



MARIANAS NAVY AND MARINE CORPS DESIGN AND CONSTRUCTION STANDARDS



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FOREWORD

This is a living document that will be periodically reviewed, updated, and made available to users as part of the Naval Facilities Engineering Command, Marianas (NAVFACMAR) responsibility for providing technical criteria for design and construction projects in Guam. Defense agencies should contact NAVFACMAR for document interpretation and improvements.

This document replaces the MRACS and is effective upon issuance.

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CHAPTER 1 EXECUTIVE SUMMARY

The **Marianas Navy and Marine Corps Design and Construction Standards (MDACS)** is a guide that provides design and construction guidelines that encourages a unified, locally-influenced, consistent strategy for the design of physical improvements in Guam. The MDACS represents an update to the MRACS (Marianas Region Architectural and Construction Standards), a regional design guideline that has been successfully used by NAVFAC's industry partners – both designers and constructors – for over a decade to provide quality facilities in a challenging environment subject to corrosive elements, high wind velocity, and strong seismic forces. The MDACS provides a single guideline to be used in new construction and renovation projects for designing all Navy and Marine Corps shore-based facilities located in Guam and Micronesia.

Coherent appearance, quality design and appropriate construction are important elements in providing the highest quality working and living environment for Navy and Marine personnel and their dependents. The MDACS shall be used as a guideline in conjunction with the applicable base Installation Appearance Plan (IAP) which provides each base with their own distinct identity.

This MDACS is developed based on tried and tested construction types and building components that have been used successfully in Guam. Specificity of the design requirements in this document is intended to provide consistent facilities that can be cost-effectively maintained with consideration to Guam's unique climate, environmental challenges and limited resources. This document is intended to supplement – but not supersede – overarching Department of Defense (DoD) criteria. This document does not take precedence over DoD Unified Facilities Criteria (UFC) or Facilities Criteria (FC); and is intended to be implemented within the constraints established by DoD Unified Facilities Guide Specifications (UFGS). No aspect of this guidance is intended to indicate preferred proprietary products or systems. General Geotechnical conditions and geological overview of Guam is included in [Appendix A – GEOTECHNICAL COMPONENTS](#).

The MDACS, like any other “design and construction standards” document, will require regular updates to keep up with new polices, new technologies, and coordination with changes to the applicable base installation appearance plan as appropriate (see [4.11](#)).

CHAPTER 2 INTRODUCTION AND OVERVIEW

This Standard shall be applied during facility development, design and construction phases in conjunction with other applicable Criteria, Building Codes and Standards. Where these standards indicate “may”, the written instruction is optional. Where “avoid”, “must”, “will”, “should”, or “shall” is indicated, the written instruction is mandatory.

For purposes of this Standard, “inhabited” is defined as a structure with personnel assigned to occupy. As an example, a warehouse with an office with assigned staff is considered an inhabited structure / facility.

It is acknowledged that this document was prepared during a bid-favorable bidding climate. Change to a less favorable bidding climate may change the affordability of the requirements set forth in this document. Requirements may, in such cases, need to be adjusted on a project-by-project basis. Changes to requirements shall be vetted via the procedure described in Section [2.3](#).

2.1 Purpose / Objectives

- a. Quality Base Appearance: Establish consistency and excellence in the design and construction of Navy and Marine base facilities.
- b. Efficient, Functional and Comfortable Facilities: Provide guidance to planners, designers, architects, engineers, contractors, fabricators and suppliers by listing appearance standards and appropriate construction components that work in Guam’s challenging environment which is subject to a salt corrosive environment, high humidity, high wind velocities and strong seismic forces.
- c. Safe and Secure Environment

2.2 Execution Strategies

- a. Select standardized building components to reduce life-cycle costs and simplify long-term maintenance, repair and spare parts requirements. Comply with the Guam Joint Military Master Plan Sustainability Program for Marine Base projects.

Federal Acquisition Regulation (FAR) Paragraph 25.202 notes exceptions to the Buy American Act. Subpart 25.4 – Trade Agreements allow acquisitions of foreign construction materials for construction contracts with an estimated acquisition value of \$7,358,000 or more. Refer to FAR for the list of countries, details and limitations.

Foreign products shall be proven to be of equal or better standard as the specified performance requirements.

- b. Incorporate “green” concepts and pursue sustainable development aspects to the fullest extent possible, consistent with mission, budget and client requirements. Unless noted

otherwise, new buildings and major renovations shall comply with DoD and NAVFAC sustainable requirements in effect as of the project's design contract award date.

- c. All construction shall conform to a coherent exterior theme through compliance with this guide and each Base IAP that reflect and highlights the military mission and the island environment.

2.3 Responsibility for Compliance

The A-E (Architect-Engineer) and/or Designer of Record (DOR) contracted to work on any Navy or Marine Corps project in Guam and the Marianas Islands shall be responsible for ensuring project compliance to these standards and all applicable DoD criteria. Exceptions or waivers to DoD Unified Facilities Criteria (UFC) must be processed in conformance with MIL-STD 3007. MDACS exceptions or waivers that do not otherwise violate overarching DoD criteria require written approval by the NAVFAC Marianas Chief Engineer or his/her designee.

Waiver request(s) shall be resolved at the earliest practicable stage prior to completion of the Final Request for Proposal (RFP) solicitation documents. Substitution or variance requests submitted after award of the construction contract involving exceptions shall be similarly processed. Time extensions and additional costs attributed to the preparation, coordination and review of waiver requests will not be granted.

DoD facilities or spaces leased or sub-leased to private entities (non-government companies such as local banks, food vendors, etc.), shall be in compliance with all applicable UFC/FC requirements, and applicable Installation IAPs, Utility Criteria, Sign Standards, etc. Private entities shall submit design documents for government review/ acceptance and shall ensure any fire protection system that is new or upgraded is also certified by a Fire Protection Engineer and final testing coordinated with a government Fire Protection Engineer for acceptance.

CHAPTER 3 GUAM ENVIRONMENTAL SETTING

3.1 Geography

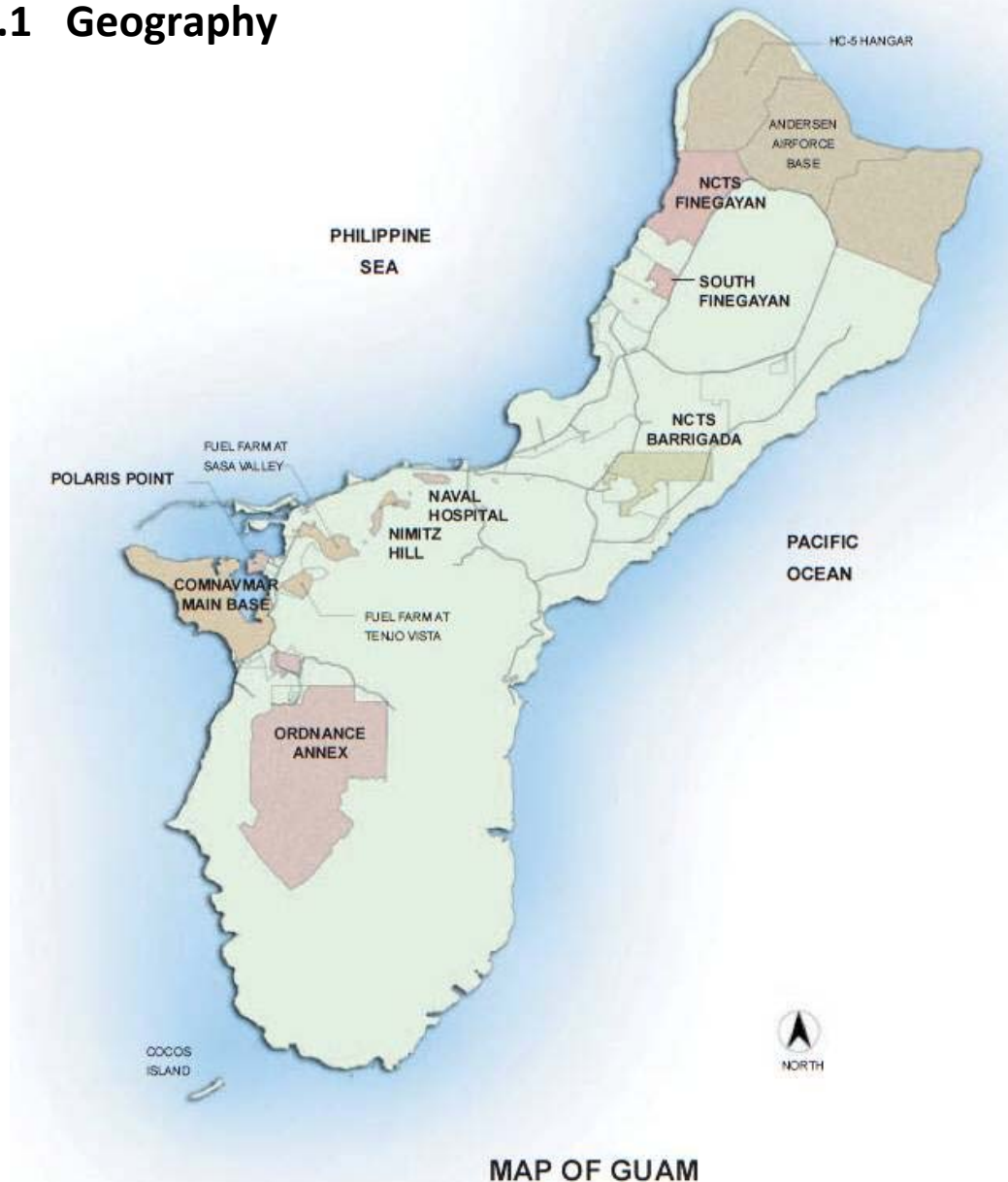


Figure 1: Map of Guam

Guam is the largest and southernmost island in the Mariana Islands archipelago. Covering an area of 212 square miles, Guam is approximately 30 miles long and has a width varying from approximately 9 miles in the north, 4 miles at its center and 12 miles in the south. The majority of the island is surrounded by coral reefs and consists of two basic geological entities. Central and northern Guam is primarily of raised limestone plateaus as high as 600 feet with steep coastal cliff lines dropping down to the ocean. Southern Guam is made up of volcanic hills with

Mount Lamlam being the island's highest point with an elevation of 1,334 feet. Rivers cut through this terrain with many waterfalls showcasing Guam's natural beauty.

3.2 Climate

Guam's climate is warm throughout the year with little seasonal temperature variation. Temperatures range between the low 70s and mid 80s year round with an average annual precipitation of approximately 90 inches. The average relative humidity ranges between the low 70% to low 80% with June to November being the months with higher relative humidity than the rest of the year. The northeast trade winds are dominant throughout the year and the average wind speed is 9.1 mph according to NOAA 12 year annual averages. Average monthly wind speed ranges from 6.2 to 16.9 mph. The months of January and February are considered the coolest months with less humidity and temperatures dropping to the low 70s at night. Guam has two seasons, a dry season from January through May and a rainy season from July through November. Guam is situated in an area referred to as "Typhoon Alley" with periodic typhoons that historically have caused great damage to both built and natural environments. The highest risks of typhoons are in October and November, although they can occur any time of the year. Typhoons can have peak wind speeds over 200 miles per hour. The high level of salt water vapor in the air makes Guam's climate corrosive in nature. Such environmental elements should be thoroughly considered when developing facilities on Guam.

CHAPTER 4 DESIGN AND CONSTRUCTION CRITERIA

Unless otherwise noted in the project criteria, applicable design and construction criteria shall be the latest adopted version as of the project's design contract award date or construction contract award date shall be used.

4.1 Applicable Building Codes

Unless specifically stated otherwise, all codes and regulations used shall be the editions adopted and/or amended for use by the Department of Defense thru applicable Unified Facilities Criteria (UFC).

- International Building Code (IBC) –Edition as amended/adopted by UFC 1-200-01.
- American Society of Civil Engineers (ASCE 7) – Minimum Design Loads for Buildings and Other Structures
- American Concrete Institute (ACI 318) - Building Code requirements for Reinforced Concrete
- American Concrete Institute (ACI 530/530.1) – Building Code Requirements and Specifications for Masonry Structures
- American Institute of Steel Construction (AISC) – Manual of Steel Construction
- Pre-stressed Concrete Institute (PCI) – PCI Design Handbook
- National Fire Protection Association (NFPA) 70: National Electrical Code
- National Fire Protection Association (NFPA) 72: National Fire Alarm Code
- National Fire Protection Association (NFPA) 101, Life Safety Code
- The Institute of Electrical and Electronics Engineers (IEEE) C2: National Electrical Safety Code.

4.2 Applicable Unified Facilities Criteria (UFC) and Facilities Criteria (FC)

UFC and FC documents provide planning, design, construction, sustainment, restoration, and modernization criteria for all Navy and Marine Corps projects and are available on the Whole Building Design Guide (WBDG) website at <http://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc>. Unless specifically stated otherwise, all UFCs and FCs used shall be the latest published editions.

In the event of a conflict between the MDACS and other UFCs/FCs, the more stringent requirement that has typically been proven to work in Guam's environment shall be utilized.

4.3 Wind Speed Criteria

Protection against typhoons and extreme weather in general is a priority at Navy and Marine Corps facilities on Guam. Typhoon-driven winds which can be amplified by Guam's topography will cause deeper-than-normal penetration of moist, corrosive marine atmosphere to many

building materials (metal fasteners, connections, structural components) and assemblies (improperly designed and sealed joints). This alone or in combination with typhoon wind-borne flying debris can result in outright building rupture, and produce pressures that may compromise the water and air infiltration resistance of the exterior building envelope.



Figure 2: Flying Debris



Figure 3: Plywood Projectile

Exterior building envelope, building components and opening protections shall be designed by the DOR (Designer of Record) to withstand design wind pressures and impact resistance in accordance with the IBC and ASCE 7, editions adopted/amended by UFC at time of project's design contract award date. Design shall also account for any amplification factors as a result of topographical effects or exposure due to reduced surface roughness conditions.

Exterior building component systems and exterior opening protection systems shall be designed, manufactured and installed to withstand the wind load, wind-borne flying debris impact resistance, and corrosion criteria. These systems include but are not limited to doors, storefronts, windows, glazing, louvers, sun control devices, typhoon shutters, railings, solar photovoltaic panels, solar hot water panels, mechanical and electrical equipment, components and related fasteners.

Building component complete systems (i.e. doors, windows, shutters, etc.) including frame and fasteners shall be designed, manufactured and installed to withstand the wind load criteria.

For Design-Build projects, wherever ASTM E 1996 is called out, the following additional criteria should be specified by the RFP Preparer for building component systems protecting all exterior openings:

- Wind Zone 4
- Level of Protection (either "Enhanced Protection" or "Basic Protection")

For DBB projects, wherever ASTM E 1996 is called out, the following additional criteria should be specified by the DOR:

- Missile Level (either A, B, C, D, or E) for building component systems protecting all exterior openings at various elevations.

4.4 Seismic Criteria

Refer to UFC 1-200-01 Design: General Building Requirements, UFC 3-301-01 Structural Engineering and UFC 3-310-04 Seismic Design for Buildings, International Building Code (IBC) and ASCE7: Minimum Design Loads for Buildings and Other Structures. Concrete reinforcement in members resisting earthquake-induced forces shall meet the tensile and yield strength criteria in accordance with the ACI 318 Seismic Provisions. Where welding of reinforcing bars is required ASTM A 706 should be specified. Designer of Record should be aware that ASTM A 706 reinforcing has a lower critical chloride threshold and various study reports have found that its corrosion rate is higher than for A615 steel.

4.5 Corrosion Prevention and Control Criteria

The combination of heat, humidity and saline atmosphere contribute to significant corrosion issues that can degrade the appearance and cause structural failure to both exterior and interior construction in Guam and the Marianas. Galvanized steel exposed to the exterior and located at the interior of unconditioned spaces behind service and garage doors will rust and fail and shall not be used.

The most corrosion-resistant metal materials for building components and assemblies shall be used and shall include but not be limited to (in descending order of preference) anodized aluminum, stainless steel, and hot-dipped galvanized steel.

Anodized aluminum construction materials shall be used to the maximum extent possible for storefronts, doors and frames, windows, louvers, typhoon shutters, railings, and other exterior building components.

Stainless steel shall be used where aluminum does not provide the required performance characteristics. These include but are not limited to fasteners, anchors, miscellaneous metal fabrications, and other exposed building components and assemblies. Specify 18-8, austenitic stainless steel type 316. If special order cannot be obtained for type 316 stainless steel, the next best corrosive-resistant stainless steel (e.g. 18-8 austenitic stainless steel type 304) shall be specified. If the stainless steel components will be welded, specify the low-carbon content type, usually designated with the letter "L" following the number, e.g. type 316L.

Unless otherwise noted in this document, hot-dipped galvanized shall only be used at interior conditioned spaces where aluminum or steel coated per UFGS 09 90 00 do not provide the required strength and corrosion performance characteristics. Hot dipped galvanized steel is preferred over electroplating zinc metal spraying or other methods of providing zinc coating to ferrous metals. Exterior chain link fencing shall be hot-dipped galvanized steel. UV-resistant vinyl coating of fence shall be considered as an added measure.

Provide protective coatings and cathodic protection for buried metallic fuel or hazardous waste storage tanks and associated pipelines. Alternatively, use non-metallic materials as allowed by applicable environmental regulations.

Construction elements shall be designed to minimize the occurrence of corrosion:

- Structural steel should be located in protected environments such as within interior air conditioned spaces.
- Utilize surfaces and finishes that promote self-cleaning through rinsing of surfaces by rainfall.
- All surfaces of materials shall be sloped and drained to prevent standing water.
- Isolate dissimilar materials to prevent galvanic action.

4.6 Sustainability Criteria

Projects must comply with applicable sustainability requirements to include UFC 1-200-02, High Performance and Sustainable Building Requirements and NAVFAC Capital Improvements Engineering and Construction Bulletin 2014-02, NAVFAC Sustainability and Energy Building Requirements which include requirements for all projects, regardless of size or scope. Provide third party certification where required by UFC 1-200-02, High Performance and Sustainable Building Requirements. In case of conflict between sustainability requirements, the more stringent requirement applies.

4.7 Accessibility Criteria

Facilities shall be designed and constructed to comply with “Accessibility Requirements for Navy and Marine Corps Facilities” guidance found on the WBDG (Whole Building Design Guide) website, located at http://www.wbdg.org/references/pa_dod_ar.php

4.8 Blind Vendor Facilities

Comply with the Randolph Sheppard Act (RSA) for all projects. RSA establishes a vending facility program to be implemented on specific Federal properties. See OPNAVINST 4535.1B for policy guidance and procedures for Navy projects. Coordinate application of the RSA at a minimum, with the following entities as applicable: a) NAVFAC Marianas, b) Commander Naval Region (COMNAVREG) Guam and c) Guam Division of Vocational Rehabilitation.

4.9 Anti-Terrorism / Force Protection Criteria

DoD projects shall comply with UFC 4-010-01, DoD Minimum Antiterrorism Standards for Buildings and consider the findings of the Comprehensive Study to reduce Stand-Off Distances for New Facilities in Guam and Commonwealth of the Northern Mariana Islands (FOUO.)

