0	$19,354	$17,280	$9,024	$15,360
1998	$0	$19,354	$17,280	$9,024	$15,360
1999	$98,338	$19,354	$17,280	$9,024	$15,360
2000	$0	$19,354	$17,280	$9,024	$15,360
2001	$0	$21,289	$17,280	$9,024	$15,360
2002	$0	$21,289	$17,280	$9,024	$15,360
2003	$98,338	$21,289	$17,280	$9,024	$15,360
2004	$0	$21,289	$17,280	$9,024	$15,360
2005	$382,434	$21,289	$17,280	$9,024	$15,360
2006	$0	$23,418	$17,280	$9,024	$15,360
2007	$98,338	$23,418	$17,280	$9,024	$15,360
2008	$0	$23,418	$17,280	$9,024	$15,360
2009	$0	$23,418	$17,280	$9,024	$15,360
2010	$348,167	$23,418	$17,280	$9,024	$15,360
2011	$98,338	$25,760	$17,280	$9,024	$15,360
2012	$0	$25,760	$17,280	$9,024	$15,360
2013	$0	$25,760	$17,280	$9,024	$15,360
2014	$0	$25,760	$17,280	$9,024	$15,360
2015	$480,772	$25,760	$17,280	$9,024	$15,360
2016	$0	$28,336	$17,280	$9,024	$15,360
2017	$0	$28,336	$17,280	$9,024	$15,360
2018	$0	$28,336	$17,280	$9,024	$15,360
2019	$98,338	$28,336	$17,280	$9,024	$15,360
2020	$79,110	$28,336	$17,280	$9,024	$15,360
%NPV	12.30	4.56	3.50	1.83	3.11
	$923,697	$342,106	$262,487	$137,075	$233,321
DISCOUNTING CONVENTION	M-O-Y	M-O-Y	M-O-Y	M-O-Y	M-O-Y

L I F E C Y C L E C O S T R E P O R T PAGE 007

ALTERNATIVE 3: Replacement

YEAR	RECONNECTION CHARGES (06)	MOVING COST (07)	BAQ/VHA (08)	REPLACEMENT COST (09)	TOTAL ANNUAL OUTLAYS
1995	$7,552	$155,138	$128,832	$6,160,000	$6,494,235
1996	$0	$0	$0	$0	$61,018
1997	$0	$0	$0	$0	$61,018
1998	$0	$0	$0	$0	$61,018
1999	$0	$0	$0	$0	$159,356
2000	$0	$0	$0	$0	$61,018
2001	$0	$0	$0	$0	$62,953
2002	$0	$0	$0	$0	$62,953
2003	$0	$0	$0	$0	$161,291
2004	$0	$0	$0	$0	$62,953
2005	$0	$0	$0	$0	$445,387
2006	$0	$0	$0	$0	$65,082
2007	$0	$0	$0	$0	$163,420
2008	$0	$0	$0	$0	$65,082
2009	$0	$0	$0	$0	$65,082
2010	$0	$0	$0	$0	$413,249
2011	$0	$0	$0	$0	$165,762
2012	$0	$0	$0	$0	$67,424
2013	$0	$0	$0	$0	$67,424
2014	$0	$0	$0	$0	$67,424
2015	$0	$0	$0	$0	$548,196
2016	$0	$0	$0	$0	$70,000
2017	$0	$0	$0	$0	$70,000
2018	$0	$0	$0	$0	$70,000
2019	$0	$0	$0	$0	$168,338
2020	$0	$0	$0	$0	$149,110
%NPV	0.10	2.02	1.68	80.24	
	$7,388	$151,761	$126,028	$6,025,909	
DISCOUNTING CONVENTION	M-O-Y	M-O-Y	M-O-Y	M-O-Y	

L I F E C Y C L E C O S T R E P O R T PAGE 008

ALTERNATIVE 3: Replacement

YEAR	MIDDLE OF YEAR DISCOUNT FACTORS	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1995	0.978	$6,352,869	$6,352,869	$5,733,357	$619,512
1996	0.936	$57,119	$6,409,988	$5,347,568	$1,062,420
1997	0.896	$54,659	$6,464,647	$4,984,373	$1,480,274
1998	0.857	$52,307	$6,516,954	$4,642,542	$1,874,412
1999	0.820	$130,720	$6,647,674	$4,320,909	$2,326,765
2000	0.785	$47,899	$6,695,573	$4,018,366	$2,677,207
2001	0.751	$47,289	$6,742,862	$3,733,868	$3,008,994
2002	0.719	$45,252	$6,788,114	$3,466,420	$3,321,694
2003	0.688	$110,949	$6,899,063	$3,215,082	$3,683,981
2004	0.658	$41,440	$6,940,503	$2,978,963	$3,961,540
2005	0.630	$280,553	$7,221,056	$2,757,217	$4,463,839
2006	0.603	$39,231	$7,260,287	$2,549,045	$4,711,242
2007	0.577	$94,265	$7,354,552	$2,353,689	$5,000,863
2008	0.552	$35,924	$7,390,476	$2,170,431	$5,220,045
2009	0.528	$34,378	$7,424,854	$1,998,591	$5,426,263
2010	0.505	$208,886	$7,633,740	$1,837,526	$5,796,214
2011	0.484	$80,180	$7,713,920	$1,686,627	$6,027,293
2012	0.463	$31,210	$7,745,130	$1,545,317	$6,199,813
2013	0.443	$29,865	$7,774,995	$1,413,049	$6,361,946
2014	0.424	$28,579	$7,803,574	$1,289,307	$6,514,267
2015	0.406	$222,357	$8,025,931	$1,173,602	$6,852,329
2016	0.388	$27,171	$8,053,102	$1,065,471	$6,987,631
2017	0.371	$26,000	$8,079,102	$964,476	$7,114,626
2018	0.355	$24,881	$8,103,983	$870,204	$7,233,779
2019	0.340	$57,257	$8,161,240	$782,263	$7,378,977
2020	0.325	$48,532	$8,209,772	$700,281	$7,509,491
%NPV				-9.33	
				$700,281	
DISCOUNTING CONVENTION				M-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $484,993 (4.50% DISCOUNT RATE, 26 YEARS)

L I F E C Y C L E C O S T R E P O R T PAGE 009

ALTERNATIVE 4: Direct Compensation

YEAR	TOTAL ANNUAL OUTLAYS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
1995	$0	$0	$0
1996	$0	$0	$0
1997	$0	$0	$0
1998	$0	$0	$0
1999	$0	$0	$0
2000	$0	$0	$0
2001	$0	$0	$0
2002	$0	$0	$0
2003	$0	$0	$0
2004	$0	$0	$0
2005	$0	$0	$0
2006	$0	$0	$0
2007	$0	$0	$0
2008	$0	$0	$0
2009	$0	$0	$0
2010	$0	$0	$0
2011	$0	$0	$0
2012	$0	$0	$0
2013	$0	$0	$0
2014	$0	$0	$0
2015	$0	$0	$0
2016	$0	$0	$0
2017	$0	$0	$0
2018	$0	$0	$0
2019	$0	$0	$0
2020	$0	$0	$0

EQUIVALENT UNIFORM ANNUAL COST = $0 (4.50% DISCOUNT RATE, 26 YEARS)

SOURCE AND DERIVATION OF COSTS AND BENEFITS:

1. Periodic Maintenance and Repair: Status Quo Periodic M&R expenses and schedule are based on values reported in CES Source Document dated 30 Oct 92 (App C-1). These are rescheduled beginning in 1995 for the Improvement and Replacement alternatives.

2. Annual Maintenance and Repair: Status Quo Annual M&R expenses are based on values reported in CES Source Document dated 30 Oct 92 (App C-1). Initially, Recurring M&R costs are reduced by 15% for the Improvement alternative, and 20% for the Replacement alternative. They are then increased 10% every fifth for 25 years (Asmp 9).

3. Electricity: Status Quo Electricity expenses are based on values reported in CES Source Document dated 30 Oct 92 (App C-1). They are reduced by 35% for the Improvement alternative, and 40% for the Replacement alternative (Asmp 11).

4. Natural Gas: Status Quo Natural Gas expenses are based on values reported in CES Source Document dated 30 Oct 92 (App C-1). They are reduced by 30% for the Improvement alternative, and 35% for the Replacement alternative (Asmp 12).

5. Non-Energy Utilities: The costs for Non-Energy Consuming Utilities are based on values reported in CES Source Document dated 30 Oct 92 (App C-1). They will remain constant for all alternatives (Asmp 13).

6. Reconnection Charges: The cost to reconnect various services and utilities for families are based on values reported in CES Source Document dated 30 Oct 92 (App C-1).

7. Moving Costs: The cost to move each family is based on values reported in the Transportation Source Document dated 25 Oct 92 (App C-2). Moving costs are estimated at maximum weight allowances for each grade (Asmp 14).

8. BAQ/VHA: BAQ/VHA costs are based on values reported in FM Source Document dated 26 Oct 92 (App C-3). BAQ costs are estimated at full BAQ with dependents rate (Asmp 15).

9. Improvement Cost: The construction cost estimate for the Improvement alternative is based on the DD Form 1391 dated 15 Aug 92 and attached Tri-Service Automated Cost Engineering System (TRACES) Report (App A).

10. Replacement Cost: The construction cost estimate for the Replacement alternative is based on the DD Form 1391 dated 15 Aug 92 and attached Tri-Service Cost Model Report (App B).

11. Residual Value Start: Residual value for the Replacement alternative will be computed using Straight Line Depreciation conventions (Asmp 6). Investment Start Value is calculated as the total construction cost less total demolition costs (demolition + contingency + SIOH) from the DD Form 1391 dated 15 Aug 92 (App B).

