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UNIFIED FACILITIES CRITERIA (UFC)

ARCHITECTURE

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UNIFIED FACILITIES CRITERIA (UFC)

ARCHITECTURE

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

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

Change No.	Date	Location

This UFC supersedes UFC 3-100-10, Architecture (Navy Draft), dated July 2006; MIL HDBK 1190, Facility Planning and Design; the Atlantic Division Architectural Design Guide and Interior Design Guide, dated July 2002; SODIV-TG-1001, dated March 1997; and SODIV-TG-1007, dated August 1997.

FOREWORD

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

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

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

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

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

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UNIFIED FACILITIES CRITERIA (UFC)
NEW DOCUMENT SUMMARY SHEET

Description of Changes: UFC 3-101-01 unifies the architectural criteria for DOD.

Reasons for Changes:

- Maximizes use of industry standards to meet DOD requirements.
- Incorporates critical architectural text from Military Handbook 1190, "FACILITY PLANNING AND DESIGN GUIDE", dated September, 1987.
- Incorporates additional building envelope criteria that will help meet EPAct 2005, EISA 2007, ANSI/ASHRAE/IESNA 90.1 2007, and portions of ANSI/ASHRAE/USGBC/IES 189.1 2009 requirements

Impact: There will be some initial construction cost impacts to meeting the new building envelope criteria, but there should be long-term life cycle cost savings in reduced energy usage and building maintenance. The following additional benefits should be realized.

- Assists the government in meeting EPAct 2005 and EISA 2007 requirements.
- By using the industry standards, on-going revision due to industry changes will minimize the need for future revisions.

Non-unification Issues:

- Referenced space planning criteria is contained in service specific publications : For **Air Force** use AFMAN 32-1084, "Facility Requirements"; for the **Army** use TM 5-803-5, "Installation Design" and model design-build RFP and standard designs, as applicable; and for the **Navy** use UFC 2-000-05N (P-80), "Facility Planning Criteria for Navy/Marine Corps Shore Installations" .
- Radon identification guidance is service specific.
- The building envelope must be designed to comply with or exceed ANSI/ASHRAE/USGBC/IES 189.1 2009 paragraph 7.4.2.1. For **Air Force** projects, the building envelope must be designed to comply with or exceed ANSI/ASHRAE/IESNA 90.1 2007.
- Service differences in Air Barrier Testing criteria are noted in this UFC.

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CHAPTER 1 INTRODUCTION

1-1 PURPOSE AND SCOPE.

This UFC provides technical guidance and outlines technical requirements for typical aspects of architectural design services. Architects shall use the information in this document in the development of plans, specifications, calculations, construction contract documents, and Design-Build Requests for Proposals (RFP). The information in this guide serves as the minimum architectural requirements. Project conditions may dictate the need for designs that exceed these requirements.

1-2 APPLICABILITY.

This UFC applies to all agencies of the U.S. Armed Services and their contractors that are preparing construction contract documents for all Department of Defense-owned facilities. These criteria are applicable in the fifty states, the District of Columbia, Puerto Rico, U.S. territories and possessions, and as far as practical, at installations in foreign countries. This UFC applies to all types of construction regardless of funding, including properties listed or eligible for listing on the National Register of Historic Places, as well as National Guard and Reserve projects constructed on military installations or non-military DoD property. Certain specialized facilities, such as health facilities, carry more stringent requirements. See UFC or other criteria that are applicable to the respective specialized facility that is being designed. This UFC is applicable to the traditional architectural services customary for Design-Bid-Build design services and for Design-Build construction contracts.

1-3 GENERAL BUILDING REQUIREMENTS.

UFC 1-200-01, "General Building Requirements", provides applicability of model building codes and government-unique criteria for typical design disciplines and building systems, as well as for accessibility, antiterrorism, security, sustainability, and safety. Use this UFC in addition to UFC 1-200-01 and the UFCs and government criteria referenced therein.

1-4 REFERENCES.

Other technical criteria may apply and shall be followed as appropriate for each project. Confirm the most recent required criteria with the Project Manager/Design Manager. Furthermore, Appendix A of this UFC contains the list of references used in this UFC. These other publications, standards, and technical data referenced herein form a part of these criteria to the extent referenced.

1-5 ADDITIONAL REQUIREMENTS.

When performing work for different Activities within the U.S., additional regional or service-specific requirements apply. Confirm with the Authority Having Jurisdiction (AHJ) the applicability of any regional requirements.

CHAPTER 2 PLANNING AND PROGRAMMING

2-1 SPACE PLANNING CRITERIA.

Program non-standardized facility sizes based on a functional analysis of activities to be accommodated to determine the actual amount of space required. Facility planning shall be based on specific requirements for each project, to include all functional, technical, and economic considerations, instead of arbitrary allowances. To obtain the most economical and efficient use of space, design facilities based on the functional organization of adequately sized spaces. The following publications contain tables of allowances for general planning purposes, but the final size of each project shall be based on actual requirements:

- AFMAN 32-1084, "Facility Requirements"
- TM 5-803-5, "Installation Design" and model design-build RFP and standard designs, as applicable
- UFC 2-000-05N (P-80), "Facility Planning Criteria for Navy/Marine Corps Shore Installations"

The documents above are used to determine general facility requirements. Other facility-specific UFCs may have more detailed requirements.

2-2 BUILDING AREA CALCULATIONS.

Include in the Basis of Design the gross floor area calculation to confirm scope and criteria compliance. Include a block diagram indicating the building outline and all areas that contribute to the building area. Gross area definitions and calculations must conform to this UFC. Provide calculations in accordance with Paragraph 5.3 of this document, applying the appropriate factor for full or half area to each area as defined herein. Figures 2-1 and 2-2 illustrate a sample gross building area calculation and block diagram.

2-2.1 Scope Changes.

Changes to scope are governed by Title 10 USC 2853.

2-2.2 Calculation of Gross Building Area.

Other UFCs for specialized facilities such as medical facilities, military family housing, or Unaccompanied Enlisted Personnel Housing dictate how to calculate the gross area of those facilities. For all other facilities, calculate the gross area of a building using the following:

- Enclosed spaces: The gross area includes the total area of all floors, including mezzanines, basements, penthouses, and other enclosed spaces as measured from the exterior faces of the exterior walls or from the centerline of walls separating joined buildings. Enclosed stairwells, elevators, utility chases, and mechanical rooms are included as part of the area of each floor that they occupy.

- One-Half Spaces: Include one-half of the gross area of paved or finished covered areas, such as balconies and porches, covered but not enclosed entrances, covered raised loading platforms, covered ground level or depressed loading facilities, covered but not enclosed walks or passageways, covered and uncovered but not enclosed exterior stairs, and covered ramps.

- Excluded Spaces: Exclude the following when the average ceiling height is less than 7 ft (2.1 m) measured from the underside of a structural system and with perimeter walls measuring a minimum of 59 in. (1500mm) in height: mezzanines; interstitial spaces; penthouses; and enclosed crawl and utility spaces such as tunnels, raceways, and trenches. Also exclude from the gross area the following: catwalks; mechanical platforms; stairs on the roof; exterior uncovered walks; ramps; stoops; uncovered loading platforms or facilities, either depressed, ground level, or raised; open courtyards; open paved terraces; and roof overhangs, shading devices, and soffits. Prefabricated enclosures housing equipment are considered equipment and are also excluded. The void areas of atria are also excluded. Only include the floor area of the lowest level of atria.

FIGURE 2-1. SAMPLE GROSS BUILDING AREA CALCULATION

PROJECT TITLE
PROJECT LOCATION

GROSS FLOOR AREA CALCULATION * (SEE BLOCK PLAN EXAMPLE)

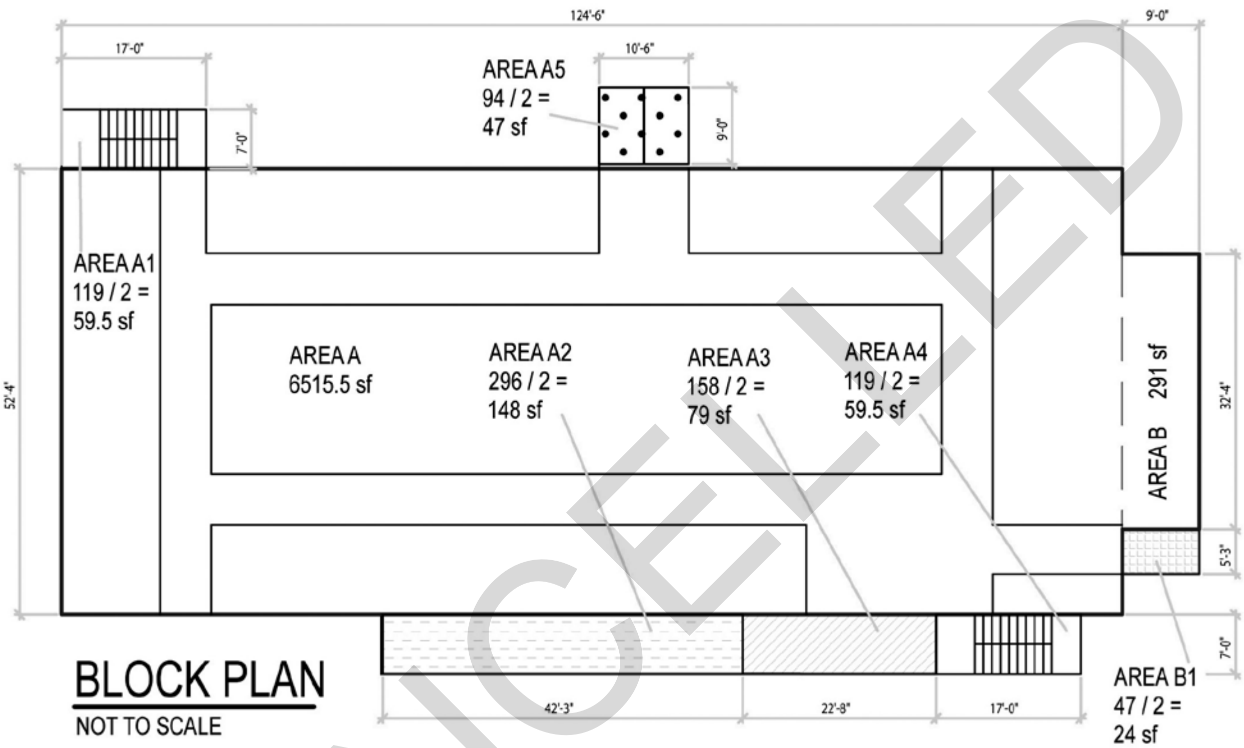
AREA A			
Area A	124’-6” x 52’-4” =	6515.5 sf	
AREA A TOTAL			**6515.5 sf**
			605.3 sm
AREAS A1 thru A5 (Exterior Covered – ½ Area)			
Area A1	17’-0” x 7’-0” / 2=	59.5 sf	
Area A2	42’-3” x 7’’-0” / 2=	148.0 sf	
Area A3	22’-8” x 7’-0” / 2=	79.0 sf	
Area A4	17’-0” x 7’-0” / 2=	59.5 sf	
Area A5	10’-6” x 9’-0” / 2=	47.0 sf	
AREAS A1 thru A5 TOTAL			**393.0 sf**
			36.5 sm
AREA B			
Area B	9’-0” x 32’-4” =		**291.0 sf**
			27.0 sm
AREA B1 (Exterior Covered – ½ Area)			
Area B1	9’-0” x 5’-3” / 2=	24.0 sf	
AREA B1 TOTAL			**24.0 sf**
			2.2 sm
BUILDING TOTAL GROSS			**7,223.5 sf**
			670.9 sm
SCOPE TOTAL MAX. ALLOWABLE GROSS AREA*			**7,224 sf**
			671 sm

