

Project Name

Project No. \_\_\_\_\_  
TI 801-02, Army Family Housing, 01 Nov 02

## **STATEMENT OF WORK**

**STATEMENT OF WORK****TABLE OF CONTENTS**

NUMBER	PARAGRAPH HEADING	PAGE
1.	DESIGN OBJECTIVES	1
2.	CRITERIA REFERENCES	6
3.	SITE PLANNING AND DESIGN	16
4.	SITE ENGINEERING	28
5.	UNIT DESIGN - ARCHITECTURE	37
6.	UNIT DESIGN - STRUCTURAL	55
7.	UNIT DESIGN - THERMAL PERFORMANCE	56
8.	UNIT DESIGN - PLUMBING	60
9.	UNIT DESIGN - ELECTRICAL	64
10.	UNIT DESIGN - HEATING, VENTILATING, AND AIR CONDITIONING	67
11.	ENERGY CONSERVATION	78
12.	CONTRACTOR PREPARED SPECIFICATIONS	80
13.	SUSTAINABLE DESIGN CONSIDERATIONS	81

**LISTING OF TABLES**

NUMBER	TABLE HEADING	PAGE
<u>Paragraph 1.</u>		
1-1	HOUSING UNITS	1
<u>Paragraph 2.</u>		
2-1	FEDERAL LAWS & REGULATIONS	6
2-2	AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION SPECIFICATIONS	8
2-3	AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) STANDARDS	8
2-4	AMERICAN SOCIETY OF HEATING, REFRIGERATION, AND AIR-CONDITIONING ENGINEERS (ASHRAE)	9
2-5	AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) SPECIFICATIONS	10
2-6	BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA) SPECIFICATIONS	12
2-7	NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) CODES	14
2-8	UNDERWRITERS LABORATORIES SPECIFICATIONS	15
<u>Paragraph 3.</u>		
3-1	HOUSING UNITS PER HECTARE [ACRE]	17
3-2	HOUSING UNIT TYPES BY DENSITY	18
3-3	MAXIMUM NUMBER OF HOUSING UNITS PER BUILDING BY GRADE	18
3-4	MINIMUM SETBACKS AND SPACING, LOW DENSITY SITES	19
<u>Paragraph 4.</u>		
4-1	SOIL COMPACTION	29

**LISTING OF TABLES (CONTINUED)**

NUMBER	TABLE HEADING	PAGE
<u>Paragraph 5.</u>		
5-1	MINIMUM SIZE OF HOUSING UNITS BY PAY GRADE	37
5-2	NOT USED	
5-3	MINIMUM AREAS AND DIMENSIONS - INTERIOR SPACES	40
5-4	MINIMUM AREAS AND DIMENSIONS - EXTERIOR SPACES	42
5-5	KITCHEN CABINET, COUNTER, & PANTRY AREA	42
5-6	MINIMUM CLOSET WIDTHS	42
5-7	MINIMUM INTERIOR, EXTERIOR, & COMBINED BULK STORAGE	43
5-8	BATHROOM REQUIREMENTS	44
5-9	ROOF SLOPES	47
5-10	HARDWARE SPECIFICATIONS	51
5-11	KITCHEN CABINET SPECIFICATIONS	52
<u>Paragraph 7.</u>		
7-1	WEATHER REGION DEFINITIONS	56
7-2	THERMAL CHARACTERISTIC REQUIREMENTS	57
<u>Paragraph 8.</u>		
8-1	WATER HEATER SIZING	63
<u>Paragraph 10.</u>		
10-1	WEATHER DATA	67
10-2	NOT USED	
10-3	MINIMUM EQUIPMENT EFFICIENCIES	68
10-4	SPLIT SYSTEM AIR CONDITIONING [HEAT PUMP] FEATURES	70
10-5	PACKAGED AIR CONDITIONING FEATURES	71

**NOTES TO USACE ACTIVITY PREPARING SOLICITATION**

- 
1. Text in brackets [brackets] are instructions and/or require editing.
  2. Reserved for future use.
  3. Page numbers in table of contents above should be revised when developing a project specific RFP.
  4. Hard page breaks should be inserted in the generic RFP to avoid breaking tables when possible.
  5. Metric dimensions are shown first with inch-pound measurements in [brackets] after to comply with the Metric Conversion Act of 1975 (Public Law 94-168) as amended by the Omnibus Trade and Competitiveness Act of 1988 (Public Law 100-418) and Executive Order 12770 dated July 25, 1991. Projects constructed using this RFP are to be in metric (SI) measurements. Review the metric dimensions to facilitate the use of metric standard products when the RFP is edited.
  6. This Statement of Work (SOW) supersedes SOW dated 1 November 1996, 29 May 1997, and 10 Sep 1999.
  7. This SOW includes EIRS Bulletins 97-02, Encl 3, Telephone Cable in Family Housing; 97-04, Encl 3, Family Housing Energy Conservation Improvements; and 99-01, Encl 1, Carbon Monoxide Alarms in New Family Housing.
-

**STATEMENT OF WORK**

**1. DESIGN OBJECTIVES.**

1-1 The design and construction shall comply with the specifications and requirements contained in this Request for Proposals (RFP). The design and technical criteria contained and cited in this RFP establish minimum standards for design and construction quality. All housing units constructed in accordance with these standards are “Energy Star Homes”.

1-1.1 Primary Consideration. The PRIMARY CONSIDERATION of this solicitation process is to provide the entire number of housing units identified in this statement of work. All proposals received MUST include the total number of units required to be considered for evaluation and award. In no case will a smaller number of units be accepted to allow inclusion of betterments or enhancements. Betterments and enhancements will not be considered unless the proposal includes ALL units required. Offerors are encouraged to review the statement of work to familiarize themselves with all of the available options and alternatives included herein. In many instances several finishes or materials are identified for a specific item, however, the primary consideration of this solicitation is obtaining all units scheduled for construction in this project.

1-2. Work Scope. The objective of this solicitation is to obtain housing complete and adequate for assignment as quarters for military personnel and their families. This contract shall consist of the design and construction of a total of [insert.] housing units on Government-owned land at [installation and location], which comply with this RFP. Work shall consist of the following:

1-2.1 Housing Units. Housing units with patio or balcony, garage, exterior storage, [individual central heating systems, energy conservation systems and central air conditioning], and including the following Contractor-furnished/Contractor-installed (CF/CI) equipment and appliances: range, refrigerator, garbage disposal, dishwasher, water heater, [carbon monoxide alarms], and smoke detectors. [Include clothes washer and dryer for overseas projects.] Housing units shall be a mix of two-, three-, four-, and/or five-bedroom housing units as shown in Table 1-1:

**TABLE 1-1 - HOUSING UNITS**

Pay Grade	Number of Bedrooms	Number of Units
O-7 and above (GFO)	4	Note <sup>1</sup>
O-6 (SO)	4	Note <sup>1</sup>
O-4 and O-5 (FGO)	4	Note <sup>1</sup>
	3	Note <sup>1</sup>
O-1 through O-3 (CGO)	5	Note <sup>1</sup>
	4	Note <sup>1</sup>
	3	Note <sup>1</sup>
	2	Note <sup>1</sup>
W-1 through W-4 (WO)	4	Note <sup>1</sup>
	3	Note <sup>1</sup>
E-7 through E-9 (SNCO)	5	Note <sup>1</sup>
	4	Note <sup>1</sup>
	3	Note <sup>1</sup>
	2	Note <sup>1</sup>
E-1 through E-6 (JNCO)	5	Note <sup>1</sup>
	4	Note <sup>1</sup>
	3	Note <sup>1</sup>
	2	Note <sup>1</sup>

Note <sup>1</sup>: [Edit for specific project requirements.]

**TABLE 1-1 - HOUSING UNITS**

Pay Grade	Number of Bedrooms	Number of Units
-----------	--------------------	-----------------

1-2.2 Accessible units. No less than five (5) percent of each unit type at each site shall be single-story ground floor housing units. New and replacement general officer units shall be built accessible. These housing units shall be designed and built in such a way that they may be easily and readily modified to accommodate physically challenged occupants at time of occupancy. See paragraph 5.a.(2)(a). Design of accessible housing units shall conform to the Uniform Federal Accessibility Standards (UFAS) and American Disabilities Act Accessibility Guidelines (ADAAG). Accessible housing units shall be well dispersed throughout the development and shall not be grouped or clustered so as to create segregated pockets within the housing community. The requirement to have an additional two (2) percent of housing units equipped with warning devices for the hearing and visually impaired will be met at the time the unit is assigned to an occupant needing this equipment.

1-2.3 Site area and density.

1-2.3.1 Site area. The site/s is/are described on the RFP drawings included as part of this solicitation and includes approximately \_\_\_\_\_ hectares [\_\_\_\_\_ acres]. Site work includes all design and construction of the site design to include grading, storm drainage, erosion control, pedestrian and vehicular circulation, utility systems, outdoor lighting, play lots, neighborhood parks, and physical security.

1-2.3.2 Site density. This project consists of [Insert] housing units on [Insert] of land area. The project site is approved for [LOW DENSITY, MEDIUM DENSITY, HIGH DENSITY] siting. [Edit as appropriate.] Site development shall comply with the minimum requirements for [LOW DENSITY, MEDIUM DENSITY, HIGH DENSITY] siting. [Insert site area, edit for appropriate site density and add any special site constraints.]

1-2.4 Special utilities and supplementary construction. [Insert special utility items, supplementary construction, on- or off-site]

1-2.5 Demolition considerations and requirements. [Insert special items with respect to demolition requirements. Asbestos and lead paint surveys should be included as an Attachment to this Statement of Work].

1-3 Energy Star Homes Program Requirements: The Contractor, at the direction of the USACE Contracting Officer's Representative, shall be required to submit to the EPA the necessary information and certifications to register the units constructed in this project as Energy Star Homes. The contractor constructing housing units in accordance with this Statement of Work is not required to be a registered Energy Star Contractor. The required information can be submitted to EPA in several methods:

1-3.1 Through the Internet by clicking on the *certificate automation system* icon at the World Wide Website <http://yosemite.epa.gov/appd/eshomes/eshomes.nsf> and following the instructions

1-3.2 By emailing to [certificates@epa.gov](mailto:certificates@epa.gov)

1-3.3 By mailing to the EPA Customer Service Manager (address & tel. no. below):

The following information needs to be submitted for each home [note: homes can be submitted *individually* (each home individually tested/rated) or in a "*batch*" (for batches of homes, particular unit types). The following data should be provided for each home (note: this can be in the form of a spreadsheet, database, word processing file or email; if the format changes in the future EPA will inform the contractor of the changes):

- Contractor company name (ex. Jones Construction Co.)
- Contractor telephone number (ex. 703-123-4567)
- Name of company/organization performing testing/rating (ex. Jones Construction Co.)
- Telephone number of company/organization performing testing/rating (ex. 703-123-4567)
- Street address of home being submitted, including city, state & zip code (ex. 123 Smith St., City, State 12345)

Type of verification:

**“FEP”** --- if this particular home underwent infiltration testing (and possibly duct leakage testing). Please list the tested infiltration value in ACH/nat (natural air changes per hour) and if tested, the duct leakage to nonconditioned spaces in cfm and % of air handler flow at a pressure of 25 pascals.

**SEP** --- if this particular home did *not* undergo infiltration and/or duct leakage testing, but was a member of a batch out of which at least 15% DID; if so, then the address of a home that was a tested member of this batch should also be identified as the tested member of the batch.

1-3.4 The following statement: “This home qualifies as an EPA Energy Star Home by conforming to the residential energy efficiency specifications and quality control confirmation of U.S. Army Corps of Engineers TI 801-02, Family Housing, dd-MM-yy [Design District fill in date of edition], which has been determined by the EPA and USACE to be an **Equivalent Program** to the EPA Energy Star Homes Program.” In addition, the “checklist” of home specifications that the USACE Contracting Officer’s Representative uses to ascertain if the TI 801-02 specifications and testing results were met should be submitted. The statement and checklist should have the USACE Contracting Officer’s Representative’s signature affixed.

The year the house was built (ex. 2001)  
The year the house was submitted for Energy Star certification (ex. 2001)  
The name and title/rank, mailing address, email address, telephone number and fax number of the USACE Contracting Officer’s Representative overseeing the contractor’s adherence to construction specifications, quality control of construction and testing/rating activities.

1-3.5 The Contractor will make arrangements with the EPA for receipt of the “Energy Star Homes” certificates and unit plaques and shall provide the certificates to the USACE Contracting Officer’s Representative and include in the project the installation of the plaques on each of the housing units. Coordination point with the EPA regarding Energy Star certification and plaques shall be as follows:

United States Environmental Protection Agency  
Climate Protection Division  
US EPA 6202J  
Washington DC 20460  
ENERGY STAR Homes Customer Service Manager  
ATTN: Mr. Brian Ng, Ng.Brian@epa.gov, 202-564-9162, fax: 202-565-2079  
<http://www.energystar.gov/homes>

Technical questions on the Energy Star Homes Program in general can be addressed to:  
ENERGY STAR Homes Technical Coordinator  
ATTN: Mr Glenn T. Chinery, Chinery.Glenn@epa.gov, 202-564-9784, fax: 202-565-2079

1-4 Design Freedom. Requirements stated in this RFP are minimums. Innovative, creative, or cost-saving proposals which meet or exceed these requirements are encouraged and will receive additional consideration in the evaluation process provided that all required units are included in the proposal. Existing housing plans or modifications thereof that meet the design and construction criteria specified herein, which an offeror has previously constructed and priced, may be submitted. They may include designs incorporating factory fabricated components or modules. Deviations from space and adjacency requirements are discouraged unless the changes result in improvement to the facilities.

1-5 Housing Units. . Site-built, factory-built, and manufactured-housing units are acceptable options for this project. [Edit in accordance with project requirements and/or special instructions contained in Design Directives.]

1-6 Definition of Housing Unit Types. Terms for housing unit types used in these criteria are defined as follows:

1-6.1 Site-built housing. A residential building or housing unit wholly or substantially constructed at the site.

1-6.2 Factory-built housing. Construction consisting of components, sub-assemblies such as modules, panelized walls, roof trusses, floor joists, and other factory-assembled components, which are transported to the construction site and further assembled into completed housing units. All interior and exterior walls, regardless of whether they

are structural (load bearing) or not, are plant fabricated (panelized). Panels must be fabricated to the extent that the structure of the panel or truss is factory-assembled. Finishes such as interior wall board may be site applied.

1-6.3 Manufactured housing. As defined in Public Law 93-383, Title 24, Chapter XX amended (1977, 1978, 1979, and 1980), a manufactured home is "a structure, transportable in one (1) or more sections which in the traveling mode is eight body feet or more in width, or forty body feet or more in length, or, when erected on site, is built on a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air conditioning and electrical systems contained therein."

1-6.4 Apartment buildings. Housing units on a single floor served by a central corridor. Apartment buildings of this type may be one (1) to three (3) stories.

1-6.5 Garden apartments. Housing units on a single floor with direct entry from a stairway landing. Housing units shall be full depth from front to back without intervening public corridors. Buildings shall be no more than three stories high, and designed so that no more than one (1) stairway per module is required. Normally, no more than two housing units will be served by each stair landing.

1-6.6 Duplex. One or two-story housing units joined together by a common party wall and each housing unit entered directly from the exterior.

1-6.7 Townhouses. One, two, or three-story housing units having one (end units) or more party walls. Configurations, such as triplexes, quadruplexes and up to six housing units, are considered to be townhouses.

1-6.8 Detached house. A single-family housing unit which is not attached to another housing unit.

1-7 Design Quality. The objectives are to obtain housing structures and complimentary site development within funds available and to optimize livability. Design quality is achieved through the optimization of interior planning, integration of housing structures to the site, and balancing architectural attractiveness, variety, function, and design for low-cost maintenance and operation. Offerors should consider sustainable design applications in developing proposals, see para 13.

1-8 Installation Real Property Master Plan. The installation real property master plan provides comprehensive documentation of the existing conditions of natural, man-made, and human resources. It also guides the future land-use development. The real property master plan should be consulted as it is the mechanism for ensuring that individual projects are sited to meet overall installation goals and objectives for land use development

1-9 Installation Design Guide. [Insert "...(Deleted)" and delete remainder of text that is not applicable.] Design of this project shall incorporate the design guidance and criteria contained in the Installation Design Guide, excerpts of which are contained in Attachment 9.

1-10 Energy and Resources Conserving Features. Public Law 102-486, Executive Order 13123, and Federal Regulations 10 CFR 435, require Federal buildings to be designed and constructed to reduce energy consumption in a life-cycle, cost-effective manner using renewable energy sources when economical. Products designed to conserve energy and resources by controlling the amounts of consumed energy or by operating at increased efficiencies should be considered. Minimum requirements for this project are [List features required such as high-efficiency central air conditioning and/or heating units, setback thermostats, and water flow-limiting plumbing fixtures]. Offerors are required to provide Energy and Resource conserving improvements that at least insure compliance with the Energy Star Homes Program parameters.

1-11 Prototype Housing Units. The purpose of the prototype housing unit is to verify the details of the approved design and material selections, and to establish the quality level against which the remaining work will be judged. At the plant, or at the site, construction connection details shall be exposed for study by authorized Government inspectors for a period of time agreed to by the Contractor and the Contracting Officer. The housing unit or units at the plant and/or the prototype at the site are subject to Contracting Officer's approval. At the site, the complete prototype shall be constructed for each housing unit type. Each stage of work shall be completed and accepted on the prototype prior to starting work on the same stage for similar housing units in the project.

1-11.1 "Site-Built." A prototype housing unit shall be required for each housing unit type.

1-11.1.1 [The following paragraph may be added at the discretion of the USACE Design Activity. Inclusion of this requirement will allow construction Quality Assurance staff to have a model by which to judge construction of the units in the project.] Where multiple prototype units are being constructed, one or two prototype units shall be left in the "rough in" stage (no interior finishes) so that the utility systems and framing construction is exposed. Exteriors of these prototypes shall be completely finished. When the last new units are constructed, these "rough in" stage prototype units shall be completed and turned over to the Government with the last turn-over group.

1-11.2 "Manufactured" or "Factory-Built." A prototype housing unit shall be required for each housing unit type of each run fabricated at the plant for manufactured or factory-built homes.

1-11.3 Manufactured. If the housing units are classified as manufactured housing, all interior and exterior systems which form integral parts of the transportable module shall be constructed and assembled for inspection by the Government. This shall include, as a minimum, wall and ceiling construction, interior finishes, utility piping, wiring, and ductwork fastening and assembling of adjacent modules, connection details to sinks, installed kitchen cabinets and countertops. Portions of the work shall be left unfinished or exposed to demonstrate interior construction details.

1-11.4 Factory-Built. If the housing units are classified as factory-built housing, all wall panels which are fabricated in the plant for shipment to the site shall have prototype units constructed and assembled for in-plant inspection by the Government. This shall include, as a minimum, wall framing, roof and ceiling framing, connection details, utility piping, wiring and ductwork, interior and exterior wall finishes which form part of the factory-built wall. In addition, the Contractor shall construct as part of the factory-built prototype, installed samples of wall insulation, finished siding (if not part of wall assembly), sample installed bathtub and sink and installed kitchen sink and cabinets to demonstrate proper installation and wall connections. Portions of the work shall be left unfinished or exposed to demonstrate interior construction details.

1-11.4.1 One Floor Prototype. If only one floor of the prototype is manufactured or factory-built, factory assembly of the manufactured or factory-built portion of the prototype is required. In all cases, the factory prototype shall consist of one of each building type. The factory prototype shall be assembled to verify assembly connections, details, construction, and transportation of the finished housing unit.

1-11.4.2 Structural Integrity. Manufactured and factory-built homes shall be of individual housing units attached to one another in a manner which shall provide a finished structural assembly having an appearance and structural integrity comparable to a site-built single or multi-family residence built to applicable codes.

1-11.4.3 Construction Tolerances. Assembled housing units shall be true and plumb and all within specified construction tolerances for all alignments represented on the drawings. Adjacent walls shall be attached at roof and floor levels in such a manner as to preclude placing any wood member in cross-grain bending or cross-grain tension, and to avoid putting nails in withdrawal.

1-12 Force Protection & Anti-Terrorism Considerations. Project design and construction shall comply with the applicable DoD standards. Specific requirements are outlined below: [Design District shall investigate applicable requirements and insert into the statement of work at this point. Beginning in FY-03 all new construction and whole neighborhood replacement projects will require compliance with the DoD standards.]

**2. CRITERIA REFERENCES.**

2-1 Criteria to be used for design and construction shall be taken from the most current references at the date of issue of the RFP. Administrative, contractual, and procedural features of the contract shall be as described in other sections of the RFP. Referenced codes and standards herein and those listed below are minimum acceptable criteria.

2-2 Local and State Codes or Standards. The following specifications, standards, bulletins, and handbooks form a part of this document to the extent specified herein. Unless otherwise indicated, copies are available from [Insert]

2-2.1 Local. [List applicable model codes or standards.]

2-2.2 State. [List applicable state codes or standards.]

2-3 Federal Laws. The Federal laws and regulations listed in Table 2-1 form a part of this document. They are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20401-9325 (202) 512 - 1800

<b>TABLE 2-1 – FEDERAL LAWS &amp; REGULATIONS</b>	
<b>CFR/USC No.</b>	<b>Description</b>
10 CFR 430	National Appliance Energy Conservation Act (NAECA)
10 CFR 435	Voluntary Performance Standards for New Commercial and Multi-Family High Rise Residential Buildings; Mandatory for Federal Buildings.
16 CFR 1630	Standard for Surface Flammability of Carpet and Rugs
40 CFR 247.12	Comprehensive Procurement Guideline for Products Containing Recovered Materials, Construction Products
49 CFR 192	Transportation of Natural Gas and Other Gas by Pipeline: Minimum Federal Safety Standards
42 USC 4321-4361	National Environmental Policy Act (NEPA)
Army Regulation 200-1	Environmental Protection and Enhancement, May 1990
E.O. 13123	Energy Efficiency and Water Conservation in Federal Facilities

2-4 Other Government Documents and Publications. The following Government documents and publications form a part of this document to the extent specified herein:

2-4.1 Americans With Disabilities Act Accessibility Guidelines, are available from U.S. Architectural and Transportation Barriers Compliance Board, 1331 F Street, N.W., Washington, D.C. 20004-1111

2-4.2 Federal Emergency Management Agency, Mitigation Directorate; 500 C Street, SW; Washington DC 20472: National Performance Criteria for Tornado Shelters and FEMA 320, Taking Shelter from the Storm: Building a Safe Room Inside Your Home. <http://www.fema.gov/>

2-5 Non-Government Publications. The following publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are Department of Defense (DoD) adopted are those listed in the Department of Defense Index of Specifications and Standards (DODISS).

2-5.1 Air-Conditioning and Refrigeration Institute (ARI). Information listed below is available from ARI, 4301 Fairfax Dr., Suite 425, ATTN: Pubs Dept., Arlington, VA 22203, Ph: 703-524-8800, Fax: 703-528-3816, Internet E-Mail: ari@dgsys.com, Directory of Certified Unitary Air Conditioners, Unitary Heat Pumps and Sound Rated Outdoor Unitary Equipment; ARI 210/240, Unitary Air Conditioning and Air-Source Heat Pump Equipment: <http://www.ari.org/>

2-5.2 AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA), AMCA 210, Laboratory Methods of Testing Fans For Rating, is available from AMCA, 30 West University Drive, Arlington Heights, IL 60004, (312) 394-0150: <http://www.amca.org/>

2-5.3 American Architectural Manufacturers Association (AAMA). AAMA specifications shown in Table 2-2 are available from AAMA, 1540 East Dundee Rd., Suite 310, Palatine, IL 60067-8321, Ph: 708-202-1350, Fax: 708-202-1480 2700 River Road, Suite 118, Des Plaines, IL 60018, (312) 699-7310.

**TABLE 2-2 - AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION SPECIFICATIONS**

No.	Description
AAMA 1002.10	Voluntary Specifications for Aluminum Insulating Storm Products for Windows and Sliding Glass Doors

2-5.4 American Gas Association (AGA). Standards and specifications are available from AGA, 1515 Wilson Blvd., Arlington, VA 22209, Ph: 703-841-8556, Fax: 703-841-8406: <http://www.aga.org/>

2-5.5 American National Standards Institute, Inc. (ANSI). Copies of the standards listed in Table 2-3 are available from ANSI, 11 West 42nd St., New York, NY 10036, Ph: 212-642-4900, Fax: 212-302-1286: <http://www.ansi.org/>

**TABLE 2-3 - AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) STANDARDS**

Std. No.	Std. Description
A112.19.1	Enameled Cast Iron Plumbing Fixtures
A112.19.2	Vitreous China Plumbing Fixtures (DoD Adopted)
A112.19.3	Stainless Steel Plumbing Fixtures (Designed for Residential Use)
A112.19.4	Porcelain Enameled Formed Steel Plumbing Fixtures (DoD Adopted)
A112.19.5	Trim for Water-Closet Bowls, Tanks, and Urinals (Dimensional Standards) (DoD Adopted)
A161.1	Recommended Construction and Performance Standards for Kitchen and Vanity Cabinets

**TABLE 2-3 - AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)  
STANDARDS**

Std. No.	Std. Description
B16.5	Steel Pipe Flanges and Flanged Fittings (DoD Adopted)
B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings (DoD Adopted)
B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes (DoD Adopted)
B31.8	Gas Transmission and Distribution Piping Systems
C2	National Electrical Safety Code
ANSI C105 AWWA A21.5	Polyethylene Encasement for Ductile-Iron Pipe Systems
Z21.10.1	Water Heaters, Gas, Volume I, Storage Type, 75,000 BTUH Input or Less
Z21.45	Flexible Connectors of Other Than All-Metal Construction for Gas Appliances
Z60.1	American Standard for Nursery Stock
Z124.1	Plastic Bathtub Units
Z124.2	Plastic Shower Receptors and Shower Stalls

2-5.6 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) documents, listed in Table 2-4, are available from ASHRAE, 1791 Tullie Cir., NE, Atlanta, GA 30329-2305, Ph: 404-636-8400 Fax: 404-321-5478 1791 Tullie Circle, N.E., Atlanta, GA 30329, (404) 636-8400: <http://www.ashrae.org/>

**TABLE 2-4 – AMERICAN SOCIETY OF HEATING, REFRIGERATION,  
AND AIR-CONDITIONING ENGINEERS (ASHRAE)**

No.	Description
ASHRAE -	Handbook of Fundamentals
ASHRAE -	Residential Cooling Load Calculations
ASHRAE 62	Ventilation for Acceptable Indoor Air Quality
ASHRAE 52	Method of Testing Air Cleaning Devices used in General Ventilation for Removing Particulate Matter
ASHRAE 111	Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air Conditioning, and Refrigeration Systems

2-5.7 American Society of Mechanical Engineers (ASME). ASME B16.11, Forged Fittings, Socket-Welding and Threaded, and ASME B31.8, Gas Transmission and Distribution Systems, are available from ASME, 22 Law Dr., Box 2300, Fairfield, NJ 07007-2900, Ph: 800-843-2763, Fax: 201-882-1717:  
<http://www.asme.org/>

2-5.8 American Society for Testing and Materials (ASTM). ASTM specifications listed in Table 2-5 are available from ASTM, AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)  
1916 Race St., Philadelphia, PA 19103, Ph: 215-299-5585, Fax: 215-977-9679: <http://www.astm.org/>

**TABLE 2-5 - AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)  
SPECIFICATIONS**

Spec. No.	Spec. Description
A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A526	Specification for Steel Sheet Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality (DoD Adopted)
B117	Method of Salt Spray (Fog) Testing (DoD Adopted)
C90	Specification for Hollow Load-Bearing Concrete Masonry Units (DoD Adopted)
C216	Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale) (DoD Adopted)
D3676	Rubber Cellular Cushion Used for Carpet or Rug Underlay
D1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft 2700kN-m/m)
D1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 (DoD Adopted)
D2513	Standard Specification for Thermoplastic Gas Pressure Piping (DoD Adopted)
D2683	Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing (DoD Adopted)
D2846	Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot and Cold-Water Distribution Systems (DoD Adopted)
D3018	Specification for Class A Asphalt Shingles Surfaced with Mineral Granules (DoD Adopted)
D3679	Specification for Rigid Poly (Vinyl Chloride) (PVC) Siding
E84	Standard Test Method for Surface Burning Characteristics of Building Materials (DoD Adopted)
E90	Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions (DoD Adopted)
E108	Standard Methods of Fire Tests of Roof Coverings

**TABLE 2-5 - AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)  
SPECIFICATIONS**

Spec. No.	Spec. Description
E119	Standard Methods of Fire Tests of Building Construction and Materials
E162	Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source (DoD Adopted)
E283	Standard Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors
E330	Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
E336	Standard Test Method for Measurement of Airborne Sound Insulation in Buildings
E547	Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential
E648	Critical Radiant Flux of Floor-Covering Systems Using a Radiant Energy Source
E779	Measuring Air Leakage by the Pressurization Method
E1007	Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures
E1465	Standard Guide for Radon Control Options for the Design and Construction of New Low-Rise Residential Buildings
F1292	Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment
E1423	Standard Practice for Determining the Steady State Thermal Transmittance of Fenestration Systems
E 1554	Determining External Air Leakage of Air Distribution Systems by Fan Pressurization.
F 1066	Standard Specification for Sheet Vinyl Composition Floor Covering
F1487-98	Standard Consumer Safety Performance Specification for Playground Equipment for Public Use
G90	Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight

2-5.9 American Water Works Association, Inc. (AWWA). Specifications listed below are available from AWWA, 6666 West Quincy, Denver, CO 80235, Ph: 800-926-7337, Fax: 303-795-1989, AWWA C500, Gate

Valves for Water and Sewerage Systems (DoD adopted); AWWA C502, Dry-Barrel Fire Hydrants; and AWWA C503, Wet-Barrel Fire Hydrants: <http://www.awwa.org/>

2-5.10 Associated Air Balance Council (AABC). AABC MN-1, National Standards for Total System Balance, is available from AABC, 1518 K St., NW, Washington, DC 20005, Ph: 202-737-0202, Fax: 202-638-4833: <http://www.aabchq.com/>

2-5.11 American Association of Textile Chemists and Colorists (AATCC). AATCC 134, Electrostatic Propensity of Carpets, is available from AATCC, P.O. Box 12215, Research Triangle Park, NC 27709, (919) 549-8141.: <http://www.aatcc.org/>

2-5.12 Builders Hardware Manufacturers Association, Inc. (BHMA). Specifications shown in Table 2-6 are available from the Builders Hardware Manufacturers Association, Inc. (BHMA), 355 Lexington Ave., New York, NY 10017, Ph: 212-661-4261, FAX: 212-370-9047.

