

# **UNIFIED FACILITIES CRITERIA (UFC)**

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## **FAMILY HOUSING**



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**UNIFIED FACILITIES CRITERIA (UFC)**

**FAMILY HOUSING**

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U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

Record of Changes (changes are indicated by \1\ ... /1/)

<b>Change No.</b>	<b>Date</b>	<b>Location</b>

## FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with [USD\(AT&L\) Memorandum](#) dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Support Agency (AFCESA) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: [Criteria Change Request \(CCR\)](#). The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide web site <http://dod.wbdg.org/>.

Hard copies of UFC printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

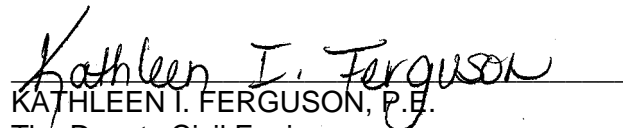
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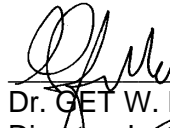
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**Unified Facilities Criteria (UFC)**  
**New Document Summary Sheet**

**Subject:** UFC 4-711-01, *DESIGN: FAMILY HOUSING*

**Cancels:** This is a new Joint-Service document. This cancels MIL-HDBK-1035 (15 June 1989) – Family Housing. Services may issue supplemental criteria. See paragraph 1-1.3 for references.

**Description of Changes:** The UFC 4-711-01, *DESIGN: FAMILY HOUSING* represents another step in the joint Services effort to bring uniformity to the planning, design and construction of military family housing. This revision of that document contains extensive modifications in the following areas:

- The document requires the use of the latest building codes including the latest version of the International Residential Code.
- New military requirements were incorporated and improved references to other documents were identified for energy conservation, sustainable development, and antiterrorism standards.
- This is the first joint Service criteria document to be published since the MH 1035. Technical representatives of each of the DoD Components developed this document to outline and detail family housing criteria agreed upon by each Service.

**Reason for Changes:** The existing guidance was inadequate for the following reasons:

- The Services are currently using their own individual criteria documents, ex. AF Guides, NAVFAC Instructions, Army Technical Instructions, and Marines P-numbered management manuals. This document promotes criteria uniformity, and reduces current reliance upon individual Service specific documents.
- The existing Service-specific guidance did not properly reference and identify recently updated and published commercial structural, seismic and wind data documents.
- The existing Service-specific guidance did not properly reference and identify recently updated joint Service needs and agreements.
- The existing Service-specific guidance did not reflect recent changes in the Fire and Life Safety documents published by the NFPA.

**Impact:** The following direct benefits will result from the update of UFC 4-711-01:

- Creation of a single source for common DoD Family Housing criteria and an accurate reference to individual Service-specific documents.
  - Eliminates misinterpretation and ambiguities that could lead to design and construction conflicts.
  - Facilitates updates and revisions and promotes agreement and uniformity of design and construction between the Services.

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## CHAPTER 1 INTRODUCTION

### 1-1 PURPOSE AND SCOPE

#### 1-1.1 Purpose.

This UFC provides guidance for the design, construction, improvement, and repair of Department of Defense (DoD) family housing facilities in the United States, its possessions, and foreign countries.

#### 1-1.2 Goal and Objectives.

The Military Family Housing Goal Statement defines the ideal end-state for military communities and housing. It is not intended to be static, but responsive to the dynamics of military family housing needs. The Military Family Housing Goal is:

- To provide quality-housing neighborhoods to contribute to a strong force of skilled people who provide the readiness of our Military Forces.

Military family housing objectives support the family housing goal. These objectives are:

- To bring the existing required housing inventory up to contemporary housing standards (i.e., codes, safety, maintainability, livability, amenities) through repair, improvement and replacement.
- To reduce energy consumption per Executive Order (EO) 13123.

All military family housing facility programs should use a “whole house” and “whole neighborhood” approach for improvement, replacement, and repair of existing family housing units and neighborhoods, to increase the overall quality of entire Family Housing areas.

Housing Improvement projects should:

- Extend the useful life of facilities and infrastructure by at least 25 years.
- Be designed and constructed to minimize life cycle costs.
- Restore housing units to structural soundness.
- Upgrade building envelopes to current energy performance standards.
- Lessen impact on the environment.
- Include utility repair and replacement, as required.
- Provide street repair and replacement.

- Provide streetscape repair and improvements.
- Provide community amenities.
- Improve heating, air conditioning, and domestic hot water generating efficiencies.

#### 1-1.3 **Supplemental Criteria.**

- Upon release of this UFC, the Army will update UFC 4-711-02A, *Design: Family Housing* to implement this UFC for one-step turnkey application. This UFC was formerly the Army publication TI 801-02 *Technical Instructions, Family Housing*.
- *Air Force Family Housing Guide for Planning, Programming, Design, and Construction*.
- MCO P11000.22 – *Marine Corps Housing Management Manual*.

### 1-2 **APPLICABILITY**

#### 1-2.1 **General.**

This UFC applies to all Service elements and contractors preparing project specifications. This UFC applies to all DoD family housing facilities. It is applicable to all methods of project delivery.

#### 1-2.2 **Standards and Criteria.**

This UFC outlines standards and criteria pertaining to acquisition, design, construction, improvement, and repair of military family housing in the United States, its possessions, and foreign countries.

#### 1-2.3 **Improvements Based on Criteria.**

Current criteria should be used to the extent that it corrects or remedies any health and safety, and major livability deficiencies. Projects should not be created for the sole purpose of meeting this UFC.

#### 1-2.4 **Historic Quarters.**

The National Historic Preservation Act of 1966, and subsequent Executive Orders, require the Government to take into account historic housing facilities listed on, or are eligible for listing on, the National Register of Historic Places. Responsibility for the majority of preservation duties falls to each installation. Maintenance, improvement, or repair of historic quarters, must comply with applicable DoD Directives and Instructions (see References). Coordinate work planned for historically significant quarters with State Historic Preservation Office (SHPO), and with local historic preservation officials.

### 1-3 REFERENCES AND GLOSSARY.

References used in this UFC are contained in Appendix A, and a Glossary of Terms is contained in Appendix B.

### 1-4 BUILDING CODES AND STANDARDS

#### 1-4.1 Applicable Codes and Referenced Standards.

UFC 1-200-01, *Design: General Building Requirements* adopts the International Building Code (IBC) as the code for the DoD for regulating and governing construction, improvement, repair and maintenance of all military family housing facilities. UFC 3-600-01, *Design: Fire Protection Engineering for Facilities* provides compliance criteria for fire and life safety. Construct, improve, or repair military family housing that conforms to the International Code Council's (ICC) definition of "One- and Two-Family Dwellings" in compliance with the latest version of the *International Residential Code* and this UFC. For military family housing located outside the US, compliance with local codes and regulations will be IAW Status of Forces Agreements (SOFA) or other international agreements. Equivalent substitutions may be authorized in foreign locations where various elements of standards, construction methods, materials, and equipment are regionally different than those in the US. The substitutions will need to meet host nation codes.

#### 1-4.2 Other Criteria.

Military criteria, other than those listed in this UFC, may be applicable to specific types of structures, building systems, or building occupancies. Such structures—systems or buildings—must meet additional requirements of applicable military criteria, such as:

- **Force Protection and Antiterrorism.**  
UFC 4-010-01, *Design: DoD Minimum Anti-terrorism Standards for Buildings.*
- **Energy Conservation.**  
UFC 3-400-01, *Design: Energy Conservation* (mid-rise to high-rise buildings, only), and UFC 3-400-02, *Engineering Weather Data.*

**CHAPTER 2 NEIGHBORHOOD AND SITE DESIGN CRITERIA**

**2-1 NEIGHBORHOOD DESIGN**

**2-1.1 General.**

Planners and designers must ensure that lot and site designs conform to standards or requirements stated in installation and family housing master plans. The goal of neighborhood design for military family housing is to develop and sustain a residential environment that responds to the military family, and reinforces the connection between families and community.

**2-1.2 Neighborhood Development.**

In designing or improving a neighborhood, an important planning element is to understand the nature of the housing area—the relationship of each dwelling unit to a cluster of units, neighborhood, and community as a whole. Housing areas should be planned so that community members can identify “their own” place in the overall neighborhood. Plan the site so that housing units are clustered into mini- or sub-neighborhoods, or are organized around a central element, such as a cul-de-sac or common area. In existing housing areas, break up large areas into smaller clusters or neighborhoods, where feasible. See Table 2-1, below, for guidance in site planning.

**Table 2-1. Maximum Units per Building Type and Grade**

Unit Type	Apartment	Townhouse	Duplex	Detached
O6-O7+	N/A	N/A	N/A	X
E9, W4/5, & O4-O5 - 3-4 BR	N/A	N/A	X	X
W1/3, O1-O3 - 2-5 BR	8	6	X	X
E7-E8 - 4-5 BR	8	6	X	X
E7-E8 - 2-3 BR	12	8	X	N/A
E1-E6 - 4-5 BR	8	8	X	N/A
E1-E6 - 2-3 BR	12	8	X	N/A

N/A – Not Applicable; X – Permitted Dwelling Type;

**Note:** Excludes foreign mid-rise and high-rise construction. Individual Services may have requirements that vary from these recommendations.

## 2-2 **SITE DESIGN**

### 2-2.1 **Site Planning.**

Site designs should ensure that construction avoids, to the maximum extent practicable, wetlands, coastal and shoreline zones, and natural habitats when making neighborhood improvements or executing construction projects. These projects must undergo environmental impact analyses in compliance with the 1969 *National Environmental Policy Act (NEPA)* as implemented by Council on Environmental Quality regulations found at 40 CFR 1500-1508.

New units should not be constructed in a 100-year floodplain. New housing must be located in compatible areas with respect to aircraft noise, as established in DODINST 4165.57 (Nov. 1977), *Air Installation Compatible Use Zone (AICUZ)*. Military Family Housing sites should have a maximum Day-Night Average Level (DNL) rating of 65. These standards also apply to housing sites near heavily traveled highways or other noise generating facilities. New Military Family Housing will not be located within any runway Clear Zone or Accident Potential Zone (APZ I or APZ II).

Site preparation and site improvements, required exclusively for support of a housing project, should be included in the design and be included in total project cost. Site preparation work includes demolition of existing structures, correction of drainage problems and unsuitable subsurface conditions, clearing, grubbing, and rough grading as applicable. Site improvements include utility systems, roads, streets, curbs and gutters, walks, driveways, off-street parking, recreation areas, bike and jogging paths, lawns, landscaping, and finish grading as required to support function and livability of housing.