SOURCE AND DERIVATION OF COSTS AND BENEFITS (cont.):

12. Inflation Indices: Adjustments for inflation are based on the "USAF Raw Inflation Indices," and "DRI Energy Indices" (FMABB) (Asmp 3).

13. Project Phasing: 1995 expenses were adjusted to account for the four month non-availability of each housing unit during the construction phase (Asmp 7). For constant use items, such as electricity and BAQ, they are prorated at 70% of the Status Quo annual costs. For one-time cost items, such as moving costs and reconnection fees, they are charged twice. They are counted once prior to construction to allow for vacating the housing units, and once upon completion of construction to account for movement back into the housing units (Asmp 8).

Section 3

BENEFITS ANALYSIS

SOURCE AND DERIVATION OF COSTS AND BENEFITS (cont.):

BENEFITS ANALYSIS:

An important consideration in determining which alternative to choose is an evaluation of the benefits each alternative will yield. The best alternative should be considered on the basis of a cost/benefit analysis. Intangibles include those factors which are neither monetary nor otherwise quantifiable. Intangibles are generally difficult to deal with in an economic analysis because they lack a common frame of reference from which they can objectively be compared. To resolve this difficulty, a measurement system has been developed to evaluate the benefits of each alternative.

1. Security/Safety: This benefit is a measure of how well the alternative provides for the security and safety needs of our service members. The Improvement and Replacement alternatives were rated superior over the Status Quo alternative since the improvements to the units will provide a newer safer living environment.

2. Morale/Retention: This benefit is a measure of the morale and retention factors. It takes into account both the esprit de corps that develops when service members live in close proximity and the resulting unit cohesiveness. The Improvement alternative will provide a slightly above average renovated living area. The Replacement alternative was rated as being the superior option since new homes would be constructed.

3. Efficiency/Comfort: This benefit measures the level of energy efficiency of the housing units and their impact on the living patterns of occupants. It takes into account the differences between new construction and renewal of existing units. The Replacement alternative was rated higher than the Improvement alternative as construction material and new construction techniques will provide superior energy efficiency, and hence a more comfortable environment with less cost. The rating for the Status Quo alternative is based on inferior windows, exterior doors and energy inefficient appliances which make it very expensive for the service members to live comfortably.

4. Privacy: This benefit measures the worth placed on a family's privacy. The Status Quo alternative was rated below-average due to a general lack of sound insulation. The Improvement alternative would alleviate some of the privacy problems, and so received an average rating. The Replacement alternative received a superior rating because the new insulated walls would absorb more noise. The double pane windows will also contribute to a quieter and more private home atmosphere.

L I F E C Y C L E C O S T R E P O R T PAGE 013

SOURCE AND DERIVATION OF COSTS AND BENEFITS (cont.):

BENEFITS ANALYSIS (cont.):

BENEFITS ANALYSIS TABLE

BENEFITS		ALTERNATIVES		
	Weight Points	1 Status Quo	2 Improve-ment	3 Replace-ment
1. Security/Safety	3.0	50%(1.50)	80%(2.40)	100%(3.00)
2. Morale/Retention	2.5	20%(0.50)	60%(1.50)	90%(2.25)
3. Efficiency/Comfort	2.0	20%(0.40)	60%(1.20)	90%(1.80)
4. Privacy	1.0	30%(0.30)	60%(0.60)	90%(0.90)
TOTAL BENEFIT SCORE		2.70	5.70	7.95

Each benefit category was assigned a weighted value from 1 to 3, with a larger value given to the more important benefits.

Scores were based on how well each alternative met each benefit criterion discussed above. Alternatives that did not meet the criteria were given a score of zero percent. Alternatives that provided an optimum solution were given a score of 100%. Other alternatives were given a relative score in between.

Section 4

SCOPE SENSITIVITY ANALYSIS

C O S T S E N S I T I V I T Y A N A L Y S I S PAGE 001

COST SENSITIVITY ANALYSIS NUMBER 01
TITLE ..... TEST +/- 25% CHANGE IN PROJECT SCOPE
ALLOWABLE CHANGE ..... 25.00 PERCENT

This sensitivity analysis checks for alternative 3 to be ranked least cost as a result of changes in the expense item(s) listed below:

ALTERNATIVE	EXPENSE ITEM(S)
2 - Improvement	1 - PERIODIC M & R
	2 - ANNUAL M & R
	3 - ELECTRICITY
	4 - NATURAL GAS
	5 - NON-ENERGY UTILITIES
	6 - RECONNECTIONCHARGES
	7 - MOVING COSTS
	8 - BAQ/VHA
	9 - IMPROVEMENT COST
3 - Replacement	1 - PERIODIC M & R
	2 - ANNUAL M & R
	3 - ELECTRICITY
	4 - NATURAL GAS
	5 - NON-ENERGY UTILITIES
	6 - RECONNECTIONCHARGES
	7 - MOVING COST
	8 - BAQ/VHA
	9 - REPLACEMENT COST

The selected expense items are allowed to vary from a value of 100% less than their input value to 25.00% more than their input value.

ALTERNATIVE	NET PRESENT VALUE
2 - Improvement	$7,236,088
3 - Replacement	$7,509,491

C O S T S E N S I T I V I T Y A N A L Y S I S PAGE 002

TABLE OF PERCENT CHANGES WHERE ALTERNATIVES' NPVs ARE EQUAL

% CHANGE OF SELECTED EXPENSE ITEMS FOR Improvement (INITIALLY LEAST COST)	% CHANGE OF SELECTED EXPENSE ITEMS FOR Replacement (INITIALLY HIGHER COST)	NET PRESENT VALUE
-100.00	-91.47	$0
-97.00	-88.83	$217,083
-94.00	-86.18	$434,165
-91.00	-83.54	$651,248
-88.00	-80.89	$868,331
-85.00	-78.25	$1,085,413
-82.00	-75.60	$1,302,496
-79.00	-72.96	$1,519,578
-76.00	-70.32	$1,736,661
-73.00	-67.67	$1,953,744
-70.00	-65.03	$2,170,826
-67.00	-62.38	$2,387,909
-64.00	-59.74	$2,604,992
-61.00	-57.10	$2,822,074
-58.00	-54.45	$3,039,157
-55.00	-51.81	$3,256,240
-52.00	-49.16	$3,473,322
-49.00	-46.52	$3,690,405
-46.00	-43.87	$3,907,488
-43.00	-41.23	$4,124,570
-40.00	-38.59	$4,341,653
-37.00	-35.94	$4,558,735
-34.00	-33.30	$4,775,818
-31.00	-30.65	$4,992,901
-28.00	-28.01	$5,209,983
-25.00	-25.37	$5,427,066
-22.00	-22.72	$5,644,149
-19.00	-20.08	$5,861,231
-16.00	-17.43	$6,078,314
-13.00	-14.79	$6,295,397
-10.00	-12.14	$6,512,479
-7.00	-9.50	$6,729,562
-4.00	-6.86	$6,946,644
-1.00	-4.21	$7,163,727
2.00	-1.57	$7,380,810
5.00	1.08	$7,597,892
8.00	3.72	$7,814,975
11.00	6.37	$8,032,058
14.00	9.01	$8,249,140
17.00	11.65	$8,466,223
20.00	14.30	$8,683,306
23.00	16.94	$8,900,388
25.00	18.70	$9,045,110

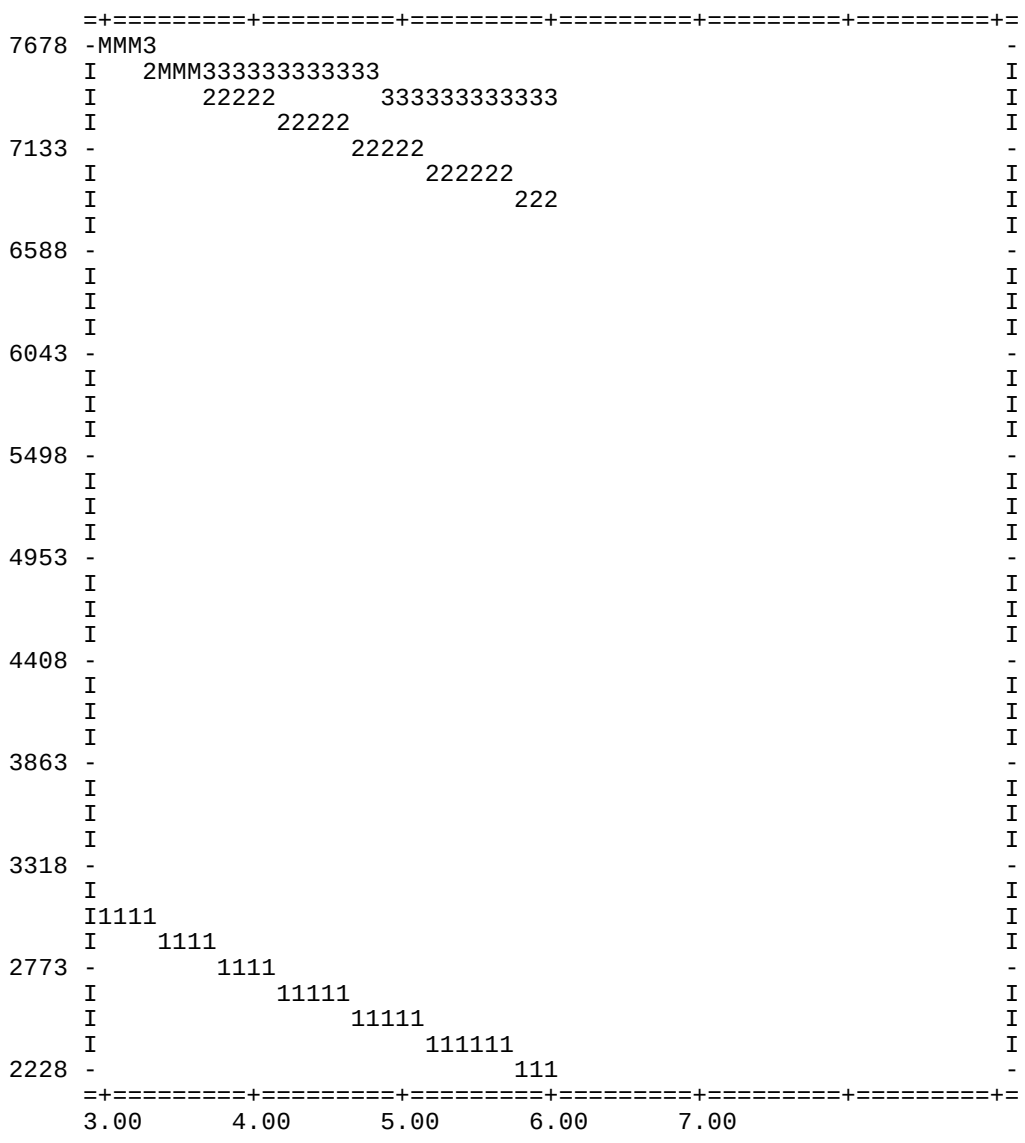
EXPLANATION OF TABLE USE: FOR ANY NUMBER IN THE FIRST COLUMN, RANKING REVERSAL WILL OCCUR IF THE CHANGE IN EXPENSE ITEM(S) FOR THE OTHER ALTERNATIVE FALLS IN THE RANGE OF -100% TO THE CORRESPONDING NUMBER IN THE SECOND COLUMN. FOR EXAMPLE: FOR A CHANGE OF -37.00% IN THE SELECTED EXPENSE ITEMS OF ALTERNATIVE 2, ANY % CHANGE IN THE SELECTED EXPENSE ITEMS OF ALTERNATIVE 3 IN THE RANGE OF -100% TO -35.94% WILL RESULT IN ALTERNATIVE 3 HAVING A NPV LESS THAN THAT OF ALTERNATIVE 2.

