Chapter 2

RESPONSIBILITIES OF THE ARCHITECT/ENGINEER

2.1 Purpose 2-1
2.2 Design, Analysis, and Selection of Options for New Housing 2-2
2.3 Inspection, Analysis, and Selection of Options for Revitalized Housing 2-4
2.4 Specification of Energy-Efficiency Options 2-8

2.1 Purpose

The purpose of this chapter is to define the A/E's responsibilities in producing plans and specifications for new and revitalized Air Force family housing projects that will result in cost-effective, energy-efficient dwelling units. The A/E's responsibilities with regard to the design of energy-efficient housing will be fulfilled in accordance with this guide through the accomplishment of the following tasks:

- design, analysis, selection, and documentation of cost-effective energy-efficiency options for new housing units, or
- inspection, analysis, selection, and documentation of cost-effective energy-efficiency options for revitalization units, and
- specification of the cost-effective energy-efficiency options identified and building envelope and equipment performance verification testing requirements.

For new construction, energy efficiency will be partially achieved by complying with various prescriptive standards referenced in this guide and the requirements set by the COSTSAFR program for each distinct housing type (see Sect. 3.2, "Selection of ECMs Using COSTSAFR"). COSTSAFR identifies the cost-effective level of energy efficiency for each new housing type at the project's location. To fully achieve the intended level of energy efficiency, quality materials and equipment and their proper installation must be specified, as well as verification testing to ensure that everything is functioning properly (Chap. 5, "Specification of Selected Energy-Efficiency Options").

For revitalization of existing housing, the use of prescriptive standards is less appropriate because existing conditions and deficiencies can limit the cost-effective application of efficiency measures. This guide provides a methodology (see Chap. 4, "Inspection, Analysis, and Selection of Options for Revitalized Housing") for making cost-effective energy-efficiency decisions in an environment when such limits must be taken into account. As with new construction, the specification of materials and equipment, commissioning, and verification testing is required.

2.2 Design, Analysis, and Selection of Options for New Housing

Chapter 3, "Design, Analysis, and Selection of Options for New Housing," will assist the A/E in selecting the appropriate types and levels of energy-efficiency options for new housing units. The design process must avoid reproducing flaws typically found in existing housing as described in Sect. 1.1, "Need for This Guide," and throughout Sect. 4.2, "Analysis and Selection."

AREAS TO BE ANALYZED

The following elements impact the energy efficiency of Air Force family housing and shall be addressed by the A/E in the analysis phase of the design process:

Building Envelope

The entire envelope will be analyzed, thermal boundaries will be defined, and insulation levels for the entire boundary will be determined and specified for the specific climate and fuel cost. Air-leakage locations and bypasses in the building thermal envelope that allow conditioned air to move directly out of the house will be avoided or sealed. Appropriate quality, energy-efficient windows and doors will be specified.

Heating and Cooling System

The proper heating and cooling equipment will be determined for the climate, fuel type and cost, and house load. A life-cycle cost approach will be used to select the appropriate level of efficiency. Equipment must be properly sized. Insulation levels for ducts located outside the thermal boundary (in attics, crawl spaces, or unheated basements) must be determined and specified.

Domestic Water Heating System

The life-cycle cost impact of alternative fuels (electric and natural gas) will be evaluated and the least costly selected. The efficiency difference among available equipment will be evaluated on a life-cycle cost basis. Water conservation opportunities will be identified and included in the project to the extent that they are cost effective.

Major Appliances

The life-cycle cost impact of alternative fuels (electric and natural gas) will be evaluated and the least costly selected. The efficiency difference among appliances will be evaluated on a life-cycle cost basis and the one with the least life-cycle cost selected.

Lighting

The lighting system will be based on a cost-effective energy-efficient lighting design.

Site Improvements

Site improvements (landscape and pavement) will be evaluated as to their potential impact on the energy performance of the dwelling units. Designs that minimize energy consumption will be used whenever cost effective.

DOCUMENTATION OF ANALYSIS

A summary of the analysis process shall be accomplished for each housing type in the project and be submitted to the program manager for review and approval. Instructions for completing specific forms for this purpose are included in Chap. 3, "Design, Analysis, and Selection of Options for New Housing."

STANDARDS FOR NEW WORK

The following manuals are the Air Force standards that govern design of new family housing: *Air Force Instruction 32-6002* dated May 12, 1994, and *Air Force Family Housing Guide for Planning, Programming, Design, and Construction* dated December 1995. The prescriptive standards and criteria that are listed in these manuals are applicable to construction of all new buildings.