### 2-2.2 **Site Development.**

Objectives of site development are to:

- Plan and provide adequate infrastructure;
- Use residential building blocks to create neighborhood identity;
- Orient buildings and paved surfaces to optimize solar control and minimize heat-islands;
- Strengthen the neighborhood with efficient traffic patterns for vehicles and pedestrians;
- Create a full range of private and shared recreational facilities; and
- Use sustainable landscape design to minimize impact on the environment and reduce water consumption.

2-2.3 **Site Density.**

Densities for family housing projects, expressed in units per acre, are listed in Table 2-2. Density ranges represent minimums and maximums for new construction, and other acquisition projects, based on geographical location of the facility and target ranges for existing housing areas. The program benchmark density should be the median value.

**Table 2-2. Site Densities**

Density Factors – Number of Units per Acre		
Low <sup>1</sup>	Medium <sup>2</sup>	High <sup>3</sup>
4-6	7-10	11-15

1. Suburban, moderately developed, and rural areas.
2. Developed urban areas, not included under “High” location.
3. Dense metropolitan areas and most overseas locations where land is not available to meet at least medium density. Only in exceptional cases will high-rise building density of up to 40 units per acre or 100 units per building be programmed.

2-3 **PUBLIC RECREATIONAL FACILITIES AND SITE AMENITIES**

2-3.1 **General.**

Each neighborhood, or cluster of housing units, should have open areas, picnic tables, benches, children’s play equipment, and other recreation facilities for common use. Each neighborhood should have age-appropriate play lots for children, common open areas, landscaped areas with trees, picnic area, sitting areas, walking, bike and jogging paths, and other recreation activities for common use by the residents. Each housing area should have specialized recreation facilities, including large open playfields and courts, room for support facilities, bike, jogging, and walking paths, and wooded natural landscape areas. Provide site amenities and recreational facilities as specified in Table 2-3, based on number of family housing units in the neighborhood. Playground equipment and surfaces must comply with the following standards:

- ASTM F1487 – *Standard Consumer Safety Performance Specification for Playground Equipment for Public Use*
- ASTM F1292 – *Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment*
- ASTM F1951 – *Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment*

For guidelines on safety of playgrounds, review CPSC Publication No. 325 – *Handbook for Public Playground Safety*.

**Table 2-3. Site Amenities**

ITEM	QUANTITY OF AMENITIES
School bus stop enclosures	1 per 100 housing units, as required
Benches	2 per tot lot, play lot, rec. court, and playfield
Bicycle racks	1 per tot lot, play lot, rec. court, and playfield
Trash receptacles	1 per tot lot, play lot, rec. court, playfield, picnic and sitting areas, mailbox cluster
Tot lots (2-5 year olds) +	1 per 50 housing units
Play lots (6-10 year olds) +	1 per 100 housing units
Picnic areas	1 per 50 housing units
Natural landscaped areas	1 per neighborhood (optional)
Common open areas	1 per neighborhood (optional)
Open playing fields	1 acre per 100-200 housing units
Tennis courts	1 per 150 housing units (optional)
Basketball courts	1 per 100 housing units
Walkways	1 per neighborhood
Bike paths*	1 per neighborhood
Jogging paths*	1 per neighborhood

+ Both DoD & CPSC Safety Standards apply.

\* Bike and jogging paths may be combined, and should be connected to existing paths, where applicable.

### 2-3.2 Support Facilities.

Concurrent with the planning of new or improvement housing projects, consider the need for support facilities, such as housing management offices, housing maintenance facilities, self-help centers, and community centers. Table 2-4 provides typical sizes in square feet for Support Facilities, based on Installation, activity, and housing inventory. Support Facility design should be based on installation and activity size. The actual support facility design must be customized based on actual personnel demand and other site-specific criteria.

**Table 2-4. Support Facilities**

	SMALL	MEDIUM	LARGE	REGIONAL
Housing Management Office	2,000 - 3,400 SF	3,500 - 5,000 SF	5,100 - 9,000 SF	>10,000 SF
Community Center	2,000 - 4,000 SF	6,000 SF	8,000 SF	>10,000 SF
Self-Help Center	2,000 - 3,000 SF	4,000 SF	6,000 SF	>12,000 SF
Housing Maintenance Facility	>3,500 SF	5,500 SF	>6,300 SF	

**2-3.3 Housing Management Offices.**

When housing offices are authorized to support military family housing projects, they must be designed to meet the functional requirements of authorized housing management staffing levels. Housing offices located in the project area should be architecturally compatible with the housing unit design and installation architectural standards.

**2-3.4 Community Centers.**

Family and community support and service centers may be authorized as required to provide services to military personnel and their dependents. Construction of family housing community centers should not be considered when housing projects or complexes have less than 250 family units or community recreational facilities are convenient and sufficient to support the housing project. Community Centers located in the project area should be architecturally compatible with the housing unit design and installation architectural standards. Where possible, the Community Centers and Housing Management Offices should be co-located.

**2-3.5 Housing Maintenance Facilities and Self-Help Centers.**

When housing maintenance or self-help facilities are authorized to support military family housing projects, they must be designed to meet the functional requirement. Facilities located within a housing area should be architecturally compatible with the surrounding units and installation architectural standards.

## CHAPTER 3 SITE ENGINEERING

### 3-1 VEHICULAR AND PEDESTRIAN CIRCULATION

#### 3-1.1 General.

Vehicular and pedestrian circulation systems should provide convenient and safe access and circulation within the housing area, and to adjacent service areas.

#### 3-1.2 Roads and Streets.

Street systems should minimize through traffic in housing areas. Roads and streets must be adequate to accommodate occupant traffic, service vehicles (including maintenance, trash removal, buses, moving vans, and fire fighting equipment), and snow removal equipment where applicable. The development of improved vehicular circulation systems is one of the best ways to strengthen identity of neighborhoods. Although the street system should provide safe, convenient access to housing units to and from the neighborhood, it must not play a dominant role with respect to overall housing area environment. The street system should defer to, and be supportive of, pedestrian-oriented systems and should be designed with the following hierarchy of street types:

##### 3-1.2.1 Residential Street.

A residential street should have a minimum width of 6.1 m (20 ft), with 3.0 m (10 ft) wide travel lanes. A residential street carries low volumes of traffic and functions as access to each housing cluster.

##### 3-1.2.2 Collector Street.

Collector streets should have a minimum width of 7.3 m (24 ft), with 3.7 m (12 ft) wide travel lanes. Collector streets handle traffic from a group of clusters and respective residential streets. Do not locate housing units on collector streets.

##### 3-1.2.3 Arterial Street.

Arterial streets should be a minimum of 9.1 m (30 ft) wide, with 3.7 m (12 ft) wide travel lanes, and 0.9 m (3 ft) wide shoulders on each side. Arterial streets are major streets that carry traffic from collector streets and provide access to other areas of the Installation. Do not locate housing units on arterial streets.

#### 3-1.3 Curb, Gutter, and Sidewalk.

Curbs and gutters should be provided on all new streets. Sidewalks are required on at least one side of each street (see paragraph 3-1.5 for additional information on sidewalks). A "greenbelt" space should separate sidewalk and curb for pedestrian

safety. Depress standing curbs at driveways, intersection corners, cross walks, and wheelchair accessibility ramps.

#### 3-1.4 **Driveways.**

Driveways should have a minimum width of 3.0 m (10 ft). The minimum length for driveways utilized for off-street parking should be 7.3 m (20 ft), measured from edge of sidewalk.

#### 3-1.5 **Pedestrian Circulation.**

Provide pedestrian-oriented circulation systems. Pave sidewalks and walks, and provide appropriate surfaces for jogging, exercise, and bike paths. Walkways should provide pedestrian access to and from housing units, public sidewalks, and other common use areas. Walkways should be a minimum of 1.2 m (4 ft) wide, and jogging paths and bikeways should be a minimum of 1.8 m (6 ft) wide. Pedestrian circulation should be separated from vehicular circulation as much as possible. Walks must conform to UFAS provisions.

#### 3-1.6 **Signage and Lighting.**

Provide street signs and markings according to Federal Highway Administration (FHWA) *Manual of Uniform Traffic Control Devices*, and applicable individual Military Service Sign Standards. Guidance for minimum lighting of walkways, streets, and parking areas is available from the Illuminating Engineering Society of North America (IESNA). Foreign locations must also adhere to Host Nation standards for street signs and markings.

**Note:** UFC 3-530-01, *Design: Interior and Exterior Lighting and Controls*, provides **Army** and **Navy** guidance on the use of IESNA standards.

### 3-2 **PARKING**

#### 3-2.1 **Private Parking.**

Each unit should have a minimum of two off-street parking spaces. Indented, 90-degree, and gang parking are not desirable. Parking areas should be designed to comply with Installation specifications and Family Housing Master Plans. Each parking space provided in a garage, carport, or driveway counts as a parking space. Provide guest parking of an additional 0.5 spaces per unit. Where necessary in high density areas, 90-degree and gang parking, and 0.25 guest parking spaces per unit, may be allowed.

### 3-3 **STORM WATER MANAGEMENT**

#### 3-3.1 **General.**

Develop a storm water management system using 10-year storm frequency methodology and local requirements. Low Impact Development (LID) principles for storm water management, such as decentralized storm water retention, should be used in the land development process to conserve and protect natural resource systems and reduce infrastructure costs. **Note:** Consider children's safety in design and construction of storm water structures.

**Note:** UFC 3-220-10, *Low Impact Development*, provides additional information for applying these strategies to projects.

#### 3-3.2 **Storm Water Runoff.**

Areas should be designed for positive drainage away from housing units. Finish grade around perimeter of each housing unit should slope a minimum of 5% (15 cm (6 in) fall in 3.0 m (10 ft)) to carry surface water away from foundation walls. Where lot lines, walls, slopes, or other physical barriers prohibit 15 cm (6 in) fall in 3.0 m (10 ft), drains or swales should be provided to ensure drainage away from structure.

#### 3-3.3 **Foundation Drains.**

Drains should be provided in accordance with *IRC* or *IBC*.

### 3-4 **UTILITIES**

#### 3-4.1 **Meters and Meter Bases.**

Meter bases should be provided to facilitate installation of individual gas and electric meters at a later date. Provide visual screening for meters and meter bases, and do not locate meters adjacent to unit entrances.