Section 5

DISCOUNT RATE SENSITIVITY ANALYSIS

D I S C O U N T R A T E S E N S I T I V I T Y A N A L Y S I S 1 PAGE 001

Graph of Net Present Value ($ in thousands) vs. Discount Rate



LEGEND	DESCRIPTION
1	Status Quo
2	Improvement
3	Replacement
M	MERGING DATA

D I S C O U N T R A T E S E N S I T I V I T Y A N A L Y S I S 1 PAGE 002

Summary of Alternative Rankings by Discount Rate

Discount Rate: 4.50 Lower Limit: 3.00 Upper Limit: 6.00

	Discount Rate (%)	Alternative Ranking				Discount Rate (%)	Alternative Ranking		
	3.00	1	3	2		4.60	1	2	3
	3.10	1	3	2		4.70	1	2	3
*	3.20	1	2	3		4.80	1	2	3
	3.30	1	2	3		4.90	1	2	3
	3.40	1	2	3		5.00	1	2	3
	3.50	1	2	3		5.10	1	2	3
	3.60	1	2	3		5.20	1	2	3
	3.70	1	2	3		5.30	1	2	3
	3.80	1	2	3		5.40	1	2	3
	3.90	1	2	3		5.50	1	2	3
	4.00	1	2	3		5.60	1	2	3
	4.10	1	2	3		5.70	1	2	3
	4.20	1	2	3		5.80	1	2	3
	4.30	1	2	3		5.90	1	2	3
	4.40	1	2	3		6.00	1	2	3
	4.50	1	2	3					

* indicates a change in the alternative ranking occurred.

D I S C O U N T R A T E S E N S I T I V I T Y A N A L Y S I S 1 PAGE 003

Table of Net Present Value for each Discount Rate

Discount Rate = 3.00%		Discount Rate = 3.10%		Discount Rate = 3.20%	
Alt	NPV	Alt	NPV	Alt	NPV
1	$3,085,107	1	$3,049,024	1	$3,013,565
3	$7,634,269	3	$7,626,658	2	$7,610,537
2	$7,675,158	2	$7,642,593	3	$7,618,922

Discount Rate = 3.30%		Discount Rate = 3.40%		Discount Rate = 3.50%	
Alt	NPV	Alt	NPV	Alt	NPV
1	$2,978,714	1	$2,944,460	1	$2,910,798
2	$7,578,979	2	$7,547,917	2	$7,517,333
3	$7,611,065	3	$7,603,087	3	$7,595,008

Discount Rate = 3.60%		Discount Rate = 3.70%		Discount Rate = 3.80%	
Alt	NPV	Alt	NPV	Alt	NPV
1	$2,877,709	1	$2,845,173	1	$2,813,200
2	$7,487,232	2	$7,457,582	2	$7,428,395
3	$7,586,832	3	$7,578,546	3	$7,570,178

Discount Rate = 3.90%		Discount Rate = 4.00%		Discount Rate = 4.10%	
Alt	NPV	Alt	NPV	Alt	NPV
1	$2,781,766	1	$2,750,858	1	$2,720,459
2	$7,399,648	2	$7,371,348	2	$7,343,466
3	$7,561,722	3	$7,553,188	3	$7,544,581

Discount Rate = 4.20%		Discount Rate = 4.30%		Discount Rate = 4.40%	
Alt	NPV	Alt	NPV	Alt	NPV
1	$2,690,578	1	$2,661,190	1	$2,632,288
2	$7,316,016	2	$7,288,971	2	$7,262,331
3	$7,535,907	3	$7,527,158	3	$7,518,352

D I S C O U N T R A T E S E N S I T I V I T Y A N A L Y S I S 1 PAGE 004

Table of Net Present Value for each Discount Rate

Discount Rate = 4.50%		Discount Rate = 4.60%		Discount Rate = 4.70%	
Alt	NPV	Alt	NPV	Alt	NPV
1	$2,603,863	1	$2,575,913	1	$2,548,407
2	$7,236,088	2	$7,210,240	2	$7,184,765
3	$7,509,491	3	$7,500,578	3	$7,491,614

Discount Rate = 4.80%		Discount Rate = 4.90%		Discount Rate = 5.00%	
Alt	NPV	Alt	NPV	Alt	NPV
1	$2,521,365	1	$2,494,756	1	$2,468,585
2	$7,159,674	2	$7,134,946	2	$7,110,579
3	$7,482,612	3	$7,473,565	3	$7,464,485

Discount Rate = 5.10%		Discount Rate = 5.20%		Discount Rate = 5.30%	
Alt	NPV	Alt	NPV	Alt	NPV
1	$2,442,838	1	$2,417,502	1	$2,392,560
2	$7,086,573	2	$7,062,910	2	$7,039,583
3	$7,455,372	3	$7,446,221	3	$7,437,046

Discount Rate = 5.40%		Discount Rate = 5.50%		Discount Rate = 5.60%	
Alt	NPV	Alt	NPV	Alt	NPV
1	$2,368,032	1	$2,343,894	1	$2,320,137
2	$7,016,593	2	$6,993,940	2	$6,971,598
3	$7,427,854	3	$7,418,633	3	$7,409,401

Discount Rate = 5.70%		Discount Rate = 5.80%		Discount Rate = 5.90%	
Alt	NPV	Alt	NPV	Alt	NPV
1	$2,296,748	1	$2,273,742	1	$2,251,087
2	$6,949,582	2	$6,927,870	2	$6,906,471
3	$7,400,150	3	$7,390,891	3	$7,381,625

D I S C O U N T R A T E S E N S I T I V I T Y A N A L Y S I S 1 PAGE 005

Table of Net Present Value for each Discount Rate

Discount Rate = 6.00%

Alt	NPV
1	$2,228,791
2	$6,885,366
3	$7,372,340

Section 6

APPENDICES

Appendix A

DD Form 1391-Improvement

1. COMPONENT AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA			2. DATE 15 AUG 92
3. INSTALLATION AND LOCATION ANY AIR FORCE BASE, ANY STATE		4. PROJECT TITLE IMPROVE CAPEHART HOUSING PHASE 1		
5. PROGRAM ELEMENT 8.87.42	6. CATEGORY CODE 711-111	7. PROJECT NUMBER ABCD 123456	8. PROJECT COST ($000) 5,111	

9. COST ESIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
IMPROVE CAPEHART HOUSING PHONE 1	UN	64	62,422	3,995
SUPPORTING FACILITIES	LS			731
ROADS & PAVING	LS			(244)
LANDSCAPING	LS			(83)
RECREATION	LS			(29)
FIRE PROTECTION				(375)
SUBTOTAL				4,726
CONTINGENCY (5%)				236
TOTAL CONTRACT COST				4,962
SUPERVISION, INSPECTION AND OVERHEAD (3%)				149
TOTAL REQUEST				5,111
MOST EXPENSIVE UNIT $99,824				
AREA COST FACTOR 0.96				

10. DESCRIPTION OF PROPOSED CONSTRUCTION Improve 64 Capehart units. Renovate and/or add to kitchens, bathrooms, bedrooms, and living areas. Construct patios, privacy fences, utility sheds, and pavements. Renovate/add interiors to include firewalls, doors lighting, electrical, plumbing, heating, floor and wall coverings. Repair roofs, foundations, and garages. Replace exterior doors and add air conditioning. Remove asbestos and lead paint. Install fire suppression sprinklers.
Air Conditioning: 2 Tons. Grade Mix: 44 E5-E6; 20 E7-E9

11. REQUIREMENT: 1,448 UN ADEQUATE: 152 UN SUBSTANDARD: 1,296 UN
PROJECT: Improve Capehart Housing Phase 1. (Current Mission).
REQUIREMENT: This project is required to provide modern and efficient housing for military members and their dependents stationed at ANY AFB, AS. Housing must be upgraded to meet current life safety codes and to provide safe, comfortable and appealing living environment comparable to the off-base civilian community. This is the first of multiple phases (of undetermined number) to upgrade 1,448 Capehart housing units. This project corresponds to part of the Housing Community Plan (HCP) designated as "Phase A."
CURRENT SITUATION: This project will upgrade housing which was constructed in 1959. All are in need of major repair and modernization to meet wholehouse guidelines and current housing standards. Kitchens have inadequate space with appliances and cabinets crowded together. Kitchen cabinets and countertops are worn and deteriorated beyond the point of reasonable repair. Bathrooms have inadequate space, and fixtures are antiquated and in need of replacement. Electrical systems do not comply with modern building standards. Insulation and energy conservation measures are below standards. Units lack modern interior and exterior appurtenances such as patios, weather vestibules, master bedroom baths, breakfast areas, and air conditioning which are common features in the local civilian community. Off-street parking is inadequate which causes snow removal problems. These units are structurally sound, and with the proposed improvements, will provide adequate housing for another 25 years without additional major investment.