**TABLE 2-6 - BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA) SPECIFICATIONS**

No.	Description (Specs. are DoD Adopted)
BHMA 101	Butts and Hinges
BHMA 301	Door Controls, Closers
BHMA 501	Auxiliary Locks and Associated Products
BHMA 601	Bored and Preassembled Locks and Latches
BHMA 611	Interconnected Locks and Latches

2-5.13 Council of American Building Officials (CABO). The CABO One (1) and Two (2) Family Dwelling Code and Model Energy Code, are available from the COUNCIL OF AMERICAN BUILDING OFFICIALS (CABO) 5203 Leesburg Pike, Suite 708, Falls Church, VA 22041, Fax: 703-379-1546: <http://www.intlcode.org/>

2-5.14 Electronic Industries Association Telecommunications Industry Association (EIA/TIA). EIA/TIA Standard EIA/TIA-570, is available from Electronic Industries Association, Engineering Department, Order From: Global Engineering Documents, 7730 Carondelet Ave., Suite 407 Clayton, MO 63105, Ph: 800-854-7179, or 714-979-8135, Fax: 314-726-6418

2-5.15 Illuminating Engineering Society of North America (IESNA). The IESNA Lighting Handbook, is available from Illuminating Engineering Society of North America, (IESNA), 120 Wall St., 17th Floor, New York, NY 10005-4001, Ph: 212-248-5000, Fax: 212-248-5017: <http://www.iesna.org/>

2-5.16 International Conference of Building Officials (ICBO). The Uniform Building Code is available from the, INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO), 5360 S. Workman Mill Rd., Whittier, CA 90601-2258, Ph: 310-699-0541, Fax: 310-692-3853: <http://www.icbo.org/>

2-5.17 National Association of Corrosion Engineers (NACE). NACE RP-0286, The Electrical Isolation of Cathodically Protected Pipelines, is available from NACE, P.O. Box 218340, Houston, TX 77218: <http://www.nace.org/>

2-5.18 National Electrical Manufacturers Association (NEMA). NEMA standards listed below are available from the National Electrical Manufacturers Association (NEMA), NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA), 2101 L St., NW, Suite 300, Washington, DC 20037-1526  
Ph: 202-457-8474 Fax: 202-457-8473 NEMA DC 3, Wall-Mounted Room Thermostats; and NEMA WD 1, General Requirements for Wiring Devices: <http://www.nema.org/>

2-5.19 NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB), NEBB-01, Procedural Standards for Testing-Adjusting-Balancing of Environmental Systems, is available from NEBB, 875 Grove Mount circle, Gaithersburg, MD 20877-4121, Ph: 301-977-3698, Fax: 301-977-9589: <http://www.nebb.org/>

2-5.20 National Fenestration Rating Council (NFRC). NFRC 100-91, Procedure for Determining Fenestration Product Thermal Properties, is available from NFRC, 1300 Spring Street, Suite 500, Silver Spring, MD. Telephone: (301) 589-NFRC, <http://www.nfrc.org>

2-5.21 National Fire Protection Association, Inc. (NFPA). NFPA codes listed in Table 2-7 are available from the National Fire Protection Association, Inc. (NFPA), 1 Battery March Park, P.O. Box 9101, Quincy, MA 02269. Telephone: (617) 770-3000, Fax: (617) 770-0700: <http://www.nfpa.org/>

**TABLE 2-7 - NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) CODES**

Code No.	Code Description
NFPA 13	Installation of Sprinkler Systems
NFPA 13R	Installation of Sprinkler Systems in Residential Occupancies Up To and Including Four Stories
NFPA 30	Flammable Liquids Code
NFPA 31	Installation of Oil Burning Equipment
NFPA 54	National Fuel Gas Code
NFPA 58	LP-Gas Storage
NFPA 70	National Electrical Code (DoD Adopted)
NFPA 72	National Fire Alarm Code
NFPA 101	Life Safety Code
NFPA 101M	Alternative Approaches to Life Safety
NFPA 255	Method of Test of Surface Burning Characteristics of Building Materials
NFPA 501A	Manufactured Home Installations
NFPA 501D	Recreational Vehicle Parks and Campgrounds
NFPA 701	Standard Methods of Fire Tests for Flame Resistant Textiles and Films

2-5.22 National Wood Window and Door Association (NWWDA) standard, NWWDA I.S.2, Standard for Wood Window Units is available from the National Wood Window and Door Association (NWWDA), 1400 East Touhy Ave., Suite 470, Des Plaines, IL 60018, (847) 299-5200, Fax: (847) 299-1286: <http://www.nwwda.org/>.

2-5.23 Sheet Metal and Air Conditioning Contractors National Association (SMACNA). SMACNA Installation Standards for Residential Heating and Air Conditioning Systems and SMACNA-07, HVAC Systems, Testing, Adjusting, and Balancing, are available from SMACNA, 4201 Lafayette Center Drive, Chantilly, VA 22180, (703) 803-2980, Fax: (703) 803-3732: <http://www.smacna.org/>

2-5.24 Underwriters Laboratories, Inc. (UL) specifications listed in Table 2-8 are available from the Underwriters Laboratories, Inc. (UL), 333 Pfingston Road, Northbrook, IL 62096. Telephone: (847) 272-8800. Fax: (847) 509-6220: <http://www.ui.com/>.

**TABLE 2-8 – UNDERWRITERS LABORATORIES SPECIFICATIONS**

No.	Description (Specs. Are DoD Adopted)
UL 58	Steel Underground Tanks for Flammable and Combustible Liquids
UL 174	Water Heaters, Household Electric Storage Tank Type
UL 430	Waste Disposers
UL 507	Electric Fans
UL 555	Fire Dampers
UL 567	Pipe Connectors for Flammable and Combustible Liquids and LP Gas
UL 732	Oil-Fired Storage Tank Water Heaters
UL 746C	Polymeric Materials - Use in Electrical Equipment Evaluations
UL 749	Household Dishwashers
UL 858	Household Electric Ranges
UL 923	Microwave Cooking Appliances
UL 900	Test Performance of Air Filter Units
UL 1316	Glass Fiber – Reinforced Plastic Underground Storage Tanks for Petroleum Products
UL 1746	Standard for Safety External Corrosion Protection Systems for Steel Underground Storage Tanks

### 3. SITE PLANNING AND DESIGN.

3-1 Scope. This project consists of [Insert] housing units on [Insert] of land area. Imaginative site design is encouraged, however, the site boundaries, project composition, and gross density are fixed. Based on the graphic and narrative description of site opportunities and constraints provided, the offeror shall verify that the site meets the program requirements.

3-2 Site Verification. Obtain the site analysis and the documented site opportunities and constraints to verify that the site meets the housing program requirements that are provided. In the event a site analysis has not been accomplished, then an analysis must be performed. The analysis results are documented in a written and graphic summary of site opportunities and constraints for housing.

3-3 Area Development Plan. Provide a housing area development plan that shows the spatial and functional arrangement of all housing requirements. The plan should ensure an economical, compatible and functional residential land use development that utilizes the advantages of the site, fosters visual order, and provides a sense of community. The area development plan shows consideration for the site opportunities and constraints, housing program requirements, and specific site design criteria and guidance provided. The recommendations of the Installation Real Property Master Plan and Installation Design Guide should be addressed.

3-3.1 Density. The project site is approved for [LOW DENSITY, MEDIUM DENSITY, HIGH DENSITY] siting. [Edit as appropriate.] Land area for density calculations excludes slopes greater than 10 percent, major highways, flood plains and flood areas, lakes and water courses. Designated major recreation areas greater than 1.2 ha [3 acres] may be excluded from the density calculation.

3-3.2 Land use. The plan for the area should reflect an optimum balance of housing unit floor area, open space, play lots, neighborhood parks, and pedestrian and vehicular circulation. The plan should show an efficient, organized and economical land use arrangement that is compatible and functional. This plan should show the relationship of the area to adjacent land uses.

3-3.3 Noise. Use mitigation techniques to moderate predictable noise in accordance with the Installation Compatible Use Zone Program. All possible methods of mitigating the impact to the site and adjacent areas should be explored.

3-3.4 Buffer area. Provide appropriate buffer areas to separate and visually isolate the community from undesirable external influences and to separate adjacent officer and enlisted personnel housing areas from each other. The width of a street should be a minimum acceptable buffer zone between officer and enlisted personnel housing areas. All possible methods of mitigating the impact to the site and adjacent areas should be explored.

3-3.5 Housing unit grouping. Variety in groupings, arrangements, and siting configurations of housing units is encouraged to fit varying terrain conditions and to provide compatible and functional residential layouts and street scapes. Building arrangements should be informal and imaginative with setbacks and orientation to provide for the best view, privacy, and variety. The proper grouping of housing units will provide backyard screening, separation of pedestrian and vehicular traffic, play lots, neighborhood parks, and natural open spaces. The layout should reflect simplicity of design and provide a visual sense of community.

3-3.6 Housing unit variation. Housing unit variation shall afford distinctly different exterior appearances within each housing unit type. Provide stylistic compatibility that will give the neighborhood a sense of order. Housing units shall vary in two or more of the following: Floor plans, massing, elevation, garage location, and exterior materials. One floor plan for each housing unit type is acceptable if sufficient variety is achieved by means of other variations mentioned above. In addition, housing units shall vary in color and siting. A reverse floor plan (mirror-image), although an acceptable means of creating variety, shall not constitute a housing unit change. Offerors shall comply with land-use restraints set forth in this document. To accept the design freedom objective of this RFP, offerors are encouraged to offer 1-story and 2-story construction for detached, duplex, and townhouse units. The preferred colors are earth tones available in commonly used durable materials. The design should reflect life cycle maintenance and energy efficiency.

3-3.7 Housing unit orientation. Housing units shall be oriented, to the maximum extent possible within the constraints of the site available, so that the long axis of the building is within 20 degrees east or west of true South, so that a major section of the roof faces within 20 degrees of South. The purpose of proper orientation is to expose a minimum surface area to direct solar gain while allowing the units the potential for passive solar applications. Additional consideration will be given during the quality evaluations with respect to unit orientations and passive solar applications considered and included. For additional passive solar information and considerations, see chapter 11 of this Statement of Work. [Edit if necessary where known site constraints preclude compliance with this requirement or if the project under design is a rehabilitation of existing units.]

3-3.8 Grading. The grading should maintain existing topography while recognizing standard gradients for the housing units and various functions. There should be a balance of the quantity of cut and fill which would create a smooth transition of graded areas into the existing natural site. The plan should reflect selective site clearing that preserves groups of trees. Grading should manage site runoff. The principles of positive drainage should be applied to control the conditions that remove rainfall away from facilities and functions.

3-4 Site Design Criteria. The following specific criteria, based on site density, are to be used as guidance in site design, and proposals will be scored accordingly.

3-4.1 Housing units per hectare (ha) [acre (ac)] by site density are shown in Table 3-1 on the following page.

**TABLE 3-1 - HOUSING UNITS PER HECTARE [ACRE]**

Pay Grade	Low Density		Medium Density		High Density	
	units/ha	units/ac	units/ha	units/ac	units/ha	units/ac
E-6 & Below	9.9-17.3	4-7	19.8-24.7	8-10	22.2-37.1	11-15
E-7 - E-9	7.4-12.4	3-5	14.8-22.2	6-9	19.8-29.7	10-12
O-1 - O-3	7.4-12.4	3-5	14.8-22.2	6-9	19.8-29.7	10-12
O-4 - O-5	6.2-7.4	2.5-3	9.9-12.4	4-5	14.8-22.2	6-9
O-6	4.9	2	7.4	3	9.9-14.8	4-6
O-7 & Above	2.5	1	4.9	2	7.4-9/9	3-4

3-4.2 Housing unit types by site density are shown in Table 3-2.

**TABLE 3-2 - HOUSING UNIT TYPES BY DENSITY**

Bedrooms/ Grade	Low Density	Medium Density	High Density
2 Bedrooms E-1 - E-9 W-1 - W-4 O-1 - O-3	1-2 Floor Duplexes, Townhouses or Apartments	1-3 Floor Townhouses or Apartments	2-3 Floor Apartments
3, 4, & 5 Bedrooms E-1 - E-9 W-1 - W-4 O-1 - O-3	1-2 Floor Detached Homes, Duplexes or Townhouses	1-3 Floor Duplexes or Townhouses	1-3 Floor Townhouses
3 & 4 Bedrooms O-4 - O-5	1-2 Floor Detached Homes, or Duplexes	1-3 Floor Duplexes or Townhouses	1-3 Floor Duplexes or Townhouses
4 Bedrooms O-6 - O-9	1-2 Floor Detached Homes	1-3 Floor Detached Homes	1-3 Floor Detached Homes

3-4.3 Maximum number of housing units per building by grade are shown in Table 3-3.

**TABLE 3-3 - MAXIMUM NUMBER OF HOUSING UNITS  
 PER BUILDING BY GRADE**

Building Types	E-1 - E-6	E-7 - E-9 & O-1 - O-3	O-4 - O-5
Apartments	12	8	N/A
Townhouses	8	6	4

3-4.4 Parking requirements by site density.

3-4.4.1 Low density: Two off-street stalls and one guest on-street stall per unit.

3-4.4.2 Medium density: Two off-street stalls and 0.5 guest on-street stall per unit.

3-4.4.3 High density: Two off-street stalls and 0.25 guest on-street stalls per unit.

3-4.4.4 Recreational vehicle (RV) storage: (Where required; prohibited at high density sites.) One 3.0 m x 6.0 m [10 ft by 20 ft] space per 20 housing units. The area shall include 2.0 m [6 ft] high chain link security fencing and security flood lighting of 2.7 Lx [0.25 foot candles] at the boundary fence. Area shall have an all-weather surface and an access drive. Design shall permit access to all spaces without moving other vehicles.

3-4.5 Children's outdoor play areas. Children's outdoor play areas are a requirements per number of housing units. See paragraph 3.g. for size and equipment specifications.

3-4.5.1 Play lot: One 325 m<sup>2</sup> [3,500 ft<sup>2</sup>] play lot per 30 housing units. The play lot shall be designed to

accommodate two age groups; 6 weeks to 5 years age group and 5 to 9 years age group. The play lot shall have a capacity for approximately 15 to 35 children. These play lots should be located within site lines of the housing units.

3-4.5.2 Neighborhood park: One 700 m<sup>2</sup> [7,500 ft<sup>2</sup>] neighborhood park per 150 housing units. The neighborhood park shall be designed to accommodate two age groups; 5 to 9 years age group and 9 to 15 years age group. The neighborhood park shall have a capacity for approximately 30 to 50 children.

3-5 Building Setbacks and Spacing. Clearances between and adjacent to buildings must consider requirements for fire protection, safety, privacy, and emergency access in addition to the following minimum criteria. Setback or yard dimensions shall be from the building wall to an imaginary lot line around each building measured perpendicular to the building. Wall lengths with horizontal offsets of 1.8 m [6 ft] or more may be measured separately when determining yard depth. Distance between buildings shall be not less than the sum of setbacks or yards, as required.

3-5.1 Minimum setbacks and spacing for low density sites is shown in Table 3-4.

**TABLE 3-4 - MINIMUM SETBACKS AND SPACING, LOW DENSITY SITES**

Description	Meters	[Feet]
From front of house to curb of residential street.	7.5	25
From house to major/arterial highway. (Edge of pavement)	45.0	150
From house to collector street. (Edge of pavement)	30.0	100
Side of carport or garage to curb.	6.0	20
Side of house to curb <sup>1</sup> .	6.0	20
Between sides of carports or garages and houses <sup>1</sup> .	1.5	5
Between outside walls of houses <sup>1</sup> .	6.0	20
Between rear walls of houses.	24.0	80
Between side and rear walls of houses.	12.0	40
Between street face of carport or garage and curb or sidewalk when second off- street parking space is next to garage or carport.	2.4	8
Between street face of carport or garage and curb or sidewalk when second off- street parking space is between carport or garage and street.	8.5	28

Note<sup>1</sup>: When patios are located within a yard, separation shall not be less than 12.0 m [40 ft].

3-5.2 Minimum setbacks and spacing for medium and high density sites.

3-5.2.1 Wall Definitions

3-5.2.1.1 Wall A contains the housing unit main entrance; or the principal window(s) of the living room, dining

room, family room, or a balcony.

3-5.2.1.2 Wall B contains window(s) other than in wall 'A.'

3-5.2.1.3 Wall C contains no windows.

3-5.2.2 Building to Building (each yard).

3-5.2.2.1 Wall A: 1.8 m [6 ft] + 0.6 m [2 ft] for each level + 5 percent wall length.

3-5.2.2.2 Wall B: 1.2 m [4 ft] + 0.3 m [1 ft] for each level + 5 percent wall length.

3-5.2.2.3 Wall C: 2.25 m [7 ft 6 in] minimum.

3-5.2.3 Building to Street (face of curb)

3-5.2.3.1 Wall A: 6.0 m [20 ft].

3-5.2.3.2 Wall B: 4.5 m [15 ft].

3-5.2.3.3 Wall C: 3.0 m [10 ft].

3-5.2.4 Garage to Street (face of curb). Detached garages may be located up to the property line or the project boundary.

3-5.2.4.1 Front: 2.4 m [8 ft] (without parking).

3-5.2.4.2 Side or Back: 4.5 m [15 ft].

3-5.2.5 Driveway length for parking, measured from face of curb.

3-5.2.5.1 To park one car: 6.0 m [20 ft].

3-5.2.5.2 To park two cars: 12.0 m [40 ft].

3-5.2.6 Building to retaining wall with a height of 1.2 m [4ft] or more, above a floor with windows.

3-5.2.6.1 Wall A: 4.5 m [15 ft].

3-5.2.6.2 Wall B: 2.25 m [7 ft 6 in].

3-5.2.6.3 Wall C: 1.5 m [5 ft].

3-5.3 Setback Notes.

3-5.3.1 Where the slope is 3:1 or steeper, top and toe of slope shall be a minimum of 4.5 m [15 ft] from the building.

3-5.3.2 Courts, outer and inner, shall have dimensions not less than the sum of the required yard distances. An inner court shall have a minimum area of 9.29 m<sup>2</sup> [100 ft<sup>2</sup>] for a one-story building and an additional 4.64 m<sup>2</sup> [50 ft<sup>2</sup>] for each additional story.

3-6 Circulation, Parking, and Bus Stops. The vehicular and pedestrian circulation system shall promote safe, efficient movement of vehicles and pedestrians within the housing area. It should maintain the maximum separation of vehicles and pedestrians. Safe circulation systems have a clear hierarchy of movement, lead to a clear destination, and do not interrupt other functions. The following criteria shall be considered for designing

streets and drives for vehicles and pedestrians:

3-6.1 Vehicular circulation. Vehicular circulation layout is determined by applying the design vehicle templates to the site design. The passenger car class includes passenger cars and light delivery trucks, such as vans and pick-ups. The passenger car template is equivalent to the non-organizational - privately owned vehicle (POV). The truck class template includes single-unit trucks, recreation vehicles, buses, truck tractor-semitrailer combinations, and trucks or truck tractors with semi-trailers in combination with full trailers. Templates showing the turning movements for design vehicles are provided by the American Association of State Highway and Transportation Officials (AASHTO). Design site entrances, exits, service drives, and special circulation areas to accommodate the largest vehicle that uses the area. In the case of family housing the largest vehicle to use the area on a weekly basis would be the 12 m (40 ft) garbage truck. Provide the vehicle clearances that are required to meet traffic safety for emergency vehicles, service vehicles, and moving vans. Streets shall include required traffic control and street identification signage, maximum spacing between drives, right-angle turns, and limit points of conflicts between traffic.

3-6.1.1 Definitions.

3-6.1.1.1 Nonresidential Streets

3-6.1.1.1.1 Arterial. Major roads and street systems external to the residential area.

3-6.1.1.1.2 Collector. Feeder street connecting external street system with residential streets in the subdivision and adjoining areas subject to future development. No houses shall be located on collector streets, and no driveway or access shall be from collector streets

3-6.1.1.2 Residential Streets

3-6.1.1.2.1 Loop. Both ends open to traffic.

3-6.1.1.2.2 Cul-De-Sac. Only one end open to access street and a turnaround (T, Y, or Circle) at the other end.

3-6.1.2 Cul-De-Sac Design. The circulation system may be based on cul-de-sacs a maximum 182.8 m [600 ft] long, measured from the center of the cul-de-sac to the centerline of the access street.

3-6.1.3 Intersection Design. Provide "T" intersection offsets of at least 38.1 m [125 ft]. The preferred angle of intersection is right-angle (90 degrees).

3-6.1.4 Street design. Street dimensions are determined by the selected design vehicle templates. Separation, corner clearances, and sight distance are established when the design vehicle templates and speed limits are selected. Streets shall be designed for vehicles with not less than 2721.5 kg [6,000 lb] code wheel load. Streets shall be provided with concrete curbs and gutters. Curbs shall be depressed at entrances to driveways unless the rolled type of curbs are provided throughout. All gradients shall provide positive drainage with no ponding.

3-6.1.5 Housing unit access drive. Access drives should provide traffic safety distances which allow safe entry and exit. Access drives serving more than 8 housing units, or subject to service and emergency truck traffic shall be designed as a street.

3-6.2 Privately owned vehicle (POV) parking. POV stalls without vehicle overhang shall be a maximum 2.7 m x 5.5 m [9 ft x 18 ft]. The design vehicle template that is used to design this space shall be described. Design on-street parking stalls to be of sufficient length and width to allow safe movement into and out of the stall and to adequately separate the parked vehicle from the traffic flow. Provide compact passenger car dimensions only when recommended by a Site Traffic Impact Study.

3-6.2.1 Housing unit POV parking. POV parking areas consisting of more than 4 vehicles backing into the street are unacceptable.

3-6.2.2 Off-street parking lots. A 90-degree parking layout is preferable. Maintain two-way movement and avoid dead-end parking lots. Provide more than one entrance and exit drive. In large parking lots provide a minimum 10 percent of the total paved area for landscape plant material.

3-6.3 Bus stops. Bus stops shall be provided along collector streets at intersections with residential streets. Bus stops shall be in compliance with the Installation Design Guide and located with a turnout from the collector street. The design vehicle that is used to design this space shall be described. [Number of bus stops required shall be in accordance with installation requirements.]

3-6.4 Pedestrian circulation. Pedestrian circulation should be safe, separated from vehicle circulation, and relate to the housing units, parking, and community facilities. Pedestrian circulation should be based on pedestrian desired lines of walking between facilities. Desired lines should be weighted to predict the most traveled routes. These routes would require paving. Topography and vegetation can be used to reinforce a sense of movement. Design pedestrian concentration areas with adequate paved area.

3-6.4.1 Sidewalk design. Sidewalks shall be provided on both sides of the street. Walks shall be a minimum of 1.2 m [4 ft] wide exclusive of curb width, and made of non-reinforced concrete with a minimum thickness of 100 mm [4 in]. Where walks are adjacent to the curb, the curb width is not to be included as sidewalk. Ramps for handicapped individuals shall be provided at intersections by depressing street curbs and adjacent sidewalk.

3-7 Children's Outdoor Play Areas. The design of the children's outdoor play areas shall comply with the safety requirements of ASTM F 1487 and ASTM F 1292. The children's outdoor play areas are unsupervised play areas and do not have a supervised play program for child development. These areas are not part of trained recreation, youth center or child development staff support. Supervised outdoor play areas occur at youth centers and child development centers.

#### 3-7.1 Child Safety and Accessibility.

3-7.1.1 Accessibility to children and adults with disabilities. Play areas shall be accessible to children and adults with disabilities. In addition to wheelchair users, the needs of children and adults who walk with canes, walkers, or crutches; who have limited use of the upper body; who have visual or hearing disabilities, or who have developmental disabilities shall be considered. Design criteria based on child dimensions should be used for the proper functioning of the play area. Every part of a play area may not be accessible to all its users, but the social experience provided should be accessible to everyone. When more than one play activity of the same type is provided, one shall be accessible. When one activity is provided, it shall be accessible. A diverse play area has the greatest potential for meeting the needs of all users. Separate play areas for the physically challenged are not acceptable. Integrating all children in the same play setting will be emphasized. Guidelines available from this design district for accessible routes, ramps for wheelchair access, transfer points, wheelchair accessible platforms, and accessible stepped platforms should be followed.

3-7.1.2 Age appropriate scale. Age appropriate scale is a term used to describe equipment which will allow safe and successful use by children of a specific chronological age, mental age, and physical ability. Play equipment height and complexity will not exceed the user's ability. The children's outdoor play areas will meet age appropriate scale for the age groups that the areas are designed to accommodate.

3-7.1.3 Use zones. In accordance with ASTM F 1487, a use zone is a clear, unobstructed area under and around play equipment where a child would be expected to land when jumping or falling from a piece of play equipment. These zones require a playground safety surface in accordance with ASTM F 1292. Requirements for use zones vary for the age group and for different pieces of equipment. All use zones for play equipment should be shown on the site plan to ensure there is no conflict between play activities on the ground and swinging or jumping from the equipment. Use zones will not overlap except for spring rocking equipment, balance beams, and play houses.

3-7.1.4 Playground safety surface. A playground safety surface is constructed of a material that meets the shock absorbency criteria recommended in ASTM F 1292. Playground safety surfaces shall be provided throughout all use zones and under all play equipment as required.

3-7.1.5 Inappropriate play events. The following play events are not appropriate for use in unsupervised play areas; Chain walks, chain or tire climbers, fulcrum seesaws, log roles, May poles, merry-go-rounds, rotating equipment, spring rocking equipment intended for standing, swinging exercise bars, trapeze bars, and whirls.

3-7.2 Play lot. Provide play lots that are located within the site lines of the housing units to be supported. Connect play lots to the units by a walkway system. Provide shade. Each play lot shall be provided with the following age appropriate play events and equipment for the two age groups to be accommodated:

3-7.2.1 Pathway. The pathway should encompass the perimeter of the area, accommodate wheeled toys, and consist of different textures, colors, and patterns for games.

3-7.2.2 Gathering place. This setting provides an open space for groups of different sizes and people of all ages. Provide an infant crawl area. The seating materials may include boulders, timbers or logs arranged with vegetation to create a room like atmosphere. A shelter may be provided.

3-7.2.3 Sand play setting. This setting supports creative play and social interaction. It provides children with a manipulative play environment. The play elements include sand, water, sand tables, containment barriers and boulders. The sieve size for sand should consist of a fine washed plaster sand. The sand used here is not the same sieve size as the sand used for the use zones. This setting should be located adjacent to the play village.

3-7.2.4 Play village. This setting supports a playhouse and a water source. It should be located adjacent to the sand play setting.

3-7.2.5 Dramatic play setting. This setting supports dramatic play elements such as playhouses, play platforms, and an open area for seating on the ground.

3-7.2.6 Manufactured play equipment setting. This setting includes an age appropriate composite structure consisting of multiple play events for each of the following age groups; 12 months to 2 years of age, 2 to 5 years of age, and 5 to 9 years of age. Other play events include free standing equipment such as spring rocking equipment, swing, and balance beam. The swing should be located as a free standing play event on the perimeter.

3-7.3 Neighborhood park. Provide neighborhood parks that are to be located on the edge of the housing unit area to be supported. Connect neighborhood parks to the housing units by a walkway system. Provide shade. Each neighborhood park shall be provided with the following age appropriate play events and equipment for the two age groups to be accommodated:

3-7.3.1 Pathway. The pathway should encompass the perimeter of the area, accommodate wheeled toys, and consist of different textures, colors, and patterns for games.

3-7.3.2 Gathering place. This setting provides an open space for groups of different sizes and people of all ages. The seating materials may include boulders, timbers or logs arranged to create a room like atmosphere. Additional points will be given for providing a picnic shelter.

3-7.3.3 Manufactured play equipment setting. This setting includes an age appropriate composite structure consisting of multiple play events for children 5 to 15 years of age. Other play events include free standing equipment such as spring rocking equipment, swing, track ride, and balance beam. The swing should be located as a free standing play event on the perimeter.