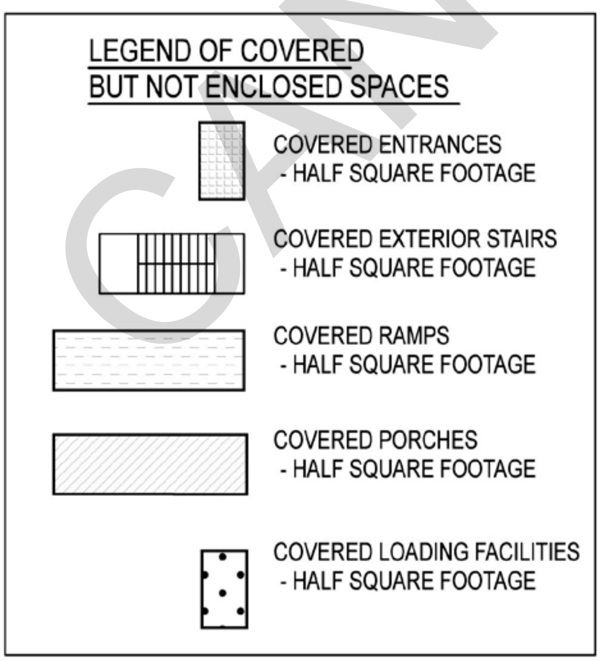
(PER DD FORM 1391)
*Calculations may be in metric or Inch-pound, as directed by the Government Project Manager.

FIGURE 2-2. SAMPLE BLOCK PLAN

ARCHITECTURAL BASIS OF DESIGN FOR PROJECT NUMBER ***

EXAMPLE BUILDING PROJECT NAME at the EXAMPLE MILITARY INSTALLATION LOCATION
SERVICE BRANCH SPECIFICATION NUMBER Xxxxxx-xx-x-xxxx





EXAMPLE BUILDING AREA TABULATION

BUILDING AREA A	6,515.5 sf	605.3 sm
OUTSIDE STAIR A1	59.5 sf	5.5 sm
RAMP A2	148.0 sf	13.7 sm
PORCH A3	79.0 sf	7.3 sm
OUTSIDE STAIR A4	59.5 sf	5.5 sm
LOADING AREA A5	47.0 sf	4.4 sm
BUILDING AREA B	291.0 sf	27.0 sm
COVERED ENTRANCE B1	24.0 sf	2.2 sm
TOTAL 1391 AREA	7,223.5 sf	670.9 sm
1391 ALLOWABLE AREA	7,224 sf	671 sm

2-3 BUILDING ORIENTATION.

Building siting shall be established in consonance with the Base Development Plan and land use compatibility respective of mission requirements. Building layout and orientation shall optimize site opportunities with regard to functional arrangement, access, exterior appearance, views, and other considerations.

Building shape, orientation and design shall utilize the site seasonal environmental factors to minimize annual facility energy use and to optimize daylighting. Coordinate building and glazing orientation and architectural shading with seasonal solar angles and prevailing winds to enhance energy performance of the building within the site-specific micro climate. See Appendix B for additional information.

2-4 ARCHITECTURAL STYLE AND CHARACTER.

Facilities shall be designed in harmony with the surrounding base architecture, judiciously employing the style and character of architecturally and historically significant facilities, as appropriate. Constructibility, maintainability, and sustainability shall be considered in design in attaining architectural compatibility.

2-4.1 Installation Exterior Architectural Guidelines.

Most military installations and/or service design agencies have published design guidelines that contain criteria relative to achieving, maintaining and emphasizing a positive exterior visual environment. Follow the design guidance contained in these documents carefully since these are published under the authority of the Secretaries of the military services. In the absence of such guidelines, design facilities to harmonize with the character of existing facilities considered historically or architecturally significant to the area.

2-4.2 Historic Architecture.

Repair or renovation of historic facilities and new construction near historic facilities shall follow the *Secretary of Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings*.

2-4.3 Projects in the National Capital Region (NCR).

In accordance with the National Capital Planning Act of 1952, as amended, submit all master plans and designs for proposed construction projects in the NCR to the National Capital Planning Commission (NCPC) for appropriate reviews and approvals consistent with the timelines issued by the NCPC.

2-5 HAZARD PREVENTION.

Design facilities to comply with 29 CFR Occupational Safety and Health Act. Pay particular attention to lead and asbestos particulates, which may be lying on top of materials to be removed, or Polychlorinated biphenyls (PCBs) that are part of caulking and sealant materials that may have been absorbed into adjacent building materials and need grinding.

2-5.1 **Radon.**

Evaluate and mitigate Radon per the appropriate Service and Installation regulations.

2-5.1.1 **Identification of Radon**

2-5.1.1.1 **Army and Navy.**

Check the Environmental Protection Agency's (EPA's) Map of Radon Zones (by state), EPA 402-R-93-071 (available from http://www.epa.gov), to determine the radon priority area.

2-5.1.1.2 **Navy**

Also check the results of the Navy radon survey by contacting the NAVFAC Facility Engineering Command (FEC) Air Pollution Engineer.

2-5.1.1.3 **Air Force.**

Check the results of the AF Radon Assessment and Mitigation Program (RAMP) study of 1987. During that study, all Air Force Installations were screened for radon in existing structures. Installations were classified as being of low, medium or high risk. Incorporate radon reduction measures in the construction of new facilities at those installations designated as medium or high risk. See AFI 48-148. For installations not assessed during the RAMP study of 1987 and for all new, permanent operating locations, a random sampling of the site's structures must be assessed for radon. Consult with the Air Force Institute of Environment, Safety, Occupational Health and Risk Analysis (AFIERA) for guidance on designing an appropriate sampling program. Any Installation or operating location found to have a single structure with radon concentrations greater than the threshold limit listed in AFI 48-148 must undergo a detailed radon assessment.

2-5.1.1.4 If no data is available for the area or site to make a prediction of radon levels, then a radon survey must be done or a passive radon mitigation system installed.

2.5.1.2 **Radon Mitigation System Design**

Provide passive subslab depressurization systems for projects located in Priority Areas No. 1 (predicted average radon level is greater than 4/pCi/L). Change the system to active, if needed, based on follow-up testing. Check the following EPA documents available from the EPA Radon Information Center, (703) 356-5346, http://www.radon.com/:

- EPA's Model Standards and Techniques for Control of Radon in New Residences, U.S. Environmental Protection Agency, Air and Radiation (6604-J), EPA 402-R-94-009, March 1994.

- Radon Prevention in the Design and Construction of Schools and Other Large Buildings, EPA/625/R-92-016,

- Radon Measurement in Schools, EPA/402/R-92-014.

2-5.2 **Mold.**

The presence of moisture in the materials of a project can promote the growth of fungi or mold and pose a hazard to the occupants, construction workers, and the design team. During construction, plan for moisture intrusion prevention and remove wet products subject to mold development. See Chapter 3, Moisture, for more information on designing to prevent mold development.

2-6 MECHANICAL/ELECTRICAL/TELECOMMUNICATION ROOMS.

Design adequate area for mechanical equipment rooms, electrical rooms, and telecommunication rooms. Provide an adequate volume of space for all building distribution systems and provide access for maintenance. For mechanical equipment room sizing, coordinate with the mechanical designer at the earliest stage to ensure the required clearances for maintenance, servicing, and safety are included. For telecommunications rooms, coordinate with the electrical designer.

CHAPTER 3 BUILDING ENVELOPE REQUIREMENTS

3-1 INTRODUCTION.

The building envelope must be designed to comply with or exceed ANSI/ASHRAE/USGBC/IES 189.1 2009 paragraph 7.4.2.1. For **Air Force** projects, the building envelope must be designed to comply with or exceed ANSI/ASHRAE/IESNA 90.1 2007.