1. COMPONENT		2. DATE
AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	15 AUG 92

3. INSTALLATION AND LOCATION
ANY AIR FORCE BASE, ANY STATE

4. PROJECT TITLE	5. PROJECT NUMBER
IMPROVE CAPEHART FAMILY HOUSING PHASE 1	ABCD 123456

IMPACT IF NOT PROVIDED : Air Force members and their families will continue to live in extremely outdated, substandard and unsatisfactory housing. The housing will continue to deteriorate with age, resulting in inconvenience to the occupants. Without this and subsequent phases of this initiative, repairs of these units will continue in a costly, piecemeal fashion with little or no improvement in living quality. The housing will increasingly become an embarrassment to the occupants as well as the United States Government. Low morale and retention problems can be expected if such conditions are permitted to continue.
WORK ACCOMPLISHED IN PREVIOUS THREE YEARS: None.
WORK PROGRAMMED FOR NEXT THREE YEARS: None.
ADDITIONAL: The replacement cost for these housing units is $6,160,000. The cost to complete this project is 83% of the replacement cost. This project meets the criteria/scope specified in Part II of Military Handbook 1190, "Facility Planning and Design Guide."

The estimates were performed using TRACES. TRACES uses a quantity method of parametric estimating. With a minimum of required information (size, building use, etc.), this method uses algorithms and default parameter information to establish quantities of materials, labor, and equipment and then links these quantities to a current price database (US Army Corps of Engineers Price Book 1992). The system also uses location modifiers, i.e., seismic, weather, and climate zones, to make the design and estimate site specific. TRACES estimates projects through the use of parameters - project requirement, characteristics, and conceptual design.

Algorithm and default parameter information was developed by preparing takeoffs for each building type on the quantity and material type used in typical military construction.

TRACES uses the mid-point of the construction project (e.g., June 1994 for a 12-month project starting in January 1994) to establish an average escalation. TRACES uses Office of Management and Budget (OMB) escalation tables for Air Force projects. The OMB escalation tables are generally identical to USAF Raw Inflation Indices. The baseline for escalation is based on the date of the pricing data (currently January 1994). Both pricing data and escalation tables are periodically updated.

As a default, TRACES projects the mid-point of construction as a function of a start date and a construction period. The user can instead override this default to enter a mid-point for escalation. For this estimate, a mid-point of April 1995 was selected and the estimate is in FY1995 project year dollars.

1. COMPONENT		2. DATE
AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	15 AUG 92

3. INSTALLATION AND LOCATION
ANY AIR FORCE BASE, ANY STATE

4. PROJECT TITLE	5. PROJECT NUMBER
IMROVE CAPEHART FAMILY HOUSING PHASE 1	ABCD 123456

Cost Report Summary

TRACES Parametric Building Models
Display System Costs

Project: IMPROVE CAPEHART FAMILY HOUSING PH2
Facility: Improve 3 Bedroom to 3 Bedroom Any Air Force Base JNCO
Model: RENOVATION 3 BEDROOM
NSF: 1,195 SF
GFA: 1,840 SF
No. of Units 34

	System	Cost	$GFA
01	SUBSTUCTURE	3,943	2.14
02	SUPERSTRUCTURE	755	.41
03	ROOFING	1,826	.99
04	EXTERIOR CLOSURE	13,781	7.49
05	INTERIOR CONSTRUCTION	10,988	5.97
06	INTERIOR FINISHES	7,385	4.01
07	SPECIALITIES	4,257	2.31
08	PLUMBING	4,162	2.26
09	H.V.A.C.	3,975	2.16
10	SPECIAL MECHANICAL SYSTEMS	0	.00
11	ELECTRICAL	4,560	2.48
12	SPECIAL ELECTRICAL SYSTEMS	442	.24
13	EQUIPMENT	950	.52
14	CONVEYING SYSTEMS	0	.00
	TOTAL	57,024	30.99
	COST ESCALATION TO 1995 = 3.7%	2,110	1.15
		59,134	32.14
	Supporting Facilities		
1	ROADS & PAVING	3,676	2.00
2	LANDSCAPING	1,251	.68
3	RECREATION	437	.24
4	FIRE PROTECTION	5,650	3.07
	TOTAL	11,014	5.99
	COST ESCALATION TO 1995=3.7%	408	.22
		11,422	6.21

1. COMPONENT		2. DATE
AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	15 AUG 92
3. INSTALLATION AND LOCATION		
ANY AIR FORCE BASE, ANY STATE		
4. PROJECT TITLE		**5. PROJECT NUMBER**
IMROVE CAPEHART FAMILY HOUSING PHASE 1		ABCD 123456

Cost Report Summary

TRACES Parametric Building Models
Display System Costs

Project: IMPROVE CAPEHART FAMILY HOUSING PH2
Facility: Improve 4 Bedroom to 4 Bedroom Any Air Force Base JNCO
Model: RENOVATION 4 BEDROOM
NSF: 1,348 SF
GFA: 2,026 SF
No. of Units 10

	System	Cost	$GFA
01	SUBSTUCTURE	4,403	2.17
02	SUPERSTRUCTURE	776	.38
03	ROOFING	1,982	.98
04	EXTERIOR CLOSURE	14,998	7.40
05	INTERIOR CONSTRUCTION	11,693	5.77
06	INTERIOR FINISHES	7,876	3.89
07	SPECIALITIES	4,737	2.34
08	PLUMBING	4,636	2.29
09	H.V.A.C.	4,493	2.22
10	SPECIAL MECHANICAL SYSTEM	0	.00
11	ELECTRICAL	4,830	2.38
12	SPECIAL ELECTRICAL SYSTEMS	487	.24
13	EQUIPMENT	950	.47
14	CONVEYING SYSTEMS	0	.00
	TOTAL	61,861	30.53
	COST ESCALATION TO 1995 = 3.7%	2,289	1.13
		64,150	31.66
	Supporting Facilities		
1	ROADS & PAVING	3,676	1.81
2	LANDSCAPING	1,251	.62
3	RECREATION	437	.22
4	FIRE PROTECTION	5,650	2.79
	TOTAL	11,014	5.44
	COST ESCALATION TO 1995=3.7%	408	.20
		11,422	5.64

1. COMPONENT		2. DATE
AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	15 AUG 92
3. INSTALLATION AND LOCATION		
ANY AIR FORCE BASE, ANY STATE		
4. PROJECT TITLE		5. PROJECT NUMBER
IMROVE CAPEHART FAMILY HOUSING PHASE 1		ABCD 123456

Cost Report Summary

TRACES Parametric Building Models
Display System Costs

Project: IMPROVE CAPEHART FAMILY HOUSING PH2
Facility: Improve 3 Bedroom to 3 Bedroom Any Air Force Base SNCO
Model: RENOVATION 3 BEDROOM
NSF: 1,345 SF
GFA: 2,110 SF
No. of Units 18

	System	Cost	$GFA
01	SUBSTUCTURE	4,619	2.19
02	SUPERSTRUCTURE	853	.40
03	ROOFING	2,046	.97
04	EXTERIOR CLOSURE	15,517	7.35
05	INTERIOR CONSTRUCTION	11,876	5.63
06	INTERIOR FINISHES	8,126	3.85
07	SPECIALITIES	5,225	2.48
08	PLUMBING	4,994	2.37
09	H.V.A.C.	4,724	2.24
10	SPECIAL MECHANICAL SYSTEM	0	.00
11	ELECTRICAL	4,992	2.33
12	SPECIAL ELECTRICAL SYSTEMS	509	.24
13	EQUIPMENT	950	.45
14	CONVEYING SYSTEMS	0	.00
	TOTAL	64,361	30.50
	COST ESCALATION TO 1995 = 3.7%	2,381	1.13
		66,742	31.63
	Supporting Facilities		
1	ROADS & PAVING	3,676	1.74
2	LANDSCAPING	1,251	.59
3	RECREATION	437	.21
4	FIRE PROTECTION	5,650	2.68
	TOTAL	11,014	5.22
	COST ESCALATION TO 1995=3.7%	408	.19
		11,422	5.41

1. COMPONENT		2. DATE
AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	15 AUG 92

3. INSTALLATION AND LOCATION
ANY AIR FORCE BASE, ANY STATE

4. PROJECT TITLE	5. PROJECT NUMBER
IMROVE CAPEHART FAMILY HOUSING PHASE 1	ABCD 123456

Cost Report Summary

TRACES Parametric Building Models
Display System Costs

Project: IMPROVE CAPEHART FAMILY HOUSING PH2
Facility: Improve 4 Bedroom to 4 Bedroom Any Air Force Base SNCO
Model: RENOVATION 4 BEDROOM
NSF: 1,448 SF
GFA: 2,250 SF
No. of Units 2