3-7.3.4 Sports and games setting. This setting includes a turf area as the central element of the park. The turf area should accommodate various sports activities. Locate a multi-use hard surface area on the perimeter. Other design elements include surfacing, fences, drinking fountains, storage, lighting, seating, and trash receptacles.

3-7.4 Plant materials. Plants and ground cover should be integrated into play settings. Plants provide a variety of learning opportunities, as they become a source for play material for crafts, dramatic play, and sensory experience. Plants define space and provide shade. Poisonous plants and plants with thorns are not allowed and should be removed from the play areas.

3-8 Landscape Planting Plan. The offeror shall obtain and use the services of a qualified landscape architect, experienced in site planning and planting design. A complete, integrated landscape planting plan shall be provided for the overall housing project. The design shall reflect appropriate groupings, foundation plantings, and street tree plantings to define the open spaces to ensure a complete landscaped project. Choose plant materials on the basis of plant hardiness, climate, soil conditions, low maintenance, and quality. Selected plant materials shall be easily maintained and tolerant of the specific site conditions. Planting or seeding shall occur only during periods when beneficial results can be obtained.

3-8.1 Trees, shrubs, and ground cover. Plant varieties shall be nursery grown or plantation grown stock conforming to ANSI/ANLA Z60.1. They shall be grown under climatic conditions similar to those in the locality of the project.

3-8.1.1 Quality. Well shaped, well grown, vigorous, healthy plants having healthy and well branched root systems shall be provided. Plants shall be free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement, and abrasion. Plants shall be provided that are typical of the species or variety, and conforming to standards as set forth in ANSI/ANLA Z60.1.

3-8.1.2 Shade and flowering trees. A height relationship to caliper shall be provided as recommended by ANSI/ANLA Z60.1. Height of branching should bear a relationship to the size and variety of tree specified, and with the crown in good balance with the trunk. Trees shall not be "poled" or the leader removed.

3-8.1.2.1 Single stem. Trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader.

3-8.1.2.2 Multi-stem. All countable stems, in aggregate, shall average the size specified. To be considered a stem, there should be no division of the trunk which branches more than 150 mm [6 in] from the ground level.

3-8.1.2.3 Specimen. A plant shall be provided that is well branched and pruned naturally according to the species. The form of growth desired, which may not be in accordance with natural growth habit, shall be as indicated.

3-8.1.3 Deciduous shrub. Plants shall be provided that have the height and number of primary stems as recommended by ANSI/ANLA Z60.1. An acceptable plant shall be well shaped with sufficient well-spaced side branches recognized by the trade as typical for the variety grown in the region.

3-8.1.4 Coniferous evergreen. Trees shall be provided that have the height-to-spread ratio as recommended by ANSI/ANLA Z60.1. Trees shall not be "poled" or the leader removed. An acceptable plant shall be exceptionally heavy, well shaped and trimmed to form a symmetrical and tightly knit plant. The form of growth desired shall be as indicated.

3-8.1.5 Broadleaf evergreen. Plants shall be provided that have ratio of height-to-spread as recommended by ANSI/ANLA Z60.1. An acceptable plant shall be well shaped and recognized by the trade as typical for the variety grown in the region.

3-8.1.6 Ground cover. Plants shall be provided with the minimum number of runners and length of runner as recommended by ANSI/ANLA Z60.1. Plants shall be furnished that have heavy, well developed, and balanced top with vigorous well developed root system, and shall be furnished in containers.

3-8.1.7 Measurement. Plant measurements shall be in accordance with ANSI/ANLA Z60.1.

3-8.1.8 Percolation test. Test for percolation shall be done to determine positive drainage of plant pits and beds. All soil and drainage conditions detrimental to the growth of plant material shall be identified and a proposal correcting the conditions shall be submitted.

3-8.2 Soil test. A soil test shall be performed for pH, chemical analysis, and mechanical analysis to establish the

quantities and type of soil amendments required to meet local growing conditions for the type and variety of plant material specified.

3-8.3 Installation. Verify the location of underground utilities. When obstructions below ground or poor drainage affect the planting operation, proposed adjustments to plant location, type of plant, and planting method or drainage correction shall be submitted. The plant material shall be installed during appropriate planting times and conditions recommended by the trade for the type and variety of plant material specified. Plant pits shall be excavated and backfilled as recommended by the trade and ANSI/ANLA Z60.1. The planting operation shall be performed only during periods when beneficial results can be obtained. When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted.

3-8.4 Pruning. The total amount of foliage shall be pruned by one-fourth to one-third on installed trees and shrubs to compensate for loss of roots and transplanting shock. The typical growth habit of individual plants shall be retained. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off."

3-8.5 Maintenance during planting operation. Installed plants shall be maintained in a healthy growing condition. Maintenance operations shall begin immediately after each plant is installed and shall continue until the plant establishment period commences.

3-8.6 Plant establishment period. On completion of the last day of the planting operation, the plant establishment period for maintaining installed plants in a healthy growing condition shall commence and shall be in effect for the remaining contract time period not to exceed 12 months. When the planting operation extends over more than one season or there is a variance to the planting times, the plant establishment periods shall be established for the work completed.

3-8.7 Maintenance during establishment period. The maintenance of plants shall include straightening plants, tightening stakes and guying material, repairing tree wrap, protecting plant areas from erosion, maintaining erosion material, supplementing mulch, accomplishing wound dressing, removing dead or broken tip growth by pruning, maintaining edging of beds, checking for girdling of plants and maintaining plant labels, watering, weeding, removing and replacing unhealthy plants.

3-8.8 Unhealthy plant. A plant shall be considered unhealthy or dead when the main leader has died back, or 25 percent of the crown is dead. Determine the cause for an unhealthy plant. Unhealthy or dead plants shall be removed immediately and shall be replaced as soon as seasonal conditions permit in accordance with the following warranty paragraph.

3-8.9 Warranty. Furnished plant material shall be guaranteed to be in a vigorous growing condition for a period of 12 months regardless of the contract time period. A plant shall be replaced one time under this guarantee. Transplanting existing plants requires no guarantee.

3-8.10 Turf. Turf consists of seed, sod, and sprigs. There may be several different types of turf mixtures applied; one for lawn areas around housing units and one for field or recreation areas. The boundaries of each area shall be clearly defined on the planting plan.

3-8.10.1 Seed quality. State approved seed of the latest season's crop shall be provided in the original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with applicable State seed laws. Seed mixtures shall be proportioned by weight. Weed seed shall not exceed one percent by weight of the total mixture.

3-8.10.2 Sod. State approved sod shall be provided as classified by applicable State laws. Each individual sod section shall be of a size to permit rolling and lifting without breaking.

3-8.10.2.1 Quality. The sod shall be relatively free of thatch, diseases, nematodes, soil-borne insects, weeds or undesirable plants, stones larger than 50 mm [2 in] in any dimension, woody plant roots, and other material detrimental to a healthy stand of turf. Sod that has become dry, moldy, or yellow from heating, or has irregular shaped pieces of sod and torn or uneven ends shall be rejected.

3-8.10.2.2 Thickness. Sod shall be machine cut to a uniform thickness of 306 mm [1ft 1/4 in] within a tolerance of 6 mm [1/4 inch] excluding top growth and thatch. Measurement for thickness shall exclude top growth and thatch.

3-8.10.2.3 Time limitation. The limitation of time between harvesting and placing sod shall be 36 hours.

3-8.10.3 Sprig quality. The cultivar shall be provided as healthy living stems, stolons, or rhizomes with attached roots, including two or three nodes, and shall be from 100 mm to 150 mm [4 in to 6 in] long, without adhering soil. Sprigs shall be provided which have been grown under climatic conditions similar to those in the locality of the project. Sprigs shall be obtained from heavy and dense sod, free from weeds or other material detrimental to a healthy stand of turf. Sprigs that have been exposed to heat or excessive drying shall be rejected. The time limitation between harvesting and placing sprigs shall be 24 hours.

3-8.10.3.1 Soil test. A soil test shall be performed for pH, chemical analysis, and mechanical analysis to establish the quantities and type of soil amendments required to meet local growing conditions for the type and variety of turf specified.

3-8.11 Temporary turf cover. When there are contract delays in the turfing operation or a quick cover is required to prevent erosion, the areas designated for turf shall be seeded with a temporary seed. When no other turfing materials have been applied, the quantity of one-half of the required soil amendments shall be applied and the area tilled.

3-8.12 Installation. The turf shall be installed during appropriate planting times and conditions recommended by the trade for the type and variety of turf specified. The turf operations shall be performed only during periods when beneficial results can be obtained. Drainage patterns shall be maintained. The turf shall be installed by using the methods as recommended by the trade for the type and variety of turf specified.

3-8.13 Protection. Immediately after turfing, the area shall be protected against traffic or other use by erecting barricades and providing signage as required.

3-8.14 Turf establishment period. The turf establishment period for establishing a healthy stand of turf shall begin on the first day of work under the turfing contract and shall end three months after the last day of the turfing operation. An unsatisfactory stand of turf shall be repaired as soon as turfing conditions permit.

3-8.15 Satisfactory stand of turf.

3-8.15.1 Seeded lawn area. A satisfactory stand of turf from the seeding operation for a lawn area is defined as a minimum of 160 grass plants per square meter. Bare spots shall be no larger than 150 mm [6 in] square. The total bare spots shall not exceed two (2) percent of the total seeded area.

3-8.15.2 Seeded field area. A satisfactory stand of turf from the seeding operation for a field area is defined as a minimum of 100 grass plants per square meter. The total bare spots shall not exceed two (2) percent of the total seeded area.

3-8.15.3 Sodded area. A satisfactory stand of turf from the sodding operation is defined as living sod uniform in color and texture. Bare spots shall be no larger than 50 mm [2 in] square.

3-8.15.4 Sprigged area. A satisfactory stand of turf from the sprigging operation is defined as a minimum of 20 sprigs per square meter. Bare spots shall be no larger than 225 mm [9 in] square. The total bare spots shall not exceed two (2) percent of the total sprigged area.

3-8.16 Maintenance during establishment period. The maintenance of the turfed areas shall include eradicating weeds, eradicating insects and diseases, protecting embankments and ditches from erosion, maintaining erosion control materials and mulch, protecting turf areas from traffic, mowing, watering, post-fertilization, and replacing unsatisfactory turf areas.

Project Name

Project No. \_\_\_\_\_  
TI 801-02, Army Family Housing, 01 Nov 02

3-9 Sprinkler and/or Irrigation system. [Use of a sprinkler and/or irrigation system should be included in only in arid regions for the protection of landscape plantings. Coordinate requirements with the installation. Insert "....(DELETED)." and delete remainder of text if not needed.] Provide a complete permanent automatic irrigation system with controllers covering all common planting areas and slopes. Design the system to function with available water pressure.

#### 4. SITE ENGINEERING.

##### 4-1 Soils.

4-1.1 Soil and Foundation Report (Geotechnical Report). A preliminary Soil and Foundation Report is provided as part of this RFP. A drawing indicating Subsurface Explorations and Geologic Profiles for the proposed site is also provided. The report provides an overview of soils and geologic conditions, and is furnished for informational purposes only. The offeror to whom this contract is awarded shall, with his or her consulting professional geotechnical engineer experienced in geotechnical engineering, be responsible for determining site specific geotechnical conditions.

4-1.1.1 The Contractor provided site specific geotechnical conditions report shall include, but not be limited to:

4-1.1.1.1 Classification of soil and rock.

4-1.1.1.2 Depth to bedrock.

4-1.1.1.3 Extent of boulders.

4-1.1.1.4 Bearing capacity of soil and rock.

4-1.1.1.5 Settlement potential.

4-1.1.1.6 Compaction requirements.

4-1.1.1.7 Groundwater characteristics.

4-1.1.1.8 Infiltration and permeability.

4-1.1.1.9 Erosion and siltation.

4-1.1.1.10 Surface and subsurface drainage.

4-1.1.1.11 Soil resistivity.

4-1.1.1.12 Other [Insert any site specific requirements.]

4-1.1.2 The offeror and his or her professional geotechnical engineer consultant shall certify in writing that the design of the project has been developed consistent with the site specific geotechnical conditions. The certification shall be stamped by the consulting professional geotechnical engineer and shall be submitted with the 50 percent design submission. If revisions are made to the 50 percent design submission, a new certification shall be provided with the final design submission.

##### 4-1.2 Soil compaction.

4-1.2.1 Soil compaction shall be achieved by equipment approved by a professional geotechnical engineer. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the compaction specified with the equipment used. Compact each layer to not less than the percentage of maximum density specified in Table 4-1, determined in accordance with ASTM D 1557 Method D.

**TABLE 4-1 – SOIL COMPACTION**

Subgrade Preparation, Fills, Embankments, and Backfills	Compaction Requirements (Percentage of Maximum Density)
Structures & Building Slabs	90
Streets, Paved Areas, Bike Paths	90
Sidewalks	85
Grassed Areas	80

4-1.2.2 The requirements shall be verified or modifications recommended by the consulting professional geotechnical engineer in the report wherever engineering, soils, or climatic factors indicate the necessity. Any modification to the stated compaction requirements shall require the approval of the Contracting Officer.

4-1.3 Capillary water barrier. A capillary water barrier is required for all interior slabs on grade, including garages, carports and storage rooms. As a minimum, the capillary water barrier shall [Define minimum requirements.]

4-1.4 Soil treatment. [If not required insert "...(DELETED)." and delete remainder of text.] Soil treatment for termites shall be by the chemical method. Methods and extent of protection required are as follows: [Insert project specific requirements.]

4-1.5 Decay treatment. Decay treatment shall apply to the following: [Insert project specific requirements.]

4-1.6 Radon mitigation. The design and construction of foundation walls, slabs, and crawl spaces shall include provisions for the reduction of radon entry and facilitate its removal. Radon mitigation shall comply with the requirements of ASTM E1465. [If not required, insert "...Deleted"." and delete remainder of text.] Design District technical specialists can contact Mr. David Price of EPA's Indoor Environments Division, 202-564-9447 regarding suggested language concerning indoor air quality and radon mitigation. Design Districts may also review: United States Environmental Protection Agency criteria are available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, (703) 487-4650: EPA/600/8-88/087, Radon-Resistant Residential New Construction; EPA/625/5-88/024, Application of Radon Reduction Methods; and EPA/625/5-87/019, Radon Reduction Techniques for Detached Houses.]

4-2 Water Distribution System. Connection to the existing water distribution system shall be made at the locations shown on the RFP drawings.

4-2.1 Water Mains and Building Service Connections. Mains shall be considered as that part of the distribution system supplying fire hydrants, or fire hydrant laterals. Service connections supply water from the main to the building. Mains shall be looped with no dead ends and be of adequate size to satisfy both domestic and fire flow requirements. Minimum main size is 0.15 m [6 in]. Sufficient sectional control valves shall be provided so that no more than two fire hydrants will be out of service in the event of a single break in a water main. A copper tracer wire shall be placed directly above all non-metallic mains when plastic marking tape does not provide means of determining alignment of pipe by metal detecting equipment. The pipe, valves, and all other materials shall meet the American Water Works Association (AWWA) standards for a 1,034.2 kPa [150 psi] working pressure system. Provide sacrificial anodes for all valves and metal pipe. Building connections shall be designed and constructed in accordance with the National Standard Plumbing Code.

4-2.2 Flow requirements. Water must be supplied by mains of appropriate capacity to provide 37.9 L/s [500 gpm] at one-story units, 56.8 L/s [750 gpm] at two-story structures, and 75.8 L/s [1,000 gpm] at structures which are three or more stories high, for a flow duration of 1-1/2 hours. This mandatory flow is over and above domestic requirements. Domestic requirements shall be based on 1135.6 liters/day (300 gal/day) per housing unit for single

family housing, and 946.3 liters/day (250 gal/day) per housing unit for multi-family housing. Mains shall be sized to carry this flow with a 2.5 peak hourly factor. Pressure shall be a minimum of 137.9 kPa [20 psi] at each fire hydrant, and a maximum of 1,034.2 kPa [150 psi] at each outlet after allowing for friction, elevation, and other pressure losses. Pressure at each housing unit shall not exceed 517.1 kPa [75 psi].

4-2.3 Trenches. Water and gas mains may be installed in the same trench, with the gas main placed on a shelf at least 0.3 m [12 in] above and to one side of the water mains. (Coordinate with the local gas utility supplier to determine system acceptability). Water mains shall have a minimum of 0.9 m [3 ft] of earth cover. Minimum cover above water lines shall be 0.75 m [2 ft 6 in] in grassed areas and 0.9 m [3 ft] in paved areas. Adequate cover must be provided for freeze protection. Where frost penetrates to a depth greater than the minimum above, greater cover will be required. Sufficient cover must also be provided to protect the pipe against structural damage due to superimposed surface loads. Lines laid lower than the minimums stated shall be concrete encased with a minimum concrete thickness of 0.15 m [6 in].

4-2.4 Fire hydrants. Hydrants shall conform to AWWA C502, Dry-Barrel Fire Hydrants, or AWWA C503, Wet-Barrel Fire Hydrants, except as required by the local utility supplier. Valves shall conform to AWWA C500, Gate Valves for Water and Sewerage Systems. Fire hydrants shall be compatible with those presently in use at the installation or local Government Juridicant, with similar pump and hose connections. Fire hydrant spacing shall be no greater than 152 m [500 ft] apart, by paved road. In addition, a hydrant shall be provided so that all parts of the housing units can be reached by hose lines not over 107 m [350 ft] long. Hydrant laterals shall be 0.15 m [6 in] minimum size, shall not exceed 15.2 m [50 ft] in length, and shall have an underground shutoff valve. Valve box, at each lateral, shall be located within 3 m [10 ft] of the hydrant, and shall not be located where obstructed by parked vehicles, shrubbery, etc. Guard post barriers shall be provided where hydrant locations are subject to vehicle damage.

4-2.5 Shutoff valve. Each building shall be provided with a separate service and main shutoff valve, readily accessible to maintenance and emergency personnel. Shutoff valves in walks are prohibited.

4-3 Sanitary Sewerage System. Connection to the existing sewage collection system shall be made at the location shown on the RFP drawings. Sewage collection systems shall be designed and constructed in accordance with the National Standard Plumbing Code criteria in this paragraph, and installation requirements. Pipe sizes and slopes shall be calculated using the Manning Formula. Manholes are required at all changes of direction and spaced not more than 152 m [500 ft] apart. Curved sewers are prohibited. Pipes shall be designed to flow full and maintain a minimum velocity of 0.6 m [2 ft] per second. If siphons are used, two lines of equivalent capacity shall be used with cleanouts. Where pumping is required, force mains shall be sized to minimize pumping head, with a 0.9 m to 1.5 m [3 ft to 5 ft] per second velocity.

4-3.1 Sewer mains. Design shall be based on an average daily per capita flow of sanitary sewage of 378.5 L [100 GAL] per day with a 4.0 peak hourly factor. Mains shall be a minimum of 0.2 m [8 in] in diameter.

4-3.2 Sewer Building Laterals. Each building lateral shall be connected directly to a sewer main. Combining multiple building laterals is prohibited. Apartment units within a building may use a single building lateral. Cleanouts shall be provided to allow cleaning of all lines to grade. Cleanouts, in yard areas, shall be set in a box with a hinged cover. Laterals from one building shall not cross under another building. Lines shall be sized in accordance with the National Standard Plumbing Code. Sewer laterals serving one or two housing units shall be a minimum of 0.15 m [6 in] in diameter. Laterals serving three or more housing units shall be a minimum of 0.2 m [8 in] in diameter.

4-3.3 Trenches. Sewer and water lines, mains or laterals, shall be placed in separate trenches. The separate trenches shall maintain a minimum lateral separation of 3.0 m [10 ft].

4-3.4 Cover. Sewer lines shall be located at a depth greater than the frost penetration. Minimum cover above the top of pipes shall be 0.6 m [2 ft] in areas not subject to vehicular loads and 0.9 m [3 ft] in all other areas. If the minimum cover can not be met, the length of pipe shall be concrete encased with a minimum 0.07 m [3 in] thickness of concrete

4-4 Storm Drainage System. The storm drainage system shall be properly coordinated with surrounding

properties to ensure that runoff does not cause damage to other properties. All drainage lines, if required, shall remain in conduit to stable grade. The minimum velocity of flow in conduits during a design storm shall be 0.07 m/s [2 ft 6 in/s]. Storm water collection, disposal (and retardation) system shall be designed for a minimum of a 10-year return frequency. Rainfall intensities for project locations shall be in accordance with local community/locality/State Transportation (Highway) agency design parameters.

4-4.1 Site specific storm drainage criteria. [Insert site specific requirements such as local and State requirements limiting runoff, permit requirements, etc.]

4-4.2 Manholes. Manholes shall be located at intersections and changes in alignment or grade. Intermediate manhole maximum spacing shall be 76.2 m [250 ft] for pipes 0.9 m [3 ft] or less in diameter or box drains with the smallest dimension less than 0.9 m [3 ft]. Maximum spacing for intermediate manholes on larger pipes and drain boxes shall be 152 m [500 ft]. Manholes shall be precast concrete and shall conform to ASTM C 478 or AASHTO M 199. Steel ladders shall be installed where the depth of the manhole exceeds 0.9 m [3 ft]. The ladder shall be galvanized after fabrication in accordance with ASTM A 123. The wall along the ladder shall be vertical. The manhole shall have a 0.6 m [2 ft] minimum opening as measured from the face of the steel ladder.

4-4.3 Drainage of roads and pavements. Provide a positive crown or sheet drainage to all streets and roads. Pavement collectors for storm water shall be by curb inlets and gutters. Open areas shall be drained by field inlets and an underground collection system. No roadside ditches shall be permitted. Overland flow shall be held to a minimum.

4-4.4 Pipe for culverts and storm drains may be of concrete, clay, corrugated steel, corrugated aluminum alloy, PVC, or PE. [Edit if metal piping is inappropriate for soil conditions.]

4-5 Gas Distribution System. [Insert " ... (DELETED)" if not applicable and delete remainder of text in subparagraphs.] [Coordinate with the installation to determine the responsible agency for installation of exterior gas lines, meters, regulators, hot taps, valves, etc. The design agent shall then add a sentence to this paragraph to inform the contractor of his or her responsibility.] Provide a gas distribution system, connected to existing systems and designed in accordance with local codes, utility company requirements, or installation regulations, whichever is more stringent. Gas distribution systems shall comply with the requirements of ASME B31.8. Connection to existing gas distribution system shall be made at the location shown on the enclosed RFP drawings. When connecting to existing steel piping system, provision shall be made to ensure that the integrity of the cathodic protection is not compromised. Shutoff valves shall be provided on the exterior of each building. A gas regulator and provision for future installation of an individual gas meter to monitor fuel use shall be provided for each housing unit or building structure. The building service entrance shall be installed at a height sufficient to allow for future installation of the gas meter. Existing lines that are to be abandoned shall be either removed or physically disconnected from all gas sources and purged. Abandoning existing gas piping shall be done in accordance with ANSI B31.8, Gas Transmission and Distribution Piping Systems. Installation of gas piping will be in accordance with ANSI B31.8 and 49 CFR 192.

4-5.1 Materials. Materials and appurtenances shall be free of defects and suitable to accomplish the stated objectives of gas distribution systems. Pipe shall be polyethylene or steel as described below.

4-5.1.1 Polyethylene pipe shall conform to ASTM D2513, Standard Specification for Thermoplastic Gas Pressure Piping Systems, with fittings complying with either ASTM D2513 or ASTM D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing. Connections to metal pipe shall comply with ANSI B16.5, Pipe Flanges and Flanged Fittings, or manufacturer's recommended standards.

4-5.1.2 Steel pipe shall conform to ASTM A 53, Grade A or B, Type E or S, Schedule 40; or seamless or electric resistance welded, Schedule 40; black, as specified in ASME B31.8. Furnace butt welded pipe may be used in sizes 40 mm [1-1/2 inch] and smaller. Fittings 40 mm [1-1/2 inch] and smaller shall conform to ASME B16.11. Pipe flanges and flanged fittings larger than 40 mm [1-1/2 inch], including bolts, nuts, and bolt patterns shall be in accordance with ASME B16.5, Class 150. Butt weld fittings shall be in accordance with ASME B16.9. Weld neck flanges shall be used.

4-5.2 Testing. Prove that the entire system of gas mains and service lines is gas-tight by an air test, in accordance with ANSI B31.8. The test shall continue for at least 24 hours between initial and final readings of pressure and temperature.

4-5.3 Drips. Unless high pressure natural gas is used, drips shall be installed at the low points, immediately following reduction from high pressure to medium pressure (at supply points) and at occasional low points throughout the system to provide for blowing out the lines.

4-5.4 Valves. Plug valves shall be installed at intersections of mains and other locations so that interruptions to service can be confined to no more than 30 housing units.

4-5.5 Mains and service lines. Lines shall not be placed under any buildings. Lines shall be placed with a minimum of 0.6 m [2 ft] of earth cover. Protective casings shall be provided to protect lines from superimposed street or heavy traffic loads.

4-6 Fuel Oil Storage and Distribution. [Insert "DELETED" if not applicable and delete remainder of text in all paragraphs.] Fuel oil storage and distribution system shall be installed to supply the fuel oil-fired heating equipment. Provide a complete fuel oil storage and distribution system designed in accordance with local codes, installation requirements, NFPA 30, and NFPA 31, whichever are more stringent.. Tank size shall be determined using the ASHRAE Degree Day Method using the degree days for the coldest 30-day period for the site.

4-6.1 Tank storage. Each housing unit shall be provided with a separate fuel oil storage tank unless more than one housing unit is served by a single heating system, in which case each heating system shall be provided with a separate fuel oil tank. Fuel oil storage tanks may be located underground or above ground if the stored volume is less than 2006 L [530 GAL]. Storage tanks shall be placed in a location suitable for filling from a curb-side delivery truck. Above ground tanks shall not be installed on the front side of the building, and shall be concealed by a screen wall or by shrubbery. Fuel oil tanks shall be located in accordance with local codes, and shall be installed a minimum of 0.3 m [1 ft] from the edge of the tank shell to the nearest outside wall of any building or basement or from the nearest adjoining property line. Where tanks are located adjacent to exterior walls or other surfaces requiring periodic painting or other maintenance/repair requirements, a minimum clearance of 1m [3ft] from the edge of the tank is preferred. Underground tanks shall be located such that loads supported by building foundations cannot be transferred to the tank. Proposed tank location shall be clearly indicated in the design submittal.

4-6.1.1 Underground tanks. Fuel oil storage tanks installed below grade shall be double-walled type constructed using fiberglass or steel, and installed in accordance with the manufacturer's recommendations. The top of the tank shall be at least 0.6 m [2 ft] below finished grade. Fiberglass tanks shall be constructed in accordance with UL 1316. Steel tanks shall be Type II, constructed in accordance with UL 58, with an STI-P3 coating and guarantee except that the cathodic protection system shall be based on protecting 5 percent of the tank's metal surface. Tanks shall be provided with the necessary fill, vent, gauge, hatch, and suction connections.

4-6.1.2 Above ground tanks. Above ground tanks shall be limited in size to a maximum of 2006 L [530 GAL]. Tank shall be provided with legs and located on a concrete pad. Tank shall be constructed of steel, primed and painted, and provided with the necessary fill with valved overflow basin, vent, gauge, and suction connections. Tank containment shall comply with applicable NFPA, EPA, and local code requirements.

4-6.2 Fuel oil piping. Underground fuel oil piping shall be of double-wall construction, installed without traps or sags. Outer, secondary containment pipe shall be non-metallic. Above ground piping shall be single-wall metallic pipe. Gate valves shall not be used in fuel oil piping systems. A replaceable filter shall be provided upstream of the fuel oil pump. Pipe connectors shall be in accordance with UL 567.

4-6.3 Leak detection system. A continuous surveillance leak detection system suitable for operation in an NFPA 70, Class 1, Division 1, Group D environment shall be provided to monitor the leak containment space between the interior and exterior walls of double-wall pipe and tanks. The system shall detect leakage into the containment space electronically or by monitoring interstitial pressure or liquid level variations. Liquids used in the containment

space for steel tanks shall have a corrosion inhibitor. Liquids subject to freezing conditions shall contain an antifreeze solution. The leak detection system shall be compatible with the piping and tank furnished. Instructions and equipment required for calibration of the leak detection system and manufacturer's recommended calibration maintenance schedule shall be provided.

4-6.4 Special requirements. [Research local requirements for fuel oil systems installation and either add or delete items from this sub-paragraph.]

4-6.4.1 Spill containment fill. Underground tank fill connection shall be provided in a spill container of 11.4 L [3 GAL] capacity minimum. Contained spills shall be drained into the storage tank by means of a quick-acting drain valve.

4-6.4.2 Overfill prevention valve. The overfill prevention valve shall be placed within the tank interior and be an integral part of the fill tube. The valve shall be a float actuated shut-off valve. The valve shall be constructed of the same material as the fill tube. The valve shall have two stages of shutoff. In the first stage, the valve shall restrict the flow of fuel oil into the tank to approximately 0.315 L/s [5 gpm] when the liquid level rises above 95 percent of the tank capacity. In the second stage, the valve shall completely stop the flow of fuel oil into the tank when the liquid level rises above 98 percent of the tank capacity.