The building envelope shall be designed to control the transfer of the following elements: heat, air, moisture, light/radiation, and noise. Design each control strategy holistically and use an integrated approach.

3-2 CONTINUITY OF BARRIERS.

There are several functions that a building enclosure needs to fulfill. In order to do so efficiently and without problems, the most important barriers in the building enclosure shall be continuous: the rain screen or water deflection layer, the insulation or thermal barrier, the air barrier, the water drainage plane, and the waterproof barrier. It is desirable to have the vapor retarder as continuous as possible, but unlike the other barriers, it can function adequately with minor imperfections in continuity. Sometimes it is possible to combine functions in a single layer, for example, medium density spray polyurethane foam can be the air barrier, the thermal insulation, the water drainage plane and the vapor retarder. Continuity of the barriers shall be traced through all details of the building enclosure.

3-3 FENESTRATION.

Fenestration is the least energy-efficient component of the building enclosure. Based on a life cycle cost analysis (LCCA), select the best possible performance from a U-factor, Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT) for the fenestration. Optimize the emissivity coatings to control both heat gain into the building due to solar radiation and heat loss from the building. Select framing that includes advanced thermal breaks of polyester-reinforced nylon. Wherever possible, select systems that incorporate pressure-equalized technology—face-sealed systems eventually break down and leak. Include flashings under fenestration in an appropriate manner.

Based on the LCCA, develop a comprehensive design that considers both exterior shading devices, including horizontal sunscreens and vertical fins (beneficial in hot southern climates), and interior shading devices (necessary to control glare when direct solar intrusion is inevitable). Optimize the window-to-wall ratio to (1) reduce lighting energy when using daylighting controls and (2) avoid the glare and added energy consumption that can result from large window areas. Glazing areas above 7 ft. (2135mm) high are useful in increasing daylight penetration, especially when coupled with light-reflecting shelves. Selection between windows, storefront and curtain wall shall be coordinated with the structural design. Final fenestration design shall be coordinated with the mechanical and electrical engineers to comply with overall facility energy requirements.

3-4 INSULATION.

Continuous insulation layers unbroken by framing are the most efficient way of insulating building assemblies. Provide a layer of continuous insulation uninterrupted by thermal bridges except for occasional fasteners and anchors. Conditioned buildings in climate zones 3-8 (defined by ANSI/ASHRAE/IESNA 90.1 2007) shall include high-density (40-100 psi depending on floor loading—use a safety factor of 5) extruded polystyrene under the vapor retarder in slab-on-grade construction. Final assembly U-Factors shall be coordinated with the mechanical engineer to comply with overall facility energy requirements.

Protect all insulation from weather, including rain, ultra-violet solar radiation, mechanical abuse, compression, or accidental or deliberate movement from its location during its service life. Coordinate insulation and its installation with the moisture analysis described in Chapter 3, Vapor Retarders.

3-5 MOISTURE BARRIER.

A building should be wrapped on all “six” sides with a moisture barrier to deflect water from its surface. A moisture barrier may be a waterproof layer or a water-resistant material shingled to shed water, depending on the slope. Water-resistive barriers (WRBs) may not perform as a waterproofing material if subjected to hydrostatic water pressure. Some WRBs can be vapor permeable, some can be vapor retarders and some can be air barriers. Seal all penetrations of the moisture barrier.

Establish the specific functions of the membrane and its position relative to the other materials in the assembly determined so that its properties can be correctly selected and a “moisture balance” (more drying than increase in moisture content) will occur in the building assemblies.

3-5.1 Water-Resistive Barriers (WRB).

3-5.1.1 Wall assemblies shall incorporate a WRB (meeting the requirements of Chapter 14 of the International Building Code (IBC) as a minimum) in the back-up wall behind the cladding, with flashings to lead water out. This is true for all claddings, including exterior insulation and finish systems (EIFS). All copings and sills shall receive through-wall flashing under them.

3-5.1.2 In order to direct moisture out of a cavity through weep holes, provide continuous flashing at the bottom of the cavity and wherever the cavity is interrupted by elements such as shelf angles, lintels and penetrations. Extend flashing through the outer masonry face and turn down at 45^0 to form a drip. Do not terminate through-wall flashing behind the exterior face. Install through-wall flashing over all openings, sills, spandrels, shelf angles and parapet copings. Where flashing is not continuous, such as over openings and at sills, extend flashing ends beyond the lintel on both sides and turn up into the head joint two inches at each end to form an end dam. Penetrations such as windows and louvers in the exterior wall assemblies shall have pan flashing installed in the rough opening sill. This pan sill flashing shall have end dams at both jambs a minimum of 2 in. (50 mm) high and a rear dam of 2 in. (50 mm) high. Comply with ASTM E 2112, the requirements in Chapter 4, Masonry, and the SMACNA *Architectural Sheet Metal Manual* recommendations.

3-5.1.3 Counteract below-grade transfer of water through walls by damp-proofing or waterproofing on walls, depending on hydrostatic pressure and drainage capability. Minimize capillary suction of water upwards from wet footings can be minimized by troweling a layer of cementitious crystalline waterproofing into the wet concrete on top of footings or by including a waterproofing admixture in the footing concrete mix. Footing drains and under-slab drainage shall be incorporated based on the recommendations of the geotechnical engineering report. Waterstops shall be provided at all concrete cold joints near or below grade. If required to address hydrostatic pressure or as recommended by the geotechnical report, provide drainage planes combined with waterproofing material and a footing drain on below-grade walls.

3-5.2 **Vapor Retarders.**

3-5.2.1 **Building Envelope Vapor Retarders.**

Follow vapor retarder requirements listed in the IBC Article 1405. For building enclosure systems or environmental conditions not covered by IBC Article 1405, design the enclosure using design tools referenced in the ASHRAE Handbook of Fundamentals (2009, Chapter 25) and the following sections.

3-5.2.1.1 First determine the vapor pressure difference between indoor and outdoor climates. For exterior vapor pressure, use the mean outdoor dry bulb and dew-point temperatures for the coldest and hottest months in UFC 3-400-02, "Design: Engineering Weather Data". If the vapor pressure difference is less than 0.25" Hg (847 Pa), place the vapor retarder with appropriate permeance for the application on the predominantly high vapor pressure side of the assembly. Do not provide multiple vapor retarders that trap moisture between the retarders. Select vapor retarders in accordance with ASTM C 755.

3-5.2.1.2 If the vapor pressure difference between indoor and outdoor climates is greater than 0.25" Hg (847 Pa), perform a job-specific vapor transmission (hygrothermal) analysis for walls, roofs, and exposed floors (and floors over crawlspaces) based on project specific climate as defined by UFC 3-400-02, "Design: Engineering Weather Data," and the specified components and materials. If the WUFI model is selected (see below), use the climate data included in the WUFI program in lieu of UFC 3-400-02. Indicate the temperature and relative humidity for the inside and the outside of the building; a complete listing of building components, including the vapor retarder, their thickness, location, thermal resistance and permanence; and building location and use. There are two options for conducting the hygrothermal analysis. Choose one of the following two options:

- Use the steady state dewpoint or Glaser methods described in the *ASHRAE Handbook of Fundamentals* (2009, Chapter 25) using the mean outdoor dry bulb and dew point temperatures for the hottest and coldest months.

- Use a mathematical model that simulates transient hygrothermal conditions such as WUFI/ORNL (ASTM Manual 40 reviews these models).

Users of such methods must understand their limitations, and interpretation of the analysis results shall be done by a trained person to reasonably extrapolate field performance approaching the design results. For the mathematical model method, use interior conditions based on a dewpoint of 53°F (12°C) in summer conditions and a dewpoint of 40°F (5°C) in winter conditions. The maximum threshold shall be a surface relative humidity of 80% averaged over a period of 30 days to achieve a successful building enclosure assembly for temperatures between 40°F and 120°F (5°C and 50°C) and other criteria described in Chapter 6 of ASHRAE Standard 160. These are thresholds above which mold can grow and building assemblies deteriorate.

3-5.2.1.3 Based on the results of the analysis, design the assemblies for appropriate diffusion control.

3-5.2.2 **Floor Slab Vapor Retarders.**

Floor slabs on grade with non-permeable floor finishes shall always have a vapor retarder of 0.05 perms or less meeting the requirements of ASTM E 1745 Class A. Non-permeable floor finishes include (but are not limited to) epoxy, polyurethane, vinyl, linoleum and rubber. Under slab vapor retarders shall be durable enough to withstand construction activity and shall be terminated around the perimeter and penetrations detailed according to the manufacturer’s instructions. Additionally, specifications shall require measurement of slab relative humidity in accordance with ASTM F 2170 to meet the requirements of the floor finish manufacturer or shall include an application of a topical moisture mitigation material. Concrete mix for floor slabs on grade with non-permeable floor finishes shall be normal-weight, moisture-cured, with a water/cement ratio of between 0.4 and 0.45; use a high-range water reducing admixture as necessary.

3-5.2.3 **Roof Vapor Retarders.**

Provide moisture analysis of the roof assemblies per Chapter 3, Building Envelope Vapor Retarders. Roof assemblies on concrete slabs shall always include a vapor retarder on top of the concrete and a vented metal deck to control construction moisture in the concrete from affecting roof assemblies. However, low slope roof assemblies using rigid insulation shall be designed without a vapor retarder whenever possible.

3-5.3 **Waterproofing.**

Use waterproofing membranes to protect the interior of the building when there is hydrostatic pressure due to a high water-table below grade or when there is paving, landscaping or a vegetated roof. Different membrane systems are available for these applications, but all should be carefully examined after installation to ensure viability.