Anti-Terrorism / Force Protection (AT/FP) compliance can significantly impact site and building layout and design. As a result, AT/FP measures shall be considered early in the design process of all projects. Attention is focused first towards preventative measures as they are often the most cost-effective, as well as considering how careful design of site and building features can minimize damage in the event of an attack.

Anti-terrorism/force protection standards are based on a specific range of assumed, baseline threats, and they serve as a cost-effective guide in minimizing the risk of mass casualties.

However, UFC 4-010-01 stipulates that installation commanders and senior commanders in buildings must protect people under their command. In addition, they are responsible for implementing additional guidance established by geographic combatant commanders. Therefore, commanders must certify that higher levels of protection than that of the minimum standards are not required.

4.10 Physical Security

DoD projects shall determine, develop, and document total Security Engineering requirements in accordance with UFC 4-020-01, DoD Security Engineering Facilities Planning Manual. Buildings with Secure Rooms may require additional security requirements per ICD 705 series of documents relating to Physical Security Standards for Sensitive Compartmented Information Facilities that has superseded the DCID 6/9. Obtain agreement from appropriate Base Security Office(r) on specific physical security measures tailored to each project.

4.11 Installation Appearance

For Navy base facilities, refer to the Commander, U.S. Naval Forces, Marianas Installation Appearance Plan (COMNAVMAR IAP). For Marine Corps base facilities, refer to Marine Corps Base, Guam Installation Appearance Plan (MCBG IAP), and the Family Housing color schemes.

4.12 Hot Humid Climate Design

- a. Guam's hot humid climate (see [3.2](#)) requires special design, knowledge, material selection, mechanical design and construction methods to prevent corrosion problems, structural failure, and moisture problems, that could lead to costly repairs and lost use of facilities while repairs and mitigation are being performed.
- b. Particular attention to preventing second vapor barriers that trap moisture hidden within construction systems is essential to mitigating moisture and mold problems. All interior surfaces must breath to prevent trapping moisture. All interior surfaces must be breathable (permeable/greater than 10 perms) or installed to prevent the entrapment of moisture. Second moisture- trapping vapor barriers that do not breathe properly include but are not limited to sheet vinyl flooring, carpet and carpet pads, floor sealers, solid surface shower stalls, impermeable wall covering, and paints. Mirrors, base cabinets, wall cabinets, backsplashes, artwork and other objects mounted to or against the interior face of exterior walls may create a second vapor barrier unless a minimum ¼" air space is provided between the object and the wall.
- c. Material selection is key to success in hot humid design. Exterior material coatings and surfaces must resist mold/moisture penetration and be self-cleaning through rainfall. Potential exterior and interior corrosion needs to be addressed. Structural failure has

occurred in Guam's corrosive environment due to improper corrosion protection for framing, connections, etc. Reinforced concrete is the structural material to be used unless otherwise indicated. Exterior metal framing and connections shall use properly selected stainless steel (or equal) corrosion protection. Exterior fasteners shall be stainless steel. Within interior conditioned spaces exposed steel elements at structural connections must be hot-dipped galvanized steel. Other interior metal surfaces also must address corrosion.

- d. Air-conditioned spaces need special attention. Proper location of vapor retarder and vapor barriers between the exterior hot humid climate and the HVAC-conditioned interior spaces is critical. The entire perimeter envelope of the facility must be pressure tested to prevent moisture intrusion. All interior spaces, including soffit areas and storage areas must be positive-pressured as well as air conditioned. HVAC systems must address proper sizing of the AC equipment for both sensible and latent loads, and must properly control indoor humidity and fresh air criteria. Due to Guam's wind-driven rains and corrosive environment, facilities shall not have uncontrolled passive venting. Proper Indoor Air Quality is dependent on these measures.
- e. Design professionals must have a successful track record in designing for Guam's Hot Humid Climate and have knowledge of Guam's local construction methods to select the appropriate materials and construction components for MCB Guam.

4.13 System Safety Engineering

Projects shall develop System Requirements Hazard Analysis in accordance with MIL-STD-882 and NAVFACPACINST 5100.4D in addressing all hazards identified in project planning documents. Risk acceptance shall be in accordance with OPNAVINST 5100.24.

4.14 Industrial Control Systems (ICS) Engineering

DoD projects shall develop comprehensive cybersecurity engineering requirements in accordance with applicable UFCs and the NAVFAC Marianas Public Works Utilities Criteria, and in compliance with NAVFAC Marianas CIO requirements. Coordinate project requirements for all new or modified industrial controls systems (e.g. AMI, SCADA, DDC) with NAVFAC Marianas CIO to obtain requirements related to cybersecurity.

Personnel that are required to conduct ICS operations, maintenance, repair, programming, configuration, installation, and/or development of systems documentation, are required to be US citizens. Requirements for background investigations, non-disclosure agreements, systems use agreements, system access request forms, system change request forms, and basic network security training, are required be executed by all personnel (as applicable) to the satisfaction of NAVFAC Marianas CIO.

4.15 Munitions and Explosives of Concern / Explosive Safety Submission (MEC/ESS)

ESS compliance is mandatory where any ground penetration and construction activity (clearing, digging, grading, excavating, planting, etc.) is to be performed. Applicable reference documents are:

- 1) Explosive Safety Submission Munitions Response Sites, Guam Construction Support (Current Amendment at time of Contract or Task Order award)
- 2) CNO ES Exemption E1-16 for COMJTREG Marianas (Current Series/Amendment at time of Contract or Task Order award)

CHAPTER 5 DESIGN AND APPEARANCE GUIDELINES

This section provides general design and appearance guidelines for uniformity throughout the Installation. Refer to the applicable Base Installation Appearance Plan as appropriate (see [4.11 Installation Appearance](#) for additional requirements.)

5.1 Site and Landscape Design

Site and landscape design shall be in accordance with the applicable Base Installation Appearance Plan (IAP) and the Final Guam Landscaping Guidelines (June 2011) as appropriate.

5.2 Architecture

The primary goal of this architecture guideline is to define a clear and consistent design theme that visually unifies building exteriors throughout the Installation. This goal is achieved by providing a set of uniform design elements that may be applied to the individual designs, such as material types, roof types, color selection and finishes. Uniformity in design throughout an Installation is also encouraged as a means to mitigate the need for future maintenance and repair projects. The design of new facilities should reflect the location, function, and selected Installation theme.

Building systems and finishes shall be designed and constructed in accordance with Section 3 and sections 4.3 (wind), 4.4 (seismic) and 4.5 (corrosion). This architecture guideline provides uniform appearance and additional requirements and recommendations based on Guam's unique environment.

5.2.1 BUILDING CHARACTER

Building and facilities shall have a uniform "Tropical" appearance and comply with the applicable base Installation Appearance Plan criteria.

The building shall have a climate-responsive design; the building's orientation, form and envelope shall take advantage of prevailing wind flows and minimize solar heat gain.

Designer shall consider the following building design elements for protection from heat build-up, solar radiation and rain.

- Building orientation
- Canopy at building entrances, large enough to protect from sun and heavy rain. For assembly buildings, provide a covered drop-off area
- Covered walkways between buildings in the same complex
- Insulation and radiant barriers at walls and ceilings
- Reflective high-albedo roofs on low slope roofs that are not readily visible. Avoid the use of vegetated, green roofs
- Natural daylighting elements

- High-performance glazing shaded by deep roof overhangs, shading fins and light shelves.
- Interior window shades
- Typhoon Shutters

5.2.2 EXTERIOR BUILDING ENVELOPE

Strength, durability (corrosion-resistance), humidity control, the ability to withstand typhoon winds and typhoon flying debris, and seismic resistance are some of the priorities in the design for exterior building envelope systems. Selected construction and finish systems shall reduce life-cycle costs and simplify maintenance. Reinforced concrete construction shall be used for the structural system unless otherwise indicated. Modular construction such as precast concrete construction systems are encouraged whenever possible. All concrete horizontal and vertical construction joints (concrete, precast concrete, tilt up concrete) shall have a concrete step detail that prevents water from being driven directly through the joint. All concrete vertical joints shall have a lapped or keyed detail that prevents water from being driven directly through the joint. All joints shall be properly prepared and sealed.

The exterior building envelope shall have an insulation system with an R-value to meet the appropriate criteria and the energy design of the facility. This includes but is not limited to all exterior storefront framing and glazing, doors and frames with or without glazing, and window frames and glazing. There should be no exterior (outboard) insulation on roof; insulation shall be placed on the interior side. At locations susceptible to moisture, do not use insulation that can retain water such as fiberglass batts as this could lead to potential moisture and mold problems. Also, do not use insulation made from cellulose (wood by-products) due to Guam's termite and mold problem.

Incorporate vapor retarders at exterior wall and roofing assemblies.

For family housing, warehouses, fire stations, retail loading areas and other facilities that have unconditioned spaces behind garage doors or roll up doors and conditioned spaces on the opposite side of the unconditioned spaces, there shall be protective interior reinforced concrete or fully grouted reinforced CMU typhoon rated interior walls to protect the occupants in the conditioned spaces..

All non-conditioned spaces (e.g. Garages, motor pool bays, vehicle repair bays, storage warehouses depending on material to be stored) are considered exterior walls of structures requiring fasteners, hardware, mechanical and electrical accessories all made of stainless steel. Any metal framing shall be hot-dipped galvanized.

Provide vapor barriers under and around slabs and footings to prevent moisture rising up through the concrete and into interior spaces and the exterior walls leading to moisture problems. See Chapter 6 DESIGN & CONSTRUCTION STANDARDS under [A10 FOUNDATIONS](#), Vapor Barrier for additional information.

All exterior construction elements in this section and other elements specifically identified shall meet the requirements for Guam's typhoon winds, wind driven rains, wind borne flying debris, wind topographic effect, corrosion and seismic loads as per applicable UFC criteria and sections [4.3](#) (wind), [4.4](#) (seismic) and [4.5](#) (corrosion) and [4.12](#) (hot humid climate design) which are critical in successfully addressing Guam's challenging environment.

5.2.2.1 Exterior Wall Systems

Due to their resistance to windborne flying debris, humid climate and corrosive salty environment, the wall system shall be cast-in-place concrete or precast concrete unless otherwise noted. Use of EIFS as an option for exterior walls can be included with the following caveats: 1) The EIFS system shall be rated to withstand impact resistance in accordance with ASTM requirements; manufacturer shall provide third party impact resistance testing certificate for compliance. 2) EIFS shall be warrantied against mold development; Manufacturer/DOR/DB-Contractor shall provide drawing details and specs that specifically address this issue.

Masonry walls should not be considered for the exterior envelope for any significant inhabited or utility buildings (i.e. pump stations, electrical substations, generator buildings, transformer buildings, and utility enclosures for essential buildings). However, where budget constraints do not allow for concrete, masonry may be cautiously used to reduce project cost. In this case, when used for the exterior envelope, masonry must be fully grouted and shall have a protective silicone enhanced EFS or similar coating to protect the interior from water and moisture infiltration and reinforcement and metal connections from corrosion that may be caused by wind driven rains and the corrosive marine environment. Masonry finish must be regularly maintained; Contractor to submit required maintenance instructions to the CME at project completion.

Restrictions on masonry use do not apply to minor utility enclosures, non-essential utility buildings (i.e. bus shelters, pavilions, chillers, air-handling units, and water heating tanks for non-essential buildings), interior walls, and exterior screen walls. However, at a minimum, masonry exposed to weather shall be weatherproofed with an exterior mildew resistant elastomeric coating in order to prolong the life of the masonry.

Mildew resistant paint/coating system or a fine textured Exterior Finish System (EFS) with integral coloring shall be applied as the exterior finishing material. Silicone or silicone-enhanced acrylic coating on EFS are suggested as applicable for color retention, wind driven rain resistance, ability to bridge hairline cracks, and permeability. Acrylic exterior coatings shall have silicone additives and EFS shall have silicone enhancement for self-cleaning during rains to remove dirt that may lead to mold formation.

Consider using glass blocks for daylighting. Glass blocks, particularly the solid glass brick variety resist typhoon damage well and require low maintenance.



Figure 4: EFS

5.2.2.2 Exterior Louvers and Screens

If required, exterior louvers and screens shall be anodized aluminum in a finish color and designed so it is compatible with the exterior building elements. Exterior aluminum louvers with stainless steel mesh shall be designed to meet wind load design criteria in section [4.3](#). Louvers with stainless steel mesh shall be designed to prevent the infiltration of typhoon wind-driven rain and pests into the building interior.



Figure 5: Exterior Louvers

Louvers with type 316 stainless steel mesh shall be heavy-gauged dark bronze anodized finish or as required to comply with the applicable IAP unless otherwise noted. All hardware, brackets, etc., shall be type 316 stainless steel.

If exterior louvers will not stop all water infiltration during a typhoon event, typhoon shutters, concrete hood, or other mitigative design element shall be included.

5.2.2.3 Typhoon Shutters

To prevent the infiltration of wind, flying debris, and rain through the exterior structure, provide typhoon shutters at all glazed fenestrations (storefronts, windows, doors with typhoon-rated vision panels exceeding 100 square inches in area) of buildings and other structures designated as essential facilities within risk category III or IV (according to IBC Table 1604.5). Typhoon shutters shall be designed to meet wind load design criteria in section [4.3](#). Typhoon shutters shall be anodized aluminum or type 316 stainless steel and constructed to ensure long-term operability and to prevent insects (e.g. wasps) from nesting within the assembly.

The finish of the entire exposed shutter assembly shall be compatible with the applicable base Installation Appearance Plan or approved housing color scheme. Stainless steel hardware and fasteners shall be concealed to the maximum extent possible.

Acceptable types of typhoon shutters systems are:

- Vertical coiling (roll-up) type shutters. Assembly should be recessed into the wall opening flush with wall plane, or have housing sloped at top to discourage bird nesting and to prevent corrosion from standing rain water.



Figure 6: Typhoon Shutter Vertical Coiling



- Side hinged (colonial) shutters: Permanently attach type 316 stainless steel operating hardware to eliminate any removable operating parts that may be misplaced or lost. Side-hinged typhoon shutters shall only be used at small single-story facilities and residential housing projects.



Figure 7: Typhoon Shutter Side Hinged

The use of other types of typhoon shutter systems (accordion, side coiling) must be approved in advance on a case-by-case basis, through a waiver request as described in Section [2.3](#).

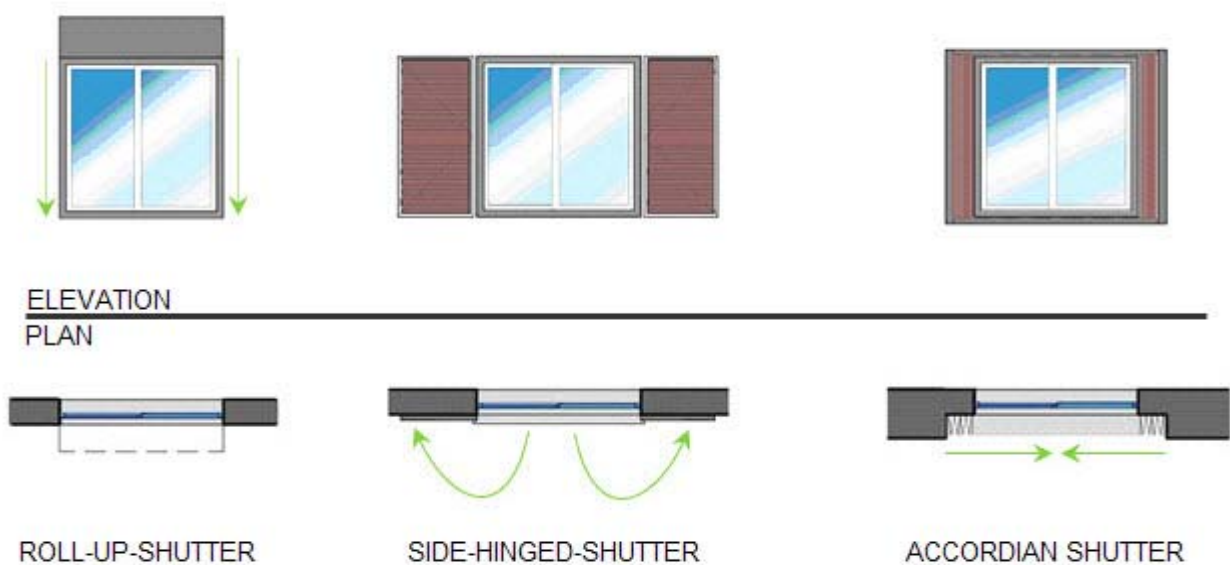


Figure 8: Typhoon Shutter Other Systems

5.2.2.4 Railings, Handrails, and Guardrails

Railings and handrails shall be aluminum with anodized finish. Provide type 316 stainless steel railings and handrails where otherwise required. All hardware, anchors, fasteners, gate latches, etc. shall be type 316 stainless steel for corrosion protection and to prevent galvanic action between dissimilar metals.

Where steel rails are used due to funding challenges, galvanized steel shall be used with compatible paint coating. Fiberglass rails may be used for special mission requirements only; fiberglass rails exposed to the exterior shall be provided with 2 coats elastomeric coating for additional UV protection. PVC rails are not allowed. All rail systems shall meet IBC load requirements.

5.2.2.5 Sun Control Devices

Sun control devices shall be integrated on the building exteriors to shield direct sunlight on glazing and to reduce cooling load and glare while maximizing daylight to interior spaces. These devices shall be integrated into the building construction so they do not appear as an afterthought addition, do not collect dirt, and allow for easy window cleaning.

Sun control devices may include overhangs, canopies, louvers, solar screens and trellises. Light shelves installed on the exterior (and / or interior) of windows are another type of shading device that increase light penetration into the building interior. Elements typically include horizontal, vertical, cantilevered and suspended, supports and surfaces. The material for exterior sun control devices may be of concrete or aluminum.



Figure 9: Sun Control Devices

Interior automated sun control devices (e.g. roller shade window treatments) may also be deployed during portions of the day to mitigate heat gain and glare.

5.2.3 BUILDING ENTRANCES / OPENINGS AND COVERED WALKWAYS

Building entrance shall be protected from weather with a canopy, or overhang. Assembly buildings shall be provided with a covered drop-off area. Functionally related buildings within the same complex shall be provided with connecting covered walkways.

The design of entrance cover and covered walkways shall be of similar style, character and materials as the main building(s); and they shall comply with Section 3, sections [4.3](#) (wind), [4.4](#) (seismic) and [4.5](#) (corrosion.)

The Designer of Record (DOR) shall coordinate the use of floor mats with floor drains and trap primers, entrance vestibules, door and door frame weather seals, or other secondary means to prevent typhoon wind driven rains from entering at the facility exterior entrances.

All exterior door thresholds and window sills shall have step detail that prevents water from being driven directly under door threshold/window sill. Door threshold shall meet accessibility requirements. Floor drains with trap primer shall be provided at the interior side of entrance doors to collect wind-driven rain that may infiltrate during typhoons.

All exterior construction elements in this section and other elements specifically identified shall meet the requirements for Guam's typhoon winds, wind driven rains, wind borne flying debris, wind topographic effect, corrosion and seismic loads as per applicable UFC criteria and sections [4.3](#) (wind), [4.4](#) (seismic) and [4.5](#) (corrosion) and [4.12](#) (hot humid climate design) which are critical in successfully addressing Guam's challenging environment.