#### 3-4.2 **Co-location of Utilities.**

Where feasible, and acceptable to local utility supplier or servicing agency, use common trenches for two or more utilities and applicable underground utility marking protocol.

#### 3-4.3 **Corrosion Control.**

Protect all ferrous materials in underground utility systems from corrosion as appropriate and required by local conditions.

## CHAPTER 4 FAMILY HOUSING SIZE AND FEATURE STANDARDS

### 4-1 UNIT SIZE BENCHMARKS

#### 4-1.1 Family Housing Size Standards.

Table 4-1 provides family housing standards for unit size by rank and number of bedrooms. Title 10 of United States Code, Section 2826 (10 USC 2826) directs the Services to design and construct military family housing to local standards.

**Table 4-1. Unit Floor Area**

Rank and Number of Bedrooms	Programming Benchmark <sup>3</sup>		Construction Minimum	Construction Maximum
	(GSF) <sup>1,2</sup>	GSM (m <sup>2</sup> )	(GSF) <sup>2</sup>	(GSF) <sup>2</sup>
O7 - 4BR	3330	309	2600	4060
O6 - 4BR	2520	234	2110	2920
O4-O5 - 4BR	2310	215	1920	2700
O4-O5 - 3BR	2020	188	1740	2300
E9 & W4/5 - 4BR	2310	215	1920	2700
E9 & W4/5 - 3BR	2020	188	1740	2300
E7/8-W1/3-O3 - 5BR	2510	233	1920	3090
E7/8-W1/3-O3 - 4BR	2150	200	1800	2500
E7/8-W1/3-O3 - 3BR	1860	173	1670	2050
E7/8-W1/3-O3 - Mod-2BR <sup>4</sup>	1670	155	1420	1920
E7/8-W1/3-O3 - 2BR	1490	138	1180	1790
E1-E6 - 5BR	2300	214	1920	2670
E1-E6 - 4BR	1950	181	1670	2220
E1-E6 - 3BR	1630	151	1490	1760
E1-E6 - Mod-2BR <sup>4</sup>	1480	137	1330	1630
E1-E6 - 2BR	1340	125	1180	1500

- 10 USC 2826 requires construction project documentation (DD-1391) to specify net square footage being constructed. See Appendix C, Unit Net Area Calculations, for a graphic example of net and gross area calculations.
- Add up to 27.9 m<sup>2</sup> (300 ft<sup>2</sup>) for harsh climates. Harsh climates are defined as having more than 7,500 Heating Degree-Days (HDD), annually, or 5,500 Cooling Degree-Days (CDD), annually.
- Gross floor area may be increased by 10% for housing units for an officer holding a special command position, for the commanding officer of a military installation, and for the senior non-commissioned officer of a military installation.
- Mod-2BR – Modified Two Bedroom unit adds a room with closet and 3/4 bath to two-bedroom unit. The additional room is designed to serve as a den/bedroom. Mod-2BR should be limited to one-story housing unit only.

#### 4-1.2 Unit Floor Area Calculation.

Gross floor area should be calculated using *American National Standard for Single-Family Residential Buildings, Square Footage-Method for Calculating*: ANSI Z765. Net floor area is defined as the area within interior faces of exterior walls and party walls of living units, with the following exclusions:

- Utility Rooms and Laundry Rooms;
- Interior and Exterior Bulk Storage;
- Space for washer and dryer, maximum area of 2.8 m<sup>2</sup> (30 ft<sup>2</sup>), when not located in separate utility or laundry room;
- Space for furnace or boiler, water heater, heat pump, or solar equipment, if any, when not located in separate utility room;
- Stairways on each floor (including intermediate landings between floors);
- Stair landing at each floor level, maximum 0.9 m<sup>2</sup> (10 ft<sup>2</sup>) per floor;
- Finished space under stairs;
- Unfinished attic space;
- Unfinished basement space;
- Porches (open, screened, or enclosed), which are not heated, cooled, or insulated, and which retain basic characteristics of a porch;
- Arctic entries, maximum area of 1.8 m<sup>2</sup> (20 ft<sup>2</sup>), in northern climates;
- Recreation rooms, maximum area of 28 m<sup>2</sup> (300 ft<sup>2</sup>), in harsh climates;
- Terraces, patios, and balconies;
- Carports and garages;
- Common stairway, halls and entries in multifamily dwellings; and
- Areas required, solely to comply with accessibility standards, maximum area of 7 m<sup>2</sup> (75 ft<sup>2</sup>).

**Note:** Appendix C contains examples for calculating net area.

## 4-2 ACCESSIBILITY REQUIREMENTS

### 4-2.1 Installation Requirements.

For the purpose of determining number of adaptable or accessible units required, an installation is defined as the area of responsibility of the Housing Office. For each installation, a minimum of five percent (5%) of units, but not less than one unit of each type must be designed and constructed as an adaptable single-story ground level unit. Design and construct a minimum of two percent (2%) of each unit type, but not less than one unit, as adaptable for persons with hearing disabilities.

### 4-2.2 Site Requirements.

Public elements of the site or project must be accessible, including walkways, tot-lots, playgrounds, etc.

### 4-2.3 Construction Project Requirements.

New and replacement construction and renovation projects must comply with the Uniform Federal Accessibility Standards (UFAS) and the Americans with Disabilities Act Accessibility Guidelines (ADAAG) to the extent that whichever provides the greatest accessibility will govern. The term "Accessible" is defined as a site, building, facility, or portion thereof that complies with the latest Code of Federal Regulations, Architectural Barriers Act of 1968, as amended, and ADAAG. The term "Adaptable" is defined as the ability of certain spaces and elements to be added or altered so as to accommodate the needs of either disabled or non-disabled persons, or to accommodate needs of persons with different types or degrees of disability.

### 4-2.4 Renovation Project Requirements.

Renovation projects must comply with accessibility standards when their scope of work includes "Alterations" of existing dwelling units, unless requirements for the Installation have been satisfied. Alterations are defined as work that modifies the functional arrangement of a unit, or moves load-bearing structures or members within unit. As an example, replacement of kitchen cabinets in-kind is not an alteration, but modifying kitchen and dining areas while installing new cabinets is an alteration. Specially designated units should be constructed or improved in accordance with ADAAG.

## 4-3 UNIT DESIGN

### 4-3.1 General.

Centrally locate and arrange circulation space to serve as many functional areas as possible without the need for extended hallways. Consider multiple furniture placement layouts in determining location of windows and doors, electrical outlets and switches, and HVAC supply and return outlets (or radiators located underneath windows as commonly used in foreign construction).

#### 4-3.2 **Bathrooms.**

Locate full bathrooms near bedrooms and out of sight of other areas of the house. In two-story units, a half-bath should serve the first floor. When a half-bath is provided on the main floor, consider access to both guests and family activities. Open a half-bath to circulation space rather than to a habitable room. In units having three or more bedrooms, the master bedroom should have a private full bathroom. Include a tub with shower assembly in at least one full bathroom in each unit.

#### 4-3.3 **Bedrooms.**

Family housing units must include a master bedroom, plus one or more additional bedrooms. Separate these sleeping areas from all other functional areas of the house, conveniently located near bathrooms. Provide access to bathrooms from bedrooms, without passage through other rooms of the house. For new construction bedrooms should be designed to accommodate a king size bed in master bedroom, and a full size bed in other bedrooms. In new construction, units for the rank of O7+ should have a bedroom located on ground floor adjacent to public areas with a private full bath.

#### 4-3.4 **Breakfast Area.**

A secondary eating area may be provided in the form of an oversized kitchen, breakfast bar, or family room and dining area. This secondary eating area may be in direct sight of food preparation areas, but not in direct sight of a bathroom.

#### 4-3.5 **Dining Room.**

The primary eating area may be a separate dining room, or combined dining and living room. If so, it should be of adequate size to accommodate a table and chairs, and china cabinet or buffet. The dining room should not be in direct sight of bathrooms or food preparation area. Design the circulation pattern through the dining room so that traffic flow is directed along one wall, and not through middle of room. Provide a separate dining room for O7+.

#### 4-3.6 **Entrance Foyer.**

Provide each housing unit with a lighted foyer and nearby coat closet. Locate entrance adjacent to living room. Provide access to other areas without passing directly through the living room, unless the living room width includes the minimum living room space and circulation width. Foyers should have a minimum dimension of 1.2 m (4 ft), and entrance door should not be in direct sight of living room. For renovations and improvements consider entrance foyer requirement whenever it is economically feasible.

#### 4-3.7 **Circulation.**

Hallways, stairways, and stairwells should be dedicated to circulation. Particular attention should be given to these areas to minimize floor space lost to circulation. Proper placement of door openings can produce more usable floor space. Design circulation areas to permit movement of a queen size box spring. Minimum hallway width of 1.1 m (3 ft 6 in) is recommended.

#### **4-3.8 Kitchen Area.**

Locate kitchen adjacent to dining room and family room, with direct access to each. Provide a visual separation between kitchen and all formal living areas. Convenient access from kitchen to a covered parking area, and to interior utility and exterior service areas, is desirable. Provide 1.2 m (4 ft) minimum space between fronts of cabinets.

#### **4-3.9 Laundry Area.**

Provide a laundry area large enough to accommodate side-by-side washing machine and dryer, plus shelving or cabinets for storing laundry supplies, located out of sight of entry, entertainment, and eating areas, and within conditioned space. Do not locate laundry area within a bedroom, bathroom, or kitchen. Exhaust from moisture-producing equipment (e.g. clothes dryers) must be vented to the exterior.

**Note:** Ventless clothes dryers are not acceptable in humid area locations.

#### **4-3.10 Living Room - Family Room.**

Units with three or more bedrooms should be provided with a family room, separate from the living room. Each room should include one wall with a minimum length of 3 m (10 ft) to accommodate a sofa and end tables. Often several compatible living functions can be combined advantageously into a single "Great Room." However, this Great Room should be able to accommodate multiple furniture arrangements associated with spaces that are combined. Benefits of such arrangements are that the combined space can be used more efficiently. For adjacent spaces to be considered a combined room, a clear opening between them, at least 2.4 m (8 ft) wide, should permit concurrent and separate use of the space. Minimum dimension of living room should be 3.6 m (11 ft 8 in).

#### **4-3.11 Interior Storage and Closets.**

Provide storage areas in the form of clothes closets, linen closets, and bulk storage in housing unit for seasonal personal effects. Interior bulk storage is in addition to required closet area and exterior storage. Minimum interior bulk storage space of 1.5 m<sup>2</sup> (16 ft<sup>2</sup>) should be provided.