	System	Cost	$GFA
01	SUBSTUCTURE	4,925	2.19
02	SUPERSTRUCTURE	980	.44
03	ROOFING	2,167	.96
04	EXTERIOR CLOSURE	16,402	7.29
05	INTERIOR CONSTRUCTION	12,436	5.53
06	INTERIOR FINISHES	8,513	3.78
07	SPECIALITIES	5,798	2.58
08	PLUMBING	5,367	2.39
09	H.V.A.C.	5,084	2.26
10	SPECIAL MECHANICAL SYSTEM	0	.00
11	ELECTRICAL	5,104	2.27
12	SPECIAL ELECTRICAL SYSTEMS	542	.24
13	EQUIPMENT	950	.42
14	CONVEYING SYSTEMS	0	.00
	TOTAL	68,268	30.34
	COST ESCALATION TO 1995 = 3.7%	2,526	1.12
		70,794	31.46
	Supporting Facilities		
1	ROADS & PAVING	3,676	1.63
2	LANDSCAPING	1,251	.56
3	RECREATION	437	.19
4	FIRE PROTECTION	5,650	2.51
	TOTAL	11,014	4.90
	COST ESCALATION TO 1995=3.7%	408	.18
		11,422	5.08

Appendix B

DD Form 1391-Replacement

1. COMPONENT	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
AIR FORCE		15 AUG 92

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
ANY AIR FORCE BASE, ANY STATE	REPLACE CAPEHART HOUSING PHASE 1

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
8.87.42	711-142	ABCD 123456	6,160

9. COST ESIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
REPLACE CAPEHART HOUSING PHONE 1	UN	64	66,859	4,279
SUPPORTING FACILITIES				1,282
DEMOLITION	LS			(203)
SITE PREPARATION	LS			(171)
ROADS & PAVING	LS			(244)
UTILITIES	LS			(307)
FOUNDATION				(245)
LANDSCAPING				(83)
RECREATION				(29)
SUBTOTAL				5,561
CONTINGENCY (5%)				278
TOTAL CONTRACT COST				5,839
SUPERVISION, INSPECTION AND OVERHEAD (5.5%)				321
TOTAL REQUEST				6,160
AREA COST FACTOR 0.96				

10. DESCRIPTION OF PROPOSED CONSTRUCTION Replace 64 Capehart units. Includes demolition, site clearing, replacement/upgrade/relocation of utility systems and roads, and construction of new multiplex housing. Provides parking, air conditioning, exterior patios, and privacy fencing, neighborhood playgrounds, recreation areas. Includes asbestos and lead based paint removal. Provides fire protection systems.

UNIT TYPE	NET AREA	PROJECT FACTOR	$ NSF	NO. UNITS	TOTAL COST
JNCO 3BR	1200	.96	55	34	2,154.240
JNCO 4BR	1350	.95	55	10	705,375
SNCO 3BR	1350	.95	55	18	1,269,675
SNCO 4BR	1450	.94	55	2	149,930
					4,279,220

11. REQUIREMENT: 1,448 UN ADEQUATE: 152 UN SUBSTANDARD: 1,296 UN
PROJECT: Replace Capehart Housing Phase 1. (Current Mission).
REQUIREMENT: This project is required to provide modern and efficient housing for military members and their dependents stationed at ANY AFB, AS. All units will meet whole house standards and are programmed in accordance with the Housing Community Plan. Replacement housing will provide a safe, comfortable, and appealing living environment comparable to the off base civilian community. This is the first phase of an initiative to provide adequate housing for base personnel. The replacement housing will provide a modern kitchen, living room, family room, and bath configuration, with ample interior and exterior storage and a single car garage. Exterior parking will be provided for a second vehicle. The basic neighborhood support infrastructure will be upgraded to meet modern housing needs. Neighborhood improvement include landscaping and recreation areas.

1. COMPONENT		2. DATE
AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	15 AUG 92

3. INSTALLATION AND LOCATION
ANY AIR FORCE BASE, ANY STATE

4. PROJECT TITLE	5. PROJECT NUMBER
REPLACE CAPEHART FAMILY HOUSING PHASE 1	ABCD 123456

CURRENT SITUATION: This project replaces Capehart housing units which were constructed in 1959. These units are showing the effects of age and continuous heavy use. They have had no major upgrades since construction, and do not meet the needs of today's families, nor do they provide a modern home environment. Walls and exterior pavements require major replacement due to the effects of age and severe winter weather. Wall insulation is inadequate. Plumbing and electrical systems are antiquated and do not meet current standard for efficiency or safety. There are no GFI circuits, and the number of outlets is minimal which results in haphazard usage of extension cords. Housing interiors are generally inadequate by any modern criteria. Bedrooms are small and lack adequate closet space. Bathrooms are small, and fixtures are outdated and energy inefficient. Kitchens have inadequate storage and counter space, cabinets are old and unsightly, countertops and sinks are badly worn. Flooring throughout the house is outdated. Lighting throughout the houses are inefficient and do not meet modern needs. Heating and air conditioning systems require upgrade or replacement.
IMPACT IF NOT PROVIDED : Major morale problems will result since personnel will continue to occupy substandard housing. The housing will continue to be occupied until it becomes uninhabitable because adequate, affordable off-base housing is not available. The current Housing Market for the base shows an on-base deficit. Without this and subsequent phases of this initiative, repairs of these units will continue out of necessity, in a costly, piecemeal fashion, with no improvement in living quality. This housing will increasingly become and eyesore and embarrassment to the United States Government.
ADDITIONAL: This project meets the criteria/scope specified in Part II of Military Handbook 1190, "Facility Planning and Design Guide." An economic analysis has been prepared comparing the alternatives of status quo operation, replacement, and direct compensation.

1. COMPONENT		2. DATE
AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	15 AUG 92

3. INSTALLATION AND LOCATION
ANY AIR FORCE BASE, ANY STATE

4. PROJECT TITLE	5. PROJECT NUMBER
REPLACE CAPEHART FAMILY HOUSING PHASE 1	ABCD 123456

TRI-SERVICE FAMILY HOUSING COST MODEL

Calculation of New Construction Cost

NUMBER OF UNITS: 64 FY: 95

GRADE	AUTH SF	ACF	PSF	USF	$/SF	#UNITS	SUBTOTAL
JNCO 3BR	1,200	.96	1.02	.98	55	34	2,153,378
JNCO 4BR	1,350	.96	1.02	.97	55	10	705,244
SNCO 3BR	1,350	.96	1.02	.97	55	18	1,269,440
SNCO 4BR	1,450	.96	1.02	.96	55	2	149,935

SUBTOTAL	4,277,997
SUPPORT COST	1,282,771
SUBTOTAL	5,560,768
CONTINGENCY (5%)	278,038
SUBTOTAL	5,838,806
SIOH (5.5%)	321,134
TOTAL CONST COST	6,159,940

SUPPORT COSTS

DEMOLITION	203,090
SITE PREPARATION	171,369
ROADS & PAVING	243,761
UTILITIES	307,247
FOUNDATION	244,898
LANDSCAPING	83,394
RECREATION	29,012
	1,282,771

CALCULATION OF RENOVATION TO REPLACEMENT COST RATIO

IMPROVEMENT COST / REPLACEMENT COST = 5,111,000 / 6,160,000 = 83.0%

DD 1391c, DEC 76 **PREVIOUS EDITION MAY BE USED INTERNALLY** **PAGE 3 of 3**
(CG using the Program, Design and Construction (PDC) System only.) **UNTIL EXHAUSTED**

Appendix C

Source Documents

DEPARTMENT OF THE AIR FORCE
INSTALLATION CE
ANY AIR FORCE BASE, ANY STATE

30 Oct 92

MEMORANDUM FOR FM

FROM: CE

SUBJECT: Civil Engineering Source Document for Economic Analysis Project Number ABCD 123456 - INFORMATION MEMORANDUM

1. The following information is provided to support the Economic Analysis for Project Number ABCD 123456, FY 95 Improve/Replace Capehart Housing Phase 1. Except where otherwise noted, all costs are in FY 1992 dollars.

2. The current facilities were built in 1959 and will be 36 years old at the beginning of the project (1995). They have not been renovated since construction.

3. Unit types and net square footages are:

Unit Type	Number of Units	Status Quo NSF	Improvement NSF	Replacement NSF
JNCO 3BR	34	953	1,195	1,200
JNCO 4BR	10	1,100	1,348	1,350
SNCO 3BR	18	1,126	1,345	1,350
SNCO 4BR	2	1,100	1,448	1,450
TOTAL	64			

4. Housing records show the housing is occupied by the following number of families:

Grade	Number of Families
E-5	24
E-6	20
E-7	10
E-8	6
E-9	4
TOTAL	64

5. Construction of the 64 units will be completed in three phases over a 12 month period. Annual M&R costs and all utility costs are estimated at 70% of Status Quo annual costs during the construction year.

6. The schedule below shows the frequency of Periodic Maintenance and Repair items for the Status Quo alternative, when they are next scheduled to be accomplished, and their associated unit costs. The replacement schedule and costs are based on current maintenance contracts and local information for this type of work. Frequency for each item has been adjusted for the local area based on historical data. For the Improvement and Replacement alternatives, the frequency and unit cost will be the same as for the Status Quo alternative; the next due date will be calculated from the construction year.