4-6.4.3 Aboveground Tank Screening. Where fuel oil storage tanks are located above grade the design shall include sight screening for the tank to reduce the visual impact of the fuel oil storage tank. Visual screening may be vegetation or fencing to match the privacy fence at the unit patios. [Design District shall ensure that aboveground fuel oil storage tanks, when selected for use, are suitably screened from view. The requirements of this paragraph may be modified to suit local requirements.]

4-7 Liquefied Petroleum (LP) Gas Storage and Distribution. LP gas tanks shall comply with requirements of NFPA 58 and the ASME Code, Section VII, Pressure Vessels. Tanks shall be pad mounted, and shall not be located inside any building. Tanks shall be provided with all required gauges, shut off valves, safety devices, and suction connections. Shut off valves shall be installed at each tank, at the service entry to the building (if not in sight of the tank), and at each heating unit. No shut off valve shall be installed between a safety device and tank. LP gas pressure shall be reduced to a minimum service pressure of 3.5 kPa [ $\frac{1}{2}$  psi] prior to the building entrance. LP gas pipe connectors shall be in accordance with UL 567.

4-8 Electrical Distribution. Connection to the existing electrical distribution system shall be made at the location shown on the enclosed RFP drawings. [Insert paragraph describing how connection is to be accomplished.]

4-8.1 System design. Provide new electrical distribution system as necessary and connect to existing system. System shall be a loop-primary radial system. Primary feeder cables shall be copper or aluminum. High voltage conductors shall have protective shielding. High voltage cable shall be buried a minimum of 1.2 m [4 ft] below the finished grade with continuous cable marker tape 0.3 m [1 ft] below grade. Cable markers shall be installed along the length of direct-burial cable runs to identify their routes from the surface. Markers will be provided at changes of direction and at intervals not to exceed 152.4 m [500 ft]. The electrical on-site distribution system shall be designed in compliance with the rules and recommendations of ANSI C2, National Electrical Safety Code, and NFPA 70, and National Electrical Code, whichever is more stringent. Underground direct-burial distribution is required unless otherwise directed.

4-8.2 Underground splices. Underground connection or splices are prohibited, except in boxes or manholes. Splices shall be in a self-draining, rodent-resistant box with a cover.

4-8.3 Service laterals. Service laterals shall be underground. The length of secondary distribution service laterals from the transformer secondary to the building service entrances shall be minimized.

4-8.4 Service entrance. Only one service entrance per building shall be provided. The service entrance conductor shall be buried a minimum of 0.9 m [3 ft] below finished grade with a minimum separation of 0.3 m [1 ft] from telephone or TV cables. System shall be designed such that the fault current available at the service entrance equipment will not exceed 10,000 amps.

4-8.5 Transformers. Transformers shall be pad-mounted and have two non-fused switches for the loop connection. The high voltage compartment of the transformer shall include a load break switch with fused circuit for the transformer. The transformed secondary voltages shall be 120/240 V, single-phase, three-wire, solid neutral service to housing units. In selecting a transformer, the name plate rating shall not be less than 90 percent of the kilovolt/amperes (kV/A) demand load calculated for the transformer. [Insert transformer sizing and demand requirements.]

4-8.6 Street and area lighting. Residential roadway lighting, including collector streets, shall be provided in accordance with the IES Lighting Handbook. Provide lighting at roadway intersections, and at intervals not exceeding 60.9 m [200 ft] between intersections. Area lighting shall be provided at intervals not exceeding 60.9 m [200 ft] along area walkways not otherwise illuminated, common area walks connecting tot lots, and at all steps in area walkways. Area lighting shall be provided in accordance with the IES Lighting Handbook. Luminaries shall be actuated by photoelectric control, one photocell per circuit, and supplied from multiple circuits originating from a pad-mounted transformer.

4-9 Metering. Metering of utilities shall be provided as follows:

4-9.1 Master meters. Master meters for water, electricity, and gas shall be provided for all new and replacement housing units except where new housing units are metered by an existing meter.

4-9.2 Individual meter and meter drops. Individual utility meter drops (excluding water), and fuel oil metering points (where applicable) shall be provided for all housing units. Provide sockets for electric watt-hour meters at each housing unit. Provide manual by-pass jumper plates for each socket. Locate utility meter drops and fuel oil metering points in an area readily accessible by service personnel. Meters and meter bases shall be sight screened, and located to provide convenient access while not distracting from building appearance. [Provide individual utility meters when required by local jurisdictions.]

4-9.3 Gas metering. Provide for future individual housing unit metering devices. Comply with local requirements. Meter and regulator location shall be sight screened, and located to provide convenient access while not distracting from building appearance.

4-9.4 Group water meter requirements. Group water meters are required for new and replacement housing projects where total daily water demand exceeds 94.6 m<sup>3</sup> [25,000 gal]. Meters shall be equipped with electronic or radio frequency transmitters for remote monitoring. The method of remote monitoring must be coordinated with installation utility systems. The size of the group for metering shall be at least five but no more than 20 single family detached, duplex, or townhouse units. Metering groups for apartment units shall be at least 25, but no more than 50 housing units.

4-10 Telephone. The [Telephone company or Contractor] will furnish and install distribution cables. Conduit required between underground terminal boxes and the buildings shall be provided by the Contractor. Trenching and backfill required to install the telephone company cables shall be included in the construction contract. Contractor provided boxes, conduits, and trenching shall comply with local telephone company criteria and shall be coordinated with the telephone company.

4-11 Television. [Provide commercial cable TV or site distribution system(s) when feasible. Requirements to be edited in accordance with local conditions and availability.] An antenna system or connection to a TV distribution system shall be provided for each housing unit. The TV system shall provide for UHF and VHF reception for color TV. The antenna system may be either a common antenna serving the entire project (mast or dish), an attic antenna system for each separate building, or attic antenna for each housing unit. The Contractor shall provide all trenching, conduit, boxes, and backfilling required to install commercial and/or Contractor provided distribution systems.

4-12 Cathodic Protection. Cathodic Protection (CP) is mandatory on buried ferrous metallic structures as described below:

4-12.1 Department of Transportation guidance as stated in 49 CFR, Part 192, requires that all metallic natural gas piping be coated and cathodically protected regardless of the soil resistivity.

4-12.2 Corrosion control is mandated for all metallic underground storage tanks storing petroleum or hazardous substance by 40 CFR, Part 280 and AR 200-1 and on hazardous liquid pipelines (e.g., liquid fuel) by 49 CFR, Part 195.

4-12.3 CP systems must be designed to provide protective potential to meet the requirements of the National Association of Corrosion Engineers (NACE) Standard RP-0169, Control of External Corrosion on Underground or Submerged Metallic Piping Systems, or NACE Standard RP-0185, Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Liquid Storage Systems, as appropriate.

4-12.4 New or supplemental CP systems shall be compatible with existing CP systems and other adjacent structures or components. New systems should be compatible with existing systems to allow ease of repair and maintenance.

4-12.5 When plastic pipe is used to extend a steel gas distribution main, an insulated No. 8 AWG copper wire shall be exothermically welded to the existing steel main and run the length of the new plastic main. This wire can be used as a locator tracer wire and to maintain continuity to any future steel gas main extension.

4-12.6 CP and protective coatings shall be provided for the following buried and submerged ferrous metallic structures regardless of soil or water resistivity:

4-12.6.1 Natural gas and propane piping.

4-12.6.2 Liquid fuel piping.

4-12.6.3 Underground fuel storage tanks except for those coated in accordance with UL 1746.

4-12.6.4 Fire protection piping.

4-12.6.5 Ductile or cast iron pressurized piping under floor (slab on grade) in soil.

4-12.6.6 Underground heat distribution and chilled water piping in ferrous metallic conduit.

4-12.6.7 Other structures with hazardous products as identified by the installation.

4-12.7 Cast iron pipe shall be treated as follows:

4-12.7.1 For soil resistivity below 10,000 Ohm-cm at pipeline installation depth, provide CP, bonded joints, and protective coatings.

4-12.7.2 For soil resistivity between 10,000 and 30,000 Ohm-cm at pipeline installation depth, provide bonded joints only.

4-12.8 Copper water service lines will be dielectrically isolated from ferrous pipe. Dielectric isolation shall conform with NACE RP-0286.

4-12.9 For ductile iron piping systems (except for ductile iron piping under floor in soil) conduct an analysis to determine if CP and/or bonded or unbonded coatings are required. Unbonded coatings are defined in ANSI/AWWA C105/A21.5.

4-12.10 Conduct an economic analysis to determine if CP and protective coatings should be provided for gravity sewer lines and the following structures in soil resistivity conditions above 10,000 Ohm-cm:

4-12.10.1 Potable water lines.

Project Name

Project No. \_\_\_\_\_  
TI 801-02, Army Family Housing, 01 Nov 02

4-12.10.2 Concentric neutral cable.

4-12.10.3 Other buried and submerged ferrous metallic structures not covered above.

4-12.11 Ferrous metallic piping passing through concrete shall not be in contact with the concrete.

**5. UNIT DESIGN - ARCHITECTURE.**

5-1 Unit Design. Designs shall provide unit gross areas which do not fall below the minimum values shown in the table below.

**TABLE 5-1- MINIMUM SIZE OF HOUSING UNITS BY GRADE**

Pay Grade	Number of Bedrooms	Minimum Gross Floor Area		Pay Grade	Number of Bedrooms	Minimum Gross Floor Area	
		M <sup>2</sup>	Ft <sup>2</sup>			M <sup>2</sup>	Ft <sup>2</sup>
O-7 & Above (GFO)	4	240	2,600	E-7/8 (SNCO)	5	180	1,920
O-6 (SO)	4	195	2,100		4	170	1,800
O-4/5 (FGO)	4	180	1,920		3	155	1,670
	3	160	1,740		2	110	1,180
O-1/3 (CGO)	5	180	1,920	E-1/6 (JNCO)	5	180	1,920
	4	170	1,800		4	155	1,670
	3	155	1,670		3	140	1,490
	2	110	1,180		2	110	1,180
W-4/5 (WO)	4	180	1,920				
	3	160	1,740				
E-9 (SNCO)							

5-1.1 Gross area definition. Gross area is defined as the heated (and cooled) space inside the exterior and party walls.

5-1.2 Allowable area increases. [Note: This additional minimum square footage will be delineated for each specific project in the project DD Form 1391 document. Identify applicable pay grade(s), number of bedrooms, and number of housing units in each special command position.]

5-1.2.2 Minimum gross floor areas indicated in Table 5-1 may be increased by a maximum of 10 percent for officers holding special command positions as designated by the Secretary of Defense, commanding officers of military installations, and senior noncommissioned officers of military installations. The increase allowed for the above designations is the maximum allowed regardless of whether the housing units are procured by conventional design-bid-build or design-build methods. [Insert "...(DELETED)" and delete remainder of text if not applicable to the project.]

5-1.3 Accessible housing units shall be designed in such a way that they may be easily and readily modified to accommodate physically challenged occupants, if necessary, at time of occupancy. This means required access clearances, room sizes, bathroom layout, kitchen layout, doors and hardware, grab bars, plumbing hookups, light switches and outlets, controls, and warning devices must meet requirements at time of construction. Readily modifiable means that requirements for adjustable height cabinets and work surfaces, plumbing fixtures, and the warning devices for the hearing and visually impaired can be made either at time of construction or at time of occupancy.

5-2 Functionality. Rooms shall be sized and arranged for efficient use, good circulation, and furniture placement. The distribution of space for food preparation living and dining, sleeping, bathing, halls, closets, and services should be balanced and should enhance the intended functions.

5-2.1 Habitable rooms shall not be used as halls for entry into a housing unit or for primary circulation within a housing unit.

5-2.2 Provide convenient access between garage and service area, and between kitchen and service area.

5-2.3 Do not use a sliding glass door as a primary housing unit access.

5-3 Indoor and Outdoor Integration. Emphasize factors that enhance indoor and outdoor living. Consider size, layout and location of patios, balconies and yards, and features that encourage family use of outdoor areas.

5-4 Fire Protection and Safety. Housing units will comply with the applicable National Fire Codes, including NFPA 101, Life Safety Code. Construction features will be provided in accordance with the Uniform Building Code (UBC). [For housing units located off-post and for privatized housing, the construction features may comply with model codes in lieu of UBC, if model codes require compliance with a nationally recognized building code.]

5-4.1 Fire resistance of party walls and roof material. Party walls shall extend without openings, from ground to the underside of roof sheathing. Provide firestops at floor, and ceiling or roof line. Provide Class A (ASTM E108, Standard Methods of Fire Tests of Roof Coverings) roof covering material throughout. Party walls (walls separating housing units) shall have the minimum fire-resistance ratings shown below:

5-4.1.1 Duplexes, one hour.

5-4.1.2 Townhouses, two hour.

5-4.1.3 Apartments, one hour with approved sprinkler system.

5-4.2 Party floors. Party floors shall have a topping slab of 50 mm [1-1/2 inch] lightweight concrete, or similar material. Party floors shall have a minimum one-hour fire-resistance rating, in accordance with ASTM E119.

5-4.3 Heater rooms. Rooms equipped with fuel-fired equipment such as boiler rooms, furnace rooms, and rooms with fuel-fired water heaters, which serve more than one housing unit shall be separated by one-hour fire-rated construction. Direct access to these rooms from the exterior is preferred. Rooms with fuel-fired equipment that serve only one housing unit shall be lined with 13 mm [1/2-inch] gypsum board or equivalent noncombustible material.

5-4.4 Alarm systems. When a general building alarm system is required by NFPA 101, such as those required for housing units four stories or higher, the required systems shall transmit alarms to the installation fire department. Exceptions are made for housing units not located on military installations and for housing units located on installations without a installation-wide or central fire reporting system. Smoke detectors which are located within the housing unit and which sound an alarm only within the housing unit are not required to be transmitted.

5-4.5 Sprinkler systems. Apartment units shall be fully sprinkled. Sprinkler systems for garden apartments (one through four floors) will comply with NFPA 13R. Sprinkler systems for apartment buildings of over four floors will comply with NFPA 13. Townhouse constructions with two hour fire walls between each unit and duplex constructions with a one hour fire wall between the units will not require sprinklers.

5-5 Sound Attenuation.

5-5.1 Testing. Certified proof-of-performance field tests will be conducted to demonstrate that the floor and wall systems as constructed provide the required sound isolation. Tests for air-borne sound shall be made in compliance with ASTM E336. Tests for impact sound shall be made in compliance with ASTM E1007. Testing of 10 percent (minimum) of each type of floor and wall system is required. Location of test sites will be chosen at random by the Contracting Officer.

5-5.1.1 Any wall or floor system found to be inadequate shall have the deficiencies corrected and the additional qualifying tests conducted at the Contractor's expense. Testing at the Contractor's expense of greater than 10 percent of each system may be required if the Contracting Officer determines that the quality of construction requires this additional testing.

5-5.1.2 Walls and floor ceiling systems shall be designed to meet or exceed the requirements stated below. In cases where the field tested performance of the systems does not meet the designed performance, the maximum acceptable difference between field tests and sound transmission ratings shall be 2 decibels (dB) for airborne sound ratings and 5 dB for impact sound ratings.

5-5.2 Plumbing and HVAC equipment. Design of plumbing and Heating, Ventilating, Air-Conditioning (HVAC), and dehumidifying equipment shall include design provisions such as location, enclosure and acoustical treatment, to minimize transmission of noise generated by equipment within each housing unit and to eliminate transmission of noise to other housing units.

5-6 Dimensions and Areas. Minimum areas and dimensions for interior spaces are shown in Table 5-3. Minimum areas and dimensions for exterior spaces are shown in Table 5-4.

**TABLE 5-3 - MINIMUM AREAS AND DIMENSIONS - INTERIOR SPACES**

Space	Area		Length		Width/Depth		Height <sup>1</sup>
	m <sup>2</sup>	ft <sup>2</sup>	mm	ft-in	mm	ft-in	mm
Living <sup>2</sup>	14.0	150	3550	11-8	3550	11-8	2300
Dining (2/3 BR) <sup>2</sup>	8.4	90	2900	9-6	2900	9-6	2300
Dining (4/5 BR) <sup>2</sup>	10.2	110	3200	10-6	3200	10-6	2300
Dining (GO) <sup>2</sup>	13.4	144	3650	12-0	3650	12-0	2300
Family Room <sup>2</sup>	8.4	90	2900	9-6	2900	9-6	2300
Kitchen <sup>3,6</sup>	6.0	64	2450	8-0	2450	8-0	2300
Eating in Kit. <sup>4</sup>	6.7	72	2600	8-6	2600	8-6	2300
Refrigerator & Freezer	0.5	6	900	3-0	600	2-0	1800
Washer/Dryer <sup>5</sup>	1.7	18	1800	6-0	900	3-0	2100
BR #1	14.0	150	3550	11-8	3550	11-8	2300
BR #2	11.1	120	3000	10-0	3000	10-0	2300
BR #3	9.0	100	3000	10-0	3000	10-0	2300
BR #4/5	8.4	90	2900	9-6	2900	9-6	2300
Half Bath <sup>6</sup>	-	-	-	-	900	3-0	2300
Full Bath <sup>6</sup>	-	-	-	-	1500	5-0	2300
Vestibule	1.2	13	1000	3-3	1200	4-0	2300
Hall & Stairway <sup>7</sup>	-	-	-	-	1000	3-3	2300

**TABLE 5-3 - MINIMUM AREAS AND DIMENSIONS - INTERIOR SPACES**

Space	Area		Length		Width/Depth		Height <sup>1</sup>
	m <sup>2</sup>	ft <sup>2</sup>	mm	ft-in	mm	ft-in	mm

Note<sup>1</sup>: Ceiling heights in habitable rooms shall be a minimum of 2300 mm [7 ft-6 inches]. Ceiling heights can be reduced in parts of these rooms to 2100 mm [7 ft] to accommodate ducts.

Note<sup>2</sup>: Room dimensions are exclusive of circulation. Circulation paths along one side of a room are permitted but add 1000 mm [3 ft-3 inches] to the minimum dimension.

Note<sup>3</sup>: A minimum of 1200 mm [4 ft] must be maintained in front of and between cabinets.

Note<sup>4</sup>: Minimum area and dimensions are measured from face of cabinets to walls.

Note<sup>5</sup>: Minimum area and dimensions are indicated for a washer and dryer closet. This area may also be provided in a utility room. When so provided, area and dimensions are exclusive of circulation.

Note<sup>6</sup>: Accessible units must conform to UFAS. UFAS requires greater minimum dimensions.

Note<sup>7</sup>: Clear width is measured between railings.

**TABLE 5-4 - MINIMUM AREAS AND DIMENSIONS - EXTERIOR SPACES**

Spaces	Area		Length		Width/Depth		Height <sup>1</sup>
	m <sup>2</sup>	ft <sup>2</sup>	mm	ft-in	mm	ft-in	mm
Garage	21.6	240	3650	12-0	6100	20-0	2300
Balconies	6.7	72	1800	6-0	1800	6-0	2300
Patio - 2 BR	11.2	120	-	-	2400	8-0	2400
Patio - 3 BR	13.6	144	-	-	3000	10-0	2400
Patio - 4 BR	17.0	180	-	-	3000	10-0	2400
Patio - 5 BR	20.4	216	-	-	3700	12-0	2400

Note<sup>1</sup>: Ceiling heights apply when patios and balconies are covered.

5-6.1 Minimum area requirements for kitchen cabinets, counters, and pantries are shown in Table 5-5. Flat area is shown for countertops and drawers. Combined shelf area is shown for pantry and base, wall and wall cabinets.

**TABLE 5-5 - KITCHEN CABINET, COUNTER, & PANTRY AREA**

Type of Housing Unit	Wall		Base		Drawer		Counter		Pantry	
	m <sup>2</sup>	ft <sup>2</sup>								
GFO/SO	3.4	36	4.4	46	2.1	22	1.9	20	1.9	20
Others 4/5 BR	2.8	30	3.8	40	1.7	18	1.5	16	1.5	16
Others 2/3 BR	2.3	24	3.0	32	1.3	14	1.1	12	-	-

5-6.2 Minimum closet width requirements are stated in Table 5-6.

**TABLE 5-6 - MINIMUM CLOSET WIDTHS<sup>1</sup>**

Type of Unit	EM		FGO/SO		GO	
	Mm	ft	mm	Ft	mm	ft
Coat/ Entry Hall	900	3	1200	4	1500	5
Master <sup>2</sup> BR #1	1800	6	1800	6	3000	10
BR #2	1200	4	1200	4	1800	6
BR #3	1200	4	1200	4	1800	6
BR #4/5	1200	4	1200	4	1200	4
Broom	900	3	900	3	900	3
Linen <sup>3</sup>	600	2	900	3	1200	4

Note<sup>1</sup>: Minimum inside clear depth for standard/broom closets shall be 600 mm [2 ft].

Note<sup>2</sup>: Walk-in closet is preferred.

Note<sup>3</sup>: Minimum clear inside depth for linen closets shall be 430 mm [1 ft-6 inches].

5-6.3 Minimum requirements for interior, exterior, and combined bulk storage are shown in Table 5-7.

**TABLE 5-7 - MINIMUM INTERIOR, EXTERIOR, & COMBINED BULK STORAGE<sup>1</sup>**

Type of Unit	Type of Storage	EM/CGO		FGO/SO		GFO	
		m <sup>2</sup>	ft <sup>2</sup>	m <sup>2</sup>	ft <sup>2</sup>	m <sup>2</sup>	ft <sup>2</sup>
2 BR	Int.	2.3	24	-	-	-	-
	Ext.	3.0	32	-	-	-	-
	Comb.	6.5	70	-	-	-	-
3 BR	Int.	3.0	32	3.7	40	-	-
	Ext.	3.7	40	4.5	48	-	-
	Comb.	7.9	85	10.3	111	-	-
4 BR	Int.	3.7	40	4.5	44	5.0	54
	Ext.	4.5	48	5.0	54	5.6	60
	Comb.	9.3	100	11.2	120	18.6	200
5 BR	Int.	4.5	48	-	-	-	-
	Ext.	5.0	54	-	-	-	-

**TABLE 5-7 - MINIMUM INTERIOR, EXTERIOR, & COMBINED BULK STORAGE<sup>1</sup>**

Type of Unit	Type of Storage	EM/CGO		FGO/SO		GFO	
		m <sup>2</sup>	ft <sup>2</sup>	m <sup>2</sup>	ft <sup>2</sup>	m <sup>2</sup>	ft <sup>2</sup>
	Comb	10.2	110	-	-	-	-

Example<sup>1</sup>: If interior bulk storage is 2.3 m<sup>2</sup>, then exterior bulk storage must be 4.2 m<sup>2</sup> to obtain the combined bulk storage requirement of 6.5 m<sup>2</sup>.

5-8 Major Zones. Living and Dining, Kitchen, Family Room, and Bedrooms.

5-8.1 Living and dining. The living room should have direct access to the front entrance foyer and to the dining area without passing through another room. When circulation is required along the perimeter of the space or between areas in open plans, minimum circulation space of 1000 mm [3 ft-3 inches] shall be added to the required minimum room dimension.

5-8.1.1 The dining area may be an extension of, or an "L" off the living room.

5-8.1.2. The dining area shall be directly accessible from the kitchen without passing through another room.

5-8.1.3 For Senior Officer family units, provide separate dining rooms or areas to accommodate furniture and seating for not less than 10 persons.

5-8.2 Kitchen and auxiliary dining area.

5-8.2.1 The kitchen shall provide an efficient work triangle. A base cabinet, minimum 380 mm [15 inches] wide, shall be provided on the handle side of the refrigerator. The range shall not be located adjacent to the refrigerator, in a corner, or adjacent to a passageway. The dishwasher shall be installed adjacent to the kitchen sink. Provide a backsplash behind the range, extending to the underside of the range hood, finished to match the countertop or range and the range hood. Space for a tenant-owned upright freezer shall be provided adjacent to the kitchen or in areas such as the utility room or garage. Space for a tenant-owned microwave oven shall be provided in the kitchen.

5-8.2.2 Provide auxiliary dining areas in the form of table space in the kitchen or in a family room adjacent to, or as an extension of, the kitchen. The auxiliary dining area shall not be located in the living or dining rooms.

5-8.2.3 In the kitchen, shoe molding (1/4 round) is required at all base cabinets where they meet the floor surface.

5-8.3 Family room. Provide a separate family room, adjacent to and contiguous with the kitchen, for all three-, four, and five-bedroom units.

5-8.4 Bedrooms. Bedrooms shall be designed to accommodate king-size beds in master bedrooms and twin beds in the other bedrooms. Window, door, and closet placement should enhance furnishability. Each bedroom shall be accessible without passing through another bedroom.

5-9 Minor Zones. Bathrooms, Laundry, Closets, and Bulk Storage.

5-9.1 Bathrooms. Emphasis shall be placed on size, furnishings, layout, and privacy. Direct access to a bathroom from the master bedroom is required for three-, four-, and five-bedroom units. Compartmented bath design, for family and guest use, is encouraged. Determine the number of bathrooms based on Table 5-8.

**TABLE 5-8 - BATHROOM REQUIREMENTS**

Number of Bedrooms per Floor	Number of Bathrooms Per Floor
None	.5
1 - 2	1
3 - 5	2

Note: General Officer (GO) units shall have three full bathrooms, with one on the first floor configured for accessibility.

5-9.1.1 A full bath shall contain a water closet, lavatory, and either a tub with shower assembly or a shower stall. One full bath in each housing unit shall include a tub with shower assembly and shall be directly accessible from the bedroom hall without passing through another room. Showers, and tubs with shower assemblies, shall include tempered glass or plastic enclosures and doors. A half bath contains a lavatory and a water closet.

5-9.1.2 Provide lavatories mounted in 610-mm [2-ft] wide (minimum) countertops, with vanity bases. Countertops shall be high pressure laminated plastic, ceramic tile, marble, or homogeneous, non-porous, solid surface type materials, with minimum 100 mm [4 inches] high back splashes.

5-9.1.3 Bathroom accessories may be surface mounted or recessed, of non-corrodible metal or ceramic tile, and shall include a toilet paper holder, soap dish (at sink and at tub/shower), toothbrush and tumbler holder, and grab bar at tub or shower stall, bathrobe hook, and towel bars totaling not less than 1100 mm [42 inches] for a full bath and not less than 750 mm [30 inches] for a half bath.

5-9.1.4 A recessed medicine cabinet shall be provided in each bathroom. Cabinets shall be corrosion-resistant with plate glass mirrors, sliding or hinged door type. Do not place recessed medicine cabinets in party walls.

5-9.1.5 Tubs and showers shall not be placed under windows.

5-9.1.6 Exhaust shall be provided in all baths, shall be ducted directly to the exterior of the building, and shall be a part of an engineered ventilation system (See paragraph 10).

5-9.2 Laundry. Washer and dryer space may be provided in an enclosed recess off the hall in two-bedroom units. Three-bedroom and larger units shall have a separate utility room.

5-9.2.1 The space provided shall have doors that provide full access when open. Two full-length shelves, 250 mm [10 inches] minimum nominal depth, are required above the washer and dryer.

5-9.2.2 Minimum net clear door width to washer and dryer space when open is 1600 mm [5 ft-4 inches] for an enclosed recess and 800 mm [2 ft-8 inches] if located within a utility room.

5-9.3 Closets. Closets shall provide the minimum widths indicated in Table 5-6. A broom closet shall be provided convenient to the kitchen, and a coat closet shall be located convenient to the housing unit entrance.

5-9.3.1 Closet shelving. Closets (except linen closets) shall be equipped with a 305 mm [12 inches] deep shelf and a clothes hanger rod. Linen closets shall be provided with at least four full-depth shelves. Closet shelving and rods in excess of 1200 mm [4 ft] shall have center supports. Shelves and supports shall be capable of carrying 52 kg/m [35 lbs/ft]. Closet shelving shall be minimum 19 mm [3/4 inch] thick solid wood, plywood, or high density particle board. [Factory Finished welded wire shelving meeting the capacity requirements is also permitted. Intermediate supports must be anchored to studs.]

5-9.3.2 Closet doors. Closet doors should be located to permit placement of furniture in the corners of the rooms by providing a 460-mm [18-inch] return adjacent to a furnishable wall. Closets 1800 mm [6 ft] or more in width shall have sliding doors, maximum 2000 mm [6 ft-8 inches] high. Wall closet width shall not extend beyond either door

jamb more than 510 mm [20 inches]. Wardrobe closet doors (sliding and bi-fold) shall be provided with both top and bottom door tracks.

5-9.4 Bulk storage. Provide each housing unit with interior and exterior bulk storage space meeting the minimum requirements of Table 5-7. Provide interior storage in a separate room or included as an extension of the utility room when one is provided. Provide exterior storage in a garage, a separate exterior enclosure, or within the housing unit with access from the exterior.

5-9.4.1 Apartment buildings shall provide an enclosed room on the ground floor level for the common storage of bicycles, prams, etc. This storage space (minimum of 1.7 m<sup>2</sup> [18 ft<sup>2</sup>] per housing unit) is in addition to the required minimum interior and exterior storage indicated in Table 5-7 for the individual housing units. Exterior storage space shall be lockable.

5-9.4.2 Bulk storage space should be at least 1200 mm [4 ft] in depth and a minimum clear height of 2000 mm [6 ft-6 inches], except that space under stairs may be counted at 1/2 area if the space is 1200 mm [4 ft] or more in height.

5-9.4.3 Provide a minimum of three nominally 305 mm [12 inches] deep shelves with a combined length of 7300 mm [24 ft] within each bulk storage room.