5.2.3.1 Windows

Locate windows to maximize interior daylighting and view opportunities while minimizing thermal heat gain. Provide overhangs, fins, tree shading or other devices to shade or partially shade windows and protect from rain, glare and solar gain. Due to the corrosive environment, exterior windows shall be aluminum with anodized finish unless otherwise required by more stringent DoD Criteria.

Fixed type windows shall prevent the infiltration of undesirable hot, humid outside air, and water leakage during typhoons.

Operable type windows shall be used at habitable air-conditioned spaces to the maximum extent possible and sized to meet minimum natural ventilation requirements for occupancy during prolonged power outages. Operable windows shall open outwards. Unless required by code for emergency escape and rescue use, provide locks which discourage the opening of windows during HVAC system operation. For child fall prevention, provide window guards at all upper floor operable windows of housing projects in compliance with ASTM F2090-01a. Window guards shall not interfere with typhoon shutter operation.

All exterior windows shall have a concrete step detail that prevents water from being driven directly under window sills. Install windows in accordance with ASTM E-2112 to prevent the infiltration of water into wall cavities. Also seal exterior wall openings and interior side furred out walls for water infiltration which may lead to moisture and mold problems.

All exterior and interior window hardware, fasteners, etc. shall be type 316 stainless steel unless not manufactured. This is to provide corrosion protection and to prevent galvanic action between dissimilar metals with the aluminum window frame.

Acceptable types of operable exterior windows systems are:

- Sliding.

- Casement. Side hinged (Colonial) at small single-story facilities and residential projects, or top-hinged (awning). Awning type shall not be located adjacent to walkways.
- Double-hung (not single-hung) provide better reach for maintenance.

Refer to section [5.2.3.3](#) for glazing.

All exterior windows on essential facilities shall be protected by typhoon shutters. Both window and shutter assemblies shall comply with wind speed criteria in Section [4.3](#). See Chapter 6, Section [B2020 Exterior Windows](#), for more detailed information.



Figure 10: Window Types

5.2.3.2 Storefronts

Due to Guam's corrosive marine environment, storefront assemblies shall be aluminum with anodized finish with type 316 stainless steel hardware and fasteners.

- Minimize use of storefront systems on primary gathering and critical designated facilities.
- Refer to section [5.2.3.3](#) for Glazing.
- Storefronts shall be protected by typhoon shutters that are manually operated or electrically operated with manual backup controls. Provide additional emergency egress as required to allow exiting when shutters are closed over storefront entrances during typhoons. Ensure that the shutter assembly is seamlessly integrated with the building architecture and does not appear as an add-on.

5.2.3.3 Glazing

Due to Guam's high wind velocities, potential exposure to flying debris during typhoons and AT/FP compliance, exterior glazing shall be laminated glass. Exterior windows shall include an insulated glazing system (low E outer glazing + air space + interior glazing meeting latest adopted edition of IBC and ASCE7 for hurricane and windborne flying debris). Contractor shall submit 3rd party certification for required impact resistance. At minimum, exterior glazing shall be minimum ¼" thick laminated glass with minimum 0.75mm thick PVB interlayer.

Consider building energy efficiency, occupant comfort, daylighting, acoustic performance, and security when selecting exterior window and glazing systems. Consider high performance glazing units with low-emissivity (low-e) coatings with high visible light transmittance for better daylighting and a low solar heat gain coefficient (SHGC) in accordance the National Fenestration Rating Council and Guam Building Energy Code.

Coordinate glazing tint with applicable IAP, sustainability recommendations and energy requirements. For Navy projects, glazing shall be light bronze tint. Unless otherwise required, unshaded glazing shall be factory tinted; shaded glazing at storefront requiring see-through visibility may be clear, non-tinted.

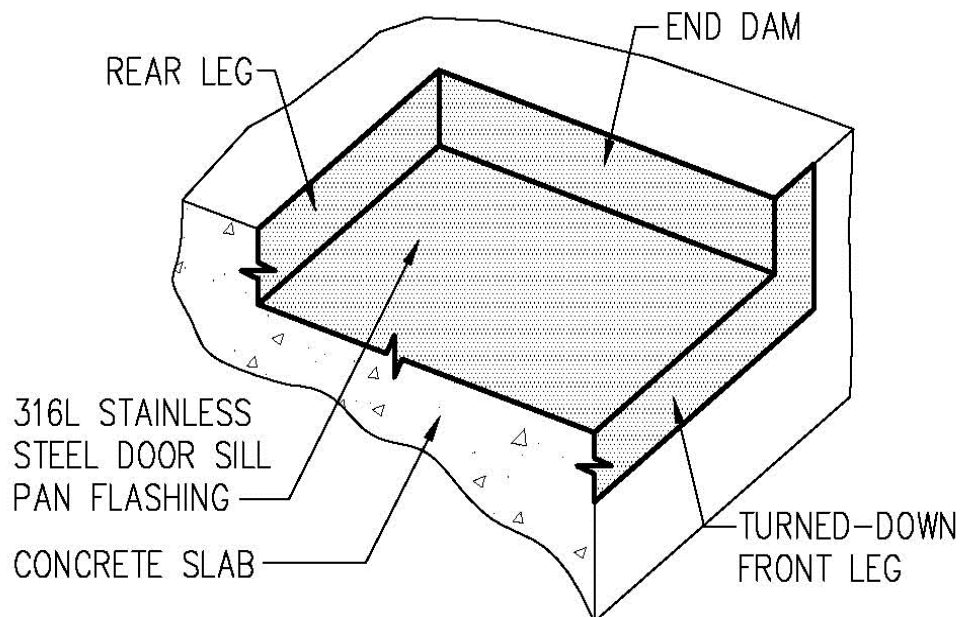
5.2.3.4 Doors

Due to the corrosive environment, all exterior doors and frames shall be aluminum doors with dark bronze anodized finish (at all facilities except residential) and fiberglass doors with simulated wood finish (single family residential only) or galvanized painted steel interior garage fire doors / frames that swing out into the garage where fire resistive requirements dictate. All exterior doors shall meet the wind requirements in sections [4.3](#) (wind), [4.4](#) (seismic) and [4.5](#) (corrosion). All exterior and interior door hardware, fasteners, etc. shall be type 316 unless not available by special order, then order the next highest corrosive stainless steel available and as last choice, hot dipped galvanized with factory painted high corrosive resistant coatings. Hardware shall include threshold, door bottom, and weather seal. All exterior doors shall have concrete step detail that prevents water from being driven directly under door sills and thresholds, and comply with accessibility. Exterior doors and garage doors shall have weather seals and automatic door bottoms (swing doors) to prevent wind-driven rain from entering facility spaces.

The following are minimum exterior doors requirements:

- Main entrances: Medium stile, full glazed aluminum door with aluminum frame. Provide pair of doors at major facilities and where required.
- Side entrances: Flush aluminum door; and provide side-lite/vision panel where required.

- Utility and other exterior doors: Flush aluminum door. Provide pair of doors only where required.
- Unless otherwise noted in the project requirements, the minimum size of all exterior doors shall be 3'x7'.
- Exterior doors shall be protected with sun/rain shade/overhang.
- It is required that storefronts and doors with glazing are protected with typhoon shutters.
- Glazing requirements at exterior door openings shall meet IBC and ASCE 7 requirements (latest adopted editions at time of project award). Do not install vision panels in exterior doors unless required by code or UFC criteria. Exterior doors with typhoon-rated vision panels that exceed 100 square inches in area shall require typhoon-rated shutters.
- All elevator doors shall be located at the interior of the building.
- Exterior swing doors shall swing out to allow frame rabbet to act as a stop to prevent door from blowing in and having door seals compress by door against door frame side and to rabbets. Doors to have handicap rated weather sealed thresholds and automatic door bottoms or door shoe with drip. Door threshold shall have concrete recessed seat and type 316 stainless steel door sill pan flashing with end dams, rear leg and turned-down front leg. Top of door to have type 316 stainless steel (or most corrosive resistant stainless available) drip with hook at top of exterior door and door frame.
- For exterior doors with glazing, the glazing shall comply with glazing requirements.



**DOOR SILL PAN FLASHING WITH END DAMS,
REAR LEG, AND TURNED-DOWN FRONT LEG**

Figure 11: Door Sill Pan Flashing

Other door systems or finishes must be approved in advance on a case-by-case basis by the Installation Commander or Regional Engineer.



STORE FRONT

ALUMINUM FLUSH

ALUMINUM FLUSH

FIBERGLASS

Figure 12: Other Door Systems

5.2.3.5 Garage and Roll-up Doors

Garage doors, roll-up service doors, and similar doors with large surface areas shall be designed to meet wind load design criteria in sections [4.3](#) (wind), [4.4](#) (seismic) and [4.5](#) (corrosion). The use of center posts and other devices shall be considered to reduce large surface areas and minimize the risk of door failure.

Unless these types of doors are located at the exterior of air-conditioned spaces, the entire assembly, both inside and outside, must utilize the most corrosion-resistant materials. Door components (door leaves, automatic door openers, hardware, fasteners, wire cable, brackets, tracks springs, etc.) shall be type 316 stainless steel. Where these service door assembly components are not available in type 316 stainless steel or next highest corrosion-resistant stainless steel by special order, they shall be hot dipped galvanized with factory painted high corrosive resistant coatings.

These types of doors shall be easily operated manually during power outages. The spaces behind these service doors shall have a barometric pressure release designed to prevent door implosion during typhoons.

Other door systems must be approved in advance on a case-by-case basis through a waiver request described in Section [2.3](#).

If used as typhoon shutters for storefronts, windows or doors, ensure that the assembly is seamlessly integrated with the building architecture and does not appear as an add-on as shown in the photo.



Figure 13: Typhoon Shutter Add-on Example

5.2.4 ROOFING SYSTEMS

Roofs can have a strong visual impact on building performance, style and appearance. All exterior construction elements in this section and other elements specifically identified shall meet the requirements for Guam's typhoon winds, wind driven rains, wind borne flying debris, wind topographic effect, corrosion and seismic loads as per applicable UFC criteria and sections [4.3](#) (wind), [4.4](#) (seismic), [4.5](#) (corrosion) and [4.12](#) (hot humid climate design) which are critical in successfully addressing Guam's challenging environment.

Penetrations (vents, roof hatches, skylights, etc.) and joints shall not be installed in roofs of new facilities due to previous historical damage from typhoons which incurred costly water damage.

Due to concerns with Guam's heavy rains, heat, mold and humidity requirements, fluid-applied silicone materials with non-woven polyester full fabric reinforcement and integrated mildewcide / anti-staining agents is the preferred fluid-applied roofing system, as it is durable, self-cleaning, and has multiple color selections. Other fluid applied roofing systems such as urethane or silicone base coatings can be considered if these systems include continuous full fabric non-woven polyester reinforcement. Elastomeric roof coating system with color other than white shall be warrantied against excessive fading for 10 years. Ensure all safety measures are taken when accessing silicone roof systems which are extremely slippery when wet.

For new facilities, roof coatings shall have minimum thickness of 60 mils DFT. For existing facility recoating work on existing fluid-applied coating, the new roof coating shall be compatible with the existing coating and shall have minimum thickness of 45 mils DFT. Where an existing facility requires roof coating repair work, the new repair coating shall be compatible with the existing coating, and shall have minimum thickness of 60 mils DFT.

For optimum typhoon resistance and ease of maintenance, steep slope concrete roof with similar liquid-applied roofing membranes are preferred.

Decorative pattern on sloped concrete roofs that do not excessively encourage dirt buildup or mold formation such as simulated tile or battens are encouraged.

Roof parapets are not to be used to the maximum extent possible, as heavy rainfall and typhoon-generated windborne flying debris may collect behind these walls and restrict runoff which could lead to structural failure. Where facility design warrant roof parapets, the DOR shall provide appropriately designed roof drainage system that will include drain overflows. Roof drain overflows shall be located at all roof drain locations and shall be a minimum of 4" high x 12" wide.



Figure 15: Concrete Batten Roof

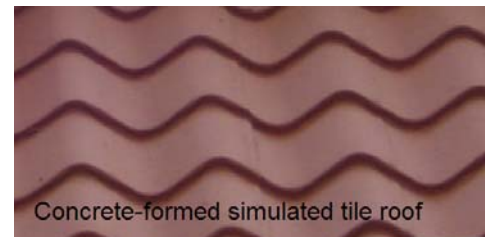


Figure 14: Concrete-formed Simulated Tile Roof

Fully grouted clay tile roof systems may be considered for certain types of USMC projects. Metal roofing on concrete substrate may be considered for Navy projects. These and all other roof systems not mentioned must be reviewed and approved as described in section [2.3](#) Responsibility For Compliance and comply with Section 3, Design and Construction Criteria. Steep sloped roof designs are preferred over low slope roofs wherever possible due to Guam's high rainfall.

5.2.4.1 Steep Sloped Roofing Systems

Steep sloped roofing systems shall be constructed with a minimum slope of 4:12 unless otherwise required by functional criteria. Sloped roofs may have various geometries. Gable or hip style roofs are preferred. Hip style roof design is preferred as it has proven resistance to wind uplift forces. Severely steep sloped roofs of greater than 5:12 pitch should be avoided as they can become "sails" that catch more wind and be subjected to both higher uplift and overturning forces.



Figure 16: Roof Style

5.2.4.2 Low Sloped Roofing Systems

Low slope roofs shall maintain a minimum of 1/2" (13 mm) per foot slope.

5.2.4.3 Roof Insulation Systems

Roof Insulation Systems: Insulate concrete roof slabs and ceilings/attics with closed cell spray foam insulation applied to the underside of the roof slab to improve thermal performance and occupant comfort. Install a thermal barrier over the insulation as required by code in compliance with ASTM 119.

For re-roofing projects, it is strongly recommended that existing above-deck insulation be replaced with insulation on the underside of the roof deck, with fluid-applied roof system applied to the roof deck.



Exposed and damaged roof insulation due to typhoon.

Figure 17: Typhoon Damaged Roof Insulation

5.2.4.4 Gutters and Downspouts

Gutters and downspouts shall be provided at all buildings (except at some small utility buildings). Downspouts at the interior of the building and within exterior wall cavities are not allowed. Downspouts shall be painted to match adjacent wall finish (except stainless steel downspouts). Provide concrete splash blocks at all downspouts except where the downspouts are connected to a storm drainage system. The use of a storm drainage system is the preferred first choice. The main intent is to provide a means to drain the foundation areas and prevent water from collecting which could lead to mold problems, soil expansion problems, and water damage.

Gutters shall be concrete formed and cast as part of the concrete roof deck. Where precast concrete roof panels and gutters are to be utilized, the precast gutters shall be designed to be installed outside the vertical wall face and below the roof panel with the outer gutter lip minimum 2 inches below the wall-roof-gutter connection joint.

5.2.4.5 Roof Openings

Roof-mounted equipment and roof penetrations have historically caused or contributed to costly typhoon damage. Eliminate these and similar items unless required by other criteria.

Roof penetrations include but are not limited to skylights, roof hatches, mechanical ductwork, roof ventilators, exhaust vents, and fasteners and plumbing/conduit piping for roof-mounted equipment (HVAC, solar hot water panels, photo voltaic rigid-framed monocrystalline and polycrystalline panels)

Design the facility to eliminate roof openings:

- Incorporate wall fenestrations (windows, light shelves, clerestories with typhoon-rated glazing blocks); do not use skylights.
- When practical, locate solar water panels, PV panels, wind turbines, other electrical equipment, and mechanical equipment at ground level (see Chapter 6, D3030, D50). Fully-adhered BIPV (Building Integrated Photovoltaic) systems shall be considered.
- Do not use interior ladders to roof hatches. Incorporate wall-mounted ladders complying with ATFP requirements (lockable access, located within a controlled area)



Figure 18: Integral Concrete Gutter and Fascia

5.3 Exterior Color

Uniform colors are established to provide consistent visual order and ease of maintenance. Colors shall be in accordance with the COMNAVMAR IAP or MCBG IAP as appropriate. Exterior colors for family housing projects that are not already approved require special approval from the applicable base Installation Commander or Regional Engineer. (Note: Provisions for exterior colors for family housing are not included in the IAPs. This is to allow residential color schemes to be used.)

All paints and coatings shall have mildewcide additives. All paints and coatings shall be self-cleaning with silicone enhancement.

5.4 Base Exterior Signs

Base exterior signs shall be in accordance with the applicable base IAP as appropriate (see 4.11). NAVBASE Guam shall also follow requirements of Navy Region Marianas Sign Standard (latest edition). A licensed Civil (or Structural) Engineer shall submit written certification indicating sign and foundation design will meet the minimum standards for wind and seismic loads per UFC and ASCE7 criteria. Exterior signs shall use type 316 fasteners and hardware or consider Very High Bonding (VHB) tape for mounting signs to buildings and sign posts. Signs and mounting methods shall meet Sections 4.3 (wind), 4.4 (seismic) and 4.5 Corrosion. Anodized aluminum signs shall be used as plastic signs deteriorate in Guam's high UV. Sign fasteners and sign shall not cause rust stains on facilities.

5.5 Solar Hot Water Panel and Photovoltaic Panel Systems

Solar hot water panels and photovoltaic (PV) panels will sustain significant damage by typhoon winds and flying debris if installed and left unprotected at ground level or on roofs. As a preventive measure, solar hot water panels shall be installed at ground level within protective reinforced concrete or masonry fence enclosures. Use galvanized chain link overhead protective screening particularly where adjacent to play areas and housing areas. Provide deployable hurricane rated (rating must meet Guam's typhoon requirements) protective screen fabric over the chain link to shield PV and Solar panels from Guam's typhoon wind up-lift and wind borne flying debris. When not deployed, fabric shall be stored in a typhoon resistant corrosion protected enclosure. See Appendix B – Drawings, for Solar Panel Enclosure conceptual design. Systems must be rated to comply with the wind criteria established in Design and Construction Criteria - Section 4.

Placement of enclosures shall consider sun angle and shadows to maximize total solar energy on panel surfaces. Enclosures for PV panels are not economically feasible due to the size of typical PV systems. Building integrated photovoltaic (BIPV) systems adhered to roof surfaces and other features of the exterior building envelope shall be considered.

Solar photovoltaic panels/modules shall not be installed unless they comply with the following: 1) the PV panels/modules have been wind load tested and certified by an approved testing agency to meet the



Figure 19: Solar Panel Enclosure

wind load resistance requirements per section 4.3 Wind Speed Criteria in this standard, and 2) the PV panels/modules meet the impact resistance requirements per IBC section 1609.1.2 Protection of Openings. The glazing shall remain in place after impact, and 3) a licensed Civil or Structural engineer shall submit written certification/calculations indicating that the support frame and PV panel/modules meet the standards for Guam wind loads per UFC and ASCE 7 criteria.

5.6 Exterior Lighting

All exterior construction elements in this section and other elements specifically identified shall meet the requirements for Guam's typhoon winds, wind driven rains, wind borne flying debris, wind topographic effect, corrosion and seismic loads as per applicable UFC criteria and sections 4.3 (wind), 4.4 (seismic) and 4.5 (corrosion) and 4.12 (hot humid climate design) which are critical in successfully addressing Guam's challenging environment.

Exterior lighting shall be in accordance with applicable base installation appearance plan as appropriate (see 4.11) for additional lighting requirements.