3-5.4 **Mold Mitigation and Prevention.**

For mold mitigation on **Navy** projects, refer to Navy Interim Technical Guide FY03-04 *NAVFAC Mold Response Manual.* For mold mitigation on **Air Force** projects, refer to Engineering Technical Letter (ETL) 04-3(Change 1): Design Criteria for Prevention of Mold in Air Force Facilities.

3-6 **AIR BARRIER REQUIREMENTS.**

3-6.1 **New Construction.**

3-6.1.1 Design, construct and test the building enclosure with a continuous air barrier to control air leakage in accordance with the requirements of ANSI/ASHRAE/USGBC/IES 189.1 – 2009 Normative Appendix B, “Prescriptive Continuous Air Barrier” as indicated herein. For semi-heated spaces, provide the continuous air barrier in climate zones 3 to 8. Clearly identify all air barrier components of each envelope assembly on construction documents and detail the joints, interconnections and penetrations of the air barrier components. Clearly identify the boundary limits of the building air barriers and of the zone or zones to be tested for building air tightness on the drawings. Include the statement of the calculated six-sided area of the air barrier envelope on the drawings for each test area.

3-6.1.2 Trace a continuous plane of air-tightness throughout the building envelope and make flexible and seal all moving joints. Air barrier requirements shall be verified per the requirements noted below in Chapter 3, Inspection and Testing.

3-6.1.3 Seal all penetrations of the air barrier. Unavoidable penetrations of the air barrier (such as electrical boxes, plumbing fixture boxes, and other assemblies that are not airtight) shall be made airtight by sealing the assembly and the interface between the assembly and the air barrier or by extending the air barrier over the assembly. The air barrier must be durable to last the anticipated service life of the assembly. Do not install lighting fixtures with ventilation holes through the air barrier.

3-6.1.4 Provide low-leakage damper when applicable and control to close all ventilation or make-up air intakes and exhausts, atrium smoke exhausts and intakes, etc when leakage can occur during inactive periods. A damper shall not be provided on the vents for battery charging rooms since these vents are provided to prevent accumulation of hydrogen gas. Coordinate these requirements with the mechanical engineer.

3-6.1.5 Compartmentalize garages under buildings by providing vestibules at building access points. Provide vestibules at building entrances with high traffic.

Compartmentalize spaces under negative pressure such as boiler rooms and laundry rooms, and provide make-up air for combustion.

3-6.2 Renovations.

When a building is undergoing a major renovation of the building envelope, see Appendix B, Air Barrier Renovations, for guidance on how to accomplish this.

3-6.3 Inspection and Testing.

Building air barrier system shall be tested in accordance with the requirements of ANSI/ASHRAE/USGBC/IES 189.1 – 2009 Normative Appendix B, “Prescriptive Continuous Air Barrier” with the following exceptions:

- For **Army** and **Navy** projects the building air leakage rate shall not exceed 0.25 cfm/ft^2 (1.25 L/s-m^2) when tested.

- For **Air Force** projects the building air leakage rate shall be determined by testing to 0.2 in. water (50 Pa) and extrapolating the test results to 0.3 in. water (75 Pa). The building air leakage rate for Air Force projects shall not exceed 0.4 cfm/ft^2 (2.00 L/s-m^2) when test results are extrapolated to 0.3 inches water (75 Pa). Use of 0.2 inches water (50 Pa) test pressure allows for the use of the building HVAC system to provide test pressure.

Other approved methods of whole building airtightness testing include: ASTM E741, and CAN/CGSB 149.15-96; for diagnostic air leakage testing, ASTM E1186 and ASTM C1060 or ISO 6781 can be used. Detailed inspection and testing requirements and acceptance criteria shall be included in the project specifications.

The following facility air barrier systems shall require inspection only:

- Those facility types outside the scope of ANSI/ASHRAE/IESNA 90.1 2007

- Buildings and conditioned spaces under 5,000 ft.^{2} (465 m^2)

- Semi-heated buildings

- Hangar bays, maintenance bays, or similar area

- Building additions onto non-renovated structures if the interface cannot be adequately sealed for testing

3-6.4 Mock-ups.

Mockups for air barrier installation require approval by the AHJ. See Appendix B, Best Practices for guidance.

3.7 ACOUSTICS.

Design the facility to provide a comfortable acoustical environment and provide comprehensive sound isolation and sound absorption measures for individual spaces as appropriate. Develop a comprehensive acoustical design for individual facilities as appropriate.

Look at the acoustic maps of the installation to determine the acoustic intrusions possible in the facility. Comply with noise reduction criteria per DoD Instruction 4165.57. If an Air Installation Compatible Use Zones (AICUZ) map is not available for the location, the specific project may require an acoustical engineer to conduct an acoustical analysis to determine the exact type and extent of the additional acoustical treatments needed to address aircraft noise.

CHAPTER 4 SPECIFIC REQUIREMENTS

4-1 INTRODUCTION.

The following requirements address specific design elements. Many of these requirements represent solutions to specific problems experienced on new and renovation DoD facility projects.

4-2 ABOVE-GRADE FINISHED FLOOR ELEVATION.

Set finished ground floor elevations with respect to the finished grades. Place the finished floor no less than 8 in. (200 mm) above the finished grade for slab-on-grade construction. Allow 18 in. (455 mm) clear space above finished grade for light frame construction. The finished grade is defined as the final grade elevation adjacent to the exterior including any planting beds.

4-3 PAINT SELECTION.

Base paint selection on Master Painters Institute's (MPI's) *Detailed Performance Standards* for the coating materials and MPI's *Architectural Painting Specification Manual* for the system. Do not use MPI's "Intended Use" standards. Refer to the National Association of Corrosion Engineers (NACE) standards for painting steel and concrete structures, particularly in marine and other severe environmental locations. Coordinate paint selection with Chapter 3, Moisture Barrier.

4-4 MASONRY

Comply with the Brick Industry Association Technote 7, Technote 18A, and Technote 21 for specific brick masonry recommendations and other topic-specific technotes as applicable.

4-4.1 Masonry Control and Expansion Joints.

Non-load bearing exterior masonry walls are often thermally isolated from the building by insulation and are therefore subjected to differential movement. Design a series of vertical and horizontal expansion joints to permit this differential movement. Masonry damage occurs most often when sufficient expansion and control joints are not provided.

4-4.2 Expansion Joint Position and Location.

No single recommendation for positioning and spacing of vertical expansion joints can be applicable to all structures. Analyze each building to determine the potential horizontal and vertical movements, and make provisions to relieve excessive stress that might be expected to result from such movement. Place expansion and/or crack control joints in accordance with BIA Technote 18A. Place expansion joints symmetrically on building elevations. Indicate expansion joints on the contract drawings.

4-4.3 **Masonry Water-Repellent Coatings.**

The use of a non-breathable, clear masonry water-repellent coating to prevent water penetration is prohibited. Determine the source or reason for moisture problems before resorting to a breathable (silane-siloxane-based) clear masonry water-repellent on repair projects.

4-4.4 **Plastic and Membrane Through-Wall Flashing.**

Plastic flashings and asphalt-impregnated felt flashings are prohibited.

4-4.5 **Clearance Between Masonry and Back-up Construction.**

Provide a 1-in. (25-mm) minimum clear dimension from the face of cavity insulation or sheathing material to the back of the exterior wythe of masonry. See ACI 530 for additional information. See BIA Technote 21 for additional guidance.

4-4.6 **Flashing at Penetrations and Projections.**

Do not design structural steel frame members to be exposed inside a cavity wall. Provide flashing at all penetrations exposed into the cavity such as columns or beams, and at floor slabs, wall projections and recesses, and wall bases. All projections, recesses and caps must be flashed and sloped away from the wall to ease drainage.

4-4.7 **Location of Weep Holes.**

Provide open head joint weeps at all through-wall flashing for brick masonry. Locate weeps on the same course as the flashing. Space weep holes at 24 in. (610 mm) on center for brick masonry and 32 in. (815 mm) on center for concrete masonry. Locate weeps above the level of the finished grade, including landscape mulching, to prevent the weeps from becoming clogged with foreign material. Weeps shall be designed to be open head joints with corrugated plastic inserts only. Provide masonry vents at top of walls and below continuous shelf angles. These provide better ventilation of cavity spaces to prevent buildup of warm, moist air at the tops of cavities.

4-5 **EXTERIOR FINISH SYSTEMS (EFS) AND EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS).**

Selection of EFS and EIFS systems shall be based on a LCCA that considers maintenance requirements and frequency of recoating. Only self-draining EIFS systems will be considered. Do not install EFS and EIFS within 6 in (150 mm) of grade, or in areas where it will be subject to abuse by moving vehicles or equipment, such as a loading dock. Do not use EIFS in areas of heavy pedestrian traffic, or if such use cannot be avoided, specify high-impact resistant system. Use high-impact systems a minimum of 4 ft (2440 mm) above grade where subject to damage from pedestrian traffic or lawn maintenance equipment. Construction documents shall provide specific design details for windows, trim, expansion joints, and drainage planes. Comply with the criteria listed in the latest version of *EIFS Standards & ICC-ES Acceptance Criteria* document produced by the EIFS Industry Members Association (EIMA). Where EIFS is applied to a (side) wall which has an eave from the roof, a premolded polypropylene / PVC kickout flashing will be used to channel the water away from the exterior wall.

In areas with design wind loads up to 35 psf (170 Kg/m^2) (118 mph or 190km/h), adhered EIFS shall only be permitted provided the EIFS assembly includes a minimum 5/8-in.- (16-mm-) thick glass-fiber-faced siliconized gypsum sheathing fastened with corrosion-resistant screws that have a minimum 3/8-in- (10-mm-) diameter washer heads fastened to engineered light-gage metal framing spaced 16 in (405 mm) on center with screws spaced 4 in (100 mm) on center. In areas with higher wind speeds, the contractor shall provide mechanically fastened assemblies and evidence of testing the proposed assemblies to wind-loads in accordance with ASCE 7.