5-9.4.4 Common walls and ceilings between adjacent storage areas shall be finished on both sides.

## 5-10 Interior Finishes

5-10.1 Walls and ceilings. Provide 13 mm [1/2-inch] gypsum wallboard, taped and smooth finished. Water-resistant wallboard shall be used in wet areas such as bath, powder, and laundry rooms. Cementitious backer board shall be used for ceramic tile applications. Textured ceiling finish may be provided in areas other than kitchen, laundry, or bathrooms. Interior finish shall have a flame-spread rating of 25 or less and a smoke-developed rating of 50 or less when tested in accordance with ASTM E84.

5-10.2 Kitchen and eating area walls and ceiling. Combined kitchen and eating rooms shall have the same type of wall and ceiling finishes.

5-10.3 Flooring and stairs, base, and carpet. Kitchen, laundry, and utility flooring shall be sheet, seamless vinyl with wood base. Bedroom, hall, and living-dining area flooring shall be carpet or vinyl composition tile with wood base. Bathrooms shall be of ceramic tile flooring with ceramic tile base or seamless sheet vinyl with premolded vinyl base. Interior stairs shall be hardwood with clear finish, or softwood with carpet. Additional consideration will be given to designs which incorporate ceramic tile bathroom floors and hardwood stairs with a clear finish. This material identification is not justification to exceed the mandatory price limitation set forth in this solicitation.

5-10.3.1 Vinyl composition floor tile shall conform to ASTM F1066, Standard Specification for Vinyl Composition Floor Tile, and have a minimum thickness of 2.381 mm [3/32-inch].

5-10.3.2 Sheet vinyl shall conform to ASTM F1303, Standard Specification for Sheet Vinyl Floor Covering with Backing, Type II, Grade 2. Flooring shall be installed as a monolithic material with seams welded or bonded for a seamless installation. No seams shall be permitted in spaces less than 12 feet in width.

5-10.3.3 Ceramic tile shall conform to ANSI 137.1, moderate or heavy grade.

5-10.3.4 Carpet shall be installed in the stretch method over carpet pad utilizing tackless strips in accordance with CRI-104. Carpet shall meet the following criteria:

5-10.3.4.1 Properties: Tufted construction, 100 percent branded continuous filament nylon or polyethylene terephthalate, soil hiding, multi-colored, loop or cut pile, 1/8 guage, yarn weight 800 grams per square meter [28 ounces per square yard], total weight grams per square meter [60 ounces per square yard], 5000 minimum density, synthetic primary and secondary backing.

5-10.3.4.2 Tuft bind for tufted carpet shall meet a minimum of 44 N (10 pounds) when tested in accordance with ASTM D1335, 1967; R-1972

5-10.3.4.3 Carpet shall meet requirements of 16 CFR 1630 and have a minimum average critical flux of .45 watts per square centimeter when tested in accordance with ASTM E648.

5-10.3.4.4 Static electricity build-up shall be permanently less than 3.5 KV at 21 degrees C [70 degrees F] with 20 percent relative humidity as determined by American Association of Textile Chemists and Colorists (AATCC) Test Method 134, Electrostatic Propensity of Carpets.

5-10.3.4.5 Ten-year warranty from the carpet manufacturer against edge ravel, delamination, and tuft bind.

5-10.3.4.6 Carpet pad shall be 1/2 inch bonded urethane, minimum 6-pound density. Urethane pad will conform to ASTM.D.3676.

5-10.3.4.7 Carpet edging shall be 38 mm [1-1/2-inch] minimum width floor flange and minimum 15.5 mm [5/8-inch] wide face.

5-10.3.4.8 Tackless strip for stretch-in installation over carpet pad shall be exterior grade Douglas Fir plywood, with minimum dimensions of 29 mm by 7 mm [1-1/8-inch wide] suitable for the cushion thickness specified. Tackless strips with two or three rows of staggered pins shall be used. For areas over 6100 mm [20 ft] long, tackless strip with three rows of pins shall be used. Pins of the proper length shall be provided to penetrate through carpet backing, but shall not be a safety hazard.

5-10.3.4.9 Carpet containing recovered material is designated in 40 CFR 247.12 as an affirmative procurement item. Products containing recovered material will be provided when price, performance, and availability meet project requirements. Various nylon and polyethylene terephthalate carpet offer the opportunity to meet this requirement.

5-10.4 Painting. Primers, paints, and stains shall meet or exceed the requirements of Corps of Engineers Guide Specification 09900, Painting, General, provided in the Technical Specifications. (USACE activity should edit current edition of CEGS 09900 to list only the applicable finish systems). Finishes shall be lead free. All interior surfaces, except factory prefinished material, shall be painted a minimum of one prime coat and one finish coat. Walls and ceilings in kitchen, baths, laundry, utility rooms, and all painted trim shall be painted with semi-gloss enamel. Colors shall be submitted by the Contractor and approved by the Contracting Officer. Blown-on acoustical finish is prohibited.

5-11 . Garages. Provide a single car garage for each housing unit. If trash or bulk storage areas are included in the garage or carport, such areas are in addition to the required car storage area. Refer to Table 5-4 for minimum dimensions. Set the garage slab elevation a minimum of 100 mm [4 inches] below the level of the housing unit floor and the floor of the adjoining exterior storage. Slope slabs to drain out the garage door. Garage doors shall have hardware that can be opened and locked from inside and outside of the garage.

5-12 Roofing and Drainage. Minimum slopes for roofs shall be as shown in Table 5-9.

**TABLE 5-9 – ROOF SLOPES**

Roof Types	Rise	Run
Shingle/Tile	1	4
Metal	1	6

5-12.1 Roof water. Gutters and downspouts shall be provided for all roof areas. Downspouts draining onto a lower roof shall have metal or plastic splash deflectors. Concrete splash blocks shall be provided under

downspouts if not connected to the storm drainage system.

5-12.2 Roof surface. Wood shake or shingle roofs are prohibited. Roofing shall be limited to the following:

5-12.2.1 Minimum of 102 kg [225 lb] Class A wind-resistant fiberglass shingles conforming to ASTM D3018, Specification for Class A Asphalt Shingles Surfaced With Mineral Granules.

5-12.2.2 Minimum of 245 kg [540 lb], standing or flat seam, metal roofing with 0.7 mm [0.027 inch] thick zinc-copper-titanium alloy factory finish.

5-12.2.3 Clay, concrete, metal, or fiberglass tile. [Design District shall add information when allowed for use.]

5-12.2.4 Aluminum standing seam roofing 0.8 mm [0.032 inch] thick.

5-12.2.5 . Copper [Design District shall add minimum thickness for roofing.]

5-12.3 Common roofs. Parapet walls are prohibited.

5-13 Exterior Finishes. Emphasis shall be placed on low maintenance and durability for exterior finish materials. Materials shall be residential in size, scale, and texture. Exterior finish materials for exterior bulk storage buildings and garages will match the primary dwelling unit. The following siding materials may be used, but are listed in declining order of preference: [Edit order of preference to reflect installation preferences.]

5-13.1 Brick. Brick shall conform to ASTM C216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale). Provide brick cap and flashing for all offset brick veneer. For grade beam design, the brick shall run a minimum of one course below the finished floor and shall be flashed at that level.

5-13.2 Stucco. Portland cement plaster or synthetic stucco shall have integral color. Stucco total surface area shall be divided into panels with control joints spaced no more than 300 mm [10 ft] apart to form a panel of less than 14 m<sup>2</sup> [150 ft<sup>2</sup>]. Contractor shall follow manufacturer's installation instructions explicitly and shall certify accurate and correct installation of all stucco type materials. [Installations on the East Coast and all those installations where high humidity is typical in the climate, extreme caution shall be exercised with consideration to the correct specification and installation of this type finish material in a humid climate. Design Districts shall suitably investigate the benefits and potential problems with this material selection prior to it's inclusion in the solicitation.]

5-13.3 Concrete masonry units. Concrete masonry units shall conform to ASTM C90, Specification for Hollow Load-Bearing Concrete Masonry Units, and shall be factory scored, fluted, or striated.

5-13.4 Factory-prefinished siding. Factory-prefinished siding shall have a minimum non-prorated 15-year warranty on the finish. Aluminum or steel siding with or without backing are acceptable only on the second story of a structure or at least 2000 mm [6 ft] above finish grade. Siding shall be kept a minimum of 150 mm [6 inches] above finish grade. Lap siding shall be either single pieces with 203 mm [8 inches] maximum width course or single pieces shaped to simulate 200 mm [8 inches] maximum width courses (double-four, double-five, triple-four sidings are acceptable). Siding shall be installed in accordance with manufacturer's recommendations. A manufacturer's representative shall instruct the installer of the siding, appurtenances, and accessories as to the manufacturer's required installation procedures. The Government construction inspectors responsible for the job shall be included in their instruction. Panel materials in large surfaces shall be avoided unless surfaces are broken with textures or battens. Battens for prefinished materials shall also be factory finished. Requirements for various siding materials are as follows:

5-13.4.1 Aluminum siding shall conform to the requirements of AAMA 1402.3, Standard Specification for Aluminum Siding, Soffit, and Fascia, except aluminum substrate shall be a minimum of 0.6 mm [0.024 inch] thick if it is not fiberboard backed. For fiberboard backed aluminum siding, the aluminum substrate shall be a minimum of 0.5 mm [0.019 inch] thick. Aluminum siding shall not be installed within 1.6 km [1 mile] of open saltwater or in other highly corrosive atmospheres.

5-13.4.2 Steel siding material shall be a minimum of 0.017-inch thick [29 gage], zinc-coated steel conforming to ASTM A526, Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality, and ASTM G90, Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight. Siding panels shall be formed to provide full-length edge interlock, so that after installation, fasteners will be concealed from view. Siding shall be pretreated and either factory-primed and finish-painted or factory-laminated with a weather-resistant polymer film. When tested for 500 hours in accordance with ASTM B117, Method of Salt Spray (Fog) Testing, the siding finish shall show no signs of cracking, blistering, peeling or significant color change, and shall show no loss of adhesion from the metal more than 1.6 mm [1/16-inch] beyond a line scratched or scribed through the coating. Steel siding shall not be installed within 1.6 km [1 mile] of open saltwater or in other highly corrosive atmospheres. Steel siding materials shall be separated from aluminum surfaces with a coating of bituminous paint or asphalt varnish.

5-13.4.3 Vinyl siding shall conform to the requirements of ASTM D3679, Rigid Poly (Vinyl Chloride) (PVC) Siding and shall be a minimum of 1.16 mm [0.044 inch] thick.

5-13.4.4 Hardboard and cement asbestos shingle siding are not acceptable.

5-13.5 Trim elements. Aluminum or vinyl clad wood trim is preferred over painted or stained wood trim. Painted exterior surfaces shall be minimized. When exterior exposed wood trim is used, the following requirements apply:

5-13.5.1 Wood fascia and rakes are required and shall be 25 mm [1 inch] nominal boards with solid blocking or 50 mm [2-inch] nominal boards without blocking. Plywood, hardboard, or gypsum board are not permitted for fascias or rakes.

5-13.5.2 . Exposed wood, such as window trim, door sills, window sills, railings and balusters, wood fencing, solar shading devices including louvers, arbors, and trellis shall be treated for rot resistance in accordance with NWWDA Industry Standards I.S.4, Water Repellant Preservative Treatment for Millwork.

5-13.5.3 Exterior surfaces requiring painting shall receive a minimum of one prime coat and two finish coats of paint. Wood trim frames, etc., shall be back primed. Exterior semi-transparent stains, two coats, are acceptable, where appropriate for wood, plywood, etc.

5-13.6 Exterior ceilings and soffits. Exposure of roof framing and underside of roof/floor decks are not permitted. Exterior ceilings and soffits will be trimmed or otherwise architecturally treated and coordinated with siding. Exterior ceilings and/or soffits may be prefinished metal, vinyl, plywood, or 9.5 mm [3/8-inch] 303 medium density overlay siding material, EXT-APA conforming to American Plywood Association Standard B840, 303 Siding Manufacturing Specifications. Cement asbestos ceiling or soffit are not permitted.

5-13.7 Patios. Patios shall be sloped to drain and have a broom-finished concrete floor surface.

5-13.8 Balconies and porches shall be sloped to drain away from the unit and have a concrete floor surface which provides a waterproof and non-slip surface. Plastic coating or films over concrete decks are not acceptable. Exposed wood decks, stained or painted, are not acceptable. Balcony topping shall have a minimum thickness of 38 mm [1 1/2-inch] with welded-wire mesh reinforcement. Exposed wood rails and trim shall be treated to deter damage from moisture decay and insect infestation.

5-13.9 Exterior Stairs. Exterior stair treads and landings shall be constructed of concrete or steel, and provided with non-slip type treads. Exposed wood rails and trim shall be treated to deter damage from moisture decay and insect infestation.

5-14 Glazed Openings. Windows and glazed door (50 percent or more glass) units shall meet the following standards and must be certified by an independent testing laboratory. Windows that slide (double-hung, single-hung, and horizontal sliding) and glass exterior doors shall meet the standards for hung units. Standards for casement windows shall apply to all hinged or fixed windows. Other window types may be used if they have been tested and conform to the standards for hung windows. The Contractor shall provide the manufacturer's certification that the window provided meets the following test requirements:

5-14.1 Required tests. Hung units will meet a National Fenestration Rating Council (NFRC) design pressure rating of 25. Casement windows will meet NFRC design pressure rating of 40. Evidence of passing the following specific tests and minimum standards are required to achieve these design pressure standards.

5-14.1.1 Structural testing. Using ASTM E330 test results shall demonstrate no glass breakage, damage to hardware, or permanent deformation that would cause any malfunction or impair the operation of the unit. Residual deflection of any member shall not exceed 0.4 percent of its span. Hung windows shall be tested at pressures of 1796 Pa [37.5 lb/ft<sup>2</sup>], and casement windows shall be tested at pressures of 2873 Pa [60.0 lb/ft<sup>2</sup>].

5-14.1.2 Operating force. The force necessary to unlatch and open units shall not exceed 13.6 k [30 lb] for hung units and 15.9 k [35 lb] for casements.

5-14.1.3 Air infiltration. Using ASTM E283 leakage rate shall not exceed 0.65 l/min/m<sup>2</sup> [0.25 ft<sup>3</sup>/min/ft<sup>2</sup>] for hung units and 0.39 l/min/m<sup>2</sup> [0.15 ft<sup>3</sup>/min/ft<sup>2</sup>] for casements, at a test pressure of 7.66 k/m<sup>2</sup> [1.57 lb/ft<sup>2</sup>].

5-14.1.4 Water penetration. Using ASTM E547, no leakage shall be evident when tested in three, five-minute cycles with a one-minute rest period between cycles at 18.3 k/m<sup>2</sup> [3.75 lb/ft<sup>2</sup>] for hung units and 29.3 k/m<sup>2</sup> [6.0 lb/ft<sup>2</sup>] for casements.

5-14.1.5 U-Value. Whole window U-values shall comply with Table 7-2. U-values shall be calculated using ASTM E1423 and NFRC 100-91.

5-14.2 Glazed doors. Glazed doors shall have insulated steel, vinyl clad wood, or thermally broken aluminum frames conforming to the above requirements. Finish shall be factory applied and conform to 44-C-22431 in accordance with the requirements of the National Association of Architectural Metal Manufacturers (NAAMM) Metal Finishes Manual. Operable panels shall be equipped with screens. Sliding panel screens shall have extruded aluminum tubular frames mitered at corners, channel-shaped corner angle reinforcement, and nylon bottom rollers. Doors shall have interior operated latch, and securing pin or throw-bolt in frame. Screening shall be nonferrous.

5-14.3 Glazing. Units shall be double glazed with low E-glass. [Requirement may be deleted in weather zones 9 and 10.]

5-14.4 Interior window stools shall be solid-wood, paint-grades with a minimum thickness of 19-mm [3/4-inch]. Marble or ceramic tile sills are preferred in masonry construction.

5-15 Screens. Screens shall be provided at all operable sashes and sliding doors. Screens shall be nonferrous, of window manufacturer's standard design, and conform to AAMA 1002.10, Voluntary Specification for Aluminum Insulating Storm Products for Windows and Sliding Doors.

[Design District Technical Specialists may wish to discuss and consider "sunscreens" material with their installations in hot climates. Sunscreens (screen composed of more dense mesh screening material than standard insect screens) fit in the same screen track and continue to act as an effective insect screen and also as a Solar Heat Gain Coefficient (SHGC) reducer should be considered for installation in west- and east-facing windows, and in south-facing windows that do not have passive solar overhang shading. In hot climates solar heat gain through the windows is often responsible for 50% or more of the air conditioning load, and sunscreen is an effective, low-cost, passive and persistent means of reducing it. This is not a mandatory requirement.]

5-16 Window Treatments. Provide 25 mm [1 inch] metal blinds at windows and glazed hung doors. Color shall be manufacturer's standard off white, and shall be coordinated with wall color. Provide single-draw traverse rod and draperies at sliding glass doors. [Edit to indicate drapery specification.]

5-17 Doors. See Table 7-2 for thermal performance requirements for exterior doors.

5-17.1 Entrance doors. The housing unit primary entrance door shall be 900 mm [3 ft] in width by 2050 mm [6 ft-8 inches] in height by 45 mm [1-3/4 inch] thick, thermal metal. Other housing unit entrance doors should meet this

requirement but may be of lesser width.

5-17.2 Bulk storage door. Exterior bulk storage door shall be a minimum 35 mm [1-3/8 inch] thick, exterior grade, thermal metal, or hollow core metal. Doors may be omitted when storage areas are located in garages.

5-17.3 Aluminum screen and storm doors. [Insert "Not Used" and delete remainder of text if not applicable.] Screen and self-storing storm doors shall be provided for all housing unit exterior hinged doors. Frames shall be a minimum of 32-mm [1-1/4-inch] thick and 51 mm [2 inches] wide. Aluminum alloy materials shall be not less than 1.27-mm [0.05-inch] thick and 51 mm [2 inches] wide. Doors shall have solid bottom panels and midsection protective grills. Screening materials shall be nonferrous.

5-17.4 Interior doors. Interior doors shall be 2050 mm [6 ft -8 inches] in height by 35 mm [1-3/8 inch] thick, hollow core wood or hollow panel. Wood doors will be painted. [Insert "Louvered doors are required for closets." This is a user and district option in areas where humidity, mold, or mildew are problems.]

5-18 Builders Hardware. Hinges, locks, and latches will comply with the specifications indicated in Table 5-10, and the following subparagraphs:

**TABLE 5-10 – HARDWARE SPECIFICATIONS**

Hardware Type/ Specification	Specific Requirements
Hinges BHMA 101	Hinges shall be 102 mm x 102 mm [4 in x 4 in] at exterior doors, and 90 mm x 90 mm [3-1/2 in x 3-1/2 in] at interior doors.
Locks & Latches BHMA 601	Series 4000, Grade 2, at exterior doors. Grade 2 or 3 at interior doors. Provide trim of wrought brass, aluminum, or stainless steel.
Auxiliary Locks BHMA 501	Series 4000, Grade 2. Provide matching trim of wrought brass, aluminum, or stainless steel.
Interconnected Lock & Latches BHMA 611	Grade 2. Provide matching trim of wrought brass, aluminum, or stainless steel.
Closers BHMA 301	Series CO2000, Grade 2.

5-18.1 Locks and keys. Lock cylinders shall have six pin tumblers and interchangeable cores which are removable by a control key. Provide a master keying system. Locks for each housing unit, including exterior storage and garage door(s), shall be keyed alike. The Contractor shall provide one extra set of cores for each 50 housing units and furnish four keys for each key change and for master key system and control key. Locks and keys shall conform to the standards and requirements of the Builders Hardware Manufacturers Association (BHMA) listed above. [Include special requirements for conformity with Installation master keying system.]

5-18.2 Weatherstripping and exterior thresholds. Provide nonferrous metal or vinyl weatherstripping for all housing unit exterior doors. Vinyl magnetic weatherstripping is acceptable for metal doors. Exterior thresholds shall be nonferrous metal.

5-18.3 Applications. Locks and hinges shall be applied as follows:

5-18.3.1 Exterior hinged doors shall have 1-1/2 pair of hinges, lockset, and an auxiliary lock or interconnected lock

and latch,

5-18.3.2 Each windowless entrance door will have a viewer mounted at eye level.

5-18.3.3 Exterior bulk storage door shall have 1-1/2 pair of hinges and lockset.

5-18.3.4 Interior doors shall have one pair of hinges and latchset with BHMA 601, F75 or F76 operations.

5-18.3.5 Doors in fire-rated walls, housing unit to garage, shall have 1-1/2 pair of ball-bearing hinges, lockset, auxiliary lock or interconnected lock and latch and closer.

5-18.3.6 Garage side exterior doors shall have 1-1/2 pair of hinges and lockset.

5-19 Postal Service and Building Signage.

5-19.1 Postal Service. All new units shall be provided with an individual mailbox. Design District shall coordinate with the Installation and the local postal authority with respect to mail delivery requirements as well as installation requirements.

5-19.2 Building Signage. All new units shall be provided with building identification signage in accordance with the Installation Design Guide requirements.

5-20 Kitchen Cabinets. Cabinets shall be factory manufactured of wood. Wall cabinets shall have adjustable shelves. Cabinets shall have magnetic catches except where spring-loaded self-closing hinges are provided. Cabinets shall include knobs/handles and or pulls and shall conform to ANSI A161.1, Recommended Performance and Construction Standards for Kitchen and Vanity Cabinets, except where modified below. Wall and base cabinets shall be essentially of the same construction and appearance. Refer to Table 5-5 for minimum kitchen cabinet area requirements.

5-20.1 Cabinets construction. Construct cabinets with frame fronts and solid ends, or of frame construction throughout. Frame members shall be mortised and tenoned, dove-tailed or doweled, and glued together. Brace the top and bottom corners with hardwood blocks that are glued with water-resistant glue and nailed in place. Wood cabinet materials and dimensions - Materials and minimum dimensions and thicknesses for cabinet construction materials shall comply with Table 5-11.

**TABLE 5-11 – KITCHEN CABINET SPECIFICATIONS**

Element Description	Specific Requirements
Frame Members	19 mm x 38 mm [3/4 in x 1-1/2 in] kiln-dried hardwood.
Base Cabinet Toe Space	64 mm deep x 102 mm high [2-1/2 in x 4 in].
Cabinet Bottoms, Backs & Tops (Unexposed)	5 mm [ 3/16 in] hardwood plywood or 3 mm [1/8] in tempered hardboard. Provide bottoms in kitchen sink cabinets. Brace bottoms with wood members glued in place.
Cabinet Ends & (Exposed Backs/Bottoms)	Hardwood plywood, 5 ply, good grade for natural finish. Base Cabinets: 13 mm [1/2 in] Wall Cabinets: 10 mm [3/8 in]

**TABLE 5-11 – KITCHEN CABINET SPECIFICATIONS**

Element Description	Specific Requirements
Doors	16 mm [5/8 in] hardwood plywood, good grade for natural finish, with hardwood trim. Raised panel or recessed panel.
Drawer Slides/Glides	20 gauge metal.
Drawer Fronts	16 mm [5/8 in] solid hardwood, matching doors.
Drawer Bottoms	3 mm [1/8 in] softwood plywood, Grade A-B veneer or 3 mm [1/8 in] tempered hardboard. Bottoms 380 mm [15 in] wide shall be braced and glued in place.
Interior Partitions	13 mm [1/2 in] hardwood or softwood plywood, Grade A-A or comparable veneer.
Shelves	13 mm [1/2 in], softwood plywood (Grade A-B Veneer), hardwood plywood (good grade veneer), or glued-up solid wood. Support shelves on ends and on 610 mm [24 in] centers. Shelf edges exposed to view shall be rounded, filled, sanded, and finished.

5-20.2 Countertops. Countertops finish may be high pressure laminated plastic 1.1-mm [0.043-inch] thick for post-formed tops or 1.3-mm [0.05-inch] thick for countertops with separate backsplash, and shall be applied with heat-resistive adhesive. Countertops may also be ceramic tile or homogeneous, non-porous, solid surface materials. Minimum backsplash height is 100 mm [4 inches]. The substrate for countertops (except solid surface countertops) shall be 19 mm [3/4-inch] thick exterior plywood.

5-21 Appliances. Provide the following equipment in accordance with specifications listed, one each per housing unit. A listing of currently labeled Energy Star appliances is available through the internet at the EPA ebsite: <http://www.energystar.gov/products/appliances.html>.

5-21.1 Refrigerators. Comply with UL 250, Household Refrigerators and Freezers and shall bear the EPA “Energy Star” certified label. Provide refrigerator with frostproof top freezer, automatic defrosting, and ice maker. Refrigerator shall have two vegetable bottom baskets, at least four adjustable shelves, at least two shelves and egg container in door; freezer compartment shall contain separate interior shelves, multiple door shelves, and ice maker. Provide reversible (left swing and right swing interchangeable) doors. Refrigerators shall conform to the energy compliance standards of 10 CFR 430, including those refrigerators manufactured before the code took effect. The use of refrigerants with an Ozone Depletion Potential (ODP) of .05 or less is required. Minimum refrigerator volume and maximum energy use are as follows:

5-21.1.1 Volume: 0.58 CM, 21 CF

5-21.1.2 Energy Efficiency: 722 kWh/yr.

5-21.2 Ranges and ovens. Ranges shall be 760 mm [30 inches] wide and provided with porcelain enamel cooktop, oven, clock and timer, oven light, and cooking surface light. Oven shall have black glass window door, broiler pan, and self-lock racks. [Applicable only to General Officer’s housing unit. Delete remainder [text] if project does not include a General Officer’s housing unit(s). (Ranges for all General Officer’s housing units shall be the

double oven type with separate burner top). Over-under microwave and conventional oven combinations will satisfy the double oven requirement.] Use either gas or electric range, depending upon energy fuel source.

5-21.2.1 Gas ranges shall have two, 150 mm [6-inch] and two, 205 mm [8-inch] burners, a self-cleaning oven, and AGA-approved electronic ignition. Gas ranges shall be in accordance with AGA Z21.1, American National Standard for Household Cooking Gas Appliances.

5-21.2.2 Electric ranges shall have four tubular plug-in surface elements of 4,500 watts minimum, removable reflector bowls, infinite-control switches, and range-indicating lights. Ovens shall be equipped with one, 2,000-watt (minimum) tubular broil element and one, 700-watt (minimum) bake element, oven indicating light, thermostatic heat control, utensil drawer, and self-cleaning oven. Electric ranges shall conform to UL 858, Household Electric Ranges.

5-21.3 Microwave ovens. [Applicable only to General Officer's housing units. Insert "...(DELETED)" and delete remainder of text if not required.] Provide microwave oven(s) for the following housing units: [Insert requirement]. Ovens shall conform to UL 923, Microwave Cooking Appliances, and be UL listed, minimum 0.042 m<sup>3</sup> [1.5 ft<sup>3</sup>], stainless steel interior, automatic oven light, built-in browning element, and temperature probe.

5-21.4 Range hoods. Provide metal range hoods, the same length and finish as the range, with separately switched light and exhaust fan. The hood shall have a washable filter. The fan shall have a capacity of not less than 78.7 L/s per meter of range hood [50 cubic ft per minute per linear foot of range hood]. The sound level shall not exceed 6 sones. Duct the fan to the exterior and provide backdraft protection.

5-21.5 Garbage disposals. Garbage disposals shall conform to UL 430; Waste Disposers; continuous feed, minimum 1/2 HP motor, stainless steel grinding elements, two 360-degree stainless steel swivel impellers, manual motor reset, and sound insulation. [A plug connector is required.]

5-21.6 Dishwashers. Dishwashers shall conform to UL 749, Household Electric Dishwashers, and be UL listed, electric type, with air gap, racks, lift-out utensil holder, spraying arms, and detergent dispenser. Unit shall be listed as "Energy Star" compliant and shall bear the "Energy Star" label. The automatic controls shall cycle through the Wash, Rinse, Dry / Heat, and Stop phases, and shall be capable of rinse and hold cycle as well as a no heat drying feature. The unit shall contain instantaneous, or in-line, water heater booster, with automatic thermostat set for 60 degrees C [140 degrees F]. Rated energy use for standard capacity models will not exceed 620 kWh/yr.

5-12.7 Water heater. See paragraph 8.

5-12.8 Ceiling Fans. See paragraph 10.

5-21.9 Color. Kitchen appliances, except disposals, shall be of matching finish, [white/almond] in color.

5-22 Maintainability. The design of housing units including the selection and specifying of exterior and interior finishes, equipment, appliances, and systems shall include consideration of maintenance ease and cost. Avoid products that require continuing maintenance at high cost.

**6. UNIT DESIGN - STRUCTURAL.**

6-1 Structural design for apartment housing (materials and construction) shall comply with the regional model code (Uniform Building Code. One and two family housing, including townhouses, shall comply with Council of American Building Officials (CABO) One and Two Family Dwelling Code. Structures which qualify as "Manufactured Homes" shall comply with the Federal Manufactured Housing Construction and Safety Standards Act (FMHCSS) [USC Title 42], except as modified herein.

6-2 Lateral Resistance. Walls used or required for lateral resistance to wind or earthquake, shall be considered bearing walls and shall have full foundations.

6-3 Embedded Steel. Nonstructural steel (handrails, etc.) embedded in concrete shall be galvanized or painted wrought iron. All damaged galvanized areas shall be repaired prior to embedment.