ITEM	FREQ	DUE	$ 1992
Interior Paint	4	1995	1,432
Floor Coverings	10	1999	2,172

Exterior Paint	10	1999	628
Water Heater	10	1999	554
Appliances	10	1999	2,215
HVAC	15	2004	2,696
Doors/Windows	15	2004	2,374
Roof	25	2009	1,152

7. This table itemizes the annual utility costs based on the DUERS Cumulative Percent Reduction Report, WIMS Real Property Records, and Base Utility Bills. Costs are in the units stated, and are for the total Family Housing area. Total area of all Family Housing is 1,592,000 square feet.

ITEM	**1990**	**1991**	**1992**
Electricity	535,226	531,867	523,768
Natural Gas	275,641	273,578	267,122
Water	116,325	113,670	115,436
Sewage	70,486	71,936	72,436
Refuse = $100/Unit (see note).			

Note: The base has negotiated a flat rate contract to collect refuse for $100.00 per unit in 1992.

8. Annual Maintenance and Repair costs for the past three years, based on local WIMS work order records are:

1990	**1991**	**1992**
337	339	348

9. Reconnection Charges for the following services are as follows:

ITEM	**$/UNIT**
Telephone	35
Cable TV	20

10. Estimated Cost Savings for the following expenses are as follows. The projections for Annual M&R savings are based on savings realized in a similar replacement project that was completed on base two years ago. The savings for electricity and natural gas are based on an evaluation of the proposed construction plans with local utility officials and construction contractors. It is assumed that non-energy consuming utilities will remain constant for all alternatives.

ITEM	**IMPR**	**REPL**
Annual M&R	15%	20%
Electricity	35%	40%
Natural Gas	30%	35%

11. POC is TSgt Jones, DSN 123-4567.

JOHN A. SMITH, Lt Col, USAF
Base Civil Engineer

DEPARTMENT OF THE AIR FORCE
INSTALLATION LG
ANY AIR FORCE BASE, ANY STATE

25 Oct 92

MEMORANDUM FOR FM

FROM: LG

SUBJECT: Civil Engineering Source Document for Economic Analysis Project Number ABCD 123456 - INFORMATION MEMORANDUM

1. The following information is provided to support the Economic Analysis for Project Number ABCD 123456, FY 95 Improve/Replace Capehart Housing Phase 1. All costs are in FY 1992 dollars.

2. Household goods transportation costs are estimated as follows:

Grade	Cost/Move $ 1992
E-5	1,050
E-6	1,071
E-7	1,196
E-8	1,338
E-9	1,421

3. These estimates are based on maximum weight allowance for each grade.

4. POC is SSgt Allen, DSN 123-5678.

SAM BROWN, GS-12
Transportation Manager

DEPARTMENT OF THE AIR FORCE
INSTALLATION FS
ANY AIR FORCE BASE, ANY STATE

26 Sep 92

MEMORANDUM FOR FM

FROM: FS

SUBJECT: Civil Engineering Source Document for Economic Analysis Project Number ABCD 123456 - INFORMATION MEMORANDUM

1. The following information is provided to support the Economic Analysis for Project Number ABCD 123456, FY 95 Improve/Replace Capehart Housing Phase 1. All costs are in FY 1992 dollars.

2. BAQ/VHA rates are as follows:

Grade	BAQ	VHA
E-5	406.50	9.48
E-6	425.40	12.89
E-7	489.30	46.85
E-8	526.80	68.73
E-9	571.50	75.29

3. This information is based on current pay tables.

4. POC is SSgt Bailey, DSN 123-6789.

FRED TAYLOR, GS-12
Chief of Military Pay

Appendix D

Interim Calculations

APPENDIX D
ECONOMIC ANALYSIS INTERIM CALCULATIONS

INSTALLATION/MAJCOM: Any Air Force Base, Any State / MAJCOM

PROJECT TITLE: FY 95 Improve/Replace Capehart Housing Phase 1

PROJECT NUMBER: ABCD 123456

OBJECTIVE: Provide 64 Enlisted Family Housing Units Meeting Air Force Standards

Inflation Indices to 1995:

Year:	**1990**	**1991**	**1992**
Base Pay:	N/A	N/A	1.064
Mil Con:	1.150	1.103	1.073
O M	1.150	1.103	1.073
Electricity:	1.109	1.049	1.028
Natural Gas:	1.003	0.962	1.013

Personnel Data:

Grade	**Number of Families**
E-5	24
E-6	20
E-7	10
E-8	6
E-9	4
	64

Housing Data:

Unit Type	**Number of Units**	**Status Quo NSF**	**Improvement NSF**	**Replacement NSF**
JNCO 3BR	34	953	1,195	1,200
JNCO 4BR	10	1,100	1,348	1,350
SNCO 3BR	18	1,126	1,345	1,350
SNCO 4BR	2	1,100	1,448	1,450
	64			

Total Area All Family Housing: 1,592,000

Construction Year Costs: 70% of Status Quo Annual Costs

PERIODIC MAINTENANCE AND REPAIR:

Item:	**Unit Cost $ 1992**	**x**	**Number of Units**	**x**	**Inflation Index**	**=**	**Total Cost $ 1995**	**Status Quo Frequency**	**Next Due**
Interior Paint	1,432		64		1.073		98,338	4	1995
Floor Coverings	2,172		64		1.073		149,156	10	1999
Exterior Paint	628		64		1.073		43,126	10	1999
Water Heater	554		64		1.073		38,044	10	1999
Appliances	2,215		64		1.073		152,108	10	1999
HVAC	2,696		64		1.073		185,140	15	2004
Doors/Windows	2,374		64		1.073		163,027	15	2004
Roof	1,152		64		1.073		79,110	25	2009

Status Quo:

Year	Item	Total Cost $ 1995
1995	Interior Paint	98,338
1999	Interior Paint	98,338
	Floor Coverings	149,156
	Exterior Paint	43,126
	Water Heater	38,044
	Appliances	152,108
		480,772
2003	Interior Paint	98,338
2004	HVAC	185,140
	Doors/Windows	163,027
		348,167
2007	Interior Paint	98,338
2009	Floor Coverings	149,156
	Exterior Paint	43,126
	Water Heater	38,044
	Appliances	152,108
	Roof	79,110
		461,544
2011	Interior Paint	98,338
2015	Interior Paint	98,338
2019	Interior Paint	98,338
	Floor Coverings	149,156
	Exterior Paint	43,126
	Water Heater	38,044
	Appliances	152,108
	HVAC	185,140
	Doors/Windows	163,027
		828,939

Improvement/Replacement:

Year	Item	Total Cost $ 1995
1999	Interior Paint	98,338
2003	Interior Paint	98,338
2005	Floor Coverings	149,156
	Exterior Paint	43,126
	Water Heater	38,044
	Appliances	152,108
		382,434
2007	Interior Paint	98,338
2010	HVAC	185,140
	Doors/Windows	163,027
		348,167
2011	Interior Paint	98,338
2015	Interior Paint	98,338
	Floor Coverings	149,156
	Exterior Paint	43,126
	Water Heater	38,044
	Appliances	152,108
		480,772
2019	Interior Paint	98,338
2020	Roof	79,110

ANNUAL MAINTENANCE AND REPAIR:

Annual Costs:

Status Quo:

Three Year Average:

Year	Unit Cost	x	Inflation Index	=	Unit Cost $ 1995	/	Number of Years	=	Average Unit Cost $ 1995
1990	337		1.150		388				
1991	339		1.103		374				
1992	348		1.073		373				
					1,135		3		378

Average

Unit Cost $ 1995	x	Number of Units	=	Total Cost $ 1995
378		64		24,192

Improvement:

Status Quo Total Cost $ 1995	x	15% Estimated Savings	=	Total Cost $ 1995
24,192		0.85		20,563

Replacement:

Status Quo Total Cost $ 1995	x	20% Estimated Savings	=	Total Cost $ 1995
24,192		0.80		19,354

Construction Year Phasing Adjustment:

Improvement:

Total Cost $ 1995	x	Construction Year Adj	=	Adj Cost $ 1995
20,563		70%		14,394

Replacement:

Total Cost $ 1995	x	Construction Year Adj	=	Adj Cost $ 1995
19,354		70%		13,548

Escalation:

Improvement/Replacement: Escalate 10% every 5 years.

Period	Improvement	Replacement
1996 to 2000	20,563	19,354
2001 to 2005	22,619	21,289
2006 to 2010	24,881	23,418
2011 to 2015	27,369	25,760
2016 to 2020	30,106	28,336

HOUSING AREA CALCULATIONS:

Status Quo:

Unit Type	Number of Units	x	Net Square Feet	=	Total Square Feet by Unit Type
JNCO 3BR	34		953		32,402
JNCO 4BR	10		1,100		11,000
SNCO 3BR	18		1,126		20,268
SNCO 4BR	2		1,100		2,200
	64				65,870
			Average Net Square Feet:		1,029

Improvement:

Unit Type	Number of Units	x	Total Net Square Feet	=	Square Feet by Unit Type
JNCO 3BR	34		1,195		40,630
JNCO 4BR	10		1,348		13,480
SNCO 3BR	18		1,345		24,210
SNCO 4BR	2		1,448		2,896
	64				81,216
			Average Net Square Feet:		1,269

Replacement:

Unit Type	Number of Units	x	Net Square Feet	=	Total Square Feet by Unit Type
JNCO 3BR	34		1,200		40,800
JNCO 4BR	10		1,350		13,500
SNCO 3BR	18		1,350		24,300
SNCO 4BR	2		1,450		2,900
	64				81,500
			Average Net Square Feet:		1,273

ELECTRICITY:

Annual Costs:

Status Quo:

Three Year Average:

Year	Annual Cost	x	Inflation Index	=	Annual Cost $ 1995	/	Number of Years	=	Average Annual Cost $ 1995
1990	535,226		1.109		593,566				
1991	531,867		1.049		557,928				
1992	523,768		1.028		538,434				
					1,689,928		3		563,309