4-6 GYPSUM BOARD CONSTRUCTION

Use glass mat gypsum (paperless or non-cellulose facing) sheathing for exterior applications, and use glass mat gypsum wall board for the interior of exterior walls (prevents food source for mold). Use cementitious wall board as a tile base for wet and high-moisture areas such as showers and commercial kitchen spaces.

Conform to gypsum board construction details from the *Gypsum Construction Handbook*, USG Corporation, latest edition, and the *Gypsum Construction Guide,* National Gypsum Company.

4-7 FIRE RATED ASSEMBLIES

Use the UL Fire Rated Assemblies Directory or Nationally Recognized Testing Laboratories for rated wall, floor and roof assemblies.

4-8 INTERIOR ACOUSTICS.

Architectural acoustics shall be carefully coordinated with the mechanical system design. Use UFC 3-450-01, “Noise and Vibration Control” for the acoustical attenuation of the mechanical systems. The “Suggested Design Values” STC ratings in UFC 3-450-01 can also be used as a guideline for the STC ratings of different wall, floor and ceiling assemblies.

At a minimum, prevent sound from noisy spaces such as corridors, toilets, elevator machine rooms, and mechanical rooms from having negative impact on the adjacent spaces. Also refer to the facility UFC for the building type for specific acoustic design requirements and/or recommendations. For projects where proper acoustical performance is critical to the function of the space, such as theaters and auditoria, use the services of an acoustic engineer.

CHAPTER 5 PRE-DESIGN, DESIGN AND POST-DESIGN SERVICES

5-1 GENERAL.

Provide architectural design services in accordance with this chapter. For the **Navy,** also provide architectural design services in accordance with UFC 1-300-09N, "Design Procedures".

5-2 PRE-DESIGN SERVICES.

This process involves meeting with the using activity and reviewing the requirements for a new project and the preparation of the programming document, the DD Form 1391, for presentation to Congress. For **Navy** projects, the preparation of the DD Form 1391 uses the Electronic Project Generator, EPG. For **Army and Air Force** projects, use the DD Form 1391 Processor System. Government personnel normally complete this process, but often an Architect/Engineer is contracted to provide planning support for preliminary programming, studying functional adjacencies, providing sketches, and other design-related support. Often, a charrette-like process is used to define the user's requirements.

5-3 DESIGN SERVICES.

Provide the following design services unless modified by the contract.

5-3.1 Functional Analysis Concept Development (FACD) and Design Charrettes.

FACDs and design charrettes are cooperative efforts by the design team, user/customer representatives, Government design and contract personnel, and other interested parties. They may last a few days, or a week or more, and include on-site development of a consensus conceptual design in response to functional, aesthetic, environmental, base planning, site, budgetary, and other requirements. For **Air Force** projects, the final document is called a Customer Concept Document (CCD). The scope of FACDs, CCDs, and design charrettes are project specific and will be defined in the Scope of Work.

5-3.2 Architectural Compatibility Submittal.

If the Scope of Work or Statement of Work for a project requires an Architectural Compatibility Submittal, it must meet or exceed the requirements herein. On high visibility projects the A&E may be asked to provide a presentation of this submittal. If a project does not require a separate Architectural Compatibility Submittal, the Architect must address exterior building design and compatibility in the Basis of Design, as defined herein, using installation and major command architectural compatibility guides/plans.

When required, the Architectural Compatibility Submittal documents the exterior architectural design of a new facility or major renovation. Determine architectural compatibility at the concept stage of the project. This submittal must provide adequate documentation that indicates that the materials, colors, and design elements used on the exterior of the building are compatible with other structures nearby and with other design guidance required by the installation or customer. In addition, it shall clearly show that the design meets the requirements of Chapter 2, Architectural Style and Character.

5-3.2.1 **Architectural Review Board.**

An Architectural Review Board reviews the Architectural Compatibility Submittal. The Architectural Review Board is a panel of architects, engineers, and landscape architects. The Review Board shall include a member or members of the using activity (user) of the building or facility.

5-3.2.2 **Exterior Finish and Color Schedule.**

The Architect is responsible for selection and coordination of all final exterior finish and color selections using installation architectural guidelines, after obtaining input from the using activity and the Government's architectural reviewer. Indicate these selections on a comprehensive schedule located on the contract drawings. .

5-3.2.3 **Format.**

The Architectural Compatibility Submittal consists of the following four elements:

5-3.2.3.1 **Statement of Compatibility.**

Provide a brief description of the design, stating concisely the architectural compatibility of the project with respect to the existing nearby permanent facilities and the Exterior Architectural Guidelines, if applicable. Include not only building characteristics, but also a site analysis, visual environment concept, and appropriateness of construction materials and colors.

5-3.2.3.2 **Drawings.**

Provide the following drawings:

1. **Site Plan** – Indicate site boundaries, building locations (existing, proposed, and future), drives and roads, parking, pedestrian circulation, pedestrian and service entrances, landscaping, and antiterrorism boundaries.

2. **Floor Plans** – Indicate main entrances, service areas, room designations, and exterior stairs and ramps.

3. **Elevations** – Provide all building elevations, and indicate all exterior materials, architectural characteristics and design elements. As an option, also provide concept renderings.

5-3.2.3.3 **Exterior Color Boards.**

Provide actual samples of all exterior materials and colors. When matching existing materials and colors, it is not sufficient to state, "match existing."

5-3.2.3.4 **Photographs.**

Provide sufficient digital photographs to indicate the character of the existing nearby facilities that have influence on the architectural design of the project. Reference photograph locations on the Site Plan or with a key plan.

5-3.3 **Architectural Basis of Design.**

The Basis of Design is a written document that describes the project at the Preliminary Stage and is updated at each subsequent stage. Include the following items:

1. **Scope of Work** – State and summarize the architectural program or scope of work, listing the overall square footage, the function of the facility and a tabulation of rooms with square footages of each space.

2. **Type of Construction** - Describe the type of construction selected and justify its use relative to building permanency, life cycle cost, functionality, and fire resistance. Coordinate with the Fire Protection Engineer.

3. **Life Safety Code Analysis** - Provide an analysis of the design to include the required number of exits, travel distances, egress capacity of exits, and fire area separations. Coordinate with the Fire Protection Engineer.

4. **Gross Floor Area Calculations** - Provide complete area breakdown tabulation for gross and net areas to confirm scope and statutory criteria compliance. Provide a supplemental drawing keyed to the area take-off and indicating method of take-off. Calculation and drawing guidance is furnished in Chapter 2.

5. **Accessibility** - Describe accessibility features included in the project, and indicate how the design meets the requirements noted in UFC 1-200-01. Indicate documentation relating to use of a military exclusion and the status of a waiver request, if applicable.

6. **Architectural Compatibility** - Identify the design guidelines that pertain to this project, and describe how the proposed design incorporates these guidelines. Discuss the approach to achieving architectural compatibility with other surrounding architecture in accordance with the installation exterior architectural guidelines. Note: Exterior color boards are required for all projects. For **Air Force** projects, refer to the *Air Force Architectural Compatibility Guide.*

7. **Roof System Selection** - Indicate the construction of the roof, roof membrane selection, substrate, roof slope, roof drainage system, and justify the use of parapets.

8. **Thermal Insulation** - Describe the types of insulation to be provided, and indicate specific "U" values for the wall, roof, and floor construction. Also, provide a description of all architectural energy conserving and generating features, including any passive solar systems. Provide a moisture vapor analysis in accordance with Chapter 3 of this UFC.

9. **Security Requirements** - Describe the physical security or hardening requirements such as controlled access, SCIF, and Secure Room requirements that will be used in the design.

10. **Anti-Terrorism** – Per UFC 4-010-01, DoD buildings are categorized as low occupancy, inhabited, primary gathering, high occupancy family housing, or billeting. Describe the occupancy of the facility, if progressive collapse avoidance will be included in the design, if the facility is within a controlled perimeter, and what the standoff distances will be. Include sketches as required to depict the site of the project and standoff distances. Include a summary of how the facility meets each of the applicable Standards in UFC 4-010-01 and Geographic Combatant Commander (GCC) Antiterrorism construction standards. Outline any special requirements, including any requirement for hardening of the facility. The project documents must provide the construction information necessary for the installation of all applicable Standards in UFC 4-010-01 and the GCC Antiterrorism construction standards. However, the documents shall not contain information on force protection methods, philosophy, explosive weights, and design threats, as this information is considered sensitive and For Official Use Only.

11. **Architectural Acoustics** – Include a statement of adherence to the applicable criteria per Chapters 3 and 4 of this UFC.

12. **Sustainable Design** - Describe the sustainable design features included in the design. Provide an analysis of compliance with the Federal High Performance and Sustainable Buildings, Guiding Principles; and the U.S. Green Building Council's (USGBC) "Leadership in Energy and Environmental Design" (LEED) Rating System criteria as it applies to the design of the project. Include updated information with each required design submittal.

13. **Doors and Windows** - Indicate the types of doors and windows selected for the project and explain the basis for their selection. If feasible, use operable windows. Indicate any special door requirements such as STC ratings, cipher locks.

14. **Interior Design** – Provide per UFC 3-120-10.

15. **Demolition or Deconstruction** – Describe the extent of any architectural demolition or deconstruction and items to be salvaged.

16. **Special Construction Features** - Describe the special construction features built into the facility, such as barred windows, special wall/roof construction, raised flooring, radio frequency electromagnetic radiation (RF) shielding, High-Altitude Electromagnetic Pulse (HEMP) protection, vaults, etc.