6-4 . Wood Flooring Systems. Wood flooring systems shall be glued and nailed. Glue lines shall not be considered for stress transfer.

6-4.1 Subfloor. Plywood is preferred as subfloor, and is required for wet areas (ie., bathrooms, kitchens, utility rooms). Subfloor will be rated for exposure 1 or exterior use.

6-4.2 Underlayment: Sanded face underlayment (plywood) is required with ceramic tile, vinyl tile, sheet vinyl, and carpet. Underlayment must be a minimum thickness of 8.7 mm (11/32 inches). Acceptable sanded face underlayment panels can be APA rated A-C, B-C, A-D, B-D, or C-C plugged. Underlayment should be rated for Exposure 1 or exterior use. Underlayment should be installed after interior finish work is complete to avoid damage to the underlayment.

6-5 Frost Penetration. Foundations and utilities shall be located below the depth of maximum frost penetration.

6-6 Construction Tolerances. Allowable variations from level, or specified slopes, shall be as follows:

6-6.1 For overall length, or surface of 3000 mm [10 ft] or less: plus or minus 3-mm [1/8-inch].

6-6.2 Up to 6100 mm [20 ft]: plus or minus 6 mm [1/4-inch].

6-6.3 Up to 12 000 mm [40 ft]: plus or minus 9 mm [3/8-inch].

6-7 Concrete Reinforcement: Fiber reinforced concrete is not an acceptable alternative to be utilized in this project.

6-8 . Tornado Protection Shelter: The design of the housing unit shall include the provision for a tornado shelter to protect the occupants during tornado events. This shelter shall be sized and designed as recommended by the FEMA National Performance Criteria for Tornado Shelters, dated May 28, 1999. The tornado shelter shall be incorporated into the building design whereby an interior space shall be designated as the tornado shelter. This interior space shall be constructed in accordance with FEMA criteria to provide protection from wind, airborne debris missiles, and shall include ventilation considerations. [Design Districts shall include this paragraph only when the project is being constructed in a location which is considered by FEMA guidelines (FEMA 320) to be "High Risk", the provision of tornado shelters must be included in the 1391 and all project programming to support inclusion of this technical requirement.]

**7. UNIT DESIGN - THERMAL PERFORMANCE.**

7-1 Thermal Characteristics. See Table 7-1 for identification of appropriate weather region. [Weather regions are identified in Table 7-1. Select the appropriate weather region and delete Table 7-1 and its associated notes after completing Table 10-1.] Housing unit construction shall provide at least the minimum R values / maximum U values indicated in Table 7-2 for the appropriate weather region. R and U values shall be calculated in accordance with ASHRAE methods.

**TABLE 7-1 - WEATHER REGION DEFINITIONS**

Weather Region	Cooling Degree Days	Heating Degree Days	
1	N/A	> 8,333 [ 15,000 ]	N/A
2	N/A	> 7,222 [ 13,000 ]	</= 8,333 [ 15,000 ]
3	N/A	> 6,111 [ 11,000 ]	</= 7,222 [ 13,000 ]
4	<1,111 [ 2,000 ]	> 5,000 [ 9,000 ]	</= 6,111 [ 11,000 ]
5	<1,111 [ 2,000 ]	> 3,889 [ 7,000 ]	</= 5,000 [ 9,000 ]
6	<1,111 [ 2,000 ]	> 3,056 [ 5,500 ]	</= 3,889 [ 7,000 ]
7	<1,111 [ 2,000 ]	> 2,222 [ 4,000 ]	</= 3,056 [ 5,500 ]
8	<1,111 [ 2,000 ]	> 1,111 [ 2,000 ]	</= 2,222 [ 4,000 ]
9	<1,111 [ 2,000 ]	N/A	</= 1,111 [ 2,000 ]
10	> 1,111 [ 2,000 ]	N/A	</= 1,111 [ 2,000 ]
11	> 1,111 [ 2,000 ]	> 1,111 [ 2,000 ]	N/A

NOTES:

1. Include in the solicitation the correct weather data for the project site, taken from TM 5-785, Engineering Weather Data, and indicate the appropriate weather region on this table.
2. Heating Degree Days are formulated on a Range Base of 18C [65F]
3. Cooling Degree Days are formulated on a Range Base of 18C [65F]
4. Weather Regions 1, 2, and 3 are determined by the Heating Degree Day Range independent of the Cooling Degree Days.
5. Weather Regions 4, 5, 6, 7, 8, and 9 are determined by the Cooling Degree Days being less than 1,111 [ 2,000 ] and then by the appropriate range bracket for the Heating Degree Days.
6. Weather Regions 10 and 11 are determined by the Cooling Degree Days being greater than 1,111 [ 2,000 ] and then by the appropriate range bracket of Heating Degree Days.

**TABLE 7-2 – THERMAL CHARACTERISTIC REQUIREMENTS<sup>1,2</sup>**

Weather Region	Wall <sup>3</sup> R Value	Ceiling / Roof R Value <sup>4</sup>	Crawl Space R Value <sup>5</sup>	Basement R Value <sup>6</sup>	Slab on Grade R Value <sup>7</sup>	Door R Value <sup>8</sup>	Glazed Openings U Value <sup>9</sup>	
							Window	Door
1	3.3 [19]	10.6 [60]	3.3 [19]	2.6 [15]	2.5 [14]	0.9 [5]	3.0 [0.33]	2.0 [0.35]
2	3.3 [19]	10.6 [60]	3.3 [19]	2.6 [15]	1.8 [10]	0.9 [5]	3.0 [0.33]	2.0 [0.35]
3	3.3 [19]	8.6 [49]	3.3 [19]	2.6 [15]	1.8 [10]	0.9 [5]	3.0 [0.34]	2.0 [0.35]
4	3.3 [19]	8.6 [49]	3.3 [19]	2.6 [15]	1.8 [10]	0.9 [5]	3.0 [0.34]	2.0 [0.35]
5	3.3 [19]	8.6 [49]	3.3 [19]	1.9 [11]	1.8 [10]	0.9 [5]	2.2 [0.38]	2.2 [0.38]
6	3.3 [19]	8.6 [49]	3.3 [19]	1.8 [10]	1.8 [10]	0.9 [5]	2.2 [0.38]	2.2 [0.38]
7	3.3 [19]	6.7 [38]	3.3 [19]	1.8 [10]	0.9 [5]	0.9 [5]	2.2 [0.38]	2.2 [0.38]
8	2.2 [13]	6.7 [38]	2.2 [13]	1.8 [10]	0.9 [5]	0.9 [5]	2.9 [0.50]	2.2 [0.38]
9	2.2 [13]	5.3 [30]	2.2 [13]	0.9 [5]	0.9 [5]	0.9 [5]	2.9 [0.50]	2.2 [0.38]
10	2.2 [13]	5.3 [30]	2.2 [13]	0.9 [5]	0.9 [5]	0.9 [5]	2.9 [0.50]	2.2 [0.38]
11	2.2 [13]	6.7 [38]	2.2 [13]	1.8 [10]	0.9 [5]	0.9 [5]	2.9 [0.50]	2.2 [0.38]

Note<sup>1</sup>: Metric R values are in square meter-kelvin (K)/watt. [English R values are bracketed, and are in square foot-degrees F/BTUH]. ( $R = 1 / U$ )

Note<sup>2</sup>: R values listed represent the minimum acceptable insulation values for each construction type. Listed U values represent the maximum thermal conductance allowed for windows and doors.

Note<sup>3</sup>: Requirements for opaque, exterior walls.

**TABLE 7-2 – THERMAL CHARACTERISTIC REQUIREMENTS<sup>1,2</sup>**

Weather Region	Wall <sup>3</sup> R Value	Ceiling / Roof R Value <sup>4</sup>	Crawl Space R Value <sup>5</sup>	Basement R Value <sup>6</sup>	Slab on Grade R Value <sup>7</sup>	Door R Value <sup>8</sup>	Glazed Openings U Value <sup>9</sup>	
							Window	Door

Note<sup>4</sup>: For buildings with ventilated attics, no credit may be taken for the roof construction. R value shall be computed for construction between conditioned space and ventilated attic or building exterior. Insulation for floors which extend over outside air spaces shall conform to the ceiling and roof requirements.

If cathedral ceilings are being used, the effective R-Value of the overall roof area must meet the required “Ceiling/Roof” performance level. The effective R-Value of the overall roof area can be determined by calculating the weighted average of the R-Values of the different areas (based on the percentage of the total roof area each type covers). For example, if the Ceiling/Roof insulation required was R-38 and 25% of the ceiling was cathedral insulated to R-19, and then the required R-Value for the remaining roof would be:  $(38 - 0.25 \times 19) / 0.75 = 44.33$ , or R-45 (min).

Note<sup>5</sup>: Requirements for crawl space exterior walls below uninsulated floors.

Note<sup>6</sup>: Requirements for basement wall insulation extending downward 3050 mm [10 ft] from outside finished grade, or downward from outside finished grade to basement floor, whichever is less.

Note<sup>7</sup>: Requirements for perimeter insulation. In Weather Regions 1 through 6, perimeter insulation shall extend 1220 mm [48 inches] down from the top of the slab, or down to the bottom of the slab then horizontally beneath the slab to a total distance of 1220 mm [48 inches]. In Weather Regions 7 through 11, perimeter insulation shall extend downward to a total distance of 610 mm [24 inches] as described above.

Note<sup>8</sup>: Requirements for opaque doors in exterior walls (insulated metal).

Note<sup>9</sup>: Window requirements for double pane, low emissivity glass windows as specified in paragraph 5.m. of this STATEMENT OF WORK. Total Window (including glazing and frame) U values as rated by the National Fenestration Rating Council (NFRC) shall be used. Glazing area in Weather Regions 1 and 2 shall be limited to 12 percent of the heated floor space. Glazing area in Weather Regions 3 through 11 shall be limited to 14 percent of the heated floor space. Solar Heat Gain Coefficient in Weather Regions 1 through 7 shall be limited to 0.55. Solar Heat Gain Coefficient in Weather Regions 8 through 11 shall be limited to 0.40.

7-2 Thermal Insulation.

7-2.1 Characteristics. Thermal insulation shall have a flame-spread rating of 25 or less and a smoke-development rating of 50 or less, exclusive of the vapor barrier, when tested in accordance with ASTM E84. A vapor barrier shall be provided on the warm-in-winter side of exterior wall and ceiling insulation, except in humid areas as defined below. Polyurethane is allowed as an insulation material for slabs and outside concrete or unit masonry walls. It is prohibited as an injected insulation material in walls or floor cavities or within the building envelope.

7-2.2 Humid area design. [Climates which have 3000 hours or more of 19.4 degrees C [67 degrees F] or higher wet bulb temperature in combination with an outside design condition of 50 percent or higher relative humidity, or climates which have 1500 hours or more of 22.8 degrees C [73 degrees F] or higher wet bulb temperature in combination with an outside design condition of 50 percent or higher relative humidity shall be considered humid areas.] In humid areas, interior surfaces of ceilings and exterior walls shall be covered with materials which allow escape of water vapor from inside the walls into the conditioned space to prevent the growth of mold on interior surfaces. The vapor barrier in humid areas shall have a maximum perm rating of 0.5, and shall be located on the

outside face of the exterior wall or ceiling insulation.

### 7-3 Air Infiltration.

7-3.1 To limit air infiltration buildings will be sealed with an air infiltration barrier, installed in accordance with the manufacturer's recommendations. The building envelope shall be caulked, gasketed, weatherstripped or otherwise sealed: around window and door frames, between wall cavities and frames, between walls and ceiling and roof, between walls and floors, at access doors and panels, at utility penetrations through walls, floors, and roofs, and at any other exterior envelope joint which may be a source of air leakage. These steps, in combination with provision of a continuous vapor barrier and sealed ductwork as specified in paragraph 10. shall constitute tight building construction.

[Design District Technical specialists can review additional information from the EPA: See [http://yosemite.epa.gov/appd/eshomes/eshaware.nsf/attachments/lib/\\$file/AirSealing.pdf](http://yosemite.epa.gov/appd/eshomes/eshaware.nsf/attachments/lib/$file/AirSealing.pdf)]

7-3.2 A blower door test, performed in accordance with ASTM E 779, Measuring Air Leakage by the Pressurization Method, shall be performed on 15 percent of the project buildings, which have been randomly selected by the Contracting Officer. If buildings are to be turned over in phases, the blower door test shall be performed on 15 percent of the buildings completed in each phase (not to exceed 10 buildings per phase). No additional testing will be required if ALL of the tested buildings pass the test requirements. If less than 100 percent of the tested buildings pass the test, an additional 10 percent of the project buildings (not to exceed 10 buildings) shall be tested. This process shall continue until 100 percent of the total number of tested buildings pass the blower door test. All proto-type units will be included in the required blower door testing procedures.

7-3.2.1 Before beginning the test, all combustion devices shall be turned off, and all intentional openings in the building envelope (dryer vent, bathroom and kitchen exhausts, etc.) shall be sealed. All doors and windows shall be closed and latched.

7-3.2.2 To pass the blower door test, the building shall have an air tightness rating within the range of 3 to 4 ACH at 50 Pa [0.2 inch of water]. The Contractor shall correct all housing units not found in compliance, and shall be responsible for all labor and materials required to reduce air leakage to within acceptable parameters. All testing shall be performed by a firm certified by the Associated Air Balance Council, the National Environment Balancing Bureau, or State licensed to perform such tests within the state where the project is being constructed.

7-3.2.3 Any measures taken to reduce the air leakage to acceptable values shall be permanent, and shall be implemented on all similar housing units.

## 8. UNIT DESIGN - PLUMBING.

8-1 Plumbing system shall be designed and installed in accordance with the International Plumbing Code (IPC). Inspection and testing of the plumbing system shall be performed as prescribed in the Plumbing Code. Additional consideration in the technical evaluation will be given to systems which incorporate measures beyond the requirements of this STATEMENT OF WORK which are designed to increase energy conservation, ease of maintenance, or occupant comfort such as water filtration and purification, higher efficiency water heating systems, higher grade plumbing fixture materials (such as enameled cast iron tubs as opposed to enameled steel or plastic), etc.

8-2 . Water Piping. Under slab supply piping shall be limited to housing unit service entrance only. Service line to each housing unit shall be no less than 25 mm [1 inch] diameter. All water piping shall be sized in accordance with methods outlined in the National Standard Plumbing Code, to limit water velocity in the pipe to 2440 mm/sec [8 ft/sec] unless a lower velocity is recommended by the plumbing fixture manufacturer(s). An isometric diagram of the water system shall be included in the design submittal. Allowable pipe materials are listed below:

8-2.1 Copper tubing. Water piping under concrete slabs shall be copper tubing, type K, annealed. Joints under the slabs are prohibited. If copper tubing is selected for interior water piping, it shall be type K, L, or M hard-drawn copper. Type M copper tubing shall not be installed in exposed areas where the tubing may be exposed to external damage. Additional consideration in the technical evaluation shall be given to designs using copper types K or L. Fittings for soft copper tubing shall conform to ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes, and for hard-drawn to ANSI B16.22, Wrought Copper and Copper alloy Solder Joint Pressure Fittings.

8-2.2 Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe. [Determine the acceptability of CPVC and edit text as required.] If plastic pipe is selected for interior water piping, it shall be Chlorinated Polyvinyl Chloride (CPVC) plastic pipe, conforming to ASTM D-2846, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Hot-and Cold-Water Distribution Systems. CPVC thicknesses shall meet Standard Design Ratio 11 for sizes 13-mm [ $\frac{1}{2}$ -inch] to 51 mm [2 inches] and shall be schedule 80 pipe for sizes larger than 51 mm [2 inches].

8-3 . Soil, Waste, Vent, and Drain Piping. Soil, waste, vent, and drain, piping may be cast iron, copper, steel, or plastic suitable for installation in a residential waste, soil, vent, and drain system. Each fixture and piece of equipment, except water closets, requiring connection to the drainage system, shall be provided with a trap. Provide deep seal trapped drain for cooling coil condensate drain. Soil, waste, and drain piping installed below floor slabs shall be service weight hub and spigot cast iron or plastic pipe. Building waste main lines shall be no less than 102-mm (4-inch) diameter. All soil, waste, and drain piping shall be sized in accordance with the methods outlined in the National Standard Plumbing Code. An isometric diagram of the sanitary sewer system shall be included in the design submittal.

8-4 Gas Connections. The use of semirigid tubing and flexible connectors for gas equipment and appliances is prohibited, except that the final connections to the kitchen ranges shall be made using flexible connectors conforming to ANSI Z21.45, Flexible Connectors of Other Than All Metal Construction for Gas Appliances, not less than 1000 mm [40 inches] long. Provide accessible gas shutoff valve and coupling for each gas equipment item. Comply with UBC or model code seismic requirements . Exposed horizontal piping shall not be installed farther than 150 mm [6 inches] from the nearest parallel wall in laundry areas or areas where clothes hanging could be attempted. See paragraph 4.e. for gas line distribution requirements.

8-5 Plumbing Fixtures. Fixtures shall be provided complete with fittings, and chromium- or nickel-plated brass (polished bright or satin surface) trim. All fixtures, fittings, and trim in a project shall be from the same manufacturer and shall have the same finish.

8-5.1 Plumbing shall meet the following criteria:

8-5.1.1 Exposed traps shall be chromium-plated, adjustable-bent tube, 20-gauge brass. Concealed traps may be plastic (ABS).

8-5.1.2 Faucets shall be single-control type, with seals and seats combined in one replaceable cartridge designed

to be interchangeable among lavatories, bathtubs and kitchen sinks, or having replaceable seals and seats removable either as a seat insert or as a part of a replaceable valve unit. Water flow shall be no more than .158 L/s [2.5 gpm] from any faucet.

8-5.1.3 Shower and bath combination shall be controlled by a diverter valve. Baths and shower and bath combinations shall be provided with waste fitting pop-up, concealed with all parts removable and renewable through the overflow and outlet openings in the tub. Showers and shower and bath combinations shall be equipped with a combination valve and flow control device to limit the flow to 0.158 L/s [2.5 gpm] at pressures between 137.9 to 413.7 kPa [20 and 60 psi].

8-5.1.4 Piping shall be concealed. Individual shutoff or stop valves shall be provided on water supply lines to all plumbing fixtures except bathtubs and showers. Shutoff valves shall be provided for each bathroom group. In multi-story units, additional consideration shall be given in the technical evaluation to designs which provide separate shutoff valves for each floor.

8-5.1.5 Fixtures shall be water conservation type, in accordance with the National Standard Plumbing Code.

8-5.1.6 Vitreous china plumbing fixtures shall conform to ANSI A112.19.2, Vitreous China Plumbing Fixtures. Stainless steel fixtures shall be in accordance with ANSI A112.19.3, Stainless Steel Plumbing Fixtures (residential design). Plastic fixtures shall conform to ANSI Z124. Enameled cast iron plumbing fixtures shall comply with ANSI A112.19.1, and enameled steel fixtures shall comply with ANSI A112.19.4.

8-5.1.7 Where tubs are installed in an end-to-end configuration in adjacent bathrooms the shower valve faucet end of the tubs shall not be back to back, but shall be located at opposite ends of the tubs to allow for maintenance and repair.

8-5.2 Water closets. Water closets shall have regular bowl with inclined tank, close coupled siphon jet, floor outlet with wax gasket, closed-front seat and cover, and an anti-siphon float valve. Water consumption shall be no more than 6 L [1.6 gal] per complete flushing cycle. Water closet trim shall conform to ANSI A112.19.5, Trim for Water-Closet Bowls, Tanks, and Urinals (Dimensional Standards).

8-5.3 Lavatories. Lavatories shall be rectangular counter top type, minimum 508 by 457 mm [20 by 18 inches] in size or oval minimum 480 by 410 mm [19 by 16 inches] in size. Lavatories shall be vitreous china, cast iron rimless type (without rings), or cross-link acrylic molded counter top with integral bowl. Lavatories shall have pop-up drains.

8-5.4 Bathtubs. Bathtubs shall be slip resistant and shall be constructed of enameled cast iron, porcelain enameled formed steel, or gel-coated, glass fiber reinforced polyester resin with wainscot. Metal bathtubs shall have fiberglass, porcelain-on-steel panels, or ceramic tile wainscot.

8-5.5 Showers. Shower stalls shall be of ceramic tile, floor to ceiling, over membrane waterproofing on a cementitious substrate; or gel-coated, glass-fiber reinforced polyester. Shower receptors shall be slip resistant cast stone or gel-coated, glass-fiber-reinforced polyester. Shower stall wainscots shall be ceramic tile or gel-coated, glass-fiber-reinforced polyester.

8-5.6 Kitchen sinks. Kitchen sinks shall be Type 302 stainless steel, 20-gauge minimum, seamless drawn, and sound deadened. Sinks shall be double bowl, self-mounting without mounting rings, complete with cup strainer and plug. Food waste disposers, where provided, shall be in accordance with UL 430 and ASSE 1008, and shall have a minimum motor size of 370 watts [ $\frac{1}{2}$  horse power]. Strainer and plug shall be eliminated where food waste disposers are provided.

8-6 Clothes Washer Connections. Drainage and hot and cold water supply shall be provided for automatic clothes washers. Washer connection, complete with 50-mm [2-inch] drain, 20-mm [ $\frac{3}{4}$ -inch] hose thread supplies shall be provided in standard manufactured recessed wall box with single-face plate. Boxes shall be constructed of plastic or sheet steel. Steel boxes shall have a corrosion-resistant epoxy enamel finish. Boxes shall be mounted a minimum of 865 mm [2 ft-10 inches] above the finish floor. Electrical outlets for both washer and dryer shall also be provided.

8-7 Refrigerator Ice Maker Connection. Cold water supply shall be provided for GF refrigerator ice makers. Ice maker connection shall include an angle valve and a 1/4 inch hose thread supply, and shall be provided in standard manufactured recessed wall box with single-face plate (plastic or steel). Boxes shall be mounted a minimum 2 ft-10 inches above the finish floor.

8-8 Hose Bibbs. Hose bibbs shall be provided at the front and rear of each building, for each ground level housing unit. Hose bibbs shall be frostproof, and shall be supplied with an integral vacuum breaker.

8-9 Piping Location. Water piping running in crawl spaces and attics shall be installed on the warm side of insulation and shall be wrapped with insulation and a vapor barrier jacket. Determination of the warm side shall be the same as determined for vapor barrier location. No water piping runs in exterior walls shall be allowed, except in climates where the 99 percent dry bulb temperature is 1.7 degrees C [35 degrees F] or higher.

8-10 . Cleanouts. Cleanouts shall be provided at each change in direction of sanitary sewer lines, at the intervals specified in the National Standard Plumbing Code, and at the building service entrance. All cleanouts shall be permanently accessible. Ground cleanouts shall be installed in a 305-mm by 305-mm [12-inch by 12-inch] concrete pad, flush with grade.

8-11 Water Heater. Water heaters shall have round, glass lined tanks, and shall be installed with an integral insulating wrap with a minimum R value of 5. Access shall be provided in the wrap for service and maintenance openings. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. Hot water piping for the first 3050 mm [10 ft] downstream of the water heater shall be insulated. The water heater relief drain shall be manufacturer approved, and shall be indirectly connected to the building sanitary sewer system. Water heaters shall be sized in accordance with Table 8-1 for a 32 degrees C [90 degrees F] rise. Water heater energy factors shall meet or exceed the minimum requirements of 10 CFR 430. Additional consideration in the technical evaluation will be given to designs which include water heaters which exceed the minimum energy efficiency requirements and which utilize high efficiency, power vented, or sealed combustion water heaters.

**TABLE 8-1 - WATER HEATER SIZING**

Requirements by Fuel Type	2 BR		3 BR		4 BR		5 BR	
	1 Bath	2 Bath	2 Bath	3 Bath	2 Bath	3 Bath	2 Bath	3 Bath
Gas & Oil:								
Storage (L [gal])	114 [30]	151 [40]	151 [40]	194 [50]	194 [50]	194 [50]	194 [50]	194 [50]
1 hour draw (L [gal])	227 [60]	265 [70]	273 [72]	310 [82]	341 [90]	341 [90]	341 [90]	341 [90]
Recovery (L/h [gph])	114 [30]	114 [30]	121 [32]	121 [32]	151 [40]	151 [40]	151 [40]	151 [40]
Electric:								
Storage (L [gal])	114 [30]	189[50]	189[50]	250 [66]	250 [66]	250 [66]	250 [66]	250 [66]
1 hour draw (L [gal])	167 [44]	273 [72]	273 [72]	333 [88]	333 [88]	333 [88]	333 [88]	333 [88]
Recovery (L/h [gph])	53 [14]	83 [22]	83 [22]	83 [22]	83 [22]	83 [22]	83 [22]	83 [22]

Note: Storage capacity, input, and recovery may vary with manufacturer. Any combination of the above which produces the required hour draw will be acceptable.

8-11.1. Gas fired water heaters shall be in accordance with ANSI Z21.10.1, Water Heaters, Gas, Volume I, Storage Type, 22 kW [75,000 BTUH] Input or less, and shall be sealed combustion high efficiency type. Water heaters with powered ventilation shall be vented in accordance with manufacturer’s instructions. Gas fired water heaters shall have annual energy use of 246 therms or less based on 10 CFR 430, Subpart B, Appendix E.

8-11.2 Oil fired water heaters shall be in accordance with UL 732.

Project Name

Project No. \_\_\_\_\_  
TI 801-02, Army Family Housing, 01 Nov 02

8-11.3 Electric water heaters shall comply with UL 174, Water Heaters, Household Electric Storage Tank Type, and shall have an Annual Energy Use (kWh) of 4,773 or less based on DOE test procedure 10 CFR430, Sub-Part B, Appendix E.

## 9. UNIT DESIGN - ELECTRICAL.

9-1 Conformance to Code. The electrical system shall be designed in compliance with the rules and recommendations of ANSI C2, National Electrical Safety Code, and NFPA 70, National Electrical Code (NEC), and applicable model codes, whichever is more stringent. Provide main circuit breaker in the main panel for each housing unit, sized in accordance with the NEC.

9-2 Service Entrance. Service entrances, exterior meters, and panels shall be enclosed or sight screened. Service feeders shall be underground with exterior meters. Panel boards shall be painted galvanized steel and furnished with main breakers. Panel board doors shall be flush one-piece fronts. Panel boards may be surface or recessed mounted depending on their location. In hallways, panel boards shall be recessed. Offset a minimum of 400 mm [16 inches] horizontally back-to-back panel boards. No recessed panel boards are to be located in party walls and fire walls.

9-3 Panel Locations. Housing unit panels shall be located in the utility or laundry room, attached garage, or hallway.

9-4 Conductors. Conductors shall be copper.

9-5 Outlet Circuits. Lighting and convenience outlets shall be on separate circuits. Outlets on party walls shall be offset to maintain integrity of the fire wall and sound deadening rating of the wall.

9-6 Exterior Lighting and Outlets. Provide energy efficient high quality lighting for each housing unit. The minimum efficiency standard for lighting is 50 lumens/watt. This efficiency can be achieved with fluorescent and compact fluorescent lighting. Lighting must also be color corrected with a Color Rendering Index (CRI) of 60 or better. Provide a minimum of one lighting fixture and one ground-fault-protected outlet in each housing unit's entry, garage or carport, and patio or balcony area(s). Light fixtures at entry and patio or balcony areas shall be switched from the housing unit interior. Entry ways serving two or more housing units, and common carports, may have a common light, photocell activated, in lieu of individual switched lights. In addition, common trash areas shall be lighted. These lights shall be controlled by photocell, activated by minimum light levels of 5.4 Lx [0.5 foot-candle]. Provide a fixture in the patio area, except that the patio area light shall not be provided where the patio is adjacent to an exterior entrance and is adequately served by the lighting fixture required herein before. Lights for common areas as in gang carports and apartments shall be photo-electric cell controlled. Lights in common areas should have high impact-resistant plastic lenses, and/or be otherwise made vandal-proof.

[Design District may consider outdoor security (corner of house and patio floodlighting, not "streetlight-type fixtures") be equipped with motion detectors in addition to photocell detectors. The motion detector capability can be overridden by the occupant. This is not a mandatory requirement]

9-7 Interior Lighting and Switched Outlets.

[Design District Technical Specialists may review <http://www.epa.gov/appdstar/fixtures/index.html> for additional information]

9-7.1 Efficiency. Interior lighting will be both efficient and color corrected. Color Rendering Index (CRI) of 85 or better and a standard lighting color of 3500 K are required. Minimum efficiency standard for lighting are as follows:

9-7.1.1 Fluorescent tubes 1220 mm [4 ft] and longer: 90 lumens/watt.

9-7.1.2 Fluorescent tubes less than 1220 mm [4 ft]: 80 lumens/watt.

9-7.1.3 Compact fluorescent and other lamps: 50 lumens/watt.

9-7.2 Locations. Provide light fixtures operated by wall switches for all rooms except living rooms. Living room shall have a convenience outlet, half controlled by a wall switch, located at the room entrance. Wall-switch operated ceiling lights shall be provided in dining and utility rooms, halls, bedrooms, kitchens, dinette areas, and basements.