#### 4-3.12 **Interior Finishes.**

##### 4-3.12.1 **Acceptable Interior Finishes.**

Select sustainable materials and finishes to achieve a balance between occupant convenience and satisfaction, appearance, durability, maintenance cost, and life cycle cost.

##### 4-3.12.2 **Flooring.**

Carpet may be installed in all living areas except kitchens, baths, laundry areas, utility areas, storage rooms, entryways, patios, porches, and areas exposed to weather elements. Install Carpet and Rug Institute (CRI) "IAQ" labeled carpet, pad, and adhesives, and underlayment that complies with flooring manufacturer's recommendations (foreign locations may adhere to local carpet standards and manufacturers guidelines).

##### 4-3.12.3 **Ceilings.**

Cathedral or vaulted ceilings are encouraged to improve the visual quality of living spaces. For new construction, minimum ceiling height should be 2.4 m (8 ft), except where minor drops occur for structural or utility soffit requirements.

#### 4-3.13 **Cabinets and Countertops.**

Cabinet boxes should be minimum 12.7 mm (1/2 in) hardwood plywood. Cabinet backs and drawer bottoms should be minimum 6.4 mm (1/4 in) hardwood plywood. Shelving should be 15.8 mm (5/8 in) hardwood plywood matching front edge banding. Hanging or mounting rails, and toe kicks, should be a 19 mm (3/4 in) hardwood. Cabinet frames, doors and drawer fronts should be 19 mm (3/4 in) hardwood. Drawer boxes should be 15.8 mm (5/8 in) hardwood plywood, with dovetail or box joints, mounted on full extension guides, rated for minimum 34 kg (75 lbs). Provide adjustable, cup type, hinges having a minimum 105-degree swing. Cabinets and countertop underlayment must comply with ANSI A208.2 or ANSI/HPVA HP-1 standards for low formaldehyde emissions. Sustainable alternative materials should be considered where they provide comparable strength, quality and durability.

#### 4-4 **OUTDOOR LIVING AREAS**

##### 4-4.1 **General.**

Each family dwelling unit should have an adjoining private or semi-private outdoor space, partially or completely surrounded by privacy screening, unless space is considered impracticable because of density or location.

#### 4-4.2 **Balconies.**

Each living unit located entirely above ground floor should have a balcony with no dimension less than 1.8 m (6 ft). Construct balconies using solid decks with an impervious surface, sloped to drain to outer edge. Provide direct access from balcony to living room, dining room, or family room.

#### 4-4.3 **Patios and Decks.**

Screen patios and decks from streets, common areas, and adjacent living units. Provide direct access from patios and decks to living room, dining room, or family room areas. For each living unit that opens to the exterior at ground level, provide a minimum patio area of 11.2 m<sup>2</sup> (120 ft<sup>2</sup>) with a minimum dimension of 2.4 m (8 ft). An acceptable alternative is a raised deck of the same size, constructed of weather-resistant materials. Consider using sustainable materials, such as post-consumer recycled plastics and certified wood, for deck and screen construction.

#### 4-4.4 **Exterior Stairs.**

Design stairs to permit movement of a queen-size bed box spring. Exterior stairways serving multiple units should be sheltered from wind and precipitation. Wood exterior stairs are prohibited. Stairs should have a minimum width of 1.1 m (3 ft 6 in).

### 4-5 **FOUNDATIONS**

#### 4-5.1 **General.**

Design foundations in accordance with UFC 1-200-01 and the *International Residential Code* (IRC).

#### 4-5.2 **Basements.**

Basements may only be provided when proven to be cost effective on a life-cycle cost basis related to economics, energy efficiency, operations and maintenance, structural integrity, and site constraints.

#### 4-5.3 **Slabs-on-Grade or Crawl Spaces.**

Type, thickness, and location of insulation should comply with applicable provisions of ASCE 32-01 (Frost-Protected Shallow Foundations), and *IBC* or *IRC*.

#### 4-5.4 **Tornado Resistance.**

Design and construction of tornado-resistant shelters in dwelling units and community shelters are recommended for installations in CONUS tornado-prone areas. For guidance in determining the probability of tornadic gust winds, refer to ASCE 7 –

Commentary, Figure C6-1A. *Tornadic Gust Wind Speed Corresponding to Annual Probability of Occurrence*, and the following publications:

- FEMA 320 – *Taking Shelter from the Storm: Building a Safe Room Inside Your House*.
- FEMA 361 – *Design and Construction Guidance for Community Shelters*.
- FEMA – *National Performance Criteria for Tornado Shelters*.

## 4-6 ROOF AND ATTIC CONSTRUCTION

### 4-6.1 Roofs.

Roofs should slope a minimum of 4:12 for maintainability, and to provide residential scale to the neighborhood. Wood shingles and shakes are prohibited. Design roof overhangs, gutters and downspouts, roofing materials, and attic ventilation in accordance with roofing installation standards to conserve energy and reduce maintenance costs. See UFC 3-190-04FA *Roofing and Waterproofing*, for additional guidance. Roofs should have minimum eave overhangs of 30 cm (12 in), and gable overhangs of 15 cm (6 in). Roofing material should comply with Energy Star<sup>®</sup> recommendations.

### 4-6.2 Attics.

Attic power ventilation should be provided, when proven to be life-cycle cost effective. Do not terminate exhaust fans or plumbing vents in attic, unless plumbing vents have air admittance valves (AAV) that comply with *IRC* provisions.

## 4-7 EXTERIOR CONSTRUCTION

### 4-7.1 General.

Use sustainable, low maintenance finish materials, such as brick, integrally-colored concrete masonry, integrally colored stucco, factory finished vinyl-clad steel, vinyl siding, fiber-cement siding, and drainable exterior insulated finish systems. Avoid materials requiring field finishing. Provide vapor barrier/diffusion retarder as required by dew point analysis. Aluminum siding should not be used.

### 4-7.2 Windows.

Provide windows that meet minimum egress requirements in NFPA 101, *Life Safety Code*. Operable windows must be manually operated and lockable. Provide non-ferrous screens for operable windows. Maximize amount of natural light in living areas. Consider passive solar energy impact on heating and cooling loads when selecting, sizing, and locating windows. Window energy performance should comply with Energy Star<sup>®</sup> recommendations. Tilt-in windows are recommended to facilitate cleaning by

occupants. Provide glass door and window treatments for occupant privacy. Window screens should be provided for operable windows in habitable rooms and spaces. Windows above ground floor should have screens capable of withstanding a minimum force of 60 pounds (27 kg) as a concentrated load applied to the middle of the screen. Screens must be removable for window cleaning and emergency egress purposes without the use of any special tools. Removable window guards or child safety locks may be provided in lieu of reinforced window screens.

#### 4-7.3 **Wall Framing.**

Use of “Advanced Framing Techniques - Optimum Value Engineering (OVE)” framing is recommended.

#### 4-7.4 **Exterior Doors.**

Provide insulated exterior doors for increased energy performance. Provide dead-bolt locks on all hinged entry doors. Provide impact-resistant side light at entry door, or a wide-angle viewer. Door energy performance should comply with Energy Star<sup>®</sup> recommendations.

#### 4-7.5 **Main Entry.**

Design main entries to provide a sense of identity for each individual unit. Visual impact from the street is extremely important. Avoid a common entry to several units. Each unit should have an appropriate number or letter designation. Provide each front entrance with a door chime or door knocker. Provide a slip-resistant finish for porch surfaces. Protect entry door with a minimum 0.6 m (2 ft) overhang, or covered porch. Provide interior and exterior lighting at each main entrance.

#### 4-7.6 **Garages or Carports.**

For new construction, a minimum of one-car garage should be provided for each unit. For renovation projects, garages or carports should be provided as the site allows. Enclosed bulk storage may be included in the garage or carport. Garages should be attached to housing unit they serve. If garages cannot be attached, locate them as close as possible to kitchen and service area of house. Design garages to compliment architectural features, materials, and roof slopes of house. Provide light switches and duplex convenience outlets in each garage. Garage floor surface must be a minimum of 10.2 cm (4 in) lower than finished floor of attached housing unit; slope floor to drain liquids away from unit walls. Design and construct any attached garages to prevent infiltration of contaminants into housing units.

#### 4-7.7 **Exterior Storage.**

Provide an outside service door opening to exterior storage areas, wide enough to accommodate lawn mowers and typical lawn tools, except when storage is provided in

garage. Locate outside service door near outdoor living and lawn areas. Provide paved access to the door. Provide a switch-controlled light at outside service door. Recommended exterior storage space is 2.8 m<sup>2</sup> (30 ft<sup>2</sup>) for two-bedroom units, 3.7 m<sup>2</sup> (40 ft<sup>2</sup>) for three-bedroom units, and 4.7 m<sup>2</sup> (50 ft<sup>2</sup>) for four- and five-bedroom units.

**4-7.8            Trash Enclosure.**

Provide each living unit with a paved pad area large enough for two 114-liter (30-gallon) containers, plus any recycling containers required by the installation. Locate pad near trash pick up point, and provide paved access for occupant. Locate trash area outside living unit envelope. If visible from street, common area, or other living units, provide a trash enclosure or screening. Garages and carports may be designed to provide adequate trash container enclosures. Locate any dumpster areas in areas least offensive to housing occupants, and provide adequate shielding with fencing or screening.

## CHAPTER 5 BUILDING SYSTEMS

### 5-1 UTILITIES

#### 5-1.1 General.

Fuel oil, liquid petroleum gas, and propane heating systems are acceptable when determined to be cost effective from a life-cycle cost basis.

#### 5-1.2 Metering.

Master meters or individual unit meters are required for family housing areas to accurately monitor the consumption and cost data for electricity, gas, and water utilities.

#### 5-1.3 Lighting.

Provide exterior lighting, controlled from inside the living unit, at each exterior door and in carport or garage. As a minimum, provide wall-switched overhead light fixtures in kitchen, dining room, bedrooms, walk-in closets, bathrooms, halls, stairs, and utility/storage rooms. An electrical wall outlet should be located in hallway near bedrooms. Unit lighting fixtures should have a minimum overall Light Efficacy Rating (LER) of 65, including ballasts. For further guidance, see standards and *Lighting Handbook* published by the Illuminating Engineering Society of North America (IESNA). Wall switch operated and Energy Star® labeled ceiling fans in living/dining area, family room, and bedrooms are desirable. Fans should be provided with compact fluorescent fixtures with T-4 827 lamps.