5-3.4 **Specifications.**

Design-Bid-Build and Design-Build projects have differing specification requirements. In either case, the specifications must be as concise as possible, definitive, and free of ambiguities and omissions that may result in controversy and contractor claims for additional compensation. For **Army** and **Navy** design-bid-build specifications, the use of SPECSINTACT and Unified Facilities Guide Specifications (UFGS) is required. These documents are available from the UFGS website at WBDG. For **Air Force** projects, the use of UFGS or other commercial guide specifications is at the discretion of the Air Force Project Manager. For **Navy** projects, see also UFC 1-300-09N, and when preparing a Design-Build Request for Proposal (RFP), see http://www.wbdg.org/ndbm.

5-3.5 **Architectural Drawings.**

Confirm drawing size with the government Project Manager prior to starting drawings. Provide architectural drawings that comply with the National CAD Standard and Spatial Data Standard (SDSFIE) for Facilities, Infrastructure, and Environment/ Computer-Aided Design and Drafting (SDS/CADD Standards) and sufficiently define and detail all architectural work. For projects accomplished using Building Information Modeling (BIM) use the National BIM Standard along with published Service supplemental standards. Although this can be adequately accomplished in a number of ways, final drawings must include, but not be limited to, the following as applicable:

1. **Title and General Sheets:** Lists all drawings in the set, project title, project name, location map, and vicinity map.

2. **Floor Plans:** Completely dimensioned and referencing other drawings. Indicate plan orientation. Draw building plans parallel to the sheet border with north generally up (or to the left edge if better suited). All discipline drawings must be consistent in orientation. The site plan and the building plan shall be in approximately the same orientation.

3. **Building Code/Life Safety Code Analysis:** Conduct a diagrammatic analysis and indicate code compliance (i.e., remoteness of exits, common path of travel, compartmentalization, fire extinguisher locations, etc.) to

graphically demonstrate compliance with the Life Safety Code. Coordinate with Fire Protection Engineer as required.

4. **Furniture Placement Plans:** Indicate furniture arrangement.

5. **Roof Plans:** Completely dimensioned and referencing other details.

6. **Reflected Ceiling Plans:** Fully coordinated with all disciplines

7. **Building Elevations:** For all elevations. Indicate location of control joints and expansion joints.

8. **Building Sections and Wall Sections:** For all differing conditions. Indentify air barrier, moisture barrier, and insulation barrier systems.

9. **Wall Types:** Indicate all wall types on the floor plan.

10. **Air Barrier:** Indicate the boundary limits of the air barrier components (pressurization area for air barrier testing) on the plan and section. Also indicate the actual area of the pressure boundary (ft.^{2}/m^2).

11. **Interior Elevations:** Indicating all different conditions and coordinated with other drawings.

12. **Door Schedule and Details and Window Types and Details.**

13. **Room Finish Schedule and Finish Notes:** For all finishes.

14. **Details:** For all differing conditions, especially the moisture barrier system, flashing details for all wall penetrations, terminations and transitions and roof ridge, edge, parapet, drainage, and penetration details. Roofing and flashing details shall be a minimum scale of 1.5 in equals 1 ft. Fully detail the air barrier system as indicated Chapter 3, Air Barrier Requirements.

Requirements for the drawings will be suitable for the type of project and the scope of work for the project.

5-3.5.1 Structural Interior Design (SID).

Provide SID per UFC 3-120-10, "Interior Design".

5-3.5.2 Exterior Finishes and Colors.

Provide a comprehensive exterior finish and color schedule, indicating selections for all exterior materials. Locate this schedule either on the finish schedule sheet or on the sheet with the exterior building elevations. When matching existing materials and colors, it is not sufficient to state, "match existing." Do not indicate that the Contracting Officer will make color selections.

5-3.5.3 **Dimensioning.**

Provide floor plans with sufficient dimensions that avoid construction difficulties for either the construction contractor or Government construction contract administration staff. Inadequate dimensions require a contractor's field personnel do many computations in order to arrive at a room size or to properly layout a facility. Provide adequate dimensions on each floor plan so that it is not necessary to refer to other drawings in order to determine dimensions. Provide vertical dimensions on elevations and sections. Dimensioning guidelines are as follows:

5-3.5.3.1 **Exterior Dimensions**

- Provide overall building dimensions.
- Provide continuous strings of dimensions of column centerlines that extend to exterior building faces.
- Provide a continuous string of dimensions that locate all exterior building wall line breaks. Wall line breaks must also be dimensioned to column centerlines.
- Provide dimensions that show masonry and wall openings. Provide through-wall dimensions.
- Provide vertical dimensions for elevations and sections.

5-3.5.3.2 **Interior Dimensions.**

- Dimensions shall indicate design intent. For example, if a door is to be centered on a space, indicate dimensions as "equal-equal."
- Indicate all statutory dimensions, such as accessibility requirements, egress, etc.
- Provide continuous strings of dimensions through the building in each direction that extend through the exterior wall.
- Dimension masonry walls and stud partitions to one side of the wall. Wall thickness may be indicated with dimensions or by wall types.
- When a dimension string passes through a space that is shown elsewhere at a larger scale, this space may be provided with an overall dimension. The large-scale plan must show additional dimensions. To ensure continuity, take dimensions from the same wall face as shown on the overall plan.

- Where a wall or partition aligns with a column, wall opening, window jamb, or other feature, ensure that all other dimensions to that wall or partition are to the same face. Additionally, if a dimension is to a particular wall or partition face, then all other dimensions to that wall must be to that face.

5-3.5.4 **Referencing.**

Use reference symbols (section and detail cuts) liberally on the drawings to indicate which section or detail applies. Use material indications to clearly identify all construction materials. Generally provide the following:

1. **Floor Plans** – Indicate building and wall sections, major details and areas of large-scale plans.

2. **Building Elevations** – Indicate building and major wall sections, expansion, control and seismic joints, construction materials.

3. **Building Sections** – Indicate wall sections, major details, such as air barrier interfaces, and construction materials.

4. **Details** – Indicate all construction materials. Where several sections or details are provided on the same drawing, it is acceptable to reference a single section or detail for materials with additional call-outs as needed for differing conditions.

5-3.6 **Color Boards and Binders.**

Exterior finish material color boards or binders displaying actual samples of all proposed finishes are required during the design of a project. If binders are provided, provide in accordance with UFC 3-120-10.

GLOSSARY

Building System and Subsystems. An assembly of dimensionally and functionally pre-coordinated subsystems which, when combined, produces an essentially complete building. A subsystem is one of many building components designed and manufactured to be integrated with other subsystems to produce an entire building system.

Building Information Model (BIM). A BIM is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward.

ABBREVIATIONS AND ACRONYMS

AAMA	American Architectural Manufacturer Association
AC	Articulation Class
ACI	American Concrete Institute
ACP	Architectural Compatibility Plan
AF	Air Force
AFCEE	Air Force Center for Engineering and the Environment
AFI	Air Force Instruction
AFIERA	Air Force Institute of Environment, Safety, Occupational Health and Risk Analysis
AHJ	Authority Having Jurisdiction
AICUZ	Air Installation Compatible Use Zones
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASTM	American Society of Testing and Materials
BEAP	Base Exterior Architecture Plan
BIA	Brick Industry Association
BIM	Building Information Modeling
C	Celsius
CADD	Computer-aided Design and Drafting
CCB	Construction Criteria Base
CCD	Customer Concept Document
CFA	Commission of Fine Arts
CFR	Code of Federal Regulations
CID	Comprehensive Interior Design
CONUS	Continental United States
DDESB	DoD Explosive Safety Board
DoD	Department of Defense
E.O.	Executive Order
EFS	Exterior Finish System
EIFS	Exterior Insulation Finish System
EPA	Environmental Protection Agency
EPG	Electronic Project Generator
ETL	Engineering Technical Letter
F	Fahrenheit
FACD	Functional Analysis Concept Development
FEC	Facilities Engineering Command
FF&E	Furniture, Fixtures & Equipment
ft	Foot or feet
HQUSACE	Headquarters, U.S. Army Corps of Engineers
Hg	Mercury
IAG	Installation Architectural Guidelines
IBC	International Building Code
ICD	Intelligence Community Directive
IESNA	Illuminating Engineering Society of North America

IHS	Information Handling System
IP	Inch-pound
in	Inch or inches
Kg	Kilogram
LCCA	Life Cycle Cost Analysis
LEED	Leadership in Energy and Environmental Design
m	Meters
mm	Millimeters
MAJCOM	Major Command
MPI	Master Painters Institute
NACE	National Association of Corrosion Engineers
NASA	National Aeronautics and Space Administration
NAVFAC	Naval Facilities Engineering Command
NCPC	National Capital Planning Commission
NCR	National Capital Region
NIST	National Institute of Standards and Technology
NOSSA	Navy Ordnance Safety and Security Agency
NRC	Noise Reduction Coefficient
OCONUS	Outside Continental United States
OMSI	Operations and Maintenance Support Information
OSHA	Occupational Safety and Health Administration
Pa	Pascal (SI unit of pressure)
PCAS	Post-Construction Award Services
psi	Pound per square inch
PTS	Performance Technical Specifications
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RAMP	Radon Assessment and Mitigation Program
RFP	Request for Proposal
SCIF	Sensitive Compartmented Information Facility
SDSFIE	Spatial Data Standard for Facilities, Infrastructure and Environment
sf	square feet
SHGC	Solar Heat Gain Coefficient
SI	Le Système International d'Unités/International System of Units (Metric System)
SID	Structural Interior Design
sm	square meters
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SPF	Spray Polyurethane Foam
STC	Sound Transmission Coefficient
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specifications
USACE	U.S. Army Corps of Engineers
USGBC	U.S. Green Building Council
VECP	Value Engineering Change Proposal
VT	Visible Transmittance
WBDG	Whole Building Design Guide

w.g.	water gauge (IP unit of pressure)
WRB	Water Resistant Barrier

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APPENDIX B – BEST PRACTICES

B-1 INTRODUCTION.