Additional light fixtures shall be provided in rooms whose configuration requires them for adequate lighting. Wall-switch operated wall-mounted lights shall be provided in bathrooms and half baths located above the mirror over the lavatory. Walk-in closets and interior and exterior bulk storage rooms shall be provided with ceiling lights, either wall switch or pull-chain operated. A minimum of one lighting fixture, ceiling or wall mounted, as appropriate, shall be provided in the garage or carport. Where exterior bulk storage is located within the enclosed walls of a garage, each space shall be lighted separately. Garage lights shall be controlled by a switch (switches) located at each door opening into the garage.

[Design District may consider and coordinate with the Installation staff equipping certain indoor lighting fixtures that have tendencies to be inadvertently left on (e.g., utility rooms, children's bathrooms, garages) with occupancy sensors. These can be overridden by the occupants. This is not a mandatory requirement.]

9-7.2.1 Dining room ceiling light fixtures (hanging type) shall be movable by means of a track, chain and hooks, or other means in order to accommodate other than the typical dining room furniture arrangement. Fixtures may be designed for incandescent use, and do not have to meet the 50 L/Watt requirement. A Ceiling fan with integral lighting fixture may be substituted for this requirement.

9-7.2.2 The general lighting intensity in kitchens shall be 320 to 540 Lx [30 to 50 foot-candles]. Supplementary lighting shall be provided at the sink and under one of the wall cabinets for a work center to produce a composite lighting level of 210 Lx [75 foot-candles] using either down-lights, surface fluorescent fixtures surface-mounted below wall cabinets or wall-mounted fixtures (1520 mm [5 ft] and higher above the floor) as appropriate. Kitchen range hood shall be provided with a light, fan, and switches.

9-7.2.3 The ceiling light fixtures boxes in the following rooms, living room, dining room, and all bedrooms shall be provided with a metallic fixture box suitably supported from the ceiling structure so that it may support a ceiling fan, and with additional wiring to allow for independent wall switch control of the fan and light.

9-8 Smoke Detectors. Provide hard-wired smoke detectors on a separate circuit in each housing unit in accordance with NFPA 72 and NFPA 101.

9-9 Carbon Monoxide Alarms: Provide carbon monoxide (CO) alarms for new and renovated family housing equipped with a fuel burning appliance inside of the unit, or a fireplace, or an attached garage. CO alarms will be provided as follows:

9-9.1 One CO alarm shall be located on each level of the housing unit. A required alarm shall be located in vicinity of the bedrooms, such as in the corridor outside of the bedrooms. CO alarms will not be provided in garages, furnace rooms, unfinished basements or unfinished attics.

9-9.2 CO alarms shall be hardwired and wall-mounted at the same height as the thermostat, approximately 52 inches off the floor. Dead air spaces such as corners shall be avoided. Units may be powered from circuits powering smoke detectors. In all cases, manufacturer's guidelines and recommendations shall be followed.

9-9.3 CO alarms shall be equipped with an audible alarm, continuous digital display, peak level memory, test button, and test reset button and shall be UL listed by passing standard test UL 2034.

9-10 Telephone. Pre-wire housing units in accordance with local telephone company requirements. Provide outlets in kitchen, dining, or family area, living room and bedrooms of each housing unit. Eight position modular jack connectors shall be provided at all outlets. The jacks provided in the kitchen, dining, or family areas shall be for a wall-mounted phone. Wiring methods shall comply with EIA/TIA Standard 570, Residential and Light Commercial Telecommunications Wiring Standard. Cable and jacks shall be Category 5 per TIA/EIA 568A, Commercial Building Telecommunications Cabling Standard. Each housing unit shall be pre-wired separately from other housing units in the same building. All wiring shall terminate in a surface mounted, weatherproof, protected telephone terminal located on an outside wall adjacent to the building meter equipment. ("Demarcation Box"). The protected telephone terminal cover shall be provided with means for padlocking, shall be accessible from the outside, and shall be permanently labeled, "Telephone". Only one protected telephone terminal shall be required for each separate building. A single #10, CU, green equipment grounding conductor shall be run in 1/2-inch non-

metallic conduit from the building metering equipment to the protected telephone terminal box. Number of pairs and type of cable, type of modular jacks, and sizes of protected telephone terminals and outlet boxes shall be coordinated with local Telephone Company.

#### 9-11 Television.

9-11.1 Commercial Cable Television. Cable Television (TV) outlets shall be located in the living room, family room, and bedrooms. Units shall be prewired in conformance with all local cable TV company requirements. Each housing unit shall be prewired separately from other housing units in the same building. All wiring shall terminate in a surface mounted, weatherproof, protected television terminal ("Demarcation Box") located on an outside wall adjacent to the protected telephone terminal. The protected television terminal cover shall be provided with means for padlocking, shall be accessible from outside and shall be permanently labeled "Television". Only one protected television terminal shall be required for each separate building. A single #10, CU, green equipment grounding conductor shall be run in 1/2-inch non-metallic conduit from the building metering equipment to the protected telephone terminal box. Type of cable, type of tapoffs, and sizes of protected television terminals and outlet boxes, shall be coordinated with local cable TV Company.

9-11.2 Commercial cable TV is the preferred system, if available. An antenna system or connection to a TV distribution system shall be provided for each housing unit. The TV system shall provide for UHF and VHF reception for color TV. The antenna system may be either a common antenna serving the entire project (mast or dish), an attic antenna system for each separate building, or attic antenna for each housing unit

9-12 Door Bell. The front entrance to each housing unit shall be provided with a low voltage bell or buzzer.

9-13 Convenience Outlets. In addition to outlets required by NEC, provide convenience outlets in the following areas:

9-13.1 Utility Room

9-13.2 Hallway outside bedrooms

9-13.3 Garage

9-14 Special Outlets. Provide 240 V electric outlets for electric dryer, electric range, and window air conditioner units. [Delete reference to window air conditioners, if not applicable to the specific project.]

9-15 Wiring. Maximum use shall be made of nonmetallic sheathed cable for branch circuit wiring, and of service entrance cable for heavy-duty interior circuits and for service entrance conductors. Installed conductors in conduit shall be used only where specifically required by the NEC.

9-16 Branch Circuit Conductors. Branch circuit conductors and over current devices shall be as rated by NEC. A minimum of one spare circuit space in the panel shall be provided per housing unit. Individual circuits shall be provided for the washer, dryer (with receptacles located behind the washer and dryer), dishwasher, garbage disposal, freezer, electric range, furnace or air handling unit, air conditioning unit, and water heater. Two utility circuits (20 amp) shall be provided in the kitchen area for the convenience outlets for small appliances serving the kitchen, dining area, and family room area.

9-17 Engine Block Heaters. [Insert "...DELETED" and delete remainder of text if not required.] Provide 20 amp outlet on separate circuit for occupant-owned engine block heater. Locate the outlet adjacent to the garage door opening(outside).

**10. UNIT DESIGN - HEATING, VENTILATING, AND AIR CONDITIONING.**

[Delete all references to comfort cooling where air conditioning is not authorized. Delete references to inapplicable systems throughout the following paragraphs.]

10-1 Design. Heat gain and loss calculations shall be, as a minimum, in accordance with the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Residential Cooling Load Calculation methodology. Computer-generated load calculations shall be provided, and shall include complete input and output summaries. Design shall be based on the weather data shown in Table 10-1.

**TABLE 10-1 – WEATHER DATA<sup>1</sup>**

Type of Design / Design Information		
Weather Region: _____	Metric	Inch-pound
Heating <sup>2</sup>		
Indoor Design Temperature	21 °C	70 °F
Outdoor Design Temperature	Note <sup>1</sup>	Note <sup>1</sup>
Annual Heating Degree <sup>3</sup> Days	Note <sup>1</sup>	Note <sup>1</sup>
Largest Number of Monthly Heating Degree Days <sup>3</sup>	Note <sup>1</sup>	Note <sup>1</sup>
Cooling		
Indoor Design Temperature	24 °C	75 °F
Outdoor Design Dry Bulb Temperature	Note <sup>1</sup>	Note <sup>1</sup>
Outdoor Design Wet Bulb Temperature	Note <sup>1</sup>	Note <sup>1</sup>

Note<sup>1</sup>: [Insert weather data from TM 5-785, Engineering Weather Data.]

Note<sup>2</sup>: Bin weather data shall be provided after this table if heat pumps are a selected alternative.

Note<sup>3</sup>: Metric data are based on Celsius degree days to a base of 18 degrees C. Inch-pound data are based on degree days Fahrenheit to a base of 65 degrees F.

10-1.1 Load calculations. Computer generated load calculations shall be performed for each possible orientation up to four representative orientations for each building type included in the project. Room air flow requirements shall be computed based on the individual room load. However, the minimum acceptable air flow shall be 2.5 (L/s)/m<sup>2</sup> [0.5 cfm/ft<sup>2</sup>] for all spaces. The design for each individual housing unit shall be based on the heating and cooling loads as well as room airflow requirements computed for the building type and orientation which it most closely matches. Internal loads shall be included in the computerized load calculations in accordance with ASHRAE recommendations for residential analyses.

10-1.2 Duct system layout. For a given building type, a single duct layout may be used regardless of orientation, provided that the system is sized to provide the required air flow for each room at its worst case orientation. Balancing dampers shall then be used to reduce air flow to the appropriate level as required. Permanent access to

dampers shall be provided.

10-2 Equipment Safety and Efficiency. All materials and equipment shall be the standard cataloged product of manufacturer's regularly engaged in production of such materials and equipment, and shall be the manufacturer's latest standard design. Each major component of the heating [and cooling] system[s] shall have the manufacturer's information on a plate secured to the equipment.

10-2.1 All heating and cooling equipment proposed and installed in this contract shall bear the Energy Star Label.

10-2.2 Equipment shall comply with the requirements of American Gas Association (AGA), American National Standards Institute (ANSI), Air Conditioning and Refrigeration Institute (ARI), American Society for Testing and Materials (ASTM), Gas Appliance Manufacturers Association (GAMA), National Electric Manufacturers Association (NEMA), National Fire Protection Association (NFPA), Underwriters Laboratories, Inc. (UL) or other national trade associations as applicable.

10-2.3 Equipment efficiencies as listed in Table 10-3 below are minimum acceptable levels. Energy conservation as it relates to equipment operating costs will be considered in the evaluation process. Additional consideration in the technical evaluation will be given to designs which include higher than minimum efficiency equipment. Verify that all available fuel sources have been compared on a life cycle cost basis prior to preparation of the RFP documents. Table 10-3 shall be edited, based on these comparisons, to retain all fuel options which fall within a range of 10 percent based on life cycle cost analysis. Fuel types which are proven to be ineffective through life cycle cost analysis shall be deleted from Table 10-3.

**TABLE 10-3 - MINIMUM EQUIPMENT EFFICIENCIES**

	Oil fired equip	Natural gas fired equip	LP gas fired equip	Electric heat pump (air cooled)		Electric cooling equip
Furnace AFUE	90% <sup>1,4</sup>	90% <sup>1,4</sup>	90% <sup>1</sup>	Size A <sup>2</sup>	Size B <sup>2</sup>	
Boiler Combustion Efficiency	80%	80%	80%			
HSPF				7.7	8.5	
SEER				12 <sup>3</sup>	13 <sup>3</sup>	12 <sup>3</sup>

Note<sup>1</sup>: Efficiency is based on DOE test procedure 10CFR430, Sub-Part B, Appendix N.

Note<sup>2</sup>: Size A heat pumps have a capacity of 5.9 kW [20,000 Btu/hr] or less. Size B heat pumps have a capacity of 5.9 to 13.5 kW [20,000 to 46,000 Btu/hr].

Note<sup>3</sup>: Efficiency is based on DOE test procedure 10CFR430, Sub-Part B, Appendix M.

Note<sup>4</sup>: [Design District may reduce the required furnace AFUE to not less than 80% in Weather Regions 8 through 11 based on the results of a life cycle cost analysis.]

10-3 Heating and Cooling Systems. Each housing unit shall be provided with central heating [and air conditioning] system[s]. Systems shall be designed, installed, balanced, and adjusted to distribute heat [and cooling] to all habitable rooms, as well as bathrooms, in proportion to the calculated load requirements of these spaces. [The Installation shall determine the allowable fuel types to be used for housing. All reasonably equivalent fuel options within a range of 10 percent based on life cycle cost analysis shall be allowed. The design activity may assist the Installation in preparation of the fuel life cycle cost comparison.] Fans in air handlers and furnaces shall be multi-speed, direct drive type. System installation shall conform to SMACNA Installation Standards for

Residential Heating and Air Conditioning Systems except as altered by this document. Additional consideration in the technical evaluation will be given to systems utilizing modular components, plugged power, drawer-type burner assemblies, additional space in the mechanical room, and other features which contribute to ease of system maintenance. Additional consideration will also be given to designs which provide measures beyond the requirements of this STATEMENT OF WORK to increase energy conservation or occupant comfort such as division of each housing unit into more than one conditioning zone for increased control.

10-3.1 Equipment sizes selected for installation shall not oversized more than 125 percent of the calculated loads.

[Design District may review and incorporate reference to ACCA Manual S HVAC equipment sizing guidelines, or EPA equipment sizing recommendations at [http://yosemite.epa.gov/appd/eshomes/eshaware.nsf/attachments/lib/\\$file/RightSizedAC.pdf](http://yosemite.epa.gov/appd/eshomes/eshaware.nsf/attachments/lib/$file/RightSizedAC.pdf).]

10-3.2 Mechanical space shall be provided to house all mechanical equipment. [Coordinate with the Installation to determine preferred location of mechanical space, and shall then edit this paragraph to indicate the desired location. Factors such as ease of maintenance, storage of family wares, cost considerations, and possibility of freezing shall be considered.] Exterior air conditioning units shall be concrete pad-mounted, with location selected based on site specific conditions and intended uses of outdoor space. Effort shall be made to locate the unit(s) out of the occupant's direct line of sight (screen with shrubbery or wall, locate on sides of housing unit, avoid placement under windows, etc.). However, the primary concern shall be coordination with the mechanical area location. Mechanical equipment shall be located in an externally accessible utility room, and shall be arranged to allow for ease of maintenance, and for proper venting if required. This utility room shall be provided with a light and electrical receptacle. See paragraph 5.d.(3) for additional requirements for mechanical spaces containing fuel-fired heating equipment.

[Edit the following list as applicable to the particular project. If not required, insert "... (Deleted)" following subparagraph letter and delete remainder of text.]

10-3.3 Forced warm air systems. Warm air furnaces shall be [induced combustion, upflow natural gas or No. 2 fuel oil-fired furnaces, or electric furnaces]. Furnaces shall be equipped with electronic ignition. [Natural gas or oil-fired furnaces shall be equipped with a flue to exhaust flue gases above the building roof. Units shall be vented in accordance with NFPA 211. Where high efficiency (AFUE > 90 percent) gas furnaces are selected for use these units shall be vented in accordance with AGA requirements and the manufacturer's instructions. Condensate drains for high efficiency units shall be manufacturer approved, and shall be indirectly connected to the building sanitary sewer system. Combustion air shall be provided from the outside in accordance with the appliance listing. For areas with a 97.5 percent outdoor dry bulb design temperature below -6.7 degrees C [20 degrees F], combustion air shall be provided in accordance with SMACNA Installation Standards for Residential Systems.] [Electric furnaces shall be sized to within 3 kW of the calculated load demand.] Furnaces shall be equipped with centrifugal fan, disposable filters, controls, and transformer. Fans shall be multi-speed, direct-drive type. It shall be possible to service and replace all controls and internal components from one side of the furnace. Heat exchangers shall be guaranteed for a minimum service life of 10 years. [In areas authorized for air conditioning, furnaces shall be equipped with a cooling coil by the same manufacturer, matched to the selected air conditioning equipment.]

10-3.4 Forced hot water systems. Convectors and baseboard or wall radiation units shall have steel core and fin or nonferrous core and fin construction. Heating hot water shall be produced by [natural gas, No. 2 fuel oil-fired, or electric] boilers. A single boiler or multiple modular boilers shall be provided for each building with each housing unit in multi-family housing individually, thermostatically controlled by means of a three-way diverting valve. Each unit shall be provided with its own circulating system. Circulation shall be by means of a two-pipe reverse return system with the circulating pump(s) prevented from operation when the outside temperature is above 18 degrees C [65 degrees F]. Any sub-slab hot water distribution piping shall be installed without joints beneath the slab. Minimum acceptable individual convector control shall be accomplished by means of dampers at each unit. Additional consideration in the technical evaluation shall be given to designs which treat each convector as an individual heating zone by means of self contained or thermostatically controlled valves located at each unit. Greatest consideration shall be given to systems incorporating thermostatically controlled valves. Hot water piping shall be vented at all high points, and shall be provided with isolation valves at each vent to facilitate servicing. A

minimum velocity of 0.61 m/s [2 fps] shall be maintained in the hot water piping. Strainers shall be provided as required to protect system equipment.

10-3.5 Split system air conditioning and air to air heat pumps. [Heat pump data bracketed]. [Air to air heat pumps shall only be considered for use in locations with heating design temperatures (97.5 percent basis) greater than -11 degrees C [12 degrees F]. The use of heat pumps shall be allowed only after a thorough analysis of all available energy sources and systems. Geothermal heat pumps may be used in any geographical location where their equipment efficiencies will exceed those listed for air to air heat pumps]

10-3.5.1 Electric air conditioning [Heat pump system] equipment shall consist of an air-cooled condensing unit and evaporator [evaporator/blower] as matched components with the furnace, all by the same manufacturer. Refrigerants used shall have an Ozone Depletion Potential (ODP) of .05 or less. The condensing unit shall contain, as a minimum, the features indicated in Table 10-4. Equipment shall be sized to meet the total load determined by computer calculation. Equipment may be oversized to no more than 115 percent of the computer generated load. [Evaporator/blower for heat pump systems shall be provided complete with centrifugal fan, disposable filters, controls, and transformer.] Fans shall be multi-speed, direct drive type.

**TABLE 10-4 – SPLIT SYSTEM AIR CONDITIONING [HEAT PUMP] FEATURES**

High and low pressure compressor protection.
Filter-drier.
Hermetically sealed compressor with built-in overloads and locked rotor protection.
Electric crankcase heaters.
Reversing valve. (heat pump only)
Start and run capacitors.
Anti-short-cycle timer. (factory installed)
Testing and charging refrigerant connections.
Compressor guaranteed for a minimum service life of 5 years.
Dipped and baked Phenolic coating on condenser coil (for equipment installed within 16 km (10 mi) of the ocean or other large body of water).
Fan and coil guards.

10-3.5.2 The evaporator coil [evaporator/blower] shall be provided with a liquid strainer, expansion device, pre-insulated housing, copper or aluminum coil, and insulated condensate drain pan. [Centrifugal blower, and electric resistance supplemental heaters.] Coil face velocity shall be limited to 2.8 m/s [550 fpm].

10-3.5.3 The condensing unit and matched coil [evaporator/blower] shall deliver a Seasonal Energy Efficiency Rating (SEER), consistent with the minimum requirements shown in Table 10-3.

10-3.5.4 [Supplementary electric heat. Each heat pump shall be provided with supplementary electric resistance heat. Electric resistance heat shall be sized to provide 100 percent of the calculated heat loss of the particular unit. Electric resistance heaters in excess of 5 kw shall be staged by means of an outdoor thermostat. Outdoor thermostat shall be installed and operated in accordance with the heat pump manufacturer's instructions.]

[Heat pumps shall only be considered for use in locations with heating design temperatures (97.5 percent basis) greater than -11 degrees C [12 degrees F]. The use of heat pumps shall be allowed only after a thorough analysis of all available energy sources and systems.]

10-3.5.5 Refrigerant Charge Verification: When split-system air conditioning systems are selected for installation, the contractor shall check, calibrate, and charge the refrigerant system following installation and start-up of the equipment. These tests shall be accomplished on the same 15% of the units which undergo blower door and duct tightness testing. If the tested units show a low or excessive refrigerant charge, all new systems shall be checked after start-up, but prior to acceptance by the Government.

10-3.6 Packaged air conditioning systems. Packaged air conditioning systems shall consist of a single, self-contained, exterior unit containing the burner, heat exchanger, compressor, condenser, evaporator, and blower. Unit shall be factory pre-piped, precharged, and prewired. Refrigerants used shall have an Ozone Depletion Potential (ODP) of .05 or less. The system shall deliver a Seasonal Energy Efficiency Rating (SEER) consistent with the minimum requirements shown in Table 10-3. The unit shall contain, as a minimum, the features indicated in Table 10-5. Length of exterior ducts between the unit and the building shall be limited to 610 mm [2 ft] maximum. Exterior duct shall be constructed of internally insulated sheet metal. Exterior duct shall also be provided with a sheet metal weather cover attached to the unit and the building, covering a minimum of the top and both sides of the ductwork. Equipment shall be sized to meet the total load determined by computer calculation.

**TABLE 10-5 - PACKAGED AIR CONDITIONING FEATURES**

High and low pressure compressor protection.
Filter-drier.
Hermetically sealed compressor with built-in overloads and locked rotor protection.
Electric crankcase heaters.
Start and run capacitors.
Anti-short-cycle timer. (factory installed)
Testing and charging refrigerant connections.
Compressor guaranteed for minimum service life of 5 years.
Dipped and baked Phenolic coating on condenser coil (for equipment installed within 16 km (10 mi) of the ocean or other large body of water).
Accessory electric heat (as required).
Insulated casing.
Fan and coil guards.
Drain outlet.
Duct adapter as required for interface with supply and return ductwork.

10-3.7 Evaporative coolers. [Evaporative coolers shall be considered only at installations which traditionally use evaporative cooling, and comfort conditions can be maintained through their use. Determine whether evaporative coolers will be allowed as a design option to the Contractor. In the event that evaporative coolers are allowed, edit the Minimum Equipment Efficiencies Table 10-3 to include a column for single stage evaporative coolers. Set minimum efficiency at 80 percent, and add the following text.] Units shall be a self-contained, single stage, weather-resistant type, and shall conform to UL 507 and UL 746C. The fan shall be centrifugal type and shall be complete with motor, drive equipment, and vibration-isolation supports between motor and fan housing on single phase motors. Water distributor or rotary wheel motor shall be provided with a time delay in the fan circuit to allow media to be thoroughly wetted before air flow starts. Manual or automatic reset type thermal overload protection shall be provided. Evaporative cooler fans shall have air delivery ratings based on AMCA 210 tests by an AMCA

approved laboratory. An ultraviolet retarding agent shall be part of or applied on exterior nonmetallic components susceptible to ultraviolet degradation from sun rays and conforming to \-UL 746C-\. Evaporative media shall be specifically manufactured for use with evaporative coolers. Media shall be honeycombed type, fabricated such that no moisture entrainment shall occur. Face velocities shall be limited to those recommended by media manufacturer. Indirect coolers shall consist of an air-to-air heat exchanger, water distribution header, scavenger fan and motor, recirculating water pump, supplemental cooling coil (as required), drain, overflow and makeup water lines and an accessible damper to allow change-over from heating to cooling. Air from the conditioned space shall be exhausted through the attic space with a backdraft damper provided at the ceiling exhaust register. Cooler shall be drainable, and shall be provided with a mounting frame. Evaporative coolers shall be controlled by an on-off switch, with a thermostat provided for heating only.

10-3.8 Integrated Domestic Water Heating and Space Heating Systems. [USACE Design Districts are cautioned that application of this system type is limited to Weather Regions 6 through 11. Installation staff shall be consulted and agree that these type systems are acceptable. These systems are acceptable for use only where natural gas is available at the site.] Units shall be provided with a dual-integrated system which consist of a domestic water heater (specifically approved for dual use) and a fan/coil equipped with hot water heating coil, centrifugal fan, disposable filters, controls, [air conditioning evaporator coil], and transformer. Fans shall be multi-speed, direct-drive type. It shall be possible to service and replace all controls and internal components from one side of the fan/coil. If this system type is selected for use, the domestic water heater must be sized in accordance with the requirements set forth below and not in accordance with the size indicated in paragraph 8 of this Statement of Work. Water heater size shall be in accordance with manufacturers guidelines, ASHRAE Transactions, Vol. 95, part 2, 1989 "Equipment Sizing Procedures for Combination Space-Heating/Water-Heating Systems", and current industry practice. The integrated system must be able to recover from a large hot water draw in one hour or less while still supplying the required heating load. Both the water heater recovery rate and the storage capacity need to be adjusted to suit the integrated system. The water heaters proposed as a part of this system must have a minimum recovery efficiency level of 78%. Additional consideration during the evaluation will given to proposals which include high efficiency water heaters.

10-3.9 Engineered High Velocity Duct Systems. [USACE Design Districts are cautioned that application of this system type is limited to Weather Regions 6 through 11. Installation staff shall be consulted and agree that these type systems are acceptable.] Units shall be provided with an engineered, high velocity duct system for the distribution of heated [and cooled] air throughout the unit. This system shall be the product of a manufacturer regularly engaged in the manufacture of these type systems. Systems will contain a fan/coil specifically designed for this type system which include a heating coil, high pressure blower, [refrigerant coil for heat pump or cooling applications]; rigid rectangular or round trunk ducts, and 50 mm [2 inch] round, pre-insulated, sound dampened, flexible duct run-outs to outlets. Outlets shall be paintable plastic finished to match the ceiling color. All outlets shall be located in the ceilings. This type system is suitable for use with hot water heating systems (not integrated with the domestic water heater) or heat pump systems.

10-3.10 Unacceptable systems. Room unit heaters (see Note<sup>1</sup>); space heaters, room (window) air conditioning units; floor furnaces, gravity warm air systems, and electric resistance heaters (see Note<sup>2</sup>) are not permitted.

[Note<sup>1</sup>: Edit text. Room unit heaters may be used where required by outdoor design conditions to maintain a minimum temperature of 4.5 degrees C [40 degrees F] in mechanical rooms where required for equipment protection.]

[Note<sup>2</sup>: Edit text. Electric resistance heaters may be used for supplemental heat in air-to-air heat pumps.]

10-4 Air Distribution. Provide systems conforming to the recommendations of the ASHRAE Air Distribution Manual or the SMACNA Residential Comfort System Installation Standards Manual. For two-floor housing units with a single air conditioning unit, provide separate, main supply ducts with volume control dampers for each floor. These main ducts shall be run directly from the air handler or furnace to the appropriate building level. As a minimum, provide a separate ducted return for each floor level. Two-floor housing units with 93 m<sup>2</sup> [1,000 ft<sup>2</sup>] or greater net floor area on each floor shall be provided with a separate heating and cooling unit and supply and return ducted system for each floor. Additional consideration in the technical evaluation will be given to designs which incorporate air distribution systems totally within the conditioned envelope.

10-4.1 Supply diffusers. Wall, ceiling, and/or baseboard supply diffusers shall be located to ensure that the air distribution will completely cover all surfaces of exterior walls with a blanket of conditioned air or may be of a compact design so long as 'dead spots' within the units are avoided. At least one diffuser shall be provided in each habitable room. Diffusers shall have louvered faces with individually adjustable blades, and shall be provided with integral opposed blade damper. Diffusers shall be provided with air deflectors as required for proper air flow in the space. Plastic diffusers are prohibited. Core velocity shall be limited to 3 m/sec [600 fpm] maximum, with a maximum pressure drop of 0.82 Pa/m [0.1 inch water]. Airflow from any single diffuser shall be limited to 94.4 L/s [200 cfm] maximum. Ceiling mounted units shall have factory finish to match ceiling color, and be installed with rims tight against ceiling. Sponge-rubber gaskets shall be provided between ceiling or wall and surface-mounted diffusers for air leakage control. Diffuser boots shall be sealed tight to the wall or ceiling they penetrate using duct mastic or caulking. Suitable trim shall be provided for flush-mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller. Wall supply registers shall be installed at least 150 mm [6 inches] below the ceiling.

10-4.2 Return and exhaust grilles. Grilles shall be fixed horizontal or vertical louver type similar in appearance to the supply diffuser face. Plastic units are prohibited. Core velocity shall be limited to 2 m/sec [400 fpm] maximum, with a maximum pressure drop of 0.5 Pa/m [0.06 inch water]. Grilles shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Register/grille boots shall be sealed tight to the wall or ceiling they penetrate using duct mastic or caulking. Wall return grilles shall be located at least 150 mm [6 inches] above the floor. Return grilles shall be located in hallways, finished basements, or other normally unoccupied spaces to minimize the sound level in occupied spaces.

10-4.3 Ductwork. Ductwork shall be externally insulated sheet metal or flexible metal. Length of flexible duct shall be limited to 1.8 m [6 ft]. Flexible ductwork shall not be spliced or joined and shall be a single continuous piece from diffuser boot to trunk/branch duct. Systems composed entirely of flexible ductwork with distribution boxes are prohibited. Sub-slab, intra-slab, or crawlspace ductwork is also prohibited. Volume dampers shall be provided at each branch take-off. All ductwork shall be concealed. No portion of the building construction (such as joist space in a floor or ceiling, wall stud space, etc.) shall be used as a duct. The requirements for ductwork set forth below apply to all ductwork installed in the housing unit, supply systems, return systems, exhaust systems, ventilation systems, and outside air supply ductwork.

10-4.3.1 Maximum velocity in supply ducts shall be limited to 4.6 m/s [900 fpm] for mains and 3.1 m/s [600 fpm] for branches.