The character of exterior lighting should be simple and refined. Fixtures shall be readily available with readily available replacement parts. The fixtures shall be a consistent dark bronze anodized color throughout the Installation as a unifying element. LED fixtures shall be used for exterior lighting, except at illuminated outdoor recreation facilities. Where feasible, utilize LED fixtures with integrated photovoltaic collectors that comply with the wind load rating.

- a. Light fixture housing shall be extremely corrosion resistant and durable. All hardware and fasteners shall be type 316 stainless steel unless not available by special order, then order the next highest corrosive stainless steel available and as last choice, hot dipped galvanized with factory painted high corrosive resistant coatings.
- b. Recess, screen or otherwise minimize the visibility of the light fixture itself. The effect of the lighting should clearly be seen but not the source.
- c. Reduce light pollution by limiting light trespass from the building and the site. Lighting design shall be in accordance with ASHRAE/IESNA Standard 90.1-2004.
- d. Exterior lighting design shall minimize light pollution that adversely impacts wildlife to the maximum extent feasible. Comply with all light pollution-related regulations.
- e. Minimize or eliminate glare from the lamp source to nearby buildings, walkways or other pedestrian areas. Dark-sky compliant or full-cut off fixtures are required to maintain light on the ground plane and avoid light spill.



Sample street light with flat lens and true 90 degrees cutoff. No light above 90 deg. Shall meet ANSI/IESNA RP8-2000 for full cutoff.

Figure 20: Sample Street Light

- f. Light poles, their foundations and any armatures shall be designed and sealed by a licensed structural engineer and Geotechnical Engineer and shall submit written certification that meet the minimum standards for wind including topographic effect, corrosion and seismic loads as per UFC and ASCE 7 criteria and sections 4.3 (wind), 4.4 (seismic) and 4.5 Corrosion. Any associated photovoltaic systems shall be integrated into the light fixture and specifically designed to be wind-resistant.
- g. Whenever possible site lighting shall be integrated with other design elements, such as recessed lighting under eaves or integrated in walls to reduce the visual impact of light poles.
- h. Lighting levels shall vary gradually, to blend the site lighting from bright areas to dark areas. This softening of the transitions creates a more beautiful effect and also helps the eyes to adjust to different lighting levels more quickly – providing a safer transition.
- i. Select fixtures with clean, classic lines. Avoid classic heavily adorned light fixtures and trendy modern fixtures, both may give the Installation a dated look.
- j. Low level lighting: bollards, niche lighting or low on-pavement lighting may be used to light walkways, stairs and ramps. These fixtures must also be shielded to cast light only on the ground plane and avoid light spill and glare.
- k. Use of LED fixtures must be considered where applicable to increase lamp life, reduce energy consumption and maintenance. Exterior LED lighting to withstand Guam's hot humid climate and corrosive environment.



Figure 21: Combination Photovoltaic & LED Streetlight



Figure 22: Standard Street Lights and Poles

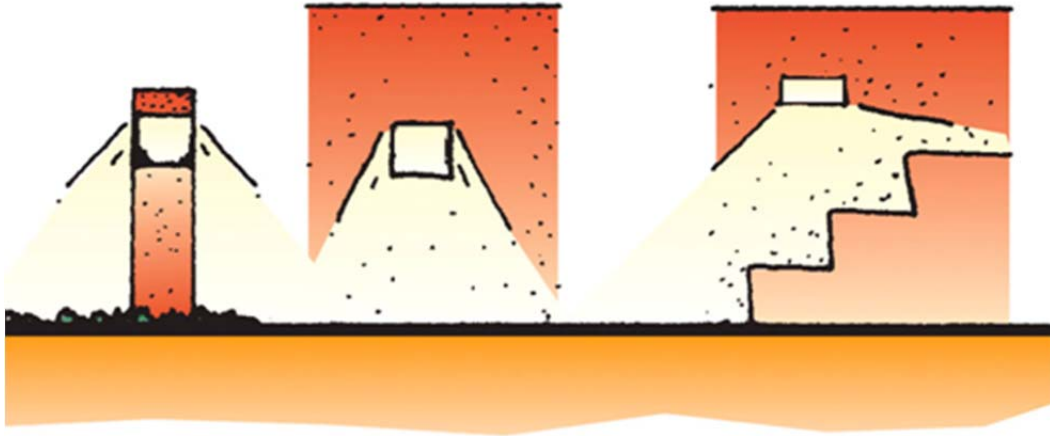
- I. Use of solar powered (photovoltaic) fixtures must be considered where applicable to reduce energy consumption.



Figure 23: Solar Powered Fixtures

5.6.1 LOW LEVEL LIGHTING TYPES

Low level light sources mounted at or below eye level are typically used for pedestrian walks, ramps and steps. Low level light sources include niche lighting for walls and steps, bollards and decorative garden pathway lights



Bollard – down light



Bollard – 360° light distribution



Niche Light - recessed in concrete pedestal



Niche Light – recessed in wall

Figure 24: Low Level Lighting Types

5.6.2 LANDSCAPE LIGHTING

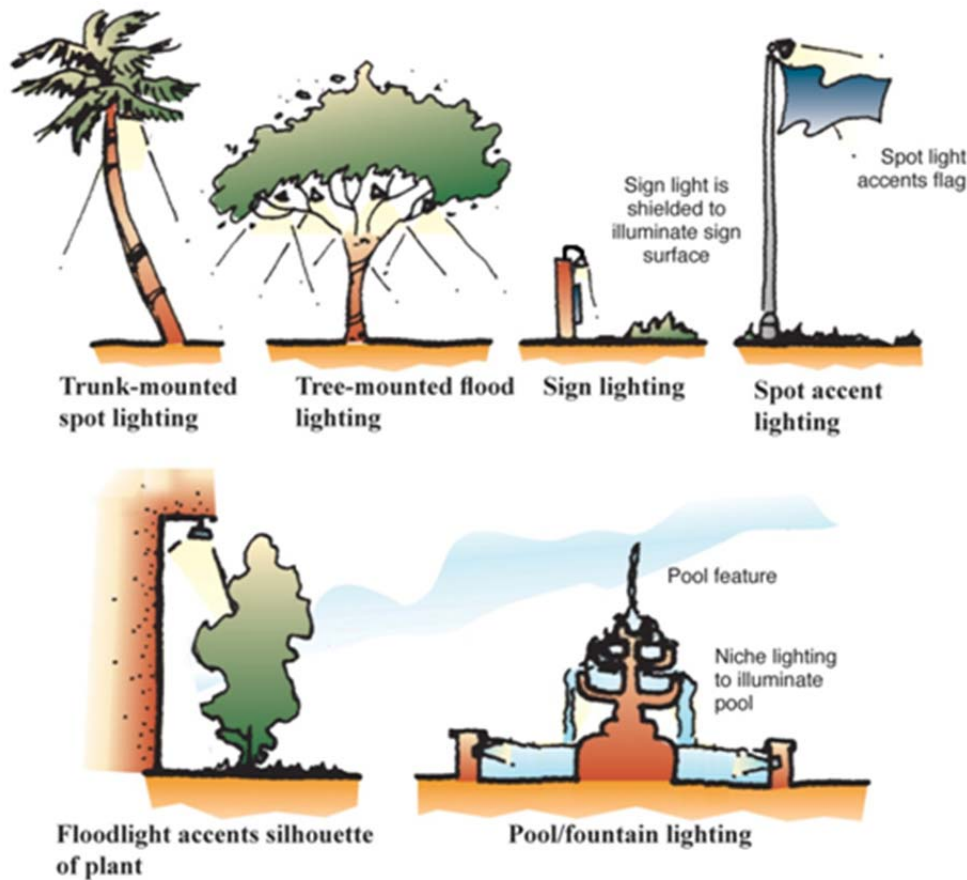


Figure 25: Landscape Lighting

5.6.3 STREET AND PARKING LIGHTS

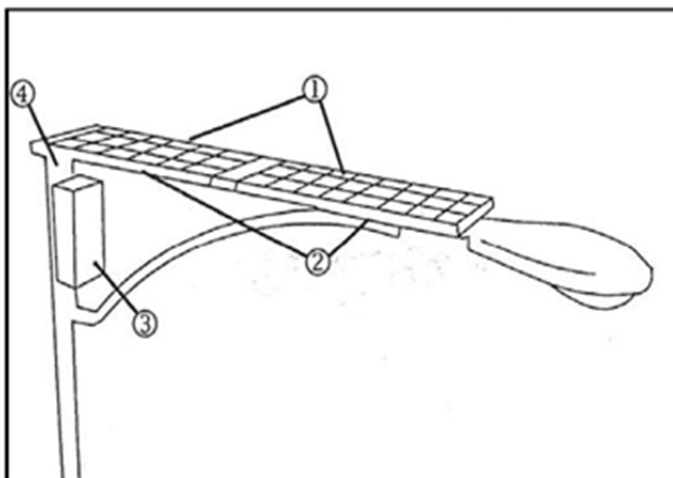


Figure 26: Street and Parking Lights

- 1) Solar panel
- 2) Vented aluminum panel cover
- 3) Battery box
- 4) Pole and light fixture assembly designed and certified to withstand wind load.

Note: The designs shown may not meet wind, seismic, and corrosion criteria. DOR is responsible for design that meets all these criteria.

5.6.4 SIGN LIGHTING

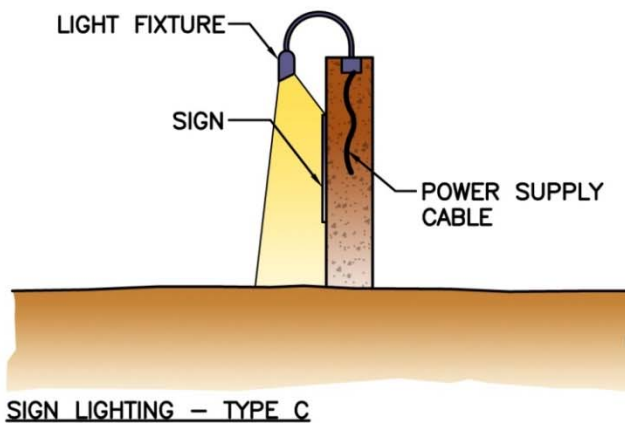
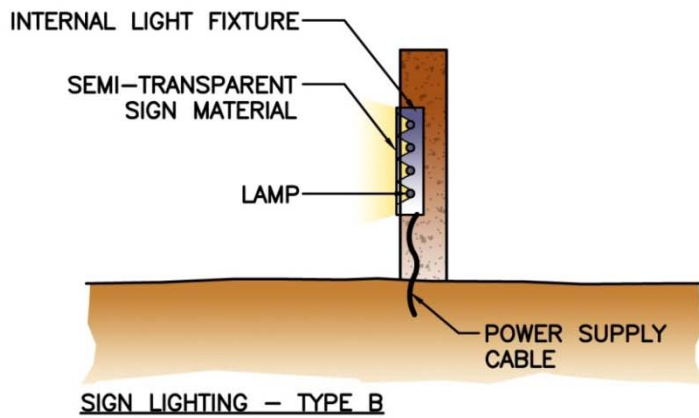
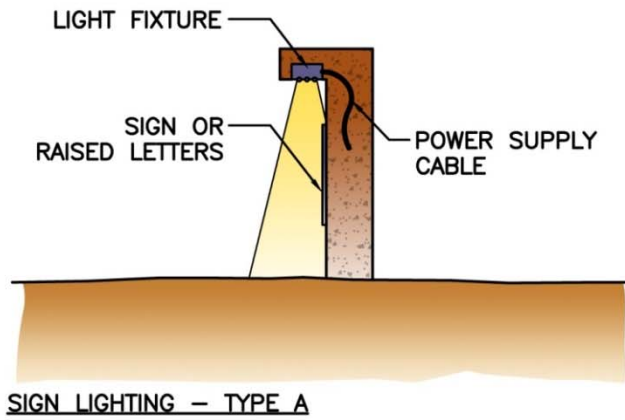


Figure 27: Sign Lighting

5.6.5 LED LIGHTING



Figure 28: LED Lighting

5.6.6 SOLAR (PHOTOVOLTAIC) POWERED LIGHTS



Figure 29: Solar Powered Lights

Note: The designs shown above may not meet wind, seismic, and corrosion criteria. DOR is responsible for design that meets all these criteria.

5.7 Temporary Buildings

Temporary buildings are non-permanent buildings that may be easily and quickly transported from one location to another. Temporary buildings including temporary construction facilities shall have similar uniform appearance similar to permanent facilities. Colors shall be uniform in accordance with Section 5.4 Exterior Colors. Provide capability for temporary buildings to be secured to the ground as required to meet the required wind and seismic design criteria for permanent structures. Steel cables and concrete deadman anchors is an acceptable method.

All exterior construction elements in this section and other elements specifically identified shall meet the requirements for Guam's typhoon winds, wind driven rains, wind borne flying debris, wind topographic effect, corrosion and seismic loads as per UFC and ASCE 7 criteria and sections [4.3](#) (wind), [4.4](#) (seismic) and [4.5](#) (corrosion) and [4.12](#) (hot humid climate design) which are critical in successfully addressing Guam's challenging environment.

Design and Construction Criteria shall be in accordance with Sections 4 and 5 with the followings added criteria:

- Temporary Buildings may be pre-engineered metal buildings.
- Sustainable strategies (including but not limited to energy efficient lighting and controls, low flow plumbing fixtures, Energy Star appliances, BIPV, high performance building insulation and high albedo roofs) shall be implemented to the maximum extent feasible

5.8 Interior Design

5.8.1 OBJECTIVES

The quality of spaces in which we live and work significantly and directly impact our quality of life, therefore, adequate thought must be given to the design and quality created within the buildings of Navy and Marine Corps bases in Guam. Workplaces should convey a sense of professionalism, pride, and respect. Lounges should convey comfort and relaxation. All spaces should serve to raise morale by providing functional, healthy and enjoyable places to live and work.

In order to maintain this quality of life in Guam's challenging environment, utilization of materials which are highly durable, low maintenance, breathable, mold resistant, and cost-efficient are prime considerations in the selection of interior finishes.

5.8.2 GENERAL INTERIOR REQUIREMENTS

Durability, maintenance, and cost-efficiency are primary considerations in choosing interior finishes. Neutral base colors with contrasting accented accessories should be applied when appropriate. Specialty areas may have specific requirements that need to be determined on an individual basis.

The designer shall consider the applicable Unified Facilities Criteria (UFC), Building Codes, fire ratings, acoustical performance, structural needs, and thermal and moisture transmission characteristics when designing project-specific interior assemblies. Where a conflict exists within this standard and other applicable codes or standards, the more stringent shall apply.

A/E's are required to submit Structural Interior Design (SID) and Comprehensive Interior Design (CID) packages for approval by Contracting Officer at each stage of the design process. If a selected material subsequently proves to be unavailable during design or construction, samples of alternative materials must be submitted for approval, prior to placing orders.

5.8.2.1 Indoor Environmental Quality

Interior design shall strive to attain high indoor environmental quality (IEQ) to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants.

Use low-emitting materials. Reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of the occupants.

5.8.2.2 Thermal Comfort

Thermal Comfort is dependent on control of indoor humidity (latent), temperature (sensible) and control of ventilation. Improperly engineered mechanical systems will lead to moisture and mold problems. Provide thermal comfort and design HVAC systems and the building envelope to meet the requirements of ASHRAE Standard 55- (latest adopted edition), Thermal Environmental Conditions for Human Occupancy. All air conditioning system designs shall incorporate provisions for continuous dehumidification including but not limited to the use of dedicated outside air systems, use of dehumidifiers for off hour or part load dehumidification, or use of reheat systems utilizing heat recovery and energy recovery systems.

5.8.2.3 Maximize Daylighting

Design the building to maximize interior daylighting. Strategies to consider include building orientation, increased building perimeter light shelves/fins, exterior and interior permanent shading devices. Consider the use of glass blocks and glass at interior partitions to increase interior daylighting and achieve direct line-of-sight to the outdoor environment for building occupants.

5.8.2.4 Energy Efficiency

Only energy-efficient type mechanical, plumbing, and electrical fixtures shall be used.

5.8.2.5 Interior Partitions & Interior Finishes

- a. Use breathable, water resistant, non cellulose (no wood by-product) and mildew-resistant interior finishes and materials. Use paperless (glass mat) gypsum board, fiberglass mesh tape, acrylic paints that breathe, ceramic coated wall board screws, galvanized G90 light gauge framing, and non-cellulose spray on foam where needed.
- b. Use products that are moisture and mold/mildew-resistant such as hard tiles with breathable grout joints and breathable sealed concrete. Use only ceramic tile floor tiles, terrazzo or other non-absorbent floor finishes on first floors and slabs on grade especially at entrance areas where typhoon flooding can occur.
- c. Do not use carpet and carpet pads that do not breathe and do not use in areas that are subject to flooding, staining and high foot traffic.
- d. Wood flooring must breathe and be termite resistant. Avoid using sheet vinyl flooring on concrete floor slabs as this flooring traps moisture. Vinyl composition tiled (VCT) are extremely difficult to install in Guam's Hot Humid climate and require rigorous installation procedures to eliminate moisture-caused adhesion failure of the VCT floor to concrete slab-on-grade substrates.
- e. Do not use vinyl wall coverings and other wall coverings, paneling, paints, solid back splashes, and other materials that do not breathe as this can create a second vapor barrier trapping moisture within construction and cause mold growth. Ensure that all adhesives used with all wall coverings are breathable. Breathable is defined as greater than 10 perms. Wall cabinets, mirror, wall decorations, picture frames, etc. must be mounted on the wall with air space behind these items so as not to create a second moisture barrier trapping moisture.
- f. Use of rapidly-renewable material is encouraged but should be evaluated when used in wall construction. Cellulose, mineral fiber, and glass fiber batts can absorb moisture in high humidity areas and promote microbial growth. In high humidity areas, specify non-absorptive cores and components.
- g. Use modular, moveable and demountable components (floors, carpeting, partitions, etc.) where appropriate to reduce material use and for ease of disassembly, deconstruction and future recycling.

CHAPTER 6 DESIGN & CONSTRUCTION STANDARDS

A10 FOUNDATIONS

Cast-in place and/or pre-cast concrete structures are the construction materials to be used unless otherwise indicated because of long-life span and inherent environmental benefits such as durability to resist rain, moisture and pests; are low VOC-emitting and can be recycled to later provide fill and roadway base material.

A thorough investigation including but not limited to destructive testing related to reuse of existing construction components is required to ascertain suitability for proposed project functions and in anticipation of future adaptive re-use. As an example, lack of an existing vapor barrier under an existing concrete slab for a proposed new air conditioned spaces may create vapor issues. Other necessary information for existing foundations included but are not limited to: concrete strength, footing bearing capacity, and steel reinforcement adequacy of slabs and walls.

The thickness of the base course shall consist of a 100 mm (4 inches) minimum layer of capillary cushion fill layer consisting of ASTM C33 Size No. 67 granular rock.

Ensure that footing excavations and finished grade are adequately sloped away to prevent the accumulation of water at the building perimeter. Foundation excavations and utility trench work shall provide adequate mechanical or natural drainage at all times to prevent trapping of water.