**Note:** UFC 3-530-01AN provides **Army** and **Navy** guidance for use of the IESNA *Lighting Handbook*.

#### 5-1.4 Telephone Systems.

The telephone company serving the installation should be responsible for installing and maintaining the telephone distribution system up to the demarcation point (the point where the telephone company wiring connects to government owned wiring). Telephone service wiring within units should be a minimum of Category 5 wiring located in kitchen, living room, family room, dining room, and all bedrooms, with multiple modular jacks compatible with furniture arrangements. Multiple communication jacks are desirable. Install a 2.5 cm (1 in) diameter conduit from telephone house connection location to attic, basement or crawl space, to facilitate future telecommunication wiring.

#### 5-1.5 Television Systems.

Where commercial cable TV (CATV) service is available, the CATV service contractor (franchisee) should be responsible for installing and maintaining the distribution system from signal source to final connections at building termination. Provide, as a minimum, duplex pre-wired cable TV/television antenna outlets in living room, family room, and

bedrooms, with duplex jacks. Ensure that outlet locations are compatible with various furniture arrangements.

## 5-2 **WATER SYSTEMS**

### 5-2.1 **General.**

Comply with UFC 3-420-01, *Design: Plumbing Systems*, FEMP, and EPA Energy Star<sup>®</sup> recommendations.

### 5-2.2 **Water Supply Cutoff.**

Provide an interior shut-off valve on water supply line entering each housing unit. Provide a curb stop/shut-off valve for each building that is located close to the water main.

### 5-2.3 **Exterior Hose Bibs.**

Provide hose bibs in easily accessible locations at front and rear of each ground floor living unit, and provide frost-proof hose bibs in areas subject to freezing temperatures.

### 5-2.4 **Domestic Hot Water.**

Water heater efficiency should comply with FEMP recommendations. A “heat trap” must be provided with all water heaters. Hot water piping should be protected with a minimum R-5 insulation. The first 1.5 m (5 ft) of cold water supply to water heater tank should also have minimum R-5 insulation. Where fuel-fired domestic water heaters are provided, sealed combustion units are recommended.

## 5-3 **SANITARY SEWER**

### 5-3.1 **General.**

Provide Drain-Waste-Vent (DWV) plumbing that complies with basic criteria in UFC 3-420-01. Locate vent stacks to rear of housing units, and consolidate or eliminate through-the-roof penetrations, when possible.

### 5-3.2 **Condensate and Overflow Drains.**

Provide drains for air-conditioning condensation, humidifier overflow, occupant-supplied washing machines, and water heater drain and relief valves. Drains should discharge to exterior or to waste water drain.

## 5-4 **GAS DISTRIBUTION**

### 5-4.1 **General.**

Fuel gas piping systems, fuel gas utilization equipment and related accessories, venting systems, and combustion air configurations must comply with applicable provisions of the *IBC* and the *IRC* as modified by UFC 1-200-01, and NFPA 54 and NFPA 58.

5-4.2           **Metering.**

Provide meter bases to facilitate installation of individual gas meters at a later date.

5-5               **ELECTRICAL DISTRIBUTION**

5-5.1           **General.**

Design and install electrical systems to conform to applicable criteria in NFPA 70, *National Electrical Code* and applicable provisions of *IBC* or *IRC*. Transformers or any other items containing PCBs are prohibited. Provide new electrical distribution systems with underground primary and secondary feeds, where feasible.

5-5.2           **Service Panel.**

Provide 150 amp minimum electrical service to each living unit (200 amp where heat pumps or air conditioning are provided). However, 200 amp service is recommended for all housing units. Locate service panel within dwelling unit, easily accessible to occupant, but not in living areas.

5-5.3           **Metering.**

Provide meter bases to facilitate installation of individual electric meters at a later date. Automated Meter Reading (AMR) meters, complying with ANSI/NEMA standard, *C12.1 Code for Electricity Metering*, should be installed.

5-6               **HEATING, VENTILATING AND AIR CONDITIONING (HVAC)**

5-6.1           **General.**

Design HVAC systems in accordance with applicable provisions of UFC 3-410-01FA, *Design: Heating, Ventilating, and Air Conditioning*, and ACCA Manuals D, J, and S. Equipment should be Energy Star® labeled. Sealed combustion heating units are recommended. Portable room heaters, floor furnaces, and heat lamps are prohibited. Electric resistance heat is not recommended, except as backup for heat pump systems, or when determined cost-effective on a life-cycle basis. Bedrooms should have a return air register, transfer grill, or undercut door to maintain pressure balance within the house. Ducts should be placed within the conditioned building envelope. Maximum duct leakage is six percent (6%), when tested in accordance with ASTM E-1554.

5-6.2           **Air Conditioning.**

Provide air conditioning in locations where during the six warmest months of the year dry bulb temperature is 26.7 degrees C (80 degrees F), or higher for over 650 hours; or wet bulb temperature is 19.4 degrees C (67 degrees F), or higher for over 800 hours in accordance with OMB Circular A-45. Window or through-wall units should not be used to provide air conditioning.

**5-6.3 Temperature Control.**

Provide Energy Star<sup>®</sup> labeled programmable (set-back) thermostats in new construction, and major revitalizations.

**5-6.4 Ventilation.**

Provide an exhaust fan (maximum 1.5 sone) in each bathroom, and an exhaust fan (maximum 5.0 sone) in each kitchen. Exhaust fans must discharge to exterior; discharging into attic or crawl space is prohibited. Provide mechanical ventilation in accordance with ASHRAE 62.2.

## CHAPTER 6 FIRE AND LIFE SAFETY

### 6-1 FIRE AND LIFE SAFETY

#### 6-1.1 General.

Design, construct, and improve family housing projects to comply with *IBC*, as modified by UFC 01-200-01, UFC 3-600-01, and *IRC*.

#### 6-1.2 Flame-Spread and Smoke-Developed Indices.

Materials must have flame-spread (FS) and smoke-developed (SD) indices in accordance with UFC 3-600-01.

#### 6-1.3 Smoke Alarms.

Provide hard-wired smoke alarms with battery backup, in accordance with UFC 3-600-01. Interconnect alarm devices in such a manner that actuation of one alarm will activate all other alarms in an individual unit. Provide an audible-visible type smoke detection device in housing unit where there is a vision or hearing impaired occupant.

#### 6-1.4 Automatic Sprinklers.

Provide sprinkler protection in accordance with UFC 3-600-01.

#### 6-1.5 Fire-Resistant Separation.

Provide fire and smoke separations in compliance with UFC 3-600-01.

#### 6-1.6 Carbon Monoxide (CO) Alarm.

Provide a CO alarm on each habitable floor of units with combustion equipment, appliances, or fireplace, in accordance with UL 2034, NFPA 720, and NFPA 101. Seal existing homes with attached garages to prevent air infiltration, or provide a CO alarm.

#### 6-1.7 Fire-Retardant-Treated (FRT) Plywood.

Use of FRT plywood is prohibited, except as permitted by the *IBC*. FRT plywood must not be used in any part of the roof or roofing system.

#### 6-1.8 Overseas and Leased Housing Requirements.

Overseas family housing, whether constructed or leased, must comply with UFC 3-600-01. Additionally, provide CO alarms in accordance with paragraph 6-1.6, above.

## CHAPTER 7 ENVIRONMENTAL

### 7-1 ENVIRONMENTAL

#### 7-1.1 General.

Construct installations in compliance with Federal, State, interstate, and local requirements, both substantive and procedural, with respect to lead-based paint, asbestos, radon, and any other housing-related environmental requirements.

#### 7-1.2 Environmental Planning.

Housing improvement and construction projects must comply with environmental laws and regulations, including NEPA. Appropriate environmental analyses in compliance with NEPA must be completed prior to initiating an improvement or construction project.

#### 7-1.3 Asbestos.

Follow OSHA and EPA regulations and guidance for asbestos management, remediation, and abatement. The Department of Defense Environmental Cleanup Program provides insight into this issue. Asbestos materials must not be used in construction, repair or maintenance at shore facilities. Use asbestos -free substitute materials.

#### 7-1.4 Lead-Based Paint.

Follow OSHA, EPA, and HUD regulations, statutes, and guidance for inspection, assessment, in-place management, and abatement of lead-based paint, lead-in-dust, lead-in-soil, and related hazards. The Department of Defense Environmental Cleanup Program provides insight into this issue.

#### 7-1.5 Volatile Organic Compounds (VOC).

Paints should have a maximum VOC concentration of 100 grams per liter (g/l). Use sealants and adhesives that have a maximum VOC concentration of 250 g/l.

#### 7-1.6 Radon.

Follow EPA recommendations for construction and mitigation. Family housing should be designed, constructed, and improved in accordance with EPA document - *Model Standards and Techniques for Control of Radon in New Residential Buildings*, 59 CFR 13402 (March 1994). Guidelines for evaluation and need and required testing can be found in UFC 3-490-04A, *EPA Radon Mitigation Standards*, and UFGS 13287 *Radon Mitigation* (August 2004).

7-1.7        **Freon and Chlorofluorocarbons (CFCs).**

Specify CFC-free refrigerators, air conditioning systems, and insulation options.

7-1.8        **Termiticides.**

In revitalization projects, replace all HVAC ducts in or below the floor slab with an above floor system, to avoid contamination of interior space. Follow OSHA and EPA regulations, statutes, and guidelines for inspection, assessment, and abatement of chlordane.

7-1.9        **Mold.**

Prevention of mold must be considered during design, and be adhered to throughout construction. Humidity and moisture must be controlled to prevent mold growth in buildings.

7-2        **SOUND ATTENUATION**

7-2.1        **Air-Borne Sound.**

Walls, partitions, and floor/ceiling assemblies separating dwelling units from each other or from public or service areas should have a Sound Transmission Class (STC) rating of not less than 50 (45 if field tested) for air-borne noise when tested in accordance with ASTM E 90. Field test assemblies in accordance with ASTM E 336. Do not apply this requirement to dwelling unit entrance doors. However, assure that frames and sills of such doors are tight fitting.

7-2.2        **Structure-Borne Sound.**

Floor/ceiling assemblies should be provided between dwelling units, or between a dwelling unit and a public or service area within the structure. These assemblies should have an Impact Insulation Class (IIC) rating of not less than 50 (45 if field tested), when tested in accordance with ASTM E 492. Assemblies should be tested on site in accordance with ASTM E 1007.