RESOLUTION OF CONFLICTING CRITERIA

Conflicting criteria will be resolved in the following order: (a) adhering to the project's Statement of Work, (b) adhering to the appropriate Air Force standards manuals previously cited, and (c) selecting the criteria that are shown to be most cost effective as applied to the specifics of the project.

2.3 Inspection, Analysis, and Selection of Options for Revitalized Housing

In conjunction with the detailed house inspection required by other parts of the A/E's contract, inspectors shall investigate existing conditions that have the potential to significantly impact the energy consumption of the units being revitalized.

Before inspections begin, current energy consumption data will be examined to determine the current performance and the extent of existing problems. A methodology of assessing existing consumption is described in Sect. 4.1.1, "Energy Use Review."

The inspection by the A/E will consist of visual observation of energy systems and components as described in Sect. 4.1, "Inspection," and the completion of the inspection report forms included in Appendix A. It is anticipated that a qualified inspector—one who has a technical background and is familiar with energy-efficiency techniques and tools (but is not necessarily an energy specialist)—can complete approximately two inspections per day. For units in which the retention of the existing air distribution duct system and/or a major portion of the interior is anticipated, a detailed evaluation by an inspector qualified in the use of a blower door is required. The procedures to follow and detailed inspection forms are provided in Appendixes C, D, E, and F of this guide.

An inspection of existing housing units for each type being revitalized is required to adequately define the areas to be addressed during revitalization. Table 2.1 shows how many buildings must be inspected in relation to the number of buildings to be revitalized. The data from the inspection reports will form the basis of decisions made during the analysis and selection of revitalization options. The inspection process identifies current efficiency levels and flaws and barriers preventing further efficiency improvements.

Section 4.2, "Analysis and Selection," will help the A/E select the appropriate kinds and levels of energy efficiency for each type of unit in the project. This section guides the A/E in determining whether and to what extent efficiency levels should be improved, the efficiency measures to consider, and the means of achieving improvements.

AREAS TO BE ANALYZED

The following elements impact the energy efficiency of Air Force family housing and shall be addressed by the A/E in the analysis phase of the process.

Building Envelope

The entire existing envelope and any additions will be analyzed, thermal boundaries will be defined, and insulation levels for the entire boundary will be determined and specified for the specific climate and fuel cost. Air-leakage locations and bypasses in the

Table 2.1. Inspection sampling requirements

Number of buildings of a specific type	Number of buildings to be inspected
1	1
2–50	2
51–75	3
76–100	4
101–125	5
126–150	6
151–175	7
>175	8

building envelope that allow conditioned air to move directly out of the house, often associated with “holes” in the envelope, will be identified for sealing. Appropriate quality energy-efficient replacement windows and doors will be identified and specified when replacement units are called for in the revitalization project or if economically justified.

Heating and Cooling System

The proper heating and cooling equipment will be determined for the climate, fuel type and cost, and house load if replacement units are called for in the revitalization project or if economically justified. A life-cycle cost approach will be used to decide whether to replace equipment and what new equipment to select. Insulation levels for uninsulated ducts that are located outside the thermal boundary (in attics, crawl spaces, or unheated basements) will be identified, and leaking ducts will be identified for repair or replacement.

Domestic Water Heating System

Water heating equipment not identified for replacement as part of the revitalization will be evaluated for replacement during revitalization based on its energy efficiency. The life-cycle cost impact of alternative fuels (electric and natural gas) will be evaluated and the least costly selected. The efficiency differences among available equipment will be evaluated on a life-cycle cost basis. Water conservation opportunities will be identified and included in the revitalization to the extent that they are cost effective.

Major Appliances

Appliances not identified for replacement in the revitalization project will be evaluated to determine if replacement based on improved energy efficiency is economically justified. The life-cycle cost impact of alternative fuels (electric and natural gas) will be evaluated and the least costly selected. The efficiency differences among appliances will be evaluated on a life-cycle cost basis and the one with the least life-cycle cost selected.

Lighting

Replacing old lighting systems will usually be part of a revitalization. However, when replacing the existing lighting system is not part of the revitalization, an energy-efficient lighting strategy will be evaluated to determine if partial or complete system replacement is economically justified.

Site Improvements

Existing and future site improvements (landscape and pavement) will be evaluated for their potential impact on the energy performance of the dwelling units. Designs that minimize energy consumption will be specified whenever cost effective.