10-4.3.2 Ducts shall be airtight with no visible or audible leaks to ensure quiet, economical system performance. Ductwork in conditioned spaces shall be constructed for a 250 Pa [1 inch] static pressure construction class with seal class C, as described in the SMACNA HVAC Duct Construction Standard, unless a higher pressure class and/or seal class is required by actual, system operating conditions. Ductwork in unconditioned spaces shall be constructed for a 500-Pa [2-inch] static pressure construction class with seal class C, unless a higher pressure class and/or seal class is required by actual, system operating conditions. All duct seams and joints shall be sealed using duct mastic. Tape shall not be used as a means for sealing ductwork.

10-4.3.3 For flexible ductwork, the inner core shall be mechanically fastened to all fittings, preferably using drawbands installed directly over the inner core and beaded fitting. If beaded fittings are not used, then the inner core shall be fastened to the fitting using #8 screws equally spaced around the diameter of the duct, and installed to capture the wire coil of the inner liner (3 screws for ducts up to 300 mm [12 inch] in diameter and 5 screws for ducts over 300 mm [12 inch] in diameter). The inner core must be sealed to the fitting using mastic or tape. Tape used for sealing the inner core shall be applied with at least 25 mm [1 inch] of tape on the duct lining and 25 mm [1 inch] of tape on the fitting, and shall be wrapped at least three times. The outer sleeve (vapor barrier) must be sealed at connections with a drawband and three wraps of approved tape. The vapor barrier must be complete without any holes or rips, and seams shall be sealed with mastic or approved tape. Pressure sensitive tapes used in conjunction with flexible duct connections shall be as recommended by the duct manufacturer and shall be UL 181A listed and so indicated with a UL 181A mark or aluminum-backed butyl adhesive tape (15 mil minimum). Drawbands shall be stainless steel worm drive hose clamps or UV resistant nylon duct ties.

10-4.3.4 Provide a minimum of 51-mm [2-inch] thick mineral fiber insulation (or other listed insulation with an equivalent R value) on the exterior of all ducts in unconditioned spaces. Exhaust ductwork does not require insulation. Insulation shall be faced with a vapor barrier material having a performance rating not to exceed 1.0 perm. Insulation, vapor barrier, and closure systems shall be non-combustible as defined in NFPA 255, with a flame-spread rating of not more than 25, and a smoke development rating of not more than 50, as defined in ASTM E-84.

10-4.3.5 Return, exhaust, and ventilation air ductwork shall be sized for a maximum velocity of 4.6 m/sec [900 fpm]. Short runs of return air duct (1525 mm [5 ft] or less) which directly precede the air handler or furnace shall be acoustically lined to minimize noise.

10-4.4 Fire dampers shall be located and installed in accordance with NFPA requirements, and shall conform to the requirements of UL 555. Fire dampers shall be automatic operating, and shall be rated for the maximum system velocity and pressure. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Access doors shall be provided at all fire dampers.

10-4.5 Filtration. Provide a pleated 25 mm [1 inch] panel filter, sized for and installed in the return air system in accordance with UL 900. Filter shall be rated for 20 percent efficiency as determined by ASHRAE 52, Method of Testing Air Cleaning Devices used in General Ventilation for Removing Particulate Matter. All filters shall be easily accessible for changing and maintenance and shall be installed in the return grilles whenever possible. Additional consideration in the technical evaluation shall be given to designs utilizing electrostatic filters. Kitchen exhaust hoods shall be provided with aluminum grease filters sized to fit the exhaust duct.

10-5 Thermostats and Humidistats. Thermostats shall be located on interior partitions, approximately 1530mm [5 ft] above the finished floor. Locating a thermostat on the wall adjacent to a stairway, on an exterior wall, or where it is subject to unrepresentative temperatures is unacceptable.

10-5.1 Thermostats shall be Energy Star labeled, microprocessor-based, with built-in key pads for scheduling of day and night temperature settings. Thermostats shall be programmable for heating only, cooling only, or heating and cooling as required. When out of the scheduling mode, thermostats shall have continuous display of time, with AM and PM indicator, continuous display of day of week, and either continuous display of room temperature with display of temperature set point on demand, or continuous display of temperature set point with display of room temperature on demand. In the programmable mode, the display shall be used for setting and interrogating time program ON-OFF set points for all 7 days of the week. The time program shall allow two separate temperature-setback intervals per day. Thermostats shall have a means for temporary and manual override of the program schedule, with automatic program restoration on the following day. Thermostats shall have a replaceable battery to maintain the timing and maintain the schedule in memory for one year in the event of a power outage. Maximum differential shall be  $\pm 1$  degree C [ $\pm 2$  degrees F]. For a listing of Energy Star labeled thermostats see <http://www.epa.gov/appdstar/hvac/thermostats.html>. [When used for heat-pump applications, the thermostat shall have an emergency heat switch.]

10-5.2 Humidistats, where required, shall be designed for indoor application and shall have a measurement range from 15 to 60 percent relative humidity (RH). The instrument shall be of the wall-mounted or return duct-mounted type, as required by the application, and shall be provided with any required accessories.

10-6 . Humid Area Design. [Climates which have 3000 hours or more of 19.4 degrees C [67 degrees F] or higher wet bulb temperature in combination with an outside design condition of 50 percent or higher relative humidity, or climates which have 1500 hours or more of 22.8 degrees C [73 degrees F] or higher wet bulb temperature in combination with an outside design condition of 50 percent or higher relative humidity shall be considered humid areas.] In humid areas, all air heating and cooling systems shall be provided, and economy cycles will not be allowed. Closet and storage spaces shall have louvered doors, and building return air shall be drawn through these spaces to a ducted return air system. Cooling coils shall have a maximum of 315 fins/m [8 fins/inch] to allow for easy cleaning, and shall be sized for a maximum face velocity of 2.8 m/s [550 fps] to preclude moisture carryover. Heating and cooling equipment in humid areas shall be designed to meet the load determined by computer

calculation. However, a larger fan may be required to meet minimum air flow requirements than would be anticipated based on the computer load. Equipment may be oversized by no more than 15 percent of the computer generated sensible load.

10-7 Exhaust Fans. Bathroom and kitchen range hood exhaust fans shall be ducted to the outside. Exhaust fans shall not discharge near the air conditioning condensing unit, entry doors, patio or balconies, carports, or garages. Fans shall be tested and rated in accordance with AMCA 210, and shall operate with 120-volt, single-phase power supply. Exhaust fans shall be provided with backdraft damper. Bathroom exhaust fans shall be ceiling mounted and shall be sized to provide not less than 10 air changes per hour in the space served. Maximum allowable noise level for bathroom exhaust fans shall be 2 sones as installed. Kitchen range exhaust fans shall be two-speed, and shall be sized for an exhaust rate of 7.6 (L/s)/m<sup>2</sup> [1.5 cfm/ ft<sup>2</sup>]. Maximum allowable noise level for range hood exhaust fans shall be 6 sones as installed.

10-8 Dryer Vents. A 100-mm [4-inch] diameter dryer vent shall discharge to the exterior, and provide connection to occupant-owned dryer (one dryer per vent). The vents shall be rigid aluminum with exterior wall cap and backdraft damper. Vent pipes shall be a maximum of 6100 mm [20 ft] long, with no more than three right angle elbows (with minimum radius of 150 mm [6 inches]), and have a maximum vertical run of 3660 mm [12 ft]. Dryer vents shall not exhaust near the air conditioning condensing unit, entry doors, patio or balconies, carports, or garages. Dryer vents shall not run through non-accessible spaces or garages.

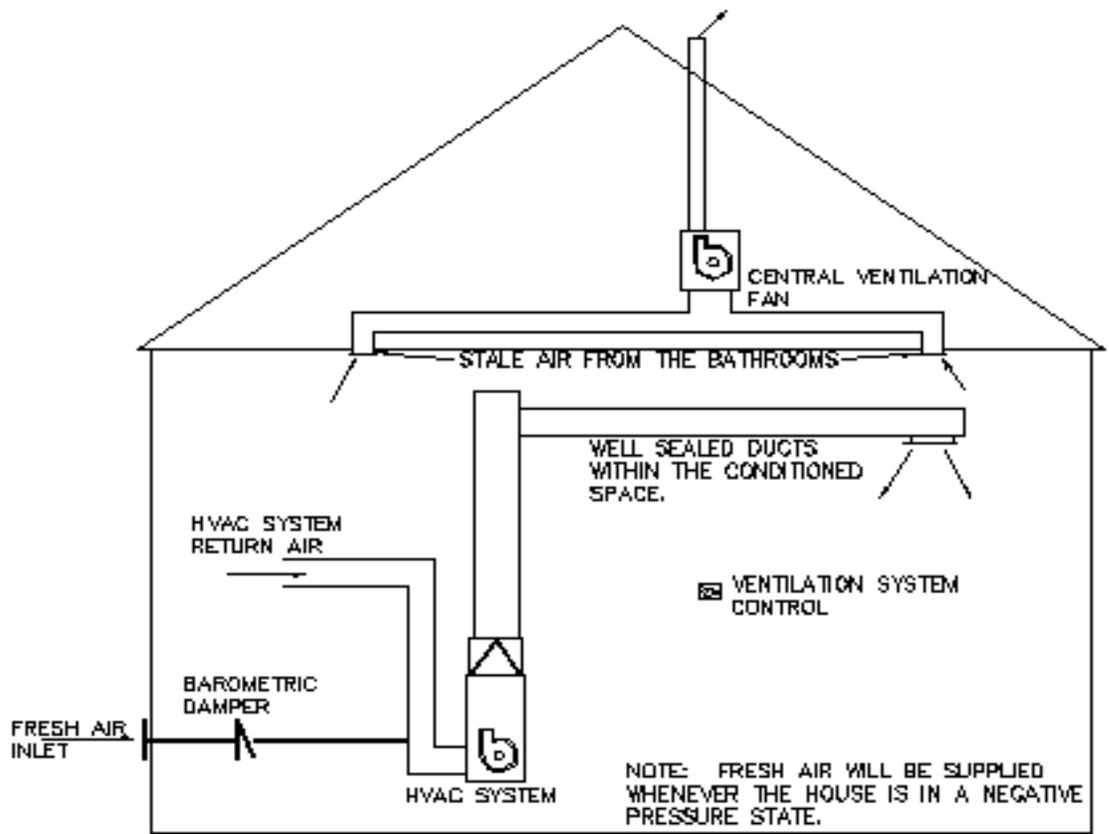
10-9 Humidification. [Use the requirements of this subparagraph to determine the allowable use of humidification. Humidification is optional. If not required, insert "... (Deleted)" following subparagraph letter and delete remainder of text. If humidification is required, edit this subparagraph to instruct the Contractor to provide humidification. Humidification shall be provided for all central forced air systems in areas having less than 1800 hours of 19.5 degrees C [67 degrees F] or higher wet bulb temperature in combination with annual heating degree days in excess of 1666 on an 18 degrees C base [3000 on a 65 degrees F base]. Humidifiers may be of the bypass or duct insertion type. Humidifiers shall be controlled by wall-mounted or return duct mounted humidistat. Humidification shall be allowed to a maximum of 30 percent relative humidity.]

10-10 Piping Requirements. Air conditioner condensate drains, refrigerant suction, and exterior refrigerant liquid lines shall be insulated with 25 mm [1 inch] (minimum) thick cellular glass or unicellular foam pipe insulation. (See subparagraph 10.f. for pipe insulation requirements in humid areas.) Exterior refrigerant line insulation shall be encased in either an aluminum or PVC jacket to prevent damage. Condensate lines shall be one size larger than the drain pan connection, be properly trapped, and not directly connected to a sanitary sewer system (air gap fitting required).

10-11 Ceiling Fans. [Ceiling fans are an optional feature which may be requested by the Installation. Delete paragraph if not required.] Provision of ceiling fans is encouraged as a means of increasing occupant comfort, and as an aid to improve the performance of heating and cooling systems. Ceiling fans with lights may be substituted for ceiling fixture requirements in bedrooms and in the dining room. Ceiling fans will be low profile 1050-1350 mm (42-52 inch), four blade type. Motors shall be three speed reversible, with air volume range between 613 and 2832 lps (1300 and 7000 CFM) and speeds between 75 and 225 rpm. Maximum power consumption shall be 80 Watts and 0.7 amps. Manufacturer's 20 year warranty is required.

10-12 Active Ventilation Engineered IAQ Enhancement. The bathroom exhausts, within each unit, shall all be ducted together to a common exhaust plenum equipped with a single long-life, low cfm, two-speed fan. The fan shall be sized to provide the required exhaust rate in each bathroom space when operated at low speed. Control for this fan shall be accomplished from a wall mounted switch, located in the linen closet, labeled HI-LOW-OFF. The OFF position of the switch shall illuminate a "RED" LED to indicate the off condition of the ventilation system. The supply ventilation portion of the system shall consist of a small duct providing a connection for fresh (outdoor air) air to the furnace return duct. This duct shall contain a barometrically-controlled vent which shall admit outdoor air to the unit whenever the housing unit is experiencing a negative pressure. ASHRAE 62-1989, "Ventilation for Acceptable Indoor Air Quality" recommends ventilation air supply rate at a minimum of 0.35 air changes per hour (ACH) but not less than 15 cfm per person. This is supplied by either natural infiltration or a combination of natural infiltration plus active ventilation. The fresh air supply duct shall be sized to provide no more than this minimum 0.35 Air Changes per hour maximum ventilation rate (but in no case shall the ventilation air introduced into the unit

from the combination of natural infiltration and active ventilation be less than recommended by ASHRAE 62 with consideration for two (2) occupants per bedroom). This system is a recommended "Energy Star Homes" approach for improving indoor air quality in residential construction. The Active Ventilation Engineered IAQ Enhancement described in this paragraph is considered to be a minimum level compliance item (See Diagram below.) in weather regions 5 through 11. In weather regions 1-4 extreme cold conditions and energy efficiency considerations may require the use of alternate approaches, some including heat recovery ventilators (HRV). Contractors are encouraged to present and propose other systems/methods which are enhancements/improvements to the system described and can ensure adequate fresh ventilation air (0.35 AC/Hr Max) is provided to the interior spaces of the housing units. Contractor are encouraged to review "Energy Star" materials and information available to them through the EPA and/or by visiting the Energy Star Web page. See, for example, [http://yosemite.epa.gov/appd/eshomes/eshaware.nsf/attachments/lib/\\$file/BalancedVentSys.pdf](http://yosemite.epa.gov/appd/eshomes/eshaware.nsf/attachments/lib/$file/BalancedVentSys.pdf) and [http://yosemite.epa.gov/appd/eshomes/eshaware.nsf/attachments/lib/\\$file/SupplyVent.pdf](http://yosemite.epa.gov/appd/eshomes/eshaware.nsf/attachments/lib/$file/SupplyVent.pdf).



### ACTIVE VENTILATION SYSTEM SCHEMATIC

10-13 Testing, Adjusting, and Balancing. Adjusting and balancing of each housing unit shall be the Contractor's responsibility. Following adjusting and balancing, testing of air and water systems shall be performed on 10 percent of the project buildings (not to exceed 10 buildings), which have been randomly selected by the Contracting Officer. If buildings are to be turned over in phases, testing shall be performed on 10 percent of the buildings completed in each phase (not to exceed 10 buildings per phase). No additional testing will be required if at least 90 percent of the tested buildings pass the test requirements. If less than 90 percent of the tested buildings pass the test, an additional 10 percent of the project buildings (not to exceed 10 buildings) shall be tested. This process shall continue until 90 percent of the total number of tested buildings pass. The contractor shall correct all housing units not found in compliance, and shall be responsible for all labor and materials required for this effort. AABC MN-1, NEBB-01, SMACNA-07 or ASHRAE 111 shall be used as the standard for providing testing of air and water

systems. The selected standard shall be used throughout the project. Instrumentation accuracy shall be in accordance with the standard selected. Testing shall be accomplished by a firm certified for testing by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Prior to testing, adjusting, and balancing, the Contractor shall verify that the systems have been installed and are operating as specified. Where specific systems require special or additional procedures for testing, such procedures shall be in accordance with the standard selected. Approved detail drawings and all other data required for each system and/or component to be tested shall be made available at the job site during the entire testing effort. Testing shall not commence until approved by the Contracting Officer. The facility shall be essentially complete with final ceiling, walls, windows, doors, and partitions in place. Doors and windows surrounding each area to be balanced shall be closed during testing and balancing operations. Air systems, hydronic systems, and exhaust fans shall be complete and operable. All data, including deficiencies encountered and corrective action taken, shall be recorded. Following final acceptance of certified reports by the Contracting Officer, the setting of all HVAC adjustment devices shall be permanently marked by the Contractor's balancing engineer so that adjustment can be restored if disturbed at any time.

10-14 Duct Tightness Testing Requirements. The installation of the supply and return ductwork within the units is an item of prime concern with respect to the energy efficient operation of the housing unit as a whole. With that consideration in mind, for heating and air conditioning designs which include ductwork outside of the conditioned envelope, the contractor will be required to test the proto-type units and all units which are blower door tested for tightness (see paragraph 7.c.(2)) to ascertain the leakage levels from the ductwork in accordance with the following requirements. For system designs which place all the ductwork within the conditioned envelope of the structure or systems which utilize evaporative cooling, no ductwork testing will be required.

10-14.1 Duct tightness testing shall ensure that the leakage rate from ductwork (where the ductwork system is not entirely within the conditioned envelop) shall not exceed  $0.15 \text{ (L/s)/m}^2$  [ $0.03 \text{ cfm/ft}^2$ ]. If the units tested fail to meet this requirement, the ductwork installation shall be examined, corrections made, and the test redone until the installation passes this requirement. No ductwork systems may be installed in other units until the proto-type units ductwork systems have been validated. Several methods to accomplish this testing are acceptable

10-14.1.1 Testing may be done in accordance with ASTM Standard E 1554-94, "Determining External Air Leakage of Air Distribution Systems by Fan Pressurization". This method describes the process and methodology required to accomplish basically a 'blower door subtraction' method of duct tightness testing.

10-14.1.2 Testing may also be accomplished utilizing "Duct Blaster" methodologies and pressurizing the ductwork to 25 Pascal [0.1 inch of water].

10-14.2 The contractor is advised that the EPA may test, or hire a consultant to test randomly selected housing units constructed in this project. These tests will be completed without cost to the contractor, however, the contractor will be required to coordinate access to the selected unit. If accomplished, this testing is not expected to interfere or delay the construction contractor in any manner.

**11. ENERGY CONSERVATION.**

11-1 Energy conservation techniques shall be considered as they relate to site design, site engineering, unit design, and unit engineering. Techniques which conserve energy, improve livability, and can be justified by life cycle cost analysis as cost effective are encouraged. Integration of energy conservation systems with the housing unit's design (lighting, structure, mechanical systems, and aesthetics) is essential to facilitate livability and maximum energy savings. If an alternative energy generation method is intended for use as the project's primary energy source, documentation shall be submitted to the Contracting Officer, verifying the system's reliability and ability to meet the project's peak demand. The following paragraphs suggest energy conservation techniques which are considered desirable. The listing is not all inclusive, and the techniques suggested may not be cost effective at a given location or site. Additional consideration in the technical evaluation will be given to designs which incorporate valid energy conservation techniques.

11-2 Passive Solar Applications. Passive solar architectural applications shall routinely be considered as a part of all project designs. Unique applications such as attached sun spaces, earth sheltering, mass trombe walls, solar chimneys, solar dehumidifiers, and other innovations may be considered. Operational controls, such as shading and venting mechanisms, to control the amount of heat admitted into the housing unit during the day, reduce the amount of heat escaping from the housing unit at night, and provide for thermal comfort of the occupants, are parts of this system.

11-2.1 Additional south glazing. If used as part of the solar energy system, glazing shall be of the commercially available off-the-shelf type and shall face within 15 degrees of solar south. The glazing shall be architecturally compatible with the housing unit and the environment, face directly into the living space so that the walls, floors, ceiling, and other massive objects can absorb the entering solar energy, and shall have a whole-window U value less than 1.6 square meter-kelvin (K)/watt [0.28 ft<sup>2</sup>-degrees F/BTUH]. The optimum amounts of **solar glazing** that will admit enough solar energy are shown below:

Average winter outdoor temperature	36° lat	40° lat	44° lat	48° lat
<i>Cold climates</i>	GA/FA	GA/FA	GA/FA	GA/FA
20°	0.24	0.25	0.29	0.31
25°	0.22	0.23	0.25	0.28
30°	0.19	0.20	0.22	0.24
<i>Temperate climates</i>	GA/FA	GA/FA	GA/FA	GA/FA
35°	0.16	0.17	0.19	0.21
40°	0.13	0.14	0.16	0.17
45°	0.10	0.11	0.12	0.13

Table: Sizing South facing Glazing, GA/FA = glazing area/floor area

Note: Window area on the other sides of the house should total no more than 5% of the floor area.

11-2.2 Storage mass. If thermal performance calculations indicate a need for additional mass (beyond that provided by the housing unit structure) substantiating data will be submitted. The storage mass will be well integrated into the housing unit design. The thermal mass surface area in the space must be a minimum of three times the glazing area. Six to nine times the glazing area is recommended to control temperature swings. The surfaces to absorb solar energy must not be more than 10% covered.

11-2.3 Shading. Movable window treatments are required. These can take the form of heavy draperies to be drawn by the occupants at night and opened in the day. Movable thermal insulation is considered the optimum

installation. Cooling season shading of glazed surfaces on the west and south elevations shall be considered.

11-3 Pre-engineered Active Solar Applications. Pre-engineered active solar applications proposed for domestic water heating shall be evaluated for life-cycle-cost effectiveness using a recognized process design program. Whether site-mounted or unit-mounted, systems must be designed for maximum ease of maintenance and for architectural compatibility with the total family housing environment. Systems shall be designed to provide no more than 60 percent of the housing unit's annual water heating load.

11-4 Geothermal. Geothermal energy sources such as wet or dry steam sources, geothermal hot water, hot dry rock, etc., when determined cost effective, may be considered in regions with established geothermal sources. Each design utilizing geothermal sources shall address the project's environmental impact relating to discharge of hazardous, noncondensable gases or other hazardous effluents, noise emission, heat rejection, ground water contamination, land use, etc.

11-5 Wind. Wind power may be considered in regions where determined cost effective. Factors such as average wind speed, available wind power, and wind variability shall be considered when investigating the annual useful energy production potential.

11-6 Condenser Heat Recovery. In regions authorized for cooling, consideration shall be given to installation of a heat exchanger to recover condenser heat and desuperheat for use in heating domestic water. A standard, domestic water heater shall be provided in conjunction with this system to provide hot water during the heating season. Heat pump water heaters can be considered in hot climates.

11-7 Energy Recovery Ventilator. Energy recovery ventilators shall be considered for use with systems designed to introduce outside ventilation air into the housing unit to address indoor air quality concerns, particularly in extreme cold climates. The increased cost and system complication associated with the introduction of outside air shall be carefully weighed against severity of indoor air quality deficiencies before the decision is made to supply outside air at the air handler. When utilized, energy recovery ventilators shall pre-condition outside air by permitting energy transfer from exhaust air. Units shall have easily accessible controls and filters.

11-8 Systems and techniques which take advantage of rebates and incentives offered by utilities are preferred and shall be stated by the government and local utility districts.

## 12. CONTRACTOR PREPARED SPECIFICATIONS

12-1 The successful offeror shall prepare a specification for all work included in the scope of work. The specification shall be tailored to this job. Inapplicable materials shall be deleted. Any reference, description, procedure or other matter required to develop a complete, accurate and concise specification shall be provided. The specification shall include but is not limited to:

12-1.1 A description of the technical requirements

12-1.2 Criteria for determining whether the requirements are met

12-1.3 Quality control requirements and procedures

12-2 Specifications for features of the work shall be organized into divisions and sections in accordance with Construction Specifications Institute (CSI), Master List of Titles and Numbers for the Construction Industry, latest edition.

12-3 Individual specification sections shall be in the format of CSI, Section Format, A Recommended Format for Construction Specification Sections, latest edition. Exceptions are:

12-3.1 Measurement Procedures and Payment Procedures shall only be used in those section(s) where rock excavation is specified. No other sections shall contain these subparagraphs of the paragraph SUMMARY.

12-3.2 Except as otherwise noted in this paragraph, CONTRACTOR PREPARED SPECIFICATIONS, the paragraph SUMMARY shall not be used.

12-3.3 Submittal requirements, submittal procedures and quality control procedures, construction operations shall be those contained in the attached Section 01005, Section 01012, Section 01111, Section 1200, Section 1300, Section 1320, Section 01330, including the submittal register, Section 1440, Section 1451, Section 1500, Section 1560, and Section 1711. These specification sections shall be incorporated into the contractor prepared specification packages without editing and shall be coordinated with all other specification sections prepared by the contractor. [USACE Design District shall edit this paragraph as required to indicate the required "construction administration" type specifications required to provide Quality Assurance for this project. Full CEGS technical guide specifications should not be included.]

12-3.4 Section 09990, Painting; shall establish a minimum level of quality for paints, stains, and varnishes to be used in this project.

12-4 Removal and disposal of asbestos shall be specified in its own section and numbered 13280. The attached section 13280 shall be reviewed, edited, and submitted by the Contractor's Industrial Hygienist during the design review process. Specification shall be edited to suit this particular project requirements as determined by the contractor's professional staff. [USACE Design District delete where no demolition activities are included in the project.]

12-5 Removal and disposal of lead based paint, shall be specified in its own section and numbered 13283. The attached section 13283 shall be reviewed, edited, and submitted by the Contractor's Industrial Hygienist during the design review process. Specification shall be edited to suit this particular project requirements as determined by the contractor's professional staff. [USACE Design District delete where no demolition activities are included in the project.]

12-6 Contractor prepared specifications shall be reviewed by the Contracting Officer or his designated representatives during the design portion of the project. Contractor will incorporate all required changes after resolution of comments and prior to work initiation on the next phase of the project.

**13. SUSTAINABLE DESIGN CONSIDERATIONS:**

13-1 Sustainable design techniques shall be considered as they relate to site design, site engineering, unit design, and unit engineering. Techniques which conserve energy, improve livability, and can be justified by life cycle cost analysis as cost effective are encouraged. Integration of energy conservation systems with the housing unit's design (lighting, structure, mechanical systems, and aesthetics) is essential to facilitate livability and maximum energy savings. The following paragraphs define the goals and general objectives for inclusion of sustainable design considerations in this project. This information is taken from US Army Corps of Engineers, ETL 1110-3-491. The listing is not all inclusive, and the techniques suggested may not be cost effective at a given location or site. Additional consideration in the technical evaluation will be given to designs which incorporate and identify Sustainable Design techniques included in the proposal.

**13-2 Goals and Objectives of Sustainable Design.**

13-2.1 The overall USACE goal of Sustainable Design is to be environmentally responsible in the delivery of facilities. The key traditional elements for decision making in the facility delivery process are cost, quality and time. These elements need to be expanded to include the ecological and human health impacts of all decisions.

13-2.2 Each project generates its own set of goals. However, sustainable design goals should apply to all projects. The goals for improving the environmental performance of facilities include: (a) use resources efficiently and minimize raw material resource consumption, including energy, water, land and materials, both during the construction process and throughout the life of the facility, (b) maximize resource reuse, while maintaining financial stewardship, (c) move away from fossil fuels towards renewable energy sources, (d) create a healthy and productive work environment for all who use the facility, (e) build facilities of long-term value, and (f) protect and, where appropriate, restore the natural environment.

13-3 Sustainable Design and Construction of the Built Environment. Design and construction of sustainable buildings should be in accordance with the following concepts:

13-3.1 Site Work and Planning--Environmentally sensitive planning looks beyond the boundary of the project site to evaluate linkages to transportation and infrastructure, ecosystems and wildlife habitat and community identification. Site planning evaluates solar and wind orientation, local microclimate, drainage patterns, utilities and existing site features to develop optimal siting and appropriate low maintenance landscape plant material.

13-3.2 Building Layout and Design--Optimize building size, and maintain an appropriate building scale for the environment and context of the building or a building component. Layout the rooms of a building for energy performance and comfort, and design for standard sizes to minimize material waste. Pay careful attention to the location of exterior windows. Avoid structural over-design and the resultant waste. Design components of the building environment for durability and for waste recycling.

13-3.3 Energy--Building orientation and massing, natural ventilation, day-lighting, shading and other passive strategies, can all lower a building's energy demand and increase the quality of the interior environment and the comfort and productivity of occupants.

13-3.4 Building Materials--Environmentally preferable building materials are durable and low maintenance. Within the parameters of performance, cost, aesthetics and availability, careful selection and specification can limit impacts on the environment and occupant health.

13-3.5 Indoor Air Quality--Indoor air quality is most effectively controlled through close coordination of architecture, interiors and mechanical, plumbing, and electrical design strategies that limit sources of contamination before they enter the building. Construction procedures for IAQ and post-occupancy user guides also contribute to good long-term IAQ.

13-3.6 Water Usage-- Site design strategies that maximize natural filtration of rainwater are desirable. Water conservation is enhanced by the use of low flow plumbing fixtures and water appropriate landscaping.

13-3.7 Recycling and Waste Management--Waste and inefficiency can be limited during construction by sorting and recycling demolition and construction waste, reuse of on-site materials and monitoring of material use and packaging. Accommodating recycling into building design reduces waste while generating revenues.

13-3.8 Building Commissioning, Operations and Management--Effective building commissioning is essential to ensure proper and efficient functioning of systems. Facilities operations benefit from energy and water saving practices, waste reduction and environmentally sensitive maintenance and procurement policies.