## CHAPTER 8 ENERGY AND WATER CONSERVATION

### 8-1 ENERGY EFFICIENCY AND WATER CONSERVATION

#### 8-1.1 General.

Energy and water conservation standards and policies for new construction have been established to minimize energy and water consumption through applications of developed sustainable energy-efficient designs, construction, improvement, and appliance equipment selections and replacement. Building systems operation should not require special attention by unit occupants. Materials and equipment should be readily available and manufactured by firms of established performance in their field. If it is not practical to meet Energy Star<sup>®</sup> standards in foreign locations, Host Nation energy conservation requirements shall be used.

#### 8-1.2 Energy Performance.

Design, construct, and improve family housing to comply with Energy Star<sup>®</sup> standards and UFC 3-400-01, *Design: Energy Conservation*. Uncontrolled air leakage (infiltration) should be limited to a maximum of 2.5 ACPH at 50 Pascals, in accordance with ASHRAE 119. Use of renewable forms of energy should be considered for all projects, when life cycle cost effective.

#### 8-1.3 Energy Star<sup>®</sup> Qualified Home Inspections.

Contractors must provide certification that all new homes have an Energy Star<sup>®</sup> label. If a sampling protocol is used for post-construction inspections, and a sample home does not pass, inspection and testing of all homes in the group is required. The Contractor is responsible for any repairs necessary to ensure all homes pass inspection.

#### 8-1.4 Energy and Water Conservation.

Executive Order 13123, *Greening the Government through Efficient Energy Management (June 1999)*—which superseded E.O. 12902, *Energy Efficiency and Water Conservation at Federal Facilities (March 1994)*—established guidelines that apply to Military Family Housing. This Order was designed to improve energy management in the Federal Government, thereby saving taxpayer dollars. Specific requirements include a thirty percent (30%) reduction of energy use per gross square foot by 2005; and a thirty-five percent (35%) reduction by 2010, compared to 1985 levels; use of renewable energy, and support of the Million Solar Roofs Initiative. Apply all DOE Water Conservation Best Management Practices (BMPs) appropriate to family housing.

#### 8-1.5 Building Products and Appliances.

New and replacement building products and appliances should be Energy Star<sup>®</sup> qualified and labeled.

8-1.6        **Insulation.**

Insulation should comply with thermal performance guidelines of Energy Star®.

8-2            **WATER CONSERVATION AND LANDSCAPING**

8-2.1        **General.**

Incorporate environmentally and economically beneficial landscape practices required by Executive Order 13148, *Greening the Government through Leadership in Environmental Management (April 2000)*. Landscaping may consist of shrubs, trees, decorative fencing, earth sculpting, rocks or special gardens, and identification signs. Trees, natural areas, and native plant species should be preserved where possible. Grade sites so that slopes follow natural contours as much as possible.

8-2.2        **Plants.**

Plants should be native species that will require minimum maintenance and watering. Xeriscaping design principles, and plants of differing heights, shapes, color, and texture, should be used in landscaping.

8-2.3        **Boundaries.**

Landscape boundaries of neighborhoods to separate neighborhoods and clusters from major streets or incompatible off-site activities, and use landscaping to emphasize and reinforce sub-areas within the community.

8-2.4        **Irrigation.**

Design any irrigation systems to minimize water consumption.

## CHAPTER 9 SUSTAINABILITY

### 9-1 SUSTAINABILITY

#### 9-1.1 General.

Executive Order 13123, *Greening the Government through Energy-Efficient Management (June 1999)*, requires that sustainable design be an integral part of every project. Energy and water conservation are primary goals of sustainable design and development, and are major requirements in complying with E.O. 13123.

#### 9-1.2 Objectives.

Objectives of this sustainability directive include: reduction of greenhouse gas emissions attributed to facility energy use, water conservation, use of recovered and recycled materials, waste reduction, and maintenance of healthful indoor environments. Results will reduce life cycle operating costs for the Services, and improve quality of life for families.

#### 9-1.3 Other Federal Requirements and Guidelines.

Executive Order 13101, *Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition (Sep. 1998)*, establishes affirmative procurement requirements to promote the acquisition and use of products that contain recycled or recovered materials, and environmental services which key components of sustainable development. Many products designated by EPA *Comprehensive Procurement Guidelines* are commonly used in family housing construction including insulation, carpet and carpet cushion, cement and concrete, latex paint, structural fiberboard and laminated paperboard, non-pressure drainage pipe, roofing materials, landscaping products, and playground equipment and surfaces.

Executive Order 13148, *Greening the Government Through Environmental Leadership (April 2000)*, establishes requirements to use environmentally and economically beneficial landscaping practices to promote sustainable management of Federal facility lands and reduce adverse impacts to the natural environment.

The Federal Energy Management Program's (FEMP) *Greening Federal Facilities: An Energy, Environmental, and Economic Resource Guide for Federal Facility Managers and Designers (May 2001)*, can assist stakeholders in reducing energy consumption and costs, improving working environment of those facilities, and reducing environmental impacts of their operations.

### 9-2 BUILDING COMMISSIONING

#### 9-2.1 General.

Commission dwelling units that are tested for ENERGY STAR<sup>®</sup> Labeled Home Performance (except foreign locations where Energy Star<sup>®</sup> standards may not be practical),

to also ensure that building shell and systems function as proposed and specified. Repairs or adjustments made in test homes must also be made to remaining homes in each group. At a minimum, commissioning includes:

- Testing for envelope and duct leakage: Paragraphs 8-1.2 and 5-6.1 specify performance standards,
- Testing for air pressure relationships under operating conditions: Paragraphs 4-7.6 and 5-6.1 specify requirements for garage-to-unit separation and “balancing” indoor pressure,
- Testing for proper ventilation of all combustion equipment and appliances under operating conditions, to ensure they meet manufacturer’s specifications,
- Testing of carbon monoxide output of combustion equipment and appliances, to ensure they meet manufacturer’s specifications, and
- Ensuring that Operation and Maintenance documentation is complete for building shell and systems (see manufacturer’s documents).

## 9-3           **SUSTAINABLE DEVELOPMENT WORKBOOK AND RATING SYSTEM**

### 9-3.1       **General.**

For more information on sustainable development principles and specifics of the Workbook and Rating System, see *Appendix D – Sustainability Workbook*. Also included in Appendix D are links to general sources of information (websites) for use with the *Sustainable Development Workbook*.

**ARMY:** Army will continue to use Sustainable Project Rating Tool (SPiRiT) and level of achievement as directed by Department of the Army until Leadership in Energy and Environmental Design for Housing (LEED-H) is released and adopted by DA.

### 9-3.2       **Minimum Rating.**

The minimum rating level for military family housing under this UFC is “Bronze” (40% to 49%), based on the percentage of Maximum Available Points that a project can earn.

**Note:** Maximum Available Points will vary for Improvement Projects, based on their specific scope of work.

### 9-3.3 **Critical Program Elements.**

The following are Critical Program Elements from the *Sustainability Workbook* that must be evaluated for all military family housing projects:

#### **1.0 Site Elements.**

- Site Planning and Design
- Site Development and Landscaping
- Site Water Management
- Site Energy Management

#### **2.0 Building Elements**

- Building Envelope Design
- Building HVAC & DHW Design
- Building Appliances and Lighting
- Building Water Management
- Material/Resource Management

#### **3.0 Indoor Environmental Quality (IEQ)**

- Building Systems Users Manuals
- Formaldehyde Reduction
- Radon Mitigation
- Carpet, Pad, and Adhesives
- HVAC Systems – HEPA Filters
- Carbon Monoxide
- HUD “Healthy Homes” Standards
- Low-VOC Adhesives, Sealants, Paints, & Coatings
- Lead-Based Paint and Asbestos Mitigation

#### **4.0 Waste Management**

- Occupant Recycling
- Interior Recycling Cabinets
- Construction and Demolition Waste Management Plan
- Deconstruction and Material Recycling
- Onsite Recycling of Demolition and Construction Waste

#### **5.0 Innovation and Design Process**

- Design Innovation – Specific Details
- LEED Accredited Design Professionals

## APPENDIX A REFERENCES

### GOVERNMENT PUBLICATIONS

**Consumer Products Safety Commission (CPSC)**, <http://www.cpsc.gov>

CPSC Publication 325 – *Handbook for Public Playground Safety*, <http://www.cpsc.gov>

### Department of Defense (DoD)

DoD Memorandum, Unified Facilities Criteria (Ref. MIL-STD-3007)  
[http://www.hnd.usace.army.mil/TECHINFO/UFC/052902\\_SignedUFCImplementationMemo.pdf](http://www.hnd.usace.army.mil/TECHINFO/UFC/052902_SignedUFCImplementationMemo.pdf)

DoD Instruction 4165.57 (Nov 1977) – *Air Installation Compatible Use Zones (AICUZ)*,  
[http://www.dtic.mil/whs/directives/corres/pdf/i416557\\_110877/i416557p.pdf](http://www.dtic.mil/whs/directives/corres/pdf/i416557_110877/i416557p.pdf)

DoD Directive 4165.63-M (Sep 1993) – Housing Management

DoD Directive 4710.1 (Jun 1984) – *Archeological and Historic Resources Management*

DoD Instruction 4715.3 (May 1996) – *Environmental Conservation Program*

MIL-STD-3007 – *DOD Standard Practice for Unified Facilities Criteria (UFC) and Unified Facilities Guide Specifications (UFGS)*  
[http://www.acq.osd.mil/ie/irm/irm\\_library/milstd3007b\\_042302.pdf](http://www.acq.osd.mil/ie/irm/irm_library/milstd3007b_042302.pdf)

TM 5-805-4 – *Technical Manual - Noise and Vibration Control*

UFC – Unified Facility Criteria [http://65.204.17.188/report/doc\\_ufc.html](http://65.204.17.188/report/doc_ufc.html).