Sustainable Design Strategies

The environmental impacts of concrete construction can be reduced by employing strategies such as:

- a. Recycle wash water during cast-in-place construction.
- b. Use recycled, not contaminated with hazardous materials, crushed concrete and/or regionally extracted and manufactured aggregate (washed coral-limestone).
- c. Use recovered mineral component (pozzolan-fly ash, silica fume). Confirm availability / feasibility of specific materials.
- d. Use low VOC admixtures.
- e. Use recycled plastic fillers.
- f. Retain the exposed concrete floor finish (sealed) to reduce material use. The design of concrete floors, especially on grade, shall address Moisture Vapor Transmission as a cause for floor sealers and floor covering failures. If appropriate, consider the use of breathable concrete sealers or another floor finish and covering.
- g. Detail vapor retarder or waterproofing membranes to control migration of soil gas emissions such as radon into the building interior.
- h. For major renovation projects, consider the reuse of existing (non-hazardous) structural floors, walls, and roof elements.

Geo-Technical Conditions

A Professional Geotechnical Engineer/Seismologist shall determine site soil conditions and make recommendations for bearing capacities and foundation requirements that includes but are not limited to buildings, pavilions, bus shelters, light posts, sign posts, fence posts, retaining walls, and road ways. The Geotechnical Engineer/Seismologist shall also establish the site classification based on geologic conditions for seismic design provisions.

A copy of the geotechnical report shall be kept at the jobsite construction office and ROICC field office and shall be referenced during excavations for foundations and foundation work. Foundation drawing details shall reflect findings of the geotechnical report.

Vapor Barrier

Under foundations on small structures where seismic friction is not compromised and continuously under concrete slabs on grade, the installer shall provide a minimum 15 mil polyolefin geomembrane vapor barrier that meets ASTM E 1745 (Class A), ASTM E 96/E 96M, ASTM E 1745, and ASTM E 1745. Vapor barriers shall be provided under the slabs of all buildings including warehouses and exterior lanai/patio slabs of residential units (except utilitarian type buildings like emergency generator buildings, pump stations and electrical transformer buildings are excluded) because the building or areas' functional use might change. Having the vapor barrier in throughout will provide for adaptability of buildings to differing functions in the future.

At a minimum, provide heavy duty 15-mil polyolefin vapor barrier that is less subjected to punctures and tears and provide a better barrier to prevent moisture and vapor penetration into interior spaces from the subgrade beneath slabs. Vapor barriers under and around slabs and footings are to prevent moisture rising up through the concrete and into interior spaces and the exterior walls leading to moisture problems. Under larger facilities and structures that may require higher friction under foundations for seismic or wind resistance, the use of the vapor barrier shall be analyzed by the Designer of Record to determine whether the vapor barrier under the footings should be used or not used. If not used, the DOR shall consider using fly ash or other concrete additives to provide for low absorption concrete and improve moisture resistance in the concrete below the ground surface to help resist moisture from rising up through the structure. However, the vapor barrier shall still run continuously under the slabs and interior face of footings. The exterior face of footings shall be waterproofed and not have the vapor barrier continuing up the exterior face

For vapor barrier accessories, provide high-density polyethylene tape with pressure sensitive tape with a minimum width of 100 mm. Tape shall be continuously applied over seams. Installer to provide pipe boots. Installer shall follow the manufacturer's installation procedures & vapor barrier accessories shall be by the vapor barrier manufacturer.

A1010 STANDARD FOUNDATIONS

The following are typical foundation types. However, it is not intended to limit the foundation types to those discussed below.

A1010.1 Spread Footings

Individual or continuous and constructed of reinforced concrete with a minimum concrete strength of 3,000 psi.

A1010.2 Mat Foundations

Continuous and constructed of two layers of reinforcement with a minimum concrete strength of 4,000 psi.

A1010.3 Pile Foundations

Square or octagonal shaped pre-cast/pre-stressed concrete piles with a minimum concrete strength of 5,000 psi and with 7-strand Grade 270 ksi pre-stressing cables.

A1010.4 Equipment Pads

Continuous and constructed of one or two layers of reinforcement with a minimum concrete strength of 3,000 psi. Equipment pads shall have foundations to support protective walls and enclosures. Equipment pads shall have sloped slabs, drains with trap primers, or a means to drain water.

A1010.5 Light Pole Foundations

Drilled concrete pier foundation type with a reinforced cage. Light poles and sign posts foundation criteria shall be determined by a geotechnical engineer and designed and stamped by a licensed structural engineer for both Guam's wind and seismic requirements as per the latest adopted IBC and ASCE.

A1030 SLAB ON GRADE

Slab on grades shall be designed for dead and live loads and equipment. Concrete slabs shall be designed to address moisture content and moisture vapor transmission (MVT) concerns in the concrete especially concrete slabs. Selection of concrete design, proper use of vapor barriers, curing compounds, concrete sealers and so forth are essential to preventing floor coating and flooring material failures. Slab on grade types are as follows:

A1030.1 Standard Floor Slab on Grade

Minimum slab thicknesses are recommended to be 5" (125 mm) for exterior slabs and 4-1/2" (115 mm) for other slabs, both with standard reinforcement bars in each direction. The slab shall have a minimum concrete strength of 3,000 psi.

A1030.2 Warehouse / Light Industrial Slab on Grade

Minimum slab thickness is recommended to be 6" (153 mm) with standard reinforcement bars in each direction. For slabs subject to forklift traffic, it is recommended that the minimum compressive strength for the concrete be 4,000 psi (27.6 MPa) for pneumatic tire traffic and 5000 psi (34.5 MPa) for steel tire traffic.

A1030.3 Heavy Traffic Slab on Grade

Minimum slab thickness shall be 8" (204 mm). The slab shall have a minimum concrete Flexural Strength of 650 psi.

A20 BASEMENT CONSTRUCTION

A2020 BASEMENT WALL CONSTRUCTION

Basement wall systems shall be of cast-in-place concrete construction. All below grade structures that are habitable or used as utility spaces shall be waterproofed. These below grade spaces shall be conditioned spaces, designed to prevent moisture and mold and have a means to remove trapped water. Basement floor shall have a vapor barrier underneath the concrete slab and extended continuously up retaining walls above finished grade. A Professional Geotechnical Engineer/Seismologist shall determine site soil conditions and make recommendations for bearing and lateral capacities and design lateral loading for the walls.

B10 SUPERSTRUCTURE

Cast-in place and/or pre-cast concrete structures are the construction materials to be used unless otherwise indicated due to its inherent benefits such as durability to resist rain, moisture and pests; are low VOC-emitting and can be recycled to later provide fill and roadway base material.

Galvanized steel structural elements shall be used at interior of conditioned spaces or long-span structures where concrete-based systems are not feasible. To the greatest extent feasible, all steel framing and fasteners shall be hot-dipped galvanized and painted with highly corrosion-resistant epoxy paint. Use of timber construction and wood frame construction is not allowed for primary structural system and not allowed for exterior framing systems/components, etc.

All exterior construction elements in this section and other elements specifically identified shall meet the requirements for Guam's typhoon winds, wind driven rains, wind borne flying debris, wind topographic effect, corrosion and seismic loads as per UFC and ASCE 7 criteria and sections

4.3 (wind), 4.4 (seismic) and 4.5 (corrosion) and 4.12 (hot humid climate design) which are critical in successfully addressing Guam's challenging environment.

A thorough investigation including but not limited to destructive testing related to reuse of existing construction components is required to ascertain suitability for proposed project functions and in anticipation of future adaptive re-use. As an example lack of an existing vapor barrier under an existing concrete slab for a proposed new air conditioned spaces may create vapor issues. Other necessary information for existing foundations included but are not limited to: concrete strength, footing bearing capacity, and steel reinforcement adequacy of slabs and walls.

Sustainable Design Strategies

The environmental impacts of concrete construction can be reduced by employing strategies such as:

- a. Recycle wash water during cast-in-place construction.
- b. Use recycled, not contaminated with hazardous materials, crushed concrete and/or regionally extracted and manufactured aggregate (washed coral-limestone).
- c. Use recovered mineral component (pozzolan-fly ash, silica fume). Confirm availability / feasibility of specific materials.
- d. Use low VOC admixtures.
- e. Use recycled plastic fillers.
- f. Retain the exposed concrete floor finish with a breathable floor sealer to reduce material use. The design of concrete floors, especially on grade, shall address Moisture Vapor Transmission as a cause for floor sealers and floor covering failures. If appropriate, consider the use of breathable concrete sealers or another floor finish and covering.
- g. Detail below slab vapor retarder or water proofing membranes to control migration of soil gas emissions such as radon into the building interior.
- h. For major renovation projects, consider the reuse of existing (non-hazardous) structural floors, walls, and roof elements.

B1010 FLOOR CONSTRUCTION

Floor construction shall be designed for dead and live loads and seismic load provisions. Floor construction elements may be of the following types:

B1010.1 Structural Frame

Steel structural connectors used in reinforced concrete or precast concrete construction shall be 18-8 austenitic stainless steel type 316 (type 316L if the stainless steel is to be welded) where they are exposed to weather. However, at an absolute minimum, these connectors shall be hot-dipped galvanized steel. All other steel structural connectors used in reinforced concrete or precast concrete construction shall be hot dipped galvanized.

Structural Frame construction may be of the following types:

a. Cast-in-Place (CIP) reinforced concrete frames

Minimum member dimensions shall be in accordance with ACI 318 and detailed with seismic provisions, i.e. confinement reinforcement. Minimum concrete strength for concrete frames shall be 4,000 psi.

b. Steel

Minimum structural strength shall be 36 ksi. Specify recycled content framing. See discussion in Section B10 for limitations for using steel frames. Structural steel framing shall not be exposed to weather, unless written approval is provided by a NAVFAC Structural Engineer, and steel is designed for Guam's corrosive environment by incorporating guidelines of UFC 3-301-01, Appendix B, § B-5.5.

c. Pre-cast reinforced concrete

Minimum member dimensions shall be in accordance with ACI 318 and detailed with seismic provisions, i.e. confinement reinforcement. Minimum concrete strength shall be 5,000 psi.

d. Pre-cast/Pre-stressed concrete

Minimum member dimensions shall be in accordance with ACI 318 and detailed with seismic provisions, i.e. confinement reinforcement. Minimum concrete strength shall be 5,000 psi.

e. Post tension concrete

Shall be designed with seismic provisions, i.e. confinement reinforcement. Minimum concrete strength shall be 5,000 psi.

B1010.2 Floor Decks and Slabs**a. Cast-in-Place (CIP) Reinforced Concrete Slabs**

Minimum slab thickness is recommended to be 6" (153 mm) with standard deformed reinforcement bars in each direction. The slab shall have a minimum concrete strength of 4,000 psi.

b. Pre-Cast/Pre-Stressed Concrete Slabs

Minimum slab thickness is recommended to be 6" (153 mm) with strand reinforcement in one direction and standard deformed reinforcement in the others. The slab shall have a minimum concrete strength of 5,000 psi. This system without a concrete topping shall only be used subject to government approval.

c. Pre-Cast/Pre-Stressed Concrete with Reinforced Concrete Topping

Precast floor elements with strand reinforcement in one direction and standard deformed reinforcement in the others. The precast/pre-stressed floor elements shall have a minimum concrete strength of 5,000 psi. Concrete topping shall have a minimum thickness of 3" (76 mm) with standard deformed reinforcement each way. Concrete topping shall have a minimum concrete strength of 4000 psi.

d. Post-Tensioned Concrete Slabs

Minimum slab thickness is recommended to be 6" (150 mm) with strand reinforcement in one or two directions and standard deformed reinforcement as required. The slab shall have a minimum concrete strength of 5,000 psi.

e. Composite Slabs

Metal pans shall be Composite hot-dipped galvanized construction in accordance with ASTM A123/A123M with perforation. Decks shall be fastened to metal framing required to meet diaphragm and uplift criteria. Minimum concrete strength for concrete topping shall be 4,000 psi. Concrete topping shall be at least 3" (76mm) minimum thick over the high points of the decking pans and with standard deformed reinforcement each way.

B1020 ROOF CONSTRUCTION

Roof construction shall be designed for dead, live, wind (lateral and uplift), and seismic load provisions. All exterior construction elements in this section and other elements specifically identified shall meet the requirements for Guam's typhoon winds, wind driven rains, wind borne flying debris, wind topographic effect, corrosion and seismic loads.

B1020.1 Structural Frame

Steel structural connectors used in reinforced concrete or precast concrete construction shall be 18-8 austenitic stainless steel type 316 (type 316L if the stainless steel is to be welded) stainless steel where they are exposed to weather. However, at an absolute minimum, these connector shall at least be hot-dipped galvanized in accordance with ASTM A153/A153M. All other steel structural connectors used in reinforced concrete or precast concrete construction shall be hot dipped galvanized in accordance with ASTM A153/A153M.

Structural Frame construction may be of the following types:

a. Cast-in-Place (CIP) reinforced concrete

Minimum member dimensions shall be in accordance with ACI 318 and detailed with seismic provisions, i.e. confinement reinforcement. Minimum concrete strength for concrete frames shall be 4,000 psi.

b. Steel

Steel is only allowed for long span conditions. Otherwise use the other allowable systems. Steel frames shall be designed as space trusses, 2-dimensional trusses, post and beam, steel joists and girder or purlins with moment resisting frames. Minimum structural steel strength shall be 36 ksi. Specify recycled content framing. Structural steel framing shall not be exposed to weather, unless written approval is provided by a NAVFAC Structural Engineer, and steel is designed for Guam's corrosive environment by incorporating guidelines of UFC 3-301-01, Appendix B, § B-5.5 and UFGS 09 90 00. To the greatest extent possible, if steel can be fabricated in shorter lengths and field erected (i.e. individual truss sections and purlin sections), then all steel shall at a minimum be hot-dipped galvanized in accordance with ASTM A123/A123M. Where hot-dipped galvanizing is not economically feasible because of the length of members involved, then steel members shall receive a minimum shop-primed coating of a zinc-rich primer with field finish coats of epoxy paint. Also see discussion in Section B10 for further limitations for using steel frames.

c. Pre-cast reinforced concrete

Minimum member dimensions in accordance with ACI 318 and detailed with seismic provisions, i.e. confinement reinforcement. Minimum concrete strength shall be 5,000 psi.

d. Pre-cast/Pre-stressed concrete

Minimum member dimensions shall be in accordance with ACI 318 and detailed with seismic provisions, i.e. confinement reinforcement. Minimum concrete strength shall be 5,000 psi.

e. Post tension concrete

Shall be designed with seismic provisions, i.e. confinement reinforcement. Minimum concrete strength shall be 5,000 psi.

B1020.2 ROOF DECKS AND SLABS**a. Cast-in-Place (CIP) Reinforced Concrete Slabs**

Minimum slab thickness is recommended to be 6" (153 mm) with standard deformed reinforcement bars in each direction. The slab shall have a minimum concrete strength of 4,000 psi.

b. Pre-Cast/Pre-Stressed Concrete Slabs

Minimum slab thickness is recommended to be 6" (153 mm) with strand reinforcement in one direction and standard deformed reinforcement in the others. The slab shall have a minimum concrete strength of 5,000 psi. This system without a concrete topping shall only be used subject to government approval.

c. Pre-Cast/Pre-Stressed Concrete Planks with Reinforced Concrete Topping

Precast roof elements with strand reinforcement in one direction and standard deformed reinforcement in the other. The precast/pre-stressed roof elements shall have a minimum concrete strength of 5,000 psi. Concrete topping shall have a minimum thickness of 3" (76 mm) with standard deformed reinforcement each way. Concrete topping shall have a minimum concrete strength of 4000 psi.

d. Post-Tensioned Concrete Slabs

Minimum slab thickness is recommended to be 6" (150 mm) with strand reinforcement in one or two directions and standard deformed reinforcement as required. The slab shall have a minimum concrete strength of 5,000 psi.

e. Composite slabs – Metal Pan with Reinforced Concrete Topping

Metal pans shall be Composite hot-dipped galvanized construction in accordance with ASTM A123/A123M (grade 75 minimum zinc thickness) with perforation. Decks shall be fastened to metal framing as required to meet diaphragm and uplift criteria. Minimum concrete strength for concrete topping shall be 4,000 psi. Concrete topping shall be at least 2-1/2" (64 mm) minimum thick over the high points of the decking pans and with standard reinforcement each way.

B20 EXTERIOR ENCLOSURE

The building exterior enclosure shall be strong, weather tight, durable, and easy to maintain. The exterior building envelope shall promote energy efficiency; constructed of low VOC-emitting material and reduce heat built-up.

All exterior openings must be sealed to prevent outside warm humid air from entering the building. The entire air-conditioned interior envelope shall be designed to have positive pressure conditioned space and include all soffits spaces with or without ducts, above ceilings, attic spaces, etc. to prevent infiltration of outside warm humid air.

Mechanical and Adhesive Anchors in Hardened Concrete and Masonry: Use only anchor systems that have been issued an ICC-ES report. Anchor systems shall be installed per the requirements of the ICC-ES evaluation services report for the specific anchor, and as required by the manufacturer. Anchors shall be designed to resist wind and seismic loading conditions per Section 3.3 and as related to the specific elements attached to the structure.

All exterior construction elements in this section and other elements specifically identified shall meet the requirements for Guam's typhoon winds, wind driven rains, wind borne flying debris, wind topographic effect, corrosion and seismic loads as per UFC and ASCE 7 (where applicable) criteria and sections [4.3](#) (wind), [4.4](#) (seismic) and [4.5](#) (corrosion) and [4.12](#) (hot humid climate design) which are critical in successfully addressing Guam's challenging environment.

In addition, steel structural connectors used in reinforced concrete or precast construction shall be type 316 stainless steel where they are exposed to weather. All other structural connectors used in reinforced concrete or precast construction shall be hot dipped galvanized. Structural steel framing shall not be exposed to weather, unless written approval is provided by a NAVFAC Structural Engineer, and steel is designed for Guam's corrosive environment by incorporating guidelines of UFC 3-301-01, Appendix B, § B-5.5.

The Designer of Record shall coordinate opening designs (including but not limited to windows, storefronts, and doors) with mold and moisture-resistant floor finishes, wall and ceiling finishes; stem walls, floor drains and trap primers located behind entrance doors and entrance vestibules. Consider recessed floor mats with drainage, door weather-strip and seals for exterior and inner doors of vestibules, storm shutter protection, and other means for water drainage to prevent flooding damage due to typhoon wind driven rains and typhoon wind borne flying debris. Maintain fire egress requirements.

A thorough investigation including but not limited to destructive testing related to reuse of existing construction components is required to ascertain suitability for proposed project functions and in anticipation of future adaptive re-use. As an example lack of an existing vapor barrier under an existing concrete slab for a proposed new air conditioned spaces may create vapor issues. Other necessary information for existing foundations included but are not limited to: concrete strength, footing bearing capacity, and steel reinforcement adequacy of slabs and walls.