Average Annual Cost $ 1995	/	Total Area	=	Cost/SF $ 1995	x	Average Net Square Feet	=	Unit Cost $ 1995	x	Number of Units	=	Total Cost $ 1995
563,309		1,592,000		0.354		1,029		364		64		23,296

Improvement:

Status Quo Cost/SF $ 1995	x	35% Estimated Savings	=	Cost/SF $ 1995	x	Average Net Square Feet	=	Unit Cost $ 1995	x	Number of Units	=	Total Cost $ 1995
0.354		0.65		0.230		1,269		292		64		18,688

Replacement:

Status Quo Cost/SF $ 1995	x	40% Estimated Savings	=	Cost/SF $ 1995	x	Average Net Square Feet	=	Unit Cost $ 1995	x	Number of Units	=	Total Cost $ 1995
0.354		0.60		0.212		1,273		270		64		17,280

Construction Year Phasing Adjustment:

Improvement:

Total Cost $ 1995	x	Construction Year Adj	=	Adj Cost $ 1995
18,688		70%		13,082

Replacement:

Total Cost $ 1995	x	Construction Year Adj	=	Adj Cost $ 1995
17,280		70%		12,096

NATURAL GAS:

Annual Costs:

Status Quo:

Three Year Average:

Year	Annual Cost	x	Inflation Index	=	Annual Cost $ 1995	/	Number of Years	=	Average Annual Cost $ 1995
1990	275,641		1.003		276,468				
1991	273,578		0.962		263,182				
1992	267,122		1.013		270,595				
					810,245		3		270,082

Average Annual Cost $ 1995	/	Total Area	=	Cost/SF $ 1995	x	Average Net Square Feet	=	Unit Cost $ 1995	x	Number of Units	=	Total Cost $ 1995
270,082		1,592,000		0.170		1,029		175		64		11,200

Improvement:

Status Quo Cost/SF	30% Estimated	Cost/SF	Average Net	Unit Cost	Number	Total Cost

$ 1995 x	Savings	$ 1995 x	Square Feet =	$ 1995 x	of Units =	$ 1995
0.170	0.70	0.119	1,269	151	64	9,664

Replacement:

Status Quo Cost/SF $ 1995 x	35% Estimated Savings =	Cost/SF $ 1995 x	Average Net Square Feet =	Unit Cost $ 1995 x	Number of Units =	Total Cost $ 1995
0.170	0.65	0.111	1,273	141	64	9,024

Construction Year Phasing Adjustment:

Improvement:

Total Cost $ 1995 x	Construction Year Adj =	Adj Cost $ 1995
9,664	70%	6,765

Replacement:

Total Cost $ 1995 x	Construction Year Adj =	Adj Cost $ 1995
9,024	70%	6,317

NON-ENERGY CONSUMING UTILITIES:

Annual Water Cost:

All Alternatives:

Three Year Average:

Year	Annual Cost x	Inflation Index =	Annual Cost $ 1995 /	Number of Years =	Average Annual Cost $ 1995
1990	116,325	1.150	133,774		
1991	113,670	1.103	125,378		
1992	115,436	1.073	123,863		
			383,015	3	127,672

Average Annual Cost $ 1995 /	Total Area =	Cost/SF $ 1995 x	Average Net Square Feet =	Unit Cost $ 1995 x	Number of Units =	Total Cost $ 1995
127,672	1,592,000	0.080	1,029	82	64	5,248

Annual Sewage Cost:

All Alternatives:

Three Year Average:

Year	Annual Cost x	Inflation Index =	Annual Cost $ 1995 /	Number of Years =	Average Annual Cost $ 1995
1990	70,486	1.150	81,059		
1991	71,936	1.103	79,345		
1992	72,436	1.073	77,724		
			238,128	3	79,376

Average Annual Cost $ 1995 /	Total Area =	Cost/SF $ 1995 x	Average Net Square Feet =	Unit Cost $ 1995 x	Number of Units =	Total Cost $ 1995

79,376	1,592,000	0.050	1,029	51	64	3,264

Annual Refuse Cost:

All Alternatives:

Status Quo Unit Cost $ 1992 x	Inflation Index =	Unit Cost $ 1995 x	Number of Units =	Total Cost $ 1995
100	1.073	107	64	6,848

Recap:

	Status Quo
Water:	5,248
Sewage:	3,264
Refuse:	6,848
Total $ 1995:	15,360

Construction Year Phasing Adjustment:

Improvement/Replacement:

Total Cost $ 1995 x	Construction Year Adj =	Adj Cost $ 1995
15,360	70%	10,752

RECONNECTION CHARGES:

Items:

Item:	Unit Cost $ 1992
Telephone	35
Cable TV	20
	55

Adjusted Cost:

Improvement/Replacement:

Unit Cost $ 1992 x	Inflation Index: =	Unit Cost $ 1995 x	Number of Families: x	Moves per Family: =	Total Cost $ 1995
55	1.073	59	64	2	7,552

MOVING COST:

Rank Breakdown:

Grade	Number of Families x	Cost/Move $ 1992 =	Total Cost $ 1992
E-5	24	1,050	25,200
E-6	20	1,071	21,420
E-7	10	1,196	11,960
E-8	6	1,338	8,028
E-9	4	1,421	5,684
			72,292

Adjusted Cost (Improvement/Replacement):

Improvement/Replacement:

Total Cost $ 1992		**Inflation Index**		**Total Cost $ 1995**		**Moves per Family**		**Adj Cost $ 1995**
72,292	x	1.073	=	77,569	x	2	=	155,138

BAQ/VHA:

Grade Breakdown:

Grade	**Number of Families**		**(Monthly (BAQ**		**Monthly) VHA)**		**Monthly Cost $ 1992**
E-5	24	x	406.50	+	9.48	=	9,983.52
E-6	20		425.40		12.89		8,765.80
E-7	10		489.30		46.85		5,361.50
E-8	6		526.80		68.73		3,573.18
E-9	4		571.50		75.29		2,587.16
							30,271.16

Adjusted Cost

Improvement/Replacement):

Monthly Cost $ 1992		**Inflation Index**		**Monthly $ 1995**		**Months of Year**		**Adj Cost $ 1995**
30,271	x	1.064	=	32,208	x	4	=	128,832

IMPROVEMENT COST:

Construction Cost $ 1995: 5,111,000

REPLACEMENT COST:

Construction Cost $ 1995: 6,160,000

Net Investment Cost:

Demolition Cost $ 1995		**5% Contingency**	=	**Subtotal**	=	**5.5% SIOH**	=	**Total Demolition Cost $1995**
203,000	+	10,150		213,150		11,723		224,873

Construction Cost $ 1995		**Total Demolition Cost $1995**	=	**Net Investment Cost $1995**
6,160,000	-	224,873		5,935,127

SAMPLE ECONOMIC ANALYSIS FOR ECIP/FEMP

1. COMPONENT AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA			**2. DATE** DD MMM YY
3. INSTALLATION AND LOCATION ANY AIR FORCE BASE, ANY STATE		4. PROJECT TITLE FEMP - Insulate Steam Lines		
5. PROGRAM ELEMENT X.XX.XX	6. CATEGORY CODE XXX.XXX	**7. PROJECT NUMBER** AFBC 968806	8. PROJECT COST ($000) 402	

9. COST ESIMATES

ITEM	**U/M**	**QUANTITY**	**UNIT COST**	**COST ($000)**
INSULATE STEAM LINES	LS			402

10. DESCRIPTION OF PROPOSED CONSTRUCTION Insulate steam lines throughout the installation to reduce energy losses in the 30-year old system. The project will increase efficiency and heating capacity of the heating distribution system and will bring the heating distribution system into compliance with the Energy Policy Act of 1992.

11. REQUIREMENT: As Required.
PROJECT: Insulate Steam Distribution System.
REQUIREMENT: This project is required to provide more energy efficient heating to installation buildings. The current steam distribution system is 30 years old and has numerous leaks. The insulation will reduce heating losses due to these leaks. Additionally, the insulation is required so that the system is in compliance with the Energy Policy Act of 1992.
CURRENT SITUATION: The system is 30 years old. Steam lines are inefficient due to numerous leaks throughout. The system does not comply with the Energy Policy Act of 1992.
IMPACT IF NOT PROVIDED: The steam lines will continue to leak steam, and the system will continue to be inefficient. Additionally, the system will continue to be out of compliance with the Energy Policy Act of 1992.

DD 1391, DEC 76 **PREVIOUS EDITION MAY BE USED INTERNALLY** **PAGE 1 of 5**
(CG using the Program, Design and Construction (PDC) System only.) **UNTIL EXHAUSTED**

1. COMPONENT AIR FORCE	**FY 1995 MILITARY CONSTRUCTION PROJECT DATA**	2. DATE DD MMM YY
3. INSTALLATION AND LOCATION ANY AIR FORCE BASE, ANY STATE		
4. PROJECT TITLE FEMP - INSULATE STEAM LINES		5. PROJECT NUMBER ABCD 968806

SECTION 11 - ECONOMIC ANALYSIS
11C CONSIDERATION OF ALTERNATIVES
Maintain Status Quo
Insulate Steam Distribution System

11D ECONOMIC JUSTIFICATION SUMMARY
Life-Cycle Cost Analysts Data Base
1. Investment costs were calculated using R.S. Means estimating publications. Total investment costs, including contingency and SIOH = $401,800.