This appendix identifies background information, good architectural design practices, and DoD preferences. The designer is expected to review and interpret this guidance and apply the information according to the needs of the project.

B-2 WHOLE BUILDING DESIGN GUIDE

The Whole Building Design Guide provides additional information and discussion on architectural practice and facility design, including a holistic approach to integrated design of facilities. .

The WBDG provides access to all Construction Criteria Base (CCB) criteria, standards and codes for the DoD Military Departments, National Aeronautics and Space Administration (NASA), and others. These include, Unified Facilities Criteria (UFC), Unified Facilities Guide Specifications (UFGS), Performance Technical Specifications (PTS), design manuals, and specifications. For approved Government employees, it also provides access to non government standards.

B-3 PLANNING ISSUES.

B-3.1 Building Orientation.

In general, minimize east- and west-facing glazing. The orientation for rectilinear CONUS buildings is with the long axis parallel to the east/west direction for optimum energy conservation. Typically orient glazing north (south in the southern hemisphere) to provide day lighting while minimizing glare. South-facing glazing (north in the southern hemisphere) should be appropriately shaded on the exterior to exclude summer (winter in the southern hemisphere) sun.

B-3.2 Design for Flexibility.

Flexibility in architectural design facilitates the change or expansion of an existing structure to accommodate changing functional requirements with minimum expenditure of resources. DoD usually owns and operates its facilities from the time of construction until the end of its useful life. During this long tenure of use, functional requirements of buildings will change, often drastically. Design facilities to accommodate change in use with a minimum expenditure of resources. Careful planning for reconfigurable technology infrastructure and utility distribution, minimizing permanent interior walls and using systems furniture and demountable partition systems enhances flexibility. For this reason, flexibility is a significant design requirement for buildings, except for those with highly specialized functions where adaptive reuse would be cost prohibitive. When feasible, design facilities to facilitate future expansion in response to mission requirements.

B-3.3 Design for Function and Life Cycle.

- Permanent Construction. Buildings shall be energy efficient, and have finishes, materials, and systems selected for low maintenance and low life cycle cost over a life cycle of more than 25 years.

- Semi-permanent Construction. Buildings shall be energy efficient, and have finishes, materials, and systems selected for an average degree of maintenance based on life cycle cost of between 5 and 25 years.

- Temporary Construction. Buildings shall use low cost construction, with finishes, materials, and systems selected with maintenance factors as secondary considerations to meet a life cycle of 5 years or less.

- Mobilization and Emergency Construction. Buildings shall be austere to minimize design and construction time and maximize conservation of critical materials and funds. Maintenance factors and longevity are secondary considerations.

- Contingency Construction. Such structures may not be used for the purpose of satisfying requirements of a permanent nature at the conclusion of combat or contingency operations.

- Manufactured and Pre engineered Buildings. This type of construction should be considered where it meets the quality, performance, and functional requirements of the project, when it will be architecturally compatible with adjacent structures, and when justified by life cycle cost. Also consider this building technique when there is limited time for on-site construction erection activities due to weather conditions.

B-4 LANDSCAPING INTERFACE.

Landscaping is a critical part of good building design and plays a vital role in blending architecture into its surroundings. Careful coordination between the landscape architect and the architect is crucial to good design.

B-5 LOCAL CONSTRUCTION METHODS, MATERIALS AND SKILLS.

Design to take advantage of economies resulting from the use of suitable local construction methods, materials and skills that are consistent with the intent of these criteria. This is particularly important in overseas locations, where local materials may not be common to architects from the United States. Construction means and methods are the responsibility of the construction contractor.

B-6 BUILDING ENVELOPE.

This section provides background on the science of building envelope design and includes additional design recommendations. Review this section in conjunction with the requirements in Chapter 3, Building Envelope.

The building enclosure functions to control the transfer of the following elements: heat, air, moisture, light/radiation, and noise.

B-6.1 **Heat.**

Heat, which is energy, is transferred from warm to cold in one of three ways, conduction, convection and radiation.

B-6.1.1 **Conduction.**

Conduction is most effectively resisted by low conduction materials such as insulation. Highly conductive materials when inserted through the insulating layer can cause a loss of efficiency in the overall assembly's ability to resist heat transfer in a phenomenon called thermal bridging. Examples of high conduction materials interrupting insulation include the following:

- steel studs,
- cantilever concrete balconies and projections,
- structural steel and aluminum that are outside the thermal envelope and connected to the building structure,
- z-furring supporting cladding interrupting the insulation, and
- shelf angles attached continuously and directly to the structure.

Many of these materials can be designed to reduce thermal bridging by intermittent support through insulation and maintaining them outside the insulation layer. Others, like cantilever balconies or exterior structure, can be thermally broken by specially designed structural thermal breaks. Structural steel should be within the insulated enclosure, unless thermally broken. Thermal bridges impact energy efficiency and are a likely cause of condensation.

B-6.1.2 **Convection.**

Convection is the movement of heat transported by fluids, including air. Air movement can transport heat as well as water vapor from warm to cold. Surfaces that can cool the air adjacent to them, such as slabs on grade and basement walls, and cause the air to become heavier and sink. This draws warm, moist air in to replace it in a continuous convective loop. Warm air can have a dew-point higher than the cold surface, which can cause condensation and the ensuing mold, rot and corrosion. Convection in exterior assemblies is caused by designing air spaces adjacent to cold materials. This can happen in a basement on a concrete wall insulated by glass fiber batts (fibrous insulation is mostly air), or adjacent to glass in fenestration. Eliminating air gaps or separating them from warm air by an air barrier is an effective strategy in reducing convective flow of heat and condensation.

B-6.1.3 **Radiation.**

Radiation is the flow of heat across space or fluid or gas from a warm body to a colder one. One example of radiational heat transfer is from the interior to a cold glass surface. Radiational heat gain is direct or reflected solar radiation coming in to a building through glazing or heating up building materials of the enclosure. Heat can be radiated from one sheet of glass to the other in insulating glass. Low emissivity coatings in glass assemblies can be effective in reducing the radiational transfer of heat from the exterior and from the interior, improving both the U-factor and Solar Heat Gain Coefficient. Heat gain from the sun can be effectively reduced by including radiant barriers such as aluminum foil with an adjacent air gap. Radiant barriers in wall and roof assemblies will only work with an adjacent air gap (see above paragraph on air gaps and convection). Quadruple glazing using Heat Mirror foils, two low emissivity low-e layers and filled with inert gas such as argon or krypton is the state of the art for glass selection today and should be considered for extreme climates.

B-6.2 **Air.**

Air leakage, or unintentional air movement through the enclosure under a pressure difference between inside and out, transfers heat (energy loss), water vapor, smoke, odors, dust, and other pollutants, including chemical, biological and radiological agents, into and out of buildings. Infiltrating air is unconditioned for temperature and moisture content and can contain pollutants. It causes discomfort and can unbalance spaces such as patient isolation rooms, protected environment rooms, or chemical storage areas that are designed for controlled pressure, thus compromising pollutant control. Mechanical systems attempt to reduce uncontrolled infiltration by introducing more air than is exhausted. This theoretically puts the building under positive pressure reducing infiltration. The success of this strategy is dependent on how leaky the building is. You cannot inflate a balloon that has a big hole in it.

Air leakage can be the major source of water vapor transfer through building enclosures. Unlike the moisture transport mechanism of diffusion due to a vapor pressure difference, air pressure differentials can transport hundreds of times more water vapor through air leaks in the envelope over the same period of time (*The Difference Between a Vapor Barrier and an Air Barrier, Quirouette, 1985*). This water vapor can condense within the envelope in a concentrated manner, depending on the pathway, if the enclosure includes surfaces below the dew-point of the air, causing building deterioration and mold growth. Internal compartmentalization of a building (floors and demising partitions) is also a key to the control of the unwanted transfer of air, pollutants, noise, smoke etc. See the following resources for more information and sample design details

- Building Envelope Design Guide: http://www.wbdg.org/design/envelope.php

- WBDG Resource Webpage for Air Barrier Systems: http://www.wbdg.org/resources/airbarriers.php

- Also see USACE *Air Barrier Continuity Guide* http://www.wbdg.org/pdfs/usace_airbarriercontinuity.pdf.

- Sample Exterior Envelope Details: http://www.mass.gov/?pageID=eopsterminal&L=4&L0=Home&L1=Consumer+Protection+%26+Business+Licensing&L2=License+Type+by+Business+Area&L3=Construction+Supervisor+License&sid=Eeops&b=terminalcontent&f=dps_inf_bbrs_sample_detail&csid=Eeops

B-6.3 **Moisture.**

B-6.3.1 Moisture in its different forms is the major cause of water intrusion, condensation, shortening of service life and disruption of operations. Walls leak when three conditions exist simultaneously: (1) Rain water is on a wall, (2) Openings exist through which the rain water can pass; and (3) Forces are present to drive or draw the rain water inward. If any of these three essential conditions is eliminated, rain water will not penetrate the enclosure.

B-6.3.2 It is difficult and impractical to keep wind-driven rain off the exterior walls of a building. Overhangs, cornices, and solar shading can be effective in minimizing, but will not prevent, wetting of a wall. Thus, it should be expected that exterior walls will be covered by a film of water during a rain event and that this film thickens when rain flows down the building wall. It is virtually impossible to build an exterior wall without any unintentional openings or leakage paths. Such openings may be pores, cracks, incompletely filled or poorly adhered mortar joints, or moving joints between elements or different materials. A typical masonry wall contains multiple apertures of various types and sizes yielding many joints between dissimilar materials prone to movement and joint failure. One square foot of brick masonry contains 6.75 modular brick, 6 lineal ft. (1830 mm) of mortar joint and 12 lineal ft (3660 mm) of brick-mortar joint interface. For 20,000 ft^2 (1858 m^2) of wall surface, this equates to 135,000 modular brick, 22.7 miles (36.5 km) of mortar joint and 45.5 miles (73.2 km) of brick-mortar joint interface. Water can penetrate openings as small as 0.005 in. (.1 mm), which is just slightly more than the thickness of a sheet of bond paper.