Sustainable Design Strategies

- a. For major renovation projects, consider the reuse of existing (non-hazardous) exterior elements.
- b. Use recycled, not contaminated with hazardous materials, regional and recovered materials and aggregates in cast-in-place concrete, pre-cast wall and CMU construction.
- c. Use of pre-cast walls reduces on-site construction waste.
- d. Integral color and pre-finished and textured CMU walls in protected locations may eliminate the need for (VOC-emitting) paints and reduce material use. In exposed locations, textured CMU and concrete surfaces require low-VOC finish coatings or sealers to protect from salt-laden, wind borne exposure.
- e. Specify high thermal insulation performance of the building envelope system, 30% beyond the ASHRAE Standard 90.1 threshold.
- f. Paints, coatings, sealants and adhesives shall be zero or low-VOC content; and mold and mildew resistant. Select finishes that are biodegradable where appropriate.
- g. Consider Building Integrated Photovoltaic (BIPV) modules integrated into window glazing.
- h. Provide ENERGY STAR® -rated windows for residential units.
- i. Retain the exposed concrete sealed floor finish. The design of concrete floors, especially on grade, shall address Moisture Vapor Transmission as a cause for floor sealers to floor covering failures. If appropriate, consider the use of breathable concrete sealers another floor finishes and covering.

Metal Finishes and Types

a. Aluminum

Unless otherwise noted, building entrances, doors, frames, windows, typhoon shutters, louvers, and railings shall be of factory finished aluminum: Aluminum surfaces shall be anodized factory finished conforming to Aluminum Association (AA) 45. AAMA 611, Anodized Architectural Aluminum and AAMA 2604 for greater durability. Finish shall be integral color anodized, designation AA-M10-C22-A42, Architectural Class 10.0175 mm 0.7 mil or thicker.

b. Stainless Steel

Exposed metal building accessories such as gutters, downspouts and other metal housing shall be type 316 stainless steel. (Note: Reinforced concrete-formed gutters shall be used to the maximum extent possible.)

All hardware, operators, fasteners, internal framing and similar items shall be type 316 stainless steel. If type 316 is not available as either standard or as a custom option, then the next highest corrosion resistant stainless steel shall be used.

c. Steel

Where steel frame doors, windows or other exterior elements are necessary because aluminum systems cannot meet the required design strength requirements, they shall be hot dipped galvanized steel. Where elements are too large for possible hot dip galvanizing procedures: a zinc coating, a phosphate treatment, and a shop prime coat of rust-inhibitive paint will be allowed on a case-by-case basis.

B2010 EXTERIOR WALLS

B2010.1 Exterior Closure

For superior durability, resistance to windborne flying debris damage, weather and saline resistance, and thermal efficiency, walls systems shall utilize cast-in-place or precast concrete construction unless otherwise noted. CMU can be only used as described herein. Concrete walls shall have a step joint in the foundation and where the exterior wall meets so this joint prevents windblown rain having direct flow through this joint. All horizontal and vertical joints are to be lapped joints and sealed.

a. Cast-in-Place (CIP) Reinforced Concrete Walls

Minimum wall thickness shall be 6" (153 mm) and reinforced in each direction. Minimum concrete strength for concrete walls shall be 4,000 psi.

b. Pre-Cast Reinforced Concrete Walls

Minimum wall thickness shall be 6" (153 mm) and reinforced in each direction. Minimum concrete strength for concrete walls shall be 4,000 psi.

c. Pre-Stressed Concrete Walls

Minimum wall thickness shall be 6" (153 mm) and reinforced in each direction. Minimum concrete strength for concrete walls shall be 5,000 psi.

d. Fully Grouted Reinforced Concrete Masonry Unit (CMU) Walls

See section 5.2.2.1 for restriction on masonry use. Minimum wall thickness shall be 8" (204 mm) and reinforced in each direction. Minimum compressive strength for CMU walls shall be 1,350 psi with minimum grout strength of 2,500 psi.

Masonry walls should not be considered for the exterior envelope of any significant, inhabited or utility buildings. However, where budgets do not allow for concrete, masonry may be cautiously considered to reduce project costs. In this case, when used for the exterior envelope, masonry must be reinforced, fully grouted and have a protective silicon enhanced EFS or similar coating to protect from interior environments from water caused by wind driven rains.

Restrictions on masonry used do not apply to minor utility enclosures, non-essential utility buildings, including bus shelters and pavilions, interior walls, and exterior screen walls. At the minimum however, masonry exposed to weather shall be waterproofed with an exterior mildew resistant elastomeric coating, to prolong the life of the masonry.

e. Glass Blocks

Due to Guam's high wind velocity, glass blocks edges/joints shall be sealed with sealants on both interior and exterior sides in lieu of grout.

Glass block units shall be made of clear colorless glass. Units shall have polyvinyl butyral PVB edge coating. Units shall have 75% light transmission allowance.

Glass blocks designated as "reflective glass blocks" shall have a highly reflective oxide surface coating of a gray color.

Glass block must comply with ASHRAE 90.1 maximum Solar Heat Gain Coefficient (SHGC) which may limit size and location on exterior walls.

B2010.2 Exterior Louvers and Screens

Exterior Louvers shall have an anodized aluminum finish conforming to the appropriate Base IAP for colors. Screens, fasteners and hardware shall be stainless steel. Wall louvers shall be storm proof type with drainable blade slope of 45 degrees minimum. Wall louvers shall be design to prevent typhoon wind driven rain from passing through and a means for removing storm water trapped inside.

B2010.3 Typhoon Shutters

Typhoon shutters shall provide protection from wind load and air-borne storm debris. Typhoon shutters and components shall be type 316 stainless steel or aluminum with anodized finish. All hardware and fasteners shall also be type 316 stainless steel. Typhoon shutters must carry Federal Emergency Management Agency (FEMA) approvals. Removable shutters are not allowed, as components requiring storage, are often misplaced or lost, and require more installation time.

a. Vertical Coiling (Roll-Up) Typhoon Shutters

Assembly should be recessed into the wall opening flush with wall plane. If roll-up housing protrudes past the wall plane, the top shall be sloped to discourage bird nesting and to prevent corrosion from standing rain water. All coiling shutters shall have interior manual operation or electronic operation with manual back-up operation.

b. Casement (Side Hinged) Typhoon Shutters

Side hinged Colonial casement type shutters shall be hardened with a 1/4" (7 mm) thick minimum solid polycarbonate panel on the interior side attached with type 316 stainless steel hardware & fasteners. Securing brackets of type 316 stainless steel shall be an integral part of the shutters (non-removable), and mechanically locked to secure shutters in closed position.

c. Accordion Typhoon Shutters

The use of accordion type shutters shall require a written exception and supporting documents for review and approval by NAVFAC Marianas, in view of the August 2003 Typhoon Readiness Assessment report which indicated these type of shutters are not reliable in Guam's typhoons.

d. Sliding Casement Typhoon Shutters

Sliding Casement type shutters are not allowed.

e. Awning (Bahama) Shutters

Awning or Bahama type shutters are not allowed.

B2010.4 Balcony Walls & Handrails

Balcony and stair railing and handrails shall conform to the applicable Base IAP and be designed to be able to withstand lateral load requirements in accordance with the UFC and building code requirements. Balcony walls may be concrete or masonry to match the exterior wall construction. Finish aluminum balcony walls and handrails to match the door/window finish or be of type 316 stainless steel. All railings and handrails including railings for accessible ramps

shall comply with ADA and ABA requirements. Refer to section C201090 for stair handrails and guardrails.

a. Aluminum railings and handrails

Aluminum railings and handrails shall be schedule 40 pipe conforming to ASTM B 429 or square aluminum semi-hollow tube with rounded corners conforming to ASTM B 221. Railings shall be coated with a high performance coating or anodized in accordance with AAMA 611, Class I. All fasteners shall be Series type 316 stainless steel.

b. Stainless steel railings and handrails

Stainless steel railings shall have a satin finish type 316 alloy.

B2010.5 Exterior Painting & Special Coatings

Exterior wall finishes shall be mildew resistant. Finish surface shall prevent dirt build up.

a. Cement Plaster

CMU walls typically have a 10mm portland cement plaster application utilizing an acrylic admixture to give additional moisture suppression to control fungus growth plus an elastomeric coating. EFS discussed below is an alternate finish to elastomeric coatings. The Designer of Record should consider the performance differences between the two options with the project-specific requirements.

Stucco (Integrally colored cement plaster) is not allowed.

b. Exterior Wall Paint or Coatings

Paint or coatings shall have additional mildewcide additives for mold and mildew resistance. Design and finish surfaces to prevent dirt build up through selection of smooth or fine texture finishes, designing positive sloping surfaces to drain rain, and incorporating self-cleaning silicone enhancements to paints and coatings.

Elastomeric coatings provide excellent durability, fade resistance, resist cracking, peeling and chipping while bridging hairline cracks. Provide elastomeric coatings with silicone enhancements. Paints and coatings shall be zero or low-VOC content.

- 1) Painting practices shall comply with applicable federal and local laws enacted to insure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates.
- 2) All paint and coatings shall be in accordance with the Master Painter Institute (MPI) standards for the exterior architectural surface being finished. All coats on a particular substrate, or a paint system, must be from a single manufacturer. No variation from the MPI Approved Products List is acceptable. Sheen selection shall be per MPI standards except where sheen is otherwise specifically identified in the design documents.

- 3) Unless noted otherwise, utilize MPI tested systems listed in the MPI Architectural Painting, Exterior System manual to identify appropriate paint coatings. Utilize the “Detailed Performance Premium Grade” systems and comply with all limitations stated in the MPI “Approved Products List” for each system.
- 4) Remove dirt, splinters, loose particles, grease, oil, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. For existing buildings, use MPI Maintenance Repainting Manual to determine the coatings that need to be removed. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-based paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.
- 5) Surface Preparation: Comply with the “Exterior Surface Preparation” section of the MPI Architectural Painting Specification Manual or the “Exterior Surface Preparation” section of the MPI Maintenance Repainting Manual.
- 6) Exterior wall paint and coating shall meet the appropriate Base IAP requirements including colors and finishes.

c. Exterior Finish System (EFS)

The Exterior Finish System shall have a silicone enhancement to the exterior coating to help prevent mold problems and for ease of cleaning. EFS shall have an integral mildewcide and silicone or silicone-enhanced acrylic finish coat.

Use of Exterior Insulation and Finish Systems (EIFS) as an option for exterior walls can be included with the following caveats:

- 1) The EIFS system shall be rated to withstand impact resistance in accordance with ASTM E2486 requirements, manufacturer shall provide third party impact testing certificate for compliance.
- 2) EIFS system shall be warrantied against mold development; Manufacturer/DOR/DB-Contractor shall provide drawing details and specs that specifically address this issue.

B2010.6 Exterior Joint Sealant

Sealants shall be applied to joints that incorporate step, lap or key joints to further provide a positive weather seal. Sealant joint design, priming, tooling, masking, cleaning and application shall be in accordance with the general requirements of Sealants: A Professionals’ Guide from the Sealant, Waterproofing & Restoration Institute (SWRI). All sealant shall conform to ASTM C 920.

Joints shall include proper backing material for sealant support during application, control of sealant depth, and to act as a bond breaker. Use filler boards, backer rods and bond breaker tapes. Confirm with sealant manufacturer if priming should be used. Applied sealant shall be tooled. Tooling shall not compact sealant less than the minimum sealant thickness required. Mask adjacent surfaces to control sealant boundaries during sealant application.

Exterior Joint sealants shall have a maintenance manual for planned scheduled maintenance and replacement of sealants as part of the O&M at facility turn over.

B2020 EXTERIOR WINDOWS

B2020.1 General

- a. Windows shall be heavy-duty commercial quality aluminum system; conform to ANSI/AAMA/WDMA 101. For window reinforcing purposes, concealed type 316 stainless steel or aluminum reinforcing inserts are required. All internal fasteners shall be type 316 stainless steel. Concealed type 316 stainless steel reinforcing for aluminum windows shall be allowed. Aluminum windows to have anodized aluminum finish and color to meet the requirements in the appropriate Base IAP.
- b. Provide nonferrous metal and UV-resistant vinyl weather stripping. Weather stripping shall be factory applied, and limit infiltration to 0.25 cubic feet/min/square foot in accordance with ASTM E 283.
- c. Install windows in accordance with ASTM E2112. The rough opening shall be continuously flashed and designed with a step or lap to prevent water penetration including into wall cavities that may cause water damage and mold growth.
- d. Window screen shall be mounted on the inside of the windows with aluminum window frame screens matching the color of the window frame. Provide the anodized aluminum screen frames with type 316 stainless steel spring clips to hold screen frame securely in window frame. Screen material shall be plastic coated fiberglass. Screens shall be mounted at the interior side of windows and match the color of the window frames.
- e. Operable windows shall open outwards. Provide locks which discourage the opening of windows during HVAC system operation. Provide window guards at all upper floor operable windows of housing projects in compliance with ASTM F2090-01a.
- f. Provide concrete step detail that prevents water from being driven directly under window sills. Install windows according to ASTM E-2112 and seal all exterior window and door rough openings to prevent water infiltration into wall cavities including sealing exterior wall and interior side furred out walls

B2020.2 Storefronts

Exterior storefront systems shall be heavy-duty commercial quality aluminum system with dark bronze anodized finish; conform to ANSI/AAMA/WDMA 101, with doors that swing outward. Storefront doors shall be medium stile.

Install storefronts in accordance with ASTM E2112. The rough opening shall be designed to prevent water penetration including into wall cavities that causes water damage and mold growth.

B2020.3 Exterior Glazing

Exterior windows shall have insulated glazing system (outer glazing low E with an air space and interior glazing that meets latest adopted edition of IBC for hurricane and windborne flying debris).

Consider building energy efficiency, occupant comfort, daylighting, acoustic performance, and security when selecting exterior window and glazing systems. Consider high performance glazing units with low-emissivity (low-e) coatings with high visible light transmittance for better daylighting and a low solar heat gain coefficient (SHGC) in accordance the National Fenestration Rating Council and Guam Building Energy Code.

Coordinate glazing tint with applicable IAP unless otherwise noted, sustainability recommendations and energy requirements. For Navy projects, glazing shall be light bronze tint. Unless otherwise required, unshaded glazing shall be factory tinted; shaded glazing at storefront requiring see-through visibility may be clear, non-tinted.

B2030 EXTERIOR DOORS

- a. All exterior swing doors (including residential) shall open outwards to provide greater resistance to wind pressure. Standard exterior doors shall be 1-3/4" (44 mm) thick, minimum 3'-0" (915 mm) wide, 7'-0" (2134 mm) high.
- b. Refer to NFPA 101 Life Safety Code for exit doors.
- c. Refer to the Americans with Disabilities Act Accessibility Guidelines (ADAAG) for accessibility.
- d. All exterior swing doors shall have top and bottom bolts that are push bar operated or manually operated for added protection from typhoon wind forces at door weak points in the exterior envelope. This is especially important at residential housing as they serve as typhoon shelters for occupants. Ensure applicable code compliance with egress requirements.
- e. Provide nonferrous metal and UV-resistant vinyl weather stripping including thresholds. Weather stripping shall be factory applied, and limit infiltration to 0.25 cubic feet/min/square foot in accordance with ASTM E 283.
- f. To protect against water infiltration, provide a vestibule where possible and weatherstrip both inner and outer doors. Provide drainage and water-resistant finishes in the vestibule.
- g. Door threshold shall have concrete recessed seat and type 316 stainless steel door sill pan flashing with end dams, rear leg and turned-down front leg.
- h. Install doors in accordance with ASTM E2112. The rough opening shall be designed to prevent water penetration including into wall cavities that causes water damage and mold growth.
- i. Designer shall not use exterior screen doors (including residential) as these screen do not meet Guam's typhoon wind speed and flying debris wind requirements.
- j. Exterior door colors shall meet the appropriate Base IAP or approved housing exterior color schemes.

B2030.1 Aluminum doors and frames

Aluminum doors and frames shall be heavy-duty commercial quality with dark bronze anodized finish; conform to ANSI/AAMA/WDMA 101.

B2030.2 Steel doors and frames

Steel doors and frames shall be hot dipped galvanized and may be used only when aluminum doors cannot meet the required criteria such as for force protection, fire ratings or other requirements.

Galvanized steel doors and frames shall be ANSI A250.8. Doors may be specified to be insulated. Galvanized steel doors and frames shall be painted with high grade corrosion resistant automotive urethane finish over an epoxy primer over an etching primer.

- a. Standard Duty Doors – Level 1, physical performance Level C.
- b. Heavy Duty Doors – physical performance Level B.
- c. Extra Heavy Duty Doors – ANSI A250.8, Level 3, physical performance Level A.
- d. Maximum Duty Doors – ANSI A250.8, Level 4, physical performance Level A.
- e. Hardware preparation shall be in accordance with ANSI A250.6. Doors shall be hung in accordance with ANSI A115.16.

B2030.3 Fiberglass doors

For Family Housing, doors shall be reinforced fiberglass type with wood grain finish and available in a minimum of six custom colors. Door frame shall be dark bronze anodized aluminum.

B2030.4 Residential Garage Doors

Hot dipped Galvanized steel with corrosion resistant powder coated finish doors shall be horizontal sections hinged together which operate in a system of tracks to completely close the door opening in the close position and make the full width and height of the door opening available for use in the open position. Sectional overhead doors, door assembly and anchoring system shall meet wind speed criteria in section 3.3. These doors shall be designed to ADA-ABA requirements at accessible housing.

Metal door frames, tracks, angles, plates, torsion springs and accessories shall be hot dipped galvanized and painted. Garage door hardware and fasteners shall be type 316 stainless steel.

Electric garage door openers with wall switch and 2 transmitters per door shall operate doors. Provide limit switches to automatically stop the doors in the fully open and closed positions. Provide easily accessible and user friendly disconnect to automatic door opener to manually operate during power outages. Provide recessed duplex electrical outlets, concealed conduit runs with pull wire, recessed junction boxes, white plastic cover plates for electronic eye safety devices on each side of the garage door, and concealed solid blocking (if wood termite treated) for overhead motor control assembly.

B2030.5 Overhead Roll-up Doors

Overhead roll-up doors and door assemblies shall be hot dipped galvanized factory painted with highly corrosion resistant paint coating. Hardware and fasteners shall be stainless steel type 316. Metal door frames, tracks, angles, plates, torsion springs and accessories shall be hot dipped galvanized and painted. Provide easily accessible and use friendly disconnect to automatic door opener to manually operate during power outages. Overhead roll-up doors, door assembly and anchoring system shall comply with wind speed criteria in section [4.3](#). Depending on the door size, steel may be required for compliance with wind load resistance and force protection needs.

- a. Do not install vision panel unless otherwise required.
- b. Overhead coiling door to meet deflection standard of maximum L/120 of door width.
- c. Provide nonferrous metal and UV-resistant vinyl weather stripping including thresholds.
- d. Roll-up doors shall be operated by electric-power with auxiliary hand chain operation.
- e. Provide stainless steel bollard protection at both sides of exposed wall systems adjacent to door frames. Include bright yellow plastic sleeves to heighten awareness and provide additional corrosion protection. Plastic shall be constructed from 1/8" thick Polyethylene (HDPE or MDPE) and reflective tape for durability and long service life. Bollard covers shall be designed not to fly off during Guam typhoons.

Coiling overhead doors shall have minimum 22 gage thermal insulated slats. Electric operators shall have 3-button switches conforming to NEMA MG 1, NEMA ICS 1, and NEMA ICS 2, and auxiliary hand chain operation, weather-stripping and wind-locks. Doors shall be capable of withstanding the design wind loading of ASCE 7 and still operate normally. Finish of the door shall be hot-dipped galvanized with a painted finish.