2. Energy savings were calculated using various energy conservation publications.

a. Documents included:
(1) Architects and Engineers Guide to Energy Conservation in Existing Buildings, DOE, 1979.
(2) ASHRAE Fundamentals, 1985.
(2) The 1975-Energy Management Guidebook, published by editors of Power Magazine, McGraw Hill Inc., New York, NY 1975.

b. Distillate fuel oil will not be affected by the project. Initial firing of the boilers uses #2 fuel oil. Firing up procedures at the beginning of the heating season will not change.

Distillate fuel oil savings = 0

c. Residual fuel oil (#6 fuel oil) is the primary fuel used in the central heating plant steam distribution system.

(1) Data base:

(a) Boiler data--temperature at 100psi = 338 F
80psi = 324 F

(b) Assume average steam/condensate temperature in the line = 240° to 250°F.

(c) To be conservative, assume some of the lost heat from the pipes will find its way to ground level, due to both the large amount of heat lost and the circulation built up by both the temperature gradient and the unit heater blowers. Assume 25 percent of the lost heat is returned to the floor level.

(2) Current situation--No insulation on steam or condensate lines in warehouse 2. No insulation on the condensate lines in warehouse 3. The steam line in warehouse 3 does have insulation installed.

1. COMPONENT AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE DD MMM YY
3. INSTALLATION AND LOCATION ANY AIR FORCE BASE, ANY STATE		
4. PROJECT TITLE FEMP-INSULATE STEAM LINES		5. PROJECT NUMBER ABCD 968806

(a) Heat loss calculations

Q(bare) T*L
where Q(bare) = bare pipe seasonal heat loss
HL=Unit heat loss
T=7-month heating season = 5040 hours
L=Unit length of pipe

(b) Heat loss

Pipe Size	BTUH/10'	10' Lengths (L)	Q(MBTU/season)
1/2 in	1125	226.8	1,285.956
3/4 in	1350	154.0	1,047.816
1 1/2 in	2300	226.8	2,629.066
2 1/2 in	3250	913.7	14,966.406
4 in	5160	446.4	11,609.257
6 in	7360	12.0	445.133
Total Q(bare) = HL*T*L =			31,983.634

(3) Proposed Situation: Install 2 inches of insulation on all bare steam and condensate lines in warehouses 2 and 3.

(a) Heat loss calculations

Pipe Size	BTUH/11	Length (LF)	Q(MBTU/season)
1/2 in	12	2268	137.169
3/4 in	13	1340	100.901
1 1/2 in	20	2268	228.614
2 1/2 in	26	9137	1,197.312
4 in	55	4464	1,237.421
6 in	75	120	45.360
Total Q (insulated) = HL*T*L =			2,946.777

(4) Residual fuel savings = q (bare) - Q (insulated)

Q(lost) = 31,983.634 MBTU/yr - 2,946.777 MBTU/yr = 29,036.857 MBTU/yr

Not all heat lost from the pipes will be lost to the facility. Even though the warehouses have high bays, we can assume 25 percent of the heat is recycled through the buildings.
Therefore, Q(lost) = 29.037 MBTU/year * .75 = 21,777 MBTU/yr.
Considering boiler efficiency of 78 percent, this equates to a residual fuel input equal to 21,777 MBTU/yr/.78 = 27,919 MBTU/yr.

Using 1054.8 Joule/BTU, this equals to a yearly residual fuel savings of $29,449 GJ/year.

1. COMPONENT	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
AIR FORCE		DD MMM YY

3. INSTALLATION AND LOCATION
ANY AIR FORCE BASE, ANY STATE

4. PROJECT TITLE	5. PROJECT NUMBER
FEMP - INSULATE STEAM LINES	ABCD 968806

11E. ENERGY CONSERVATION INVESTMENT PROJECT/FEDERAL ENERGY MANAGEMENT PROGRAM (ECIP/FEMP)
LIFE CYCLE COST ANALYSIS SUMMARY

INSTALLATION & LOCATION: XYZ AFB. REGION NOS. 2 PROJECT NO. ABCD 968806
PROJECT TITLE: ECIP-INSULATE STEAM LINES FISCAL YEAR 1996
ANALYSIS DATE: 9-Feb-95 ECONOMIC LIFE 15 PREPARER: Wayne F. Myers
DISCRETE PORTION NAME: INSULATE WAREHOUSE STEAM DISTRIBUTION

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$ 350,000.		
B. SIOH (6.5%)	$ 22,750.		
C. DESIGN COST (8.3%)	$ 29,050.		
D. TOTAL COST (1A+1B+1C)	$ 401,800.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 401,800.

2. ENERGY SAVINGS (+) OR COST (-):
DATE OF NISTIR 4942-2 USED FOR DISCOUNT FACTORS OCT 1994

ENERGY SOURCE	COST $/GJ (1)	SAVINGS GJ/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTORS (4)	DISCOUNTED SAVINGS (5)
A. ELECT	$17.12	10.43	$179	12.2103	$ 2,180
B. DIST			$0	14.588	$0
C. RESID	$6.97	29,449	$205,325	16.1813	$3,322,428
D. NG			$0	13.8933	$0
E. PPG			$0	13.8993	$0
F. COAL			$0	12.6897	$0
G. SOLAR			$0		$0
H. OTHER			$0		$0
I. DEMAND SAVINGS					$0
J. TOTAL		29,459.43	$205,504		$3,324,608

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) $0.
(1) DISCOUNT FACTOR (TABLE E-2) 11.5902
(2) DISCOUNTED SAVING/COST (3A X 3A1) $0.
B. NON RECURRING SAVINGS (+) / COSTS (-) (Discount Factor from Table E-1)

ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCURRENCE (2)	DISCNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.				$0
b.				$0
c.				$0
d. TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2+3B4d) $0

4. TOTAL NET SAVINGS (2J3+3A+3B1d)	$205,504
5. SIMPLE PAYBACK (1G/4)	1.96
6. TOTAL NET DISCOUNTED SAVINGS (2J5 + 3C)	$3,324,608
7. SAVINGS TO INVESTMENT RATIO (SIR) (6/1G)	8.27
8. FIRST YEAR DOLLAR SAVINGS (2J3+3A+(3B1d/ECONOMIC LIFE))	$205,504

1. COMPONENT AIR FORCE	**FY 1995 MILITARY CONSTRUCTION PROJECT DATA**	2. DATE DD MMM YY
3. INSTALLATION AND LOCATION ANY AIR FORCE BASE, ANY STATE		
4. PROJECT TITLE FEMP - INSULATE STEAM LINES		5. PROJECT NUMBER ABCD 968806

11F SAVINGS VERIFICATION PLAN

The savings that are expected as a result of these initiatives will be verified as follows: First, a baseline of energy consumption will be established for several typical metered facilities prior to installation of the insulation. This will be done by reviewing past meter readings over the entire year of actual energy consumption per square foot for these facilities. This data will then be compared to the new energy consumption after the installation of the insulation. True dollar costs and GigaJoule consumption rates can then be calculated to show the savings associated with the metered facilities and estimated savings can be derived through application of square foot costs/savings to similar facilities which are not metered. Once these facilities are metered, the actual readings can be used to verify savings due to the installation of the insulation.

PRELIMINARY ECONOMIC ANALYSIS FORMAT

A preliminary economic analysis is a concise tool for making a recommendation to a decision maker without going through the effort of a full EA. Preliminary EAs are internal planning tools for installations and commands. The goal is to bring the benefits of economic analysis to decision making early on in the process without being unnecessarily burdened by the more demanding requirements of a full EA. In no case may a preliminary EA be substituted for a full EA when a full EA is required by the provision of this manual. The format suggested below is intended to provide the minimum contents required for a preliminary EA. It is generally a document of no more than a few pages which must be submitted along with the required for waiver from economic analysis.

1. **Problem Requirement:** Provide a brief, clear and accurate background statement about what needs to be addressed, e.g., 300 unaccompanied enlisted personnel are currently housed in substandard facilities (condition code 3 dormitories).

2. **Objective:** State the generic need in an unbiased, non-limiting manner, quantified to the extent possible, e.g., provide adequate housing for 300 unaccompanied enlisted personnel. If "adequate" can be translated into square footage or other parameters, this quantification should be done.

3. **Assumptions/Ground Rules:** Identify only the most significant limitations, constraints, assumptions, legal or regulatory considerations, e.g., all condition code 1 and 2 dormitories are currently averaging 95% occupancy, no present base organizations will be inactivated or relocated.

4. **Alternatives:** Identify, as a minimum, the most obvious alternatives. Categorize the alternatives in to groups: feasible alternatives to be analyzed (e.g., status quo, renovation, new construction, BAQ/VHA), or infeasible alternatives to be eliminated (e.g., leasing). Include reasons for eliminating infeasible alternatives.

5. **Costs:** Identify the major categories of costs and include preliminary estimates by major category. "Wash" or common costs may be excluded (unlike in a full EA). Ignore minor categories of cost or incidental costs. Round total costs to the nearest $1,000 in keeping with the "rough nature of the estimate, and summarize the differences in costs among alternatives as a rough order of magnitude. Discounting would only be necessary if cash flows vary significantly in timing. Work to develop cost estimates with the appropriate base level functional expert, e.g., facility maintenance and new facility construction costs from civil engineering, number of dorm occupants by pay grade from base billeting office, BAQ/VHA costs from appropriate Accounting & Finance office. Documentation of costs is not necessary, but check calculations for accuracy.

6. **Benefits:** Identify the more important benefits associated with each of the alternatives being analyzed, e.g., renovation corrects all deficiencies, or opting for off-base housing (BAQ/VHA) results in demolishing old dorms, reducing facility maintenance and repair workload.

7. **Risk Assessment:** Identify the key variables which could possibly change to the extent that the recommendation would change.

8. **Conclusion and Recommendation:** Briefly explain which alternative appears best and why. Emphasize that the choice is based on preliminary analysis only and could possibly change based on the results of a complete, formal EA.