B-6.3.3 Even if a good seal is achieved initially, odds are that the seal will deteriorate over time under the action of temperature, water, deterioration due to ultraviolet radiation and differential movement. For these reasons, a single 4-in. (100-mm) wythe of masonry conventionally laid up in the field (or any cladding for that matter) should not by itself be expected to be watertight. It is also why sealants cannot be expected to keep water out of building enclosures. There needs to be an underlying drainage plane or WRB and flashings to lead water that penetrates building assemblies out again.

B-6.3.4 Forces acting on an exterior wall during a rain event that individually or in combination can contribute to rain penetration include the following: (1) raindrop momentum or kinetic energy, (2) capillary suction; (3) external or internal air pressure; (4) gravity, and (5) surface tension. Water hits and wets the tops of buildings first, as well as projections. Water tends to travel over and flow down reveals and channels in the façade in a concentrated manner.

B-6.3.5 When the joints are well-pointed, brick masonry tends to absorb moisture for 4 to 6 in. (100 to 150 mm) depth after a rain event, and to dry out in dry periods. All masonry mass wall must have ventilation on the interior face of the exterior wall (and parapets) to assure proper drying. Single wythe concrete block walls are undesirable because they do not manage moisture well. Wall design today should be a rain screen design; in other words cladding should have a WRB in the wall assembly behind the cladding, with flashings to lead water out. This is true for all claddings including EIFS; face-sealed assemblies are not acceptable.

B-6.4 **Air Barrier Renovations.**

The need for and reasonableness of destructive analysis of the state of existing air barriers shall be evaluated based on the type of renovation considering related cost issues. This can be challenging due to difficulty in accessing gaps through hard or expensive finishes. Removable ceiling tiles allow easy access to problem areas, and walls require destructive access through finishes to expose gaps such as those around windows. If a gap is discovered it may be possible to blind-seal with spray polyurethane foam injected through holes drilled in the drywall. For large holes, bulkheads can be built out of studs and drywall sealed with spray polyurethane foam (SPF). Seal gaps up to 2 in. (50 mm) with one part SPF; seal larger gaps with two-component SPF. Stuffing glass-fiber insulation in cracks is not an acceptable sealing method because glass-fiber merely acts as a dust filter and allows air under a pressure differential to pass through it. Fiber glass insulation will hold moisture that can lead to hidden moisture and mold problems. Seal air leaks in the following order of priority:

1. Top of building
    - Attics
    - Roof/wall intersections and plenum spaces
    - Mechanical penthouse doors and walls
    - HVAC equipment
    - Other roof penetrations
2. Bottom of Building
    - Soffits and ground floor access doors
    - Underground parking access doors
    - Exhaust and air intake vents

- Pipe, duct, cable and other service penetrations into core of building
- Sprinkler hangar penetrations, inspection hatches and other holes
- Seal core wall to floor slab
- Crawl spaces

3. Vertical shafts
   - Gasket stairwell fire doors
   - Fire hose cabinets or toilet room recessed accessories connected to shafts
   - Plumbing, electrical, cable and other penetrations within service rooms
   - Elevator rooms and electric rooms (reduce size of cable holes, firestop and seal bus bar)
   - Openings
4. Exterior Walls
   - Weather-strip windows, doors, including balcony/patio doors and seal window trim
   - Exhaust fans and ducting
   - All service penetrations
   - Baseboard heaters
   - Electrical receptacles
   - Baseboards
5. Compartmentalize
   - Garages
   - Vented mechanical rooms
   - Garbage compactor rooms
   - Emergency generator rooms
   - High voltage rooms

- Shipping docks
- Elevator rooms
- Workshops

B-6.5 **Light/Radiation.**

Generally speaking, light is desirable while the accompanying heat (radiation) is not. They penetrate through the fenestration, which is the least energy-efficient component of the envelope. In addition to effective glazing design and shade structures, building orientation plays a large role in managing the light/heat gain balance. See discussions under Building Orientation and Radiation in this Appendix for more information.

B-6.6 **Noise.**

Noise attenuation must address both sound isolation and sound absorption. The sound transmission coefficient (STC) measures the ability of a wall, floor or ceiling assembly to reduce sound transmission. Materials that have a high Noise Reduction Coefficient (NRC) absorb sound and reduce noise reflection. Ceiling materials that have a high Articulation Class (AC) rating attenuate sound.

B-7 **AIR BARRIER MOCK-UP TESTING**

B-7.1 **Guidance on When to Test.**

See Figure B8-1, Construction Mock-up Guidance Matrix, for recommendations. Approximate suggested definitions of sizes to use for the matrix:

- Small: Up to 5,000 sf (465 sm)
- Medium: 5,000 to 50,000 sf (465 to 4645 sm)
- Large (Common): above 50,000 sf (4645 sm)
- Large (Unique): above 25,000 sf (2323 sm)

B-7.2 **On Site Mockups.**

When approved by the AHJ, a mockup of the wall system will include a representative wall and window constructed on site, complete with all its components, and shall be tested for air and water infiltration.

Each item that contributes to the moisture control and air barrier performance shall be included in the mockup. The installed fenestration shall be tested first using ASTM E783 to determine air tightness. ASTM E1105 can then be used to determine if fenestrations and their connections to walls are meeting liquid water leakage requirements.

Figure B7-1 CONSTRUCTION MOCK-UP GUIDANCE MATRIX

Guidance: The Authority Having Jurisdiction (AHJ) may give consideration to implementing construction mock-ups based upon the following decision matrix.

FACILITY TYPE	APPLICATION	RECOMMENDED GUIDANCE
SMALL SIZE FACILITY COMMON FACILITY SUCH AS: MECH BUILDING; PUMP HOUSE; SMALL AND MEDIUM WAREHOUSES. SIZE RANGE: SQUARE FEET	SMALL FACILITIES WHICH ARE NOT UNIQUE AND PROVIDE SUPPORT FUNCTIONS ON AN INSTALLATION	RECOMMEND NOT REQUIRING CONSTRUCTION MOCK-UPS
MEDIUM SIZE FACILITY COMMON FACILITY TYPES SUCH AS MWRS; CHAPELS; CHILD CARE CENTERS; SMALL AND MEDIUM SIZE ADMINISTRATIVE FACILITIES, POST OFFICES; POST EXCHANGES, ETC. SIZE RANGE: SQUARE FEET	MEDIUM SIZE FACILITIES WHICH ARE NOT UNIQUE AND UTILIZE TYPICAL AND PROVEN CONSTRUCTION MATERIALS, METHODS AND PROCESSES. THE APPLICATION OF THESE SYSTEMS CARRIES LITTLES TO NO RISK OF NOT BEING CONSTRUCTED SATISFACTORILY.	RECOMMEND NOT REQUIRING CONSTRUCTION MOCK-UPS
LARGE SIZE FACILITY: COMMON FACILITY TYPES SUCH AS BARRACKS BUILDINGS; LARGE DINING FACILITIES; LABORATORIES; HIGHLY VISIBLE HEADQUARTER'S FACILITIES; LARGE COMPANY OPERATIONS FACILITIES, MAINTENANCE FACILITIES, LARGE STORAGE WAREHOUSES, ETC. SIZE RANGE: SQUARE FEET	LARGE SIZE FACILITIES WHICH DO NOT NECESSARILY EMPLOY UNIQUE CONSTRUCTION TECHNOLOGY OR INNOVATIVE FEATURES BUT DUE TO SIZE, VISIBILITY AND INTEREST ON THE INSTALLATION; FAILURE OF THIS FACILITY WOULD BE DETRIMENTAL TO MISSION EXECUTION AND WOULD REFLECT POORLY ON THE INSTALLATION COMMAND.	RECOMMEND CONSIDERATION BE GIVEN TO PROVIDING CONSTRUCTION MOCK-UP AT CRITICAL CONNECTIONS FOR WINDOWS; ADVANCED STRUCTURAL SYSTEMS; ETC
LARGE SIZE FACILITY: UNIQUE FACILITIES WHICH UTILIZE UN-COMMON OR PROTOTYPE SYSTEMS; ADVANCED TECHNOLOGY OR INNOVATIVE TECHNOLOGY FOR STRUCTURAL SYSTEMS OR WINDOW WALLS, ETC. SIZE RANGE: SQUARE FEET	LARGE SIZE FACILITIES WHICH EMPLOY UNIQUE CONSTRUCTION TECHNOLOGY OR INNOVATIVE FEATURES; MAINTENANCE PROBLEMS OR SYSTEMS FAILURE WITHIN THIS FACILITY WOULD BE DETRIMENTAL TO MISSION EXECUTION AND WOULD REFLECT POORLY ON THE INSTALLATION COMMAND.	STRONGLY RECOMMEND PROVIDING CONSTRUCTION MOCK-UPS AT CRITICAL CONNECTIONS FOR WINDOW; ADVANCED STRUCTURAL SYSTEMS OR UNIQUE CURTAIN WALL SYSTEMS THAT EMPLOY DAYLIGHTING SENSORS OR INTEGRAL SHADING SCREENS, ETC.

B-8 EXTERIOR INSULATION AND FINISH SYSTEM (EIFS).

EIFS is not recommended for exterior wall finish, especially in regions where hurricanes and typhoons are a concern and in other regions where water penetration is a particular problem. If EIFS is used, follow the guidance provided in Chapter 4 and also consider the new generation of self-cleaning EIFS finish coatings to reduce maintenance costs.