DOCUMENTATION OF ANALYSIS

The analysis process (Forms G.1 to G.17, Appendix G) will be completed and provided to the program manager for review and approval.

STANDARDS FOR REVITALIZATION

The following manuals are Air Force standards that govern the design of new family housing: *Air Force Instruction 32-6002*, dated May 12, 1994, and *Air Force Family Housing Guide for Planning, Programming, Design, and Construction* dated December 1995. The prescriptive standards and criteria listed in these manuals are applicable to “all buildings of new construction or substantially altered building envelopes.” They shall be consulted in those portions of revitalization projects in which

- new construction replaces or adds to the existing building envelope (e.g., building additions),
- access is provided (for other than energy-efficiency reasons) to normally inaccessible portions of the existing

building envelope, allowing the changes to meet prescriptive standards and to be made cost effectively (e.g., removal of the interior or exterior finish of a wall because of deteriorated conditions or electrical upgrade, permitting increased levels of wall insulation), or

- the total cost of modifying the existing envelope (demolition, modification, and restoration) to prescriptive standards can be shown to be cost effective based on energy savings alone.

The U.S. Department of Commerce annually updates the present worth factors to be used in military life-cycle cost analyses. Annual figures are published in *Present Worth Factors for Life-Cycle Cost Studies in the Department of Defense* (S. R. Peterson, NISTIR 4942-2). Factors presented in this Guide are for 1995. Revised factors must be obtained for future years from the reference.

BASIS OF SELECTION

Three different bases for selecting efficiency options are likely to be encountered in revitalization projects and are as follows:

1. A revitalization option is selected for other than energy-efficiency reasons. These reasons could include deterioration of building components (e.g., new double-pane windows to replace worn out windows), equipment that has reached the end of its useful life [e.g., a new 80% annual fuel utilization efficiency (AFUE) furnace to replace an existing 20-year-old unit], or other aesthetic or functional reasons (e.g., upgrading space to conform to current private-sector practices).
2. The incremental cost of a higher efficiency replacement option compared with the standard replacement option is cost effective. An example is replacing a worn-out furnace with a high-efficiency (92% AFUE) furnace rather than a minimum efficiency (80% AFUE) unit because the incremental cost increase provides benefits that are cost effective over the life of the furnace.
3. A revitalization measure is selected on the basis of energy conservation potential and is cost effective. Examples are adding insulation to an uninsulated wall, converting an existing electric water heater in good condition to a new gas heater, or installing a new high-efficiency furnace even though the existing unit has remaining life.

For purposes of this guide, the total project energy savings does not depend on which basis is used to determine to replace a component. For example, the savings of new windows is the same whether the windows were replaced because they were worn out or because they were inappropriate for the climate. The total savings generated will be related only to the design of the new windows compared with the windows that were replaced.

The cost of installation and the energy savings to be used for life-cycle analysis, however, will depend on which basis is used to determine to replace a component. For example, if the windows need replacement because of the condition of the old windows, then the cost and energy comparisons should be based only on the incremental cost and energy savings of a new efficient window over a new basic window. However, if the existing windows are in good shape but should be replaced for energy reasons, the total energy savings should be used and the cost of an upgraded window should include the cost of the new window, demolition and disposal of the old window, and installation of the new one.

This guide contains the information needed to make cost-effective revitalization decisions based on climate, fuel cost, and the A/E's estimate of installation cost. The procedures are detailed in Sect. 4.2, "Analysis and Selection."

RESOLUTION OF CONFLICTING CRITERIA

Conflicting criteria will be resolved in the following order: (a) adhering to the project's Statement of Work, (b) adhering to the appropriate Air Force standards manuals previously cited, and (c) selecting the criteria that are shown to be most cost effective as applied to the specifics of the project.

2.4 Specification of Energy-Efficiency Options

Use existing commercial/industry standards and specifications as identified in the Statement of Work and applicable Air Force standards manuals cited in Sects. 2.2 and 2.3 for routine equipment and materials such as furnaces, air conditioners, water heaters, insulation, etc. These are examples of components that are routinely available in the marketplace and for which existing specifications are referenced.

Use the following additional or supplemental specifications from this guide (provided in Chap. 5, "Specification of Selected Energy-Efficiency Options") for areas not appropriately covered in existing specifications: infiltration reduction, windows and doors, heating and cooling equipment, and air distribution systems.