B2030.6 Exterior Door Hardware

Provide the services of an Architectural Hardware Consultant (AHC), Certified Door Consultant (CDC), or an Electrified Hardware Consultant (EHC) to assist the Designer of Record in preparation of the door hardware schedule and product selection. The hardware consultant shall sign and seal the door hardware construction submittal. Provide, as far as possible, door hardware of one manufacturer's make. All hardware shall be clearly and permanently marked by the manufacturer where it will be visible after installation.

- a. All hardware shall be type 316 stainless steel. If type 316 is not available as either standard or as a custom option, then the next highest corrosion resistant stainless steel shall be used.
- b. Hardware shall comply with the Americans with Disabilities Act Accessibility Guidelines.
- c. Exterior doors shall have seal and door bottom to prevent wind driven rain from entering.
- d. All exterior door hardware shall be designed meet the requirements for Guam's typhoon winds, wind driven rains, wind borne flying debris, wind topographic effect, corrosion and seismic loads as per UFC and ASCE 7 criteria and sections [4.3](#) (wind), [4.4](#) (seismic) and [4.5](#) Corrosion.

B30 ROOFING

Roofing includes roofing components (fluid applied roofing systems, heavy gauge type 316 stainless steel flashing, concrete gutter integral with concrete roof, steel heavy gage type 316 stainless steel or schedule 40 PVC downspouts, and similar items), penetrations (vents, roof hatches, skylights, etc.), type 316 stainless steel expansion joints and required trim. These roofing elements shall not be roof mounted on new facilities due to previous historical damage from typhoons and incur costly water damage.

Fully-adhered BIPV roof mounted systems may be considered. Since BIPV will not adhere to silicone-surfaced roofing, careful consideration on roof covering selection should be made if there is a possibility that BIPV will be installed on the roof in the future.

The roof assembly including roof coating system shall meet the requirements for Guam's typhoon winds, wind driven rains, wind borne flying debris, wind topographic effect, corrosion and seismic loads as per UFC and sections [4.3](#) (wind), [4.4](#) (seismic) and [4.5](#) (corrosion) and [4.12](#) (hot humid climate design) which are critical in successfully addressing Guam's challenging environment.

Roof coating systems shall provide a minimum 10-year warranty.

Roofing appearance shall meet the appropriate Base IAP.

Place spray-on non-cellulose foam insulation with 15 minute fire barrier under structural decks. Provide gutters and downspouts or overflow scuppers as appropriate to the roofing system provided.

Sustainable Design Strategies

- a. Consider installing radiant barriers with manufacturer's perforated option directly at the inside face of the roof deck to reduce cooling loads and to ensure proper passage of moisture through the radiant barrier. Do not install as to create a secondary vapor barrier.
- b. Insulate concrete roof slabs and ceilings/attics to improve thermal performance and occupant comfort. Consider low-emission (formaldehydes), high recycled content, non-ozone depleting insulation materials.
- c. To reduce heat island effect, use light colored roofing materials having a high solar reflectance (SRI), high infrared emittance, and good convective heat transfer.
- d. Provide roof coatings with low-VOC, recycled content and bio-based content coatings if appropriate.
- e. Follow Best Management Practices (BMP) / Integrated Management Practices (IMP) to comply with Low Impact Development guidelines for roof drainage / disposal.

B3010 ROOF COVERINGS

B3010.1 Steep Slope Roof Systems

This section applies to all roof coverings on a substrate slope of 3:12 pitch or steeper. Steep sloped roofing systems shall be constructed with a minimum slope of 4:12 unless otherwise required by functional criteria.

An elastomeric coating directly applied to a concrete roof deck is the preferred roofing system. The three types of elastomeric roofing membrane to be considered are: polyurethane type, self-cleaning silicone type, and acrylic type with integrated mildewcide / anti-staining agents. Coatings shall be formulated to resist algae and fungi growth, and shall not oxidize or discolor in Guam's hot and humid climates.

Roof systems that will be significantly damaged by Guam's typhoon wind forces and become wind-borne flying debris shall not be used. These systems include but are not limited to: wood, metal and composite shingles; single-ply membrane roofing; built-up membrane roofing including asphalt and modified bitumen systems; and concrete tiles.

Decorative pattern on sloped concrete roofs that do not excessively encourage dirt buildup or mold formation such as simulated tile and battens are encouraged.

Steep roofing visible from the ground or from other buildings shall have selected albedo color with an otherwise lower Solar Reflectance Index (SRI) to help hide dirt and mold. The selected roof color shall meet the appropriate Base IAP.

To reduce heat island effect, use roof coating having solar reflectance index (SRI) or equal to or greater than 29 for steep-sloped roofs. Glare or light reflectance of the roof and the other critical surfaces of the building shall not create an operational hazard to the surrounding areas (e.g. airfields).

Clay tile roof systems shall be S-type, low profile Spanish tiles, fired clay with a factory-applied sealer. Roof tiles shall be installed over a full mortar bed and individually attached directly to the concrete roof slab with type 316 stainless steel fasteners.

Metal roofing systems on concrete substrate may be considered for Navy projects and shall provide a minimum 35-year non-prorated finish warranty and 20-year water tightness warranty. Metal roof system must be installed on a solid concrete substrate and all roof panels and components must be extremely corrosion resistant and comply with required wind load design criteria. Metal panel profile (e.g., standing seam) and fastening system shall not prevent or interfere with the installation of BIPV panels which may be adhered to the metal roof panel surface.

B3010.2 Low Slope Roof Systems

This section applies to all roof coverings on a substrate slope of less than 3:12 pitch. Elastomeric coatings on Low Roof Systems shall be similar to the approved Steep Slope Roof Systems.

Low sloped roofing systems shall only be used for buildings with very large footprints (hangars, warehouses, stadiums, arenas, shopping centers, etc.) and where it is impractical to use a steep sloped roof system for functional reasons.

To reduce heat island effect, use roof coating having SRI or equal to or greater than 78 for low-sloped

Metal roofing on low sloped roofs shall require a waiver per Section [2.3](#).

B3010.3 Roof Insulation & Fill

Roof insulation shall be installed on the underside of the structural roof deck. Provide systems that comply with relevant fire and safety regulations. Provide fire barriers where required. Ensure insulation will not absorb water, to prevent mold/mildew growth.

Unless indicated otherwise, provide spray-applied closed-cell polyurethane or mineral fiberboard insulation where insulation is used. If any other type of insulation is used, a written waiver request shall be required.

Nonstructural fill to create sloped drainage shall not be used and is not an acceptable option to sloping the concrete roof plane.

B3010.4 Gutters & Downspouts

Gutters and downspouts shall be provided for all roofs. Design shall be integral to roof slab. Eliminate non-integral gutters where possible for typhoon hardening.

Concrete gutters cast integrally with the roof slab shall be used to the maximum extent possible. Heavy-gauge type 316 stainless steel standard rectangular shape may be used on certain types of facilities. Downspouts shall be type 316 stainless steel, epoxy-coated-painted cast iron, and /or Schedule 40 PVC. Downspouts shall be connected directly to an underground storm water system, discharge onto splash blocks, or into concrete troughs under walk surfaces adjacent to buildings and extend beyond the building excavation to minimize the accumulation of runoff at the building perimeter. Schedule 40 PVC downspouts are allowed. If not possible, provide concrete splash blocks extending 6" (153 mm) beyond the footing excavations to prevent rain water from entering previously excavated areas (bath tub effect that collects water), or provide a means to drain water out of excavations.

C10 INTERIOR CONSTRUCTION

Rough Carpentry

Unless noted otherwise, rough carpentry shall be concealed from view. Moisture content shall be 19% maximum. Comply with AWPAC C20 or AWPAC C27 for fire-retardant treatment; and preservative treated in accordance with AWPAC standards.

Non Air-Conditioned Interior Spaces

All non-air conditioned interior spaces including but not limited to non-air conditioned garages and stairs shall meet construction criteria for exterior enclosure construction as described in Section B20 Exterior Enclosure and its subsections.

Sustainable Design Strategies

- a. Moisture control and mold-resistant products. Use of rapidly-renewable material is encouraged but should be evaluated when used in wall construction. Cellulose, mineral fiber, and glass fiber can absorb moisture in high humidity areas and promote microbial growth. In high humidity areas, specify non-absorptive cores and components.
- b. Use environmentally preferred materials of recycled-content, locally sourced materials, FSC-certified wood products, and bio-based products to comply with EAP and DoD Procurement guidelines.
- c. For renovation projects, reuse existing (non-hazardous) interior non-structural elements (doors, walls, ceiling systems, floor covering) if possible.
- d. Identify and incorporate salvaged material into the building design (flooring, beams, paneling, cabinetry, ceiling systems, decorative items.)

C1010 PARTITIONS

Wood studs are not allowed.

C1010.1 Interior Concrete Walls

Accomplish work in accordance with UFC 1-200-01. Concrete Mix Design shall be suitable for the job conditions.

C1010.2 Masonry Partitions

Accomplish work in accordance with UFC 1-200-01. Unless noted otherwise, exposed surface shall be smooth cement plaster finish.

C1010.3 Cold-Form Metal Framing/Furring and Gypsum Board

Interior partitions and perimeter furring shall be constructed of ASTM A 653/A 653M G90 galvanized metal studs/furring channels, 25 gage minimum, fastened with ceramic

coated screws. Load bearing cold-formed metal framing is not allowed for building structure; and where otherwise provided shall be designed in accordance with ASTM C 955.

Install in accordance with ASTM C 1007. Use 18 gage metal studs at plumbing walls and supporting hung items such as cabinets, equipment and fixtures. All light gage galvanized steel framing shall have field cuts treated with galvanized rich coating spray. G90 framing is to have paperless sill gasket/tape to separate the G90 floor channel with bottom channel tape from direct contact with the concrete slabs and hold G90 framing held away from exterior walls.

Gypsum board shall be paperless, moisture and mildew resistant. Taping of paperless gypsum board shall be done with non-paper or paperless taping. The bottom of paperless gypsum board shall be undercut 1/2" (13 mm) to prevent water wicking up during potential flooding during typhoons.

At all perimeter walls and at wet locations, provide 4" (102mm) high reinforced concrete curbs with sufficient dowels to the concrete floor slab

In unfinished, and/or unconditioned spaces and industrial work areas, partitions should be painted concrete block masonry, concrete, or pre-cast concrete, as applicable.

a. Perimeter walls

Provide metal furring channels as required to provide space for electrical conduits and required insulation. Where insulation is provided, provide an effective thermal break between metal furring channels and the exterior wall construction. Consider a chase construction with self-supporting steel studs and an air gap thermal break. Install a vapor barrier as required. Provide rigid board (no voids or air gaps, all joints sealed) or spray foam insulation between the furring channels, and paperless gypsum wallboard as the finish material. For walls requiring ceramic tile finish, provide cementitious tile backer board instead of gypsum board.

b. Interior stud partitions

Interior stud partitions shall be constructed of minimum three and five-eighths-inch (3-5/8" or 92 mm) G90 metal studs with painted paperless gypsum wallboard board on each side, except provide cementitious tile backer board where ceramic tile is to be installed.

C1020 INTERIOR DOORS

Bottom of doors shall be undercut to clear floor finish and as required by return air requirements for HVAC design. Painted hollow metal steel doors and frames shall not be used at interiors to and within non-conditioned spaces.

Provide sound insulated door and frame assemblies into rooms requiring wall assemblies to be sound insulated with a Sound Transmission Class (STC) rating as required. The STC rating for the

door and frame assembly shall not be less than the STC rating of the wall where it is to be located unless otherwise allowed in UFC criteria. For walls with high STC ratings, this may require special door assemblies (thicker door, gaskets, etc.) and power assist operation for accessibility.

C1020.1 Standard Galvanized Steel Doors

ANSI A 250.8, Level 1, (occasional use, low abuse types such as closet doors without locks); Level 2, (low use, moderate abuse types such as office/storeroom doors); Level 3, (moderate use, high abuse types such as BEQ sleeping room doors); Level 4, (high use, high abuse types such as corridors, stairways, assembly spaces, and main entry doors), with a physical performance level of 'A'.

Hardware preparation shall be in accordance with SDI 17, ANSI/DHI A115 and ANSI/SDI 100. Doors shall be hung in accordance with ANSI/SDI 100.

C1020.2 Standard Galvanized Steel Frames

ANSI A 250.8. Form frames with welded corners for installation in masonry partitions and knock-down field assembled corners for installation in metal stud and GWB partitions. Frames shall be set in accordance with SDI 105. Form stops and beads with 20 gauge steel.

Provide a minimum of three 18 gauge minimum hot-dipped galvanized jamb anchors and two hot-dipped galvanized steel base anchors per frame, zinc-coated or painted with rust inhibitive paint. Secure frames to previously installed concrete or masonry with expansion bolts in accordance with SDI 11-F. Provide mortar infill of frames in masonry walls, and gypsum board compound infill at each jamb anchor in metal frame walls.

C1020.3 Wood Doors and Frames

Install termite-treated wood doors and frames in accordance with workmanship requirements of the Architectural Woodwork Institute Quality Standard 900-T-4 Custom Grade. Wood door frames may only be used in residential construction. No wood doors are allowed at exterior conditions.

For non-residential buildings provide extra-heavy duty doors for stairways, corridors, assembly spaces, and other high use interior doors. Provide heavy duty doors for other non-residential locations and for residential buildings.

Wood doors shall be solid wood doors with wood core and solid wood edge bands. Vertical edge bands shall be one piece or laminated two-piece solid lumber to match face veneer species for natural finish wood doors. Reinforce door at all hardware attachments to door with sound grade hardwood. Horizontal edge bands shall be solid wood or structural composite lumber. Wood door frames and interior hollow core wood doors may only be used in residential construction.

Residential wood door will be undercut 1" above finished floor for return air & door swing to clear tenant added carpets.

C1020.4 Aluminum Doors, Frames and Storefront

Aluminum doors and frames including framing members, transoms, side-lites, and accessories shall be fabricated in accordance with ASTM B 221, Alloy 6063-TS for extrusions.

Aluminum Frames: Provide frames with removable glass stops and glazing beads to accommodate fixed glazing. Countersink screws for exposed fastenings. Jointing of framing members shall obtain hairline fit, be reinforced, and mechanically secured.

Aluminum Doors: Doors shall be not less than 1-3/4 inches (44 mm) thick, with a minimum wall thickness of 0.125 inch (3.2 mm), except beads and trim, 0.050 inch (1.27 mm). Full glazed stile and rail doors shall have medium or wide stiles and rails.

C1020.5 Fire and Smoke Doors and Frames

Provide in conformance with NFPA 80 and NFPA 105. Fire doors and frames shall bear the label of UL, FM or WHI attesting to the rating required. Door and frame assemblies shall be tested for conformance per NFPA 252 or UL 10B (for neutral pressure) or UL 10C (for positive pressure). Wood fire doors shall also comply with ASTM E 152.

Provide type 316 stainless steel astragals complying with NFPA 80 for fire-rated assemblies and NFPA 105 for smoke control assemblies.

C1020.6 Door Hardware

Provide the services of an Architectural Hardware Consultant (AHC), Certified Door Consultant (CDC), or an Electrified Hardware Consultant (EHC) to assist the Designer of Record in preparation of the door hardware schedule and product selection. The hardware consultant shall sign and seal the door hardware construction submittal.

Provide, as far as feasible, locks, hinges, pivots, and closers from one lock, hinge, pivot, or closer manufacturer's make. All door hardware shall be clearly and permanently marked by the manufacturer, on a location to be visible after installation. Modify hardware as necessary to provide features indicated or specified. Interior door hardware shall be 304 stainless steel, chrome plated solid brass and non-ferrous metal for door closers. Exterior door hardware shall be type 316 stainless steel, chrome plated solid brass and non-ferrous metal for door closers. If type 316 stainless steel is not available by custom order then select the next highest custom ordered corrosion resistant stainless steel available.

C1030 SPECIALTIES

C1030.1 Compartments, Cubicles & Toilet Partitions

At unconditioned spaces, such as park restrooms, compartments, cubicles and toilet partitions shall be special order type 316 stainless steel and if not available, the next highest corrosion resistant stainless steel; solid plastic or 6" steel reinforced CMU / concrete with

type 316 or solid plastic doors. All accessories (stile shoes, hinges, latches, fasteners, brackets, cross bars, hardware, etc.) shall be type 316 stainless steel.

Interior compartments, cubicles and toilet partitions in conditioned spaces may be 304 stainless steel or solid plastic. Metal toilet partitions and urinal screens shall be made of type 316 stainless steel panels. All accessories (stile shoes, hinges, latches, fasteners, brackets, cross bars, hardware, etc.) may be type 304 stainless steel.

Solid plastic partitions shall be fabricated of polymer resins (polyethylene) formed under high pressure forming a single component. Partition thickness shall be one inch. Color shall extend throughout the panel thickness. All accessories (stile shoes, hinges, latches, fasteners, brackets, cross bars, hardware, etc.) shall be type 316 stainless steel.

All toilet partitions shall have overhead bracing across, between stalls and to all surrounding walls.

C1030.2 Toilet & Bath Accessories

At unconditioned spaces, such as park restrooms, finish and assembly shall be special order type 316 stainless steel and if not available, the next highest corrosion resistant stainless steel. Interior toilet and bath accessories in conditioned spaces can be 304 stainless steel. Provide complete toilet and bath accessories including grab bars, shower curtain rod, mirror with stainless steel frame, soap dispenser, soap/shampoo holder, robe hook, toilet paper holder, paper towel dispenser, and trash receptacle.

C1030.3 Firestopping Penetrations

a. Firestopping

Provide asbestos-free firestopping material capable of maintaining an effective barrier against flame, gases and temperature. Provide non-combustible firestopping that is non-toxic to human beings during installation or during fire conditions. Devices and equipment for firestopping service shall be UL FRD listed or FM P7825 approved for use with applicable construction, and penetrating items.

b. Fire Hazard Classification

Material shall have a flame-spread of 25 or less, a smoke developed rating of 50 or less when tested in accordance with UL 723 or UL listed and accepted. Products with a smoke develop rating greater than 50, can be consider if protected by a 15 minute fire barrier as required by code and manufacturer of product.

c. Firestopping Rating

Firestopping materials shall be UL FRD listed or FM P7825 approved for "F" and "T" ratings at least equal to the fire-rating of the fire wall in which penetrated openings are to be protected.

C20 STAIRS

C2010 STAIR CONSTRUCTION

The entire stair assembly shall meet the requirements for Guam's typhoon winds, wind driven rains, wind borne flying debris, wind topographic effect, corrosion and seismic loads as per applicable UFC criteria and sections [4.3](#) (wind), [4.4](#) (seismic) and [4.5](#) (corrosion) and [4.12](#) (hot humid climate design) which are critical in successfully addressing Guam's challenging environment.

Ensure all tread and riser dimensions, handrail and guardrail locations, dimensions and heights and spacing of balustrades comply with the latest adopted editions of the IBC and ADA-ABA guidelines.

C2010.1 Interior and Exterior Stairs

Stair construction shall be compatible with the building construction system. Refer to NFPA 101 for life safety requirements.

Concrete stairs shall be used to the maximum extent possible. Steel stairs, steel with concrete filled pans and wood stairs are not acceptable at exterior stair conditions. All stairs that are not in a conditioned interior space shall be considered exterior stairs.