*UFC 1-200-01 – Design: General Building Requirements*

*UFC 2-600-01 – Installation Design*

*UFC 3-190-04FA – Roofing and Waterproofing, Chapter 11 – Steep Roofing*

*UFC 3-220-10 - Low Impact Development*

*UFC 3-400-01 – Design: Energy Conservation*

*UFC 3-400-02 – Engineering Weather Data*

*UFC 3-410-01FA – Design: Heating, Ventilating, and Air Conditioning*

*UFC 3-420-01 – Design: Plumbing Systems*

*UFC 3-530-01AN - Design: Interior and Exterior Lighting and Controls*

*UFC 3-600-01 – Design: Fire Protection Engineering For Facilities*

UFC 4-010-01 – Design: DoD Minimum Anti-terrorism Standards for Buildings

## Department of the Air Force

*Air Force Family Housing Guide for Planning Programming, Design and Construction*  
<http://www.afcee.brooks.af.mil/dc/dch/mfhguide/toc.doc>

## Department of the Army

*TI 801-02 Technical Instruction, Family Housing.*  
<http://www.hnd.usace.army.mil/techinfo/ti/801-02/famhouse.htm>

SPIRIT – Sustainable Project Rating Tool, <http://www.cecer.army.mil/SustDesign/SPiRit.cfm>

USD (AT&L) Memorandum, *Department of Defense Unified Facilities Criteria*  
[http://www.hnd.usace.army.mil/TECHINFO/UFC/052902\\_SignedUFCImplementationMemo.pdf](http://www.hnd.usace.army.mil/TECHINFO/UFC/052902_SignedUFCImplementationMemo.pdf)

## Department of the Navy

NAVFACINST 11101.85H.1, *Appendix A – Navy Housing Project Standards*  
[http://www.housing.navy.mil/pubs/85H\\_Rev1\\_30Oct01.pdf](http://www.housing.navy.mil/pubs/85H_Rev1_30Oct01.pdf)

## U.S. Marine Corps

MCO P11000.22 – *Marine Corps, Housing Management Manual*  
<http://www.usmc.mil/directiv.nsf/0dce83e13c9c8aa685256c0c0066c2e0/a2213818c030ffdb85256497006b1211?OpenDocument>

## Department of Energy (DOE)

Million Solar Roofs Initiative, <http://www.millionsolarroofs.com/>

*National Environmental Policy Act (NEPA) of 1969*  
<http://ceq.eh.doe.gov/nepa/regs/nepa/nepaegia.htm>

## Environmental Protection Agency (EPA)

*Comprehensive Procurement Guidelines (for recycled content standards)*  
<http://www.epa.gov/cpg/products>

## Federal Emergency Management Agency (FEMA)

*National Performance Criteria for Tornado Shelters.*  
[www.fema.gov/doc/library/ts5-28.doc](http://www.fema.gov/doc/library/ts5-28.doc)

FEMA 320, *Taking Shelter from the Storm: Building a Safe Room Inside Your House,*  
[www.fema.gov/fima/tsfs02.shtm](http://www.fema.gov/fima/tsfs02.shtm)

FEMA 361, *Design and Construction Guidance for Community Shelters.*  
[www.fema.gov/fima/fema361.shtm](http://www.fema.gov/fima/fema361.shtm)

**Federal Highway Administration (FHWA), Department of Transportation**

*Manual of Uniform Traffic Control Devices*, <http://mutcd.fhwa.dot.gov/>

**Office of Management and Budget (OMB)**, <http://www.whitehouse.gov/omb/>

OMB Circular A-45 - *Rental and Construction of Government Quarters*

**U.S. Government Printing Office (GPO)**

*Architectural Barriers Act of 1968*, <http://www.access-board.gov/about/ABA.htm>

Code of Federal Regulations, <http://www.gpoaccess.gov/cfr/index.html>

40 CFR 1500-1508 - *Regulations for Implementing NEPA*  
[http://ceq.eh.doe.gov/nepa/regs/ceq/toc\\_ceq.htm](http://ceq.eh.doe.gov/nepa/regs/ceq/toc_ceq.htm)

59 CFR 13402 (March 1994) – *Model Standards and Techniques for Control of Radon in New Residential Buildings*

**Executive Orders (EO)**

EO 12902, *Energy Efficiency and Water Conservation at Federal Facilities*, (revoked by E13123)

EO 13123 – *Greening the Government through Efficient Energy Management*,  
<http://www.ofee.gov/eo/eo13123.pdf>

EO 13148 – *Greening the Government Through Leadership in Environmental Management*

National Historic Preservation Act of 1966 (16 USC 470)  
<http://www2.cr.nps.gov/laws/NHPA1966.htm>

Public Law 104-113, *National Technology Transfer and Advancement Act of 1995*.

United States Code (USC), <http://uscode.house.gov>

10 USC 2826 – *Military Family Housing: Local Comparability of Room Patterns and Floor Areas*

16 USC 470 – *National Historic Preservation Act of 1966*  
<http://www2.cr.nps.gov/laws/NHPA1966.htm>

## NON-GOVERNMENT PUBLICATIONS

**Air Conditioning Contractors of America (ACCA)**, <http://www.acca.org/>

ACCA – Manual D - Duct size design

ACCA – Manual J - Heating and cooling load calculations

ACCA – Manual S - Residential HVAC equipment selection

**American National Standards Institute (ANSI)**,  
<http://www.ansi.org> and <http://www.nssn.org/search.html>

ANSI A208.2 – *Medium Density Fiberboard (MDF) For Interior Use*

ANSI/HPVA-HP-1 – *Hardwood and Decorative Plywood*

ANSI/NEMA C12.1 *Code for Electricity Metering.*

ANSI Z765 – *American National Standard for Single-Family Residential Buildings, Square Footage-Method for Calculating.*

**American Society of Civil Engineers (ASCE)**, <http://www.pubs.asce.org>

ASCE 7, *Minimum Design Loads for Buildings and Other Structures*

ASCE 32-01, *Design and Construction of Frost-Protected Shallow Foundations*

**American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)** <http://www.ashrae.org/>

ASHRAE 62.2 – *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*

ASHRAE 119 – *Air Leakage Performance for Detached Single-Family Residential Buildings*

**American Society of Testing Materials International (ASTM)**  
[www.astm.org](http://www.astm.org) and <http://www.nssn.org/search.html>

ASTM E84 – *Standard Test Method for Surface Burning Characteristics of Building Materials*

ASTM E90 – *Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements,*

ASTM E336 – *Standard Test Method for Measurement of Airborne Sound Insulation in Buildings,*

ASTM E413 – *Classification for Rating Sound Insulation,*

ASTM E 492 – *Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine,*

ASTM E1007 – *Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures,*

ASTM F1292 – *Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment,*

ASTM E1321 – *Standard Test Method for Determining Material Ignition and Flame Spread Properties,*

ASTM F1487 – *Standard Consumer Safety Performance Specification for Playground Equipment for Public Use,*

ASTM F1951 – *Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment,*

**International Code Council (ICC).** <http://www.iccsafe.org/>

IBC – *International Building Code*<sup>TM</sup>

IRC – *International Residential Code*<sup>TM</sup>

**National Electrical Manufacturer's Association (NEMA),** <http://www.nema.org>

NEMA C12.1, *Electric Meters; Code for Electricity Metering*  
<http://www.nssn.org/search.html>

**National Fire Protection Association (NFPA),** <http://www.nfpa.org/catalog/home/index.asp>

NFPA 13 – Installation of Sprinkler Systems

NFPA 54 – National Fuel Gas Code

NFPA 58 – Liquefied Petroleum Gas Code

NFPA 70 – National Electrical Code (NEC)

NFPA 101 – Life Safety Code

NFPA 720 – Household Carbon Monoxide (CO) Warning Equipment

TIA/EIA-570 Residential Telecommunication Infrastructure Standard

**Underwriters Laboratory (UL),** <http://www.ul.com/>

UL 2034 – Standard for Single and Multiple Station Carbon Monoxide Alarms

## APPENDIX B GLOSSARY

AAV –	Air Admittance Valve or Vent
ACPH –	Air Changes Per Hour
ADA –	<i>Americans with Disabilities Act</i> , <a href="http://www.usdoj.gov/crt/ada/adahom1.htm">http://www.usdoj.gov/crt/ada/adahom1.htm</a>
ADAAG –	<i>ADA Accessibility Guidelines</i> , <a href="http://www.access-board.gov/adaag/html/adaag.htm">http://www.access-board.gov/adaag/html/adaag.htm</a>
AICUZ –	<i>Air Installations Compatible Use Zones</i>
AMR –	Automated Meter Reading
BMP –	Best Management Practice
CATV –	Cable Access Television
CEQ –	Council on Environmental Quality
CFC –	Chlorofluorocarbon
CO –	Carbon Monoxide
CPG –	<i>Comprehensive Procurement Guidelines</i> (see EPA)
CRI –	Carpet and Rug Institute, <a href="http://www.carpet-rug.com/">http://www.carpet-rug.com/</a>
DNL –	Day Night (average sound) Level
Energy Star <sup>®</sup> –	Government-backed program helping businesses and individuals protect the environment through energy efficiency, <a href="http://www.energystar.gov/">http://www.energystar.gov/</a>
FEMP –	Federal Energy Management Program
FIIC –	Field Impact Insulation Class
FPL –	Forest Products Laboratory, <a href="http://www.fpl.fs.fed.us">http://www.fpl.fs.fed.us</a>
FRT –	Fire-Retardant-Treated (plywood)
FS –	Flame-spread (index)
FSTC –	Field Sound Transmission Class
HPVA –	Hardwood Plywood and Veneer Association
HUD –	U.S. Department of Housing and Urban Development, <a href="http://www.hud.gov/">http://www.hud.gov/</a>

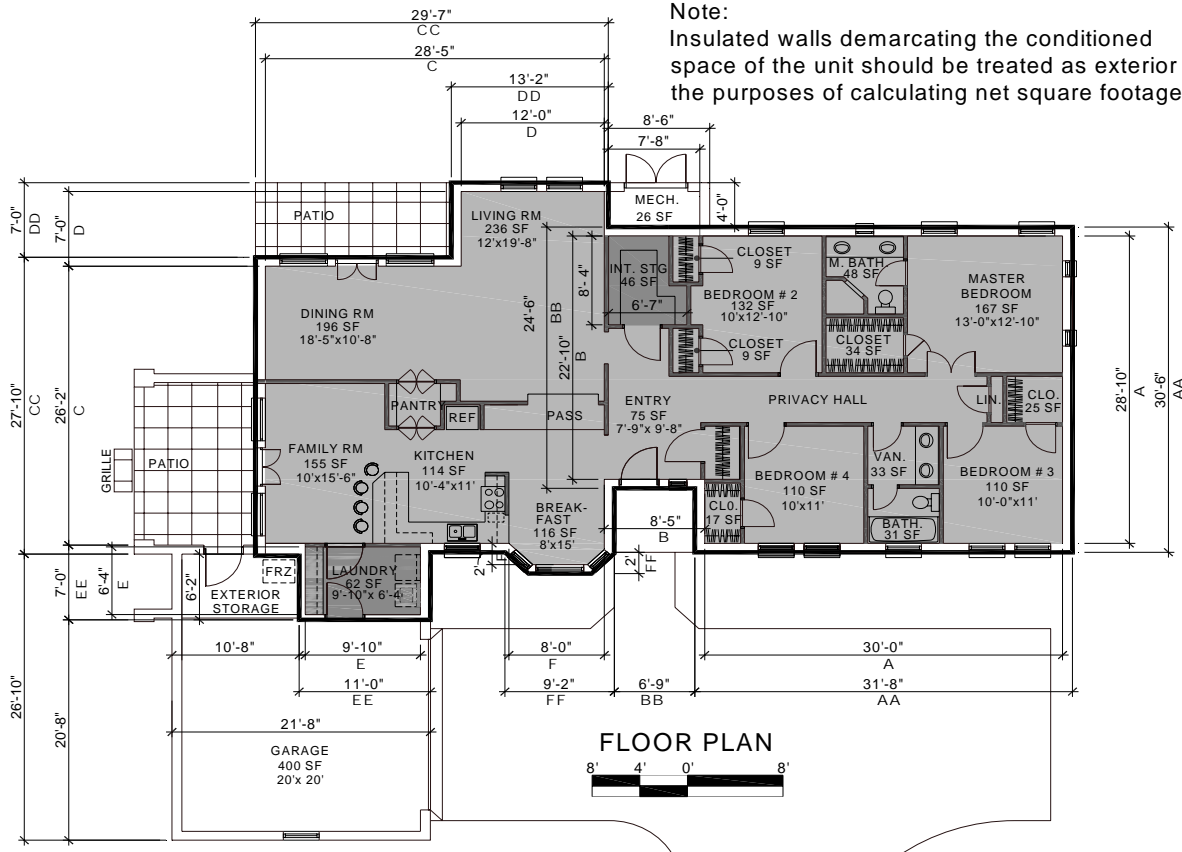
HVAC –	Heating Ventilation and Air Conditioning
IAQ –	Indoor Air Quality
IBC –	<i>International Building Code</i> <sup>TM</sup>
IEEE –	Institute of Electrical and Electronics Engineers, <a href="http://www.ieee.org/">http://www.ieee.org/</a>
IESNA –	Illuminating Engineering Society of North America, <a href="http://www.iesna.org">www.iesna.org</a>
IIC –	Impact Isolation Class
IRC –	<i>International Residential Code</i> <sup>TM</sup>
LER –	Light Efficacy Rating
LID –	Low Impact Development
O&M –	Operations and Maintenance
OSHA –	Occupational Safety and Health Administration, <a href="http://www.osha.gov/">http://www.osha.gov/</a>
OVE –	Optimum Value Engineering, <a href="http://www.toolbase.org/PATH-OVE">http://www.toolbase.org/PATH-OVE</a>
PCB –	Polychlorinated Biphenyl
SD –	moke-developed (rating)
SHPO –	State Historic Preservation Office
STC –	Sound Transmission Class
UFAS –	<i>Uniform Federal Accessibility Standards</i>
UFGS -	<i>Unified Facilities Guide Specifications</i>

## APPENDIX C-1 NET AND GROSS AREA CALCULATIONS – SINGLE STORY

(Mechanical Room and Exterior Storage excluded from Gross SF)

- Bold line defines limits of Gross area
- Dark shading = excludable areas from the Net
- Light shading = defines Net scope area
- A Designates a Net dimension
- AA Designates a Gross dimension

**Note:**  
Insulated walls demarcating the conditioned space of the unit should be treated as exterior for the purposes of calculating net square footage.



Total Gross		
AA	31'-8" x 30'-6"	= 966 SF
BB	6'-9" x 24'-6"	= 165 SF
CC	29'-7" x 27'-10"	= 823 SF
DD	13'-2" x 7'-0"	= 92 SF
EE	11'-0" x 7'-0"	= 77 SF
FF	9'-2" x 2'-0"	= 18 SF
(Less corners) 2'-0" x 2'-0" x 2 x 1/2		= - 4 SF
<b>Total Gross</b>		<b>2,137 SF</b>
Garage	21'-8" x 20'-8"	= 448 SF
Ext. Stg	10'-8" x 6'-2"	= 66 SF
Mech. Rm.	8'-6" x 4'-0"	= 34 SF

"Benchmark" 2,310 SF

Total Net		
A	30'-0" x 28'-10"	= 865 SF
B	8'-5" x 22'-10"	= 192 SF
(Less Int. Stg.)		6'-7" x 8'-4" = - 46 SF
C	28'-5" x 26'-2"	= 744 SF
D	12'-0" x 7'-0"	= 84 SF
E	9'-10" x 6'-4"	= 62 SF
(Less Laundry)		9'-10" x 6'-4" = - 62 SF
F	8'-0" x 2'-0"	= 16 SF
(Less corners) 2'-0" x 2'-0" x 2 x 1/2		= - 4 SF
<b>Total Net</b>		<b>1,851 SF</b>

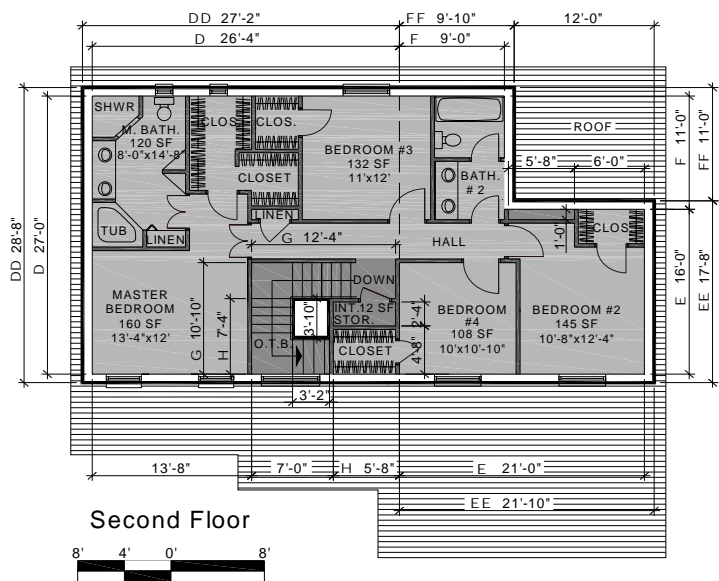
"Benchmark" 1,860 SF

## APPENDIX C-2 NET AND GROSS AREA CALCULATIONS – TWO STORY

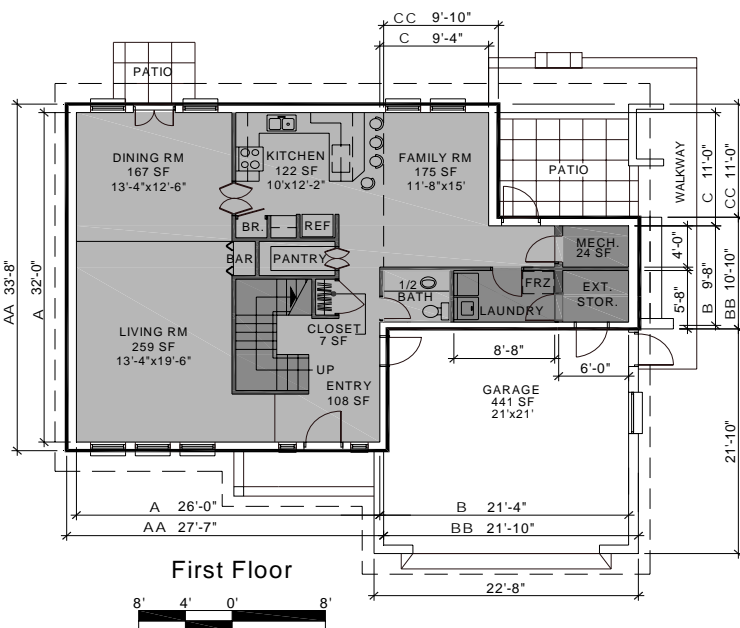
(Mechanical Room and Exterior Storage included in Gross SF)

- Bold line defines limits of Gross area
- Dark shading = excludable areas from the Net
- Light shading = defines Net scope area
- A Designates a Net dimension
- AA Designates a Gross dimension

Total Gross		
<b>Second Floor</b>		
DD	27'-2" x 28'-8" =	779 SF
(Less open to below)	3'-2" x 3'-10" =	- 12 SF
EE	21'-10" x 17'-8" =	386 SF
FF	9'-10" x 11'-0" =	108 SF
<b>Subtotal Second Floor</b>		<b>1,261 SF</b>
<b>First Floor</b>		
AA	27'-2" x 33'-8" =	915 SF
BB	21'-10" x 10'-10" =	236 SF
CC	9'-10" x 11'-0" =	108 SF
<b>Subtotal First Floor</b>		<b>1,259 SF</b>
<b>Total Gross</b>		<b>2,520 SF</b>
"Benchmark" 2,520 SF		



Total Net		
<b>Second Floor</b>		
D	26'-4" x 27'-0" =	711 SF
E	21'-0" x 16'-0" =	336 SF
F	9'-0" x 11'-0" =	99 SF
(Less Open to Below and 10 SF Landing) G-H		
G	12'-4" x 10'-10" =	-134 SF
H	5'-8" x 7'-4" =	42 SF
		= -92 SF
(Less Interior Storage)	5'-4" x 2'-4" =	- 12 SF
(Less interior chase)	5'-8" x 1'-0" =	- 6 SF
<b>Subtotal Second Floor</b>		<b>1,036 SF</b>
<b>First Floor</b>		
A	26'-0" x 32'-0" =	832 SF
(Less under stair run)	13'-4" x 4'-0" =	- 53 SF
B	21'-4" x 9'-8" =	206 SF
(Less Laundry)	8'-8" x 5'-4" =	- 46 SF
(Less Mech. Room)	6'-0" x 4'-0" =	- 24 SF
(Less Ext. Storage)	6'-0" x 5'-8" =	- 34 SF
C	9'-4" x 11'-0" =	103 SF
<b>Subtotal First Floor</b>		<b>984 SF</b>
<b>Total Net</b>		<b>2,020 SF</b>
"Benchmark" 2,030 SF		



**APPENDIX D  
SUSTAINABILITY WORKBOOK**

[Sustainability Workbook.xls](#)