The following exterior metal stairs alternatives may be used: pre-finished aluminum with fluoropolymer coating, anodized aluminum or type 316 stainless steel stairs.

The following interior metal stairs in air-conditioned spaces may be used: painted, galvanized steel, pre-finished aluminum or anodized aluminum and type 316 stainless steel.

All metal stair fasteners, connectors and accessories shall be of type 316 stainless steel. All exterior stair safety nosing shall be of non-corrosive material.

C2010.2 Stair Handrails, Guardrails & Accessories

Aluminum handrails, guardrails and accessories with clear anodized finish to be used in low occupancy areas; brushed type 316 stainless steel to be used at high occupancy areas. Refer to sections B2010.4 Balcony Walls & Handrails for additional requirements. Maximum openings between vertical and horizontal balustrades or rails shall comply with latest adopted edition IBC requirements.

C30 INTERIOR FINISHES

Sustainable Design Strategies

- a. Use environmentally preferred materials of recycled-content, locally sourced materials, FSC-certified wood products, and bio-based products to comply with EPA and DoD Procurement guidelines.
- b. Paints, coatings, sealants and adhesives used on the building interiors shall be zero- or low-VOC content, and if possible water-based.

- c. Specify wood and agrifiber products and adhesives that contain no added urea-formaldehyde resins.
- d. Use of rapidly-renewable material is encouraged but should be evaluated when used in wall construction. Cellulose, mineral fiber, and glass fiber can absorb moisture in high humidity areas and promote microbial growth. In high humidity areas, specify non-absorptive cores and components.
- e. Use products that are moisture and mold-resistant such as tiles and sealed concrete. Avoid vinyl wall coverings and minimize drywall, carpet, upholstered and textured surfaces and unfinished wood.
- f. Use modular, moveable and de-constructible components (floors, carpeting, partitions, etc.) to reduce material use and for ease of disassembly, deconstruction and future recycling.
- g. Interior finishes shall comply with flame resistant rating for materials as required by the building codes.
- h. All floor finishes and coverings (sealants, carpet, carpet pads, tile joints, etc.) on concrete slabs shall be breathable to allow moisture from concrete to escape and shall not create a second vapor barrier that traps moisture and creates mold situations.
- i. All wall and ceiling finishes shall be breathable to allow moisture to escape and shall not create a second vapor barrier that traps moisture and creates mold situations.

C3010 WALL FINISHES

Refer to C1010 Partitions for additional requirements.

Do not use vinyl-coated wall covering and other impermeable wall coverings as these create a second vapor barrier that trap moisture and create mold situations.

C3010.1 Plaster Wall Finishes

Veneer plaster shall be portland cement plaster finish on concrete or masonry in accordance with ASTM C150, gray portland cement.

C3010.2 Gypsum Wallboard Finishes

ASTM C1178 paperless, mildew resistant gypsum board.

Use fire resistant (type X) gypsum board where required for fire resistant rated construction.

ANSI 108.11 and ANSI A118.9 cementitious backing units shall be used as a substrate for ceramic wall tiles.

Bottom channels and floor area to receive these shall be vacuumed prior to installation of channels and drywall to prevent mold growth.

C3010.3 Tile & Terrazzo Wall Finishes

Provide ceramic wall tile finishes as defined in the Tile Council of America (TCA) handbook for ceramic tile installation and materials for the service requirements listed. Install systems in accordance with ANSI A108/A118. Include all trim pieces, caps, stops and returns to complete installation.

Wall tile with grout joint not greater than 1/8" shall be used but is not limited to kitchen and stove backsplashes, wainscots, restroom walls, tub walls and shower walls. Grout joint sealers must breathe to allow the concrete Moisture Vapor Transmission (MVT) to pass through the grout otherwise wall tile failures could occur. Non-breathing wall surfaces such as stainless steel backsplashes, solid surface wall panels and other impermeable wall coverings shall not be used in order to help prevent a second vapor barrier leading to trapping of moisture and to mold problems.

C3020 FLOOR FINISHES

All floor finishes shall be stable, firm and slip resistant and meet ADA – ABA requirements. Because of Guam's high humidity, substituting the standard adhesive with the manufacturer's adhesive for wet environments should be considered. A knowledgeable trained individual(s) and an accredited laboratory specialized in flooring installations shall conduct all the most current ASTM F1869, ASTM F2170, ASTM F2420, ASTM F710 and ASTM D4541 moisture testing.

C3020.1 Tile Floor Finishes

Provide ceramic tile floor systems as defined in the Tile Council of North America (TCNA) handbook for ceramic tile installation and materials for the service requirements listed. Provide installation and materials in accordance with ANSI A108/A118 series standards, except do not use organic adhesives. Provide manufacturer's full range of colors and styles. Tile shall be a minimum of one grade above base grade.

- a. Mortar shall be Portland cement, ANSI A108.1A/1B/1C/ A118.1, Latex-portland cement, ANSI A108.5/A118.4 or Epoxy ANSI A108.6/A118.3.
- b. Grout shall be factory sanded Portland cement, ANSI A108.10/A118.6, Latex-portland cement, ANSI A108.10/A118.7 or Epoxy ANSI A108.6/A118.3. Provide tile joint grout sealer on white, light colored areas that are routinely exposed to water and liquid cleaning materials, entrance areas, and areas that require a high degree of stain resistance, and as required by the manufacturer. Grout joint sealers must breathe to allow the concrete Moisture Vapor Transmission (MVT) to pass through the grout or this could lead to tile floor failures. Provide chemical resistant breathable (to allow for concrete floor slab's Moisture Vapor Transmission that could cause flooring failure) epoxy resin for kitchens and other areas where high resistance to staining and absorption are required, ANSI A118.3.
- c. Slip resistant tile shall have a minimum Coefficient of Friction (wet and dry) of 0.6, ASTM C1028. Tile shall have smooth, non-slip or textured surface and a glazed or unglazed finish. Non-slip or textured surface required for tile in areas where there is

excessive water or grease and oils such as kitchens, dining facilities, toilets, and in industrial and maintenance facilities.

1) Porcelain floor tile

Porcelain floor tiles shall be a minimum of 5/16 inch (8 mm) thick with a maximum of 1/4 inch (6 mm) grout width with cushioned edge. Tile shall have a minimum breaking strength of 300 pounds (202 kg), ASTM C648 and a maximum absorption rate of 0.5%, ASTM C373. Use in lobbies, corridors, toilets, kitchens, dining facilities, and other areas with minimal maintenance requirements, high resistance to staining, absorption and high durability requirements. Tile shall be color through, impervious, unglazed or glazed finish with an unpolished, semi-polished, polished, or textured surface.

2) Ceramic glazed floor tiles

Ceramic glazed floor tiles shall be a minimum of 5/16 inch (8 mm) thick with a minimum of 1/8 inch (3 mm) grout width with cushioned edge. Tile shall have a 0.5 to 3.0 percent water absorption rate, ASTM C373. Do not use in areas where there is excessive water or grease and oils such as kitchens, dining facilities, toilets, showers, shower drying rooms, building entrance areas, and in industrial and maintenance facilities.

3) Ceramic mosaic unglazed floor tiles

Ceramic mosaic unglazed floor tiles shall be a minimum of 1/4 inch (6 mm) thick with a maximum of 1/16 inch (1.6 mm) grout width with cushioned edge. Tile shall have less than a 0.5 percent water absorption rate, ASTM C373. Use in toilets, showers and shower drying rooms and locker rooms.

4) Quarry floor tiles

Quarry floor tiles shall be a minimum of 1/2 inch (12.7 mm) thick tiles with a maximum of 1/4 inch (6 mm) grout width. Tile shall have a minimum breaking strength of 350 pounds (158 kg), ASTM C648 and a maximum absorption rate of 3%, ASTM C373. Use in lobbies, corridors, kitchens, dining facilities, and other areas with high durability requirements. Use grout release for darker pigmented grout colors. Tile shall have a maximum of 3.0 percent water absorption rate when tested in accordance with ASTM C373. Non-slip, abrasive grain or textured surface required for tile in areas where there is excessive water or grease and oils. Tile shall consist of semi-vitreous, vitreous or clay material with smooth or textured surface and unglazed finish.

C3020.2 Wood Floor Finishes

Wood flooring shall not be used at the first floor except for special circumstances (i.e., required by UFC). If wood strip flooring is used, allow for adequate exposure to air, install as not to create a vapor barrier and provide protection from termites and excess humidity.

Use only in areas that are not subject to flooding, staining, or high traffic. If wood strip flooring is used it shall be detailed in such a manner to allow for expected range of movement due to expansion and contraction. The exterior building enclosure shall be completed, pressure-tested, certified and the HVAC system shall be installed and operational prior to installation of any wood flooring.

C3020.3 Resilient Floor Finishes

Resilient vinyl composition tile (VCT) shall be commercial grade, asbestos free, with a nominal overall gauge of 1/8 inch (3 mm) and a wear layer thickness of 1/8 inch (3 mm) nominal. The tile shall be manufactured in accordance with Federal Specification SS-T-312B (1), Type IV, Comp. 1, Class 2, through pattern. Tile shall be finished in accordance with manufacturer's written instructions.

- a. Where required for high traffic areas, resilient vinyl tile shall be 0.1 inch (2.5 mm) thick, with a vinyl wear layer of 0.035 inches (.9 mm). It shall include a protective urethane finish for ease of maintenance and conform to ASTM E648, Type III, Class 1 and ASTM F1700, Class III. Provide vinyl tile that are easily cleaned with off-the-shelf products. Surface finishes requiring manufacturer supplied or special order cleaning solutions are not acceptable. Vinyl tile flooring shall have a marble, granite, stone or terrazzo pattern. A manufacturer's 10-year warranty is required.
- b. Resilient static dissipative vinyl composition tile (SDT) shall be of commercial grade, asbestos free, with a nominal overall gauge of 1/8-inch (3 mm) and a wear layer thickness of 1/8-inch (3 mm) nominal; with an antistatic additive. The SDT tile shall conform to ASTM F1066, Class 2 through pattern. The flooring shall be installed with the required adhesive and accessories, and finished in accordance with the manufacturer's written instructions. Use SDT floors in computer areas or areas with sensitive electronic where the Project Program requires tiles.
- c. Installing VCT on concrete floor slabs in Guam's hot humid climate is very difficult to do successfully. Provide close quality control for successful installation.
- d. No resilient flooring of any type shall be used at areas fronting exterior doors.

C3020.4 Carpet

Use materials that meet the requirements of UFC 3-600-01 Fire Protection Engineering for Facilities and conform to IBC latest adopted edition code for flame/smoke rating requirements in accordance with ASTM E84. Conform to NFPA 253 ASTM E648 Class I for flooring radiant panel test. Conform to ASTM D2859 for surface flammability ignition test. Physical Requirements: Provide carpet of tufted, woven, fusion bonded, or knitted construction, first quality; and free of visual blemishes, streaks, poorly dyed areas, and other physical and manufacturing defects. Use nontoxic carpet materials and treatments, reasonably non allergenic, and free of other recognized health hazards.

Carpet shall conform to the following:

- a. 100% premium branded, solution-dyed, type 6 or type 6.6 continuous hollow filament nylon
- b. Textured loop pile or textured loop with tip shear as selected in the project's requirements
- c. Machine gauge: 1/12 or 5/64 gauge
- d. Pile height/tufted: high .281 inch, low .187 inch
- e. Yarn weight/tufted: 24 oz.
- f. Pattern repeat: random
- g. Flame resistance: passes methenamine pill test (DOC-FF1-70) and passes ASTM E648 Radiant Panel Test.
- h. 25% recycle material
- i. Carpet, carpet pad and adhesives on concrete floor slabs shall be breathable to allow moisture to escape and shall not create a second vapor barrier that traps moisture and creates mold situations.
- j. All carpets shall be CRI (Carpet & Rug Inst.) Green Label Plus certified.
- k. All Carpets shall be certified NSF/ANSI Standard 140, gold for Commercial Carpets and Rugs.

C3020.5 Wall Base Finishes

Rubber wall base shall be in accordance with Federal Specification SS-W-40 Wall Base: Vinyl Plastic, Type II, Styles A and B. Base shall be 4 inches (100 mm) minimum high, 1/8 inch (3.2 mm) thick, in color as selected.

Ceramic tile wall base shall match either the floor tiles or wall tiles.

C3020.6 Hardeners & Sealers

Exposed concrete floor shall be hardened and sealed with a breathable sealant that allows moisture to escape and shall not create a second vapor barrier that may lead to sealant failure.

C3030 CEILING FINISHES

C3030.1 Acoustical Ceiling Tiles & Panels

- a. **Acoustical Tile** - Shall be moisture/humidity resistant and sag resistant, with sound absorption in accordance with ASTM C 423, Method of Test and ASTM E 1264, Acoustical Ceiling Product.
- b. **Suspension System** - Exposed powder-coated aluminum grid type in accordance with ASTM C 635, Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings and stainless steel wire hangers.

C3030.2 Gypsum Wallboard Ceiling Finishes

Use paperless, moisture and water resistant gypsum board at dry locations.

Use fire resistant (type X) gypsum board where required for fire resistant rated construction.

Use fiber-reinforced cement board at wet and damp locations and for interior soffits.

C3040 INTERIOR COATINGS & SPECIAL FINISHES

All paint and gloss level shall be in accordance with the Master Painter Institute (MPI) standards for the interior architectural surface being finished unless otherwise specified in contract document.

All coats on a particular substrate or a paint system must be from a single manufacturer. No variation from the MPI approved products list is acceptable. All coatings and paints shall contain an integral mildewcide, be breathable to allow moisture to escape and shall not create a second vapor barrier that traps moisture and creates a mold growing environment.

D20 PLUMBING

Sustainable Design Strategies

- a. Select high-efficiency, low water use plumbing fixtures and controls (infrared sensors) to reduce the potable water demand.
- b. Install WaterSense-certified fixtures and fittings where available.
- c. Eliminate materials that are lead-polluting on renovation projects.
- d. Where feasible utilize rainwater collections systems to reduce potable water use (eg. flush toilet and urinals) and provide no net increase in storm water runoff. Landscape irrigation is not allowed except temporary irrigation during the landscaping establishment periods.
- e. Utilize a highly efficient hot water heating system such as a heat recovery from chillers to heat hot water, solar hot water heating system, heat recovery system for hot water heating, or use of heat pumps. Selection of an appropriate system shall be based on a life cycle cost analysis.

D2010 PLUMBING SYSTEMS

Plumbing fixtures shall be energy and water efficient type, and also comply with accessibility requirements in section 3.6.

Provide stainless steel termite mesh barriers at pipe penetrations through new concrete slabs such as Termi-shield, etc. This includes waste line pipe penetrations at water closets and bath tubs.

All toilet water closet tanks, hot water tanks, washers, sinks and similar type plumbing fixtures shall have stainless steel flexible hose connections and shut off valves for both cold and hot water to minimize corrosion and prevent breakage and leaks during seismic events.

D2010.1 Flush Valve WC, Floor Mounted

ASME A112.19.2, white vitreous china, siphon jet, elongated bowl, floor-mounted, floor outlet. Water flushing volume shall not exceed 4.85 liters per flush [1.28 gallons per flush]. Provide white solid plastic elongated open-front seat, large diameter flush valve, angle control-stop valve, and vacuum breaker.

D2010.2 Flush Valve WC, Wall Hung

ASME A112.19.2, white vitreous china, siphon jet, elongated bowl, wall mounted, wall outlet. Water flushing volume shall not exceed 4.85 liters per flush [1.28 gallons per flush]. Provide white solid plastic elongated open-front seat, large diameter flush valve, angle control-stop valve, and vacuum breaker.

D2010.3 Dual Flush Water Closets

ASME A112.19.2, white vitreous china, siphon jet, elongated bowl, dual flush, floor-mounted, floor outlet. Water flushing volume of the water closet shall not exceed 6.1 LPF [1.6 gpf] for solid waste and 4.1 LPF [1.1 gpf] for liquids. Provide white solid plastic open-front seat with cover.

D2010.4 Waterless Urinals

Waterless urinals may be considered for sustainable purposes on a case-by-case basis if allowed by applicable Base standards. A capped waterline is required for waterless urinals to allow for future switchover to ultra-low flow urinals. Follow the specific urinal manufacturer's installation and maintenance recommendations or recommendations in this section whichever is stricter.

Comply with ERDC / CERL TN-06-3 revised January 2007 US Army Corps of Engineers Technical Evaluation recommendations. Care should be exercised in selecting waterless urinals. In order to maintain sanitary conditions, the urinal trap inserts should be replaced two to four times per year. The urinal's immiscible barrier liquid needs to be replenished according to the urinal's use, or approximately once a month, so the urinal maintains its seal. If cleaned with excessive water, the trap seal liquid will be washed down the drain allowing sewer gasses to enter the space. The Designer of Record must insure that responsible installation representatives are aware of these maintenance requirements and approve the use of waterless urinals

D2010.5 Urinals

ASME A112.19.2, white vitreous china, wall-mounted, wall outlet, siphon jet, integral trap, and extended side shields. Water flushing volume shall not exceed 1.89 liters per flush [.5 gallons per flush]. Ultra-low water consumption, 0.473 liters per flush [.125 GPF], fixtures may be considered. Provide concealed chair carriers with vertical steel pipe supports, large diameter flush valve, angle control-stop valve, and vacuum breaker.

D2010.6 Wall Hung Lavatories

ASME A112.19.2, white vitreous china, straight back type, 483 mm (19"), wide by 432 mm front to rear, centerset faucets. Water flow rate shall not exceed 90 mL per second at 414 kPa for residential installations and 30 mL per second for non-residential applications. Provide ASME A112.6.1M concealed chair carriers.

D2010.7 Bathroom, Restroom, & Toilet Lavatories

Lavatories to be integral with countertop (e.g., solid surface material) with top mounted centerset faucets. Provide lever handles where required for accessibility.

Water flow rate shall not exceed 90 mL per second 414 kPa for residential installations and 30 mL per second for non-residential applications.

D2010.8 Kitchen, Breakroom, & Classroom Sinks

ASME A112.19.3, 18 gage stainless steel with integral mounting rim for flush installation, 838 mm wide by 533 mm front to rear, two compartments, sound deadened, with top mounted washerless sink faucets with hose spray, and with 89 mm drain outlet. Provide lever handles where required for accessibility. Water flow rate shall not exceed 90 mL (1.5 gpm) per second at 414 kPa (60 psi) or shall comply with EPA Water Sense Specifications and shall be labeled accordingly. Provide stainless steel drain outlets and stainless steel cup strainers. Provide top

mounted washerless sink faucets with hose spray and UL 430 waste disposer in right compartment.

D2010.9 Janitor Sink

ASME A112.19.2, white vitreous china with integral back and wall hanger supports, minimum dimensions of 559 mm wide by 508 mm front to rear, with two supply openings in 254 mm high back, 75 mm (3") minimum wall waste outlet, cast iron P-trap and stainless steel rim guards, back mounted washerless service sink faucets with vacuum breaker and 19 mm (3/4") external hose threads. Service sink faucet shall have a maximum floor rate of 7.6 Lpm (2 gpm) at 414 kPa (60 psi). Provide lever handles where required for accessibility. Stainless steel janitor sinks are optional.

D2010.10 Mop Sinks

Terrazzo shall be made of marble chips cast in white Portland cement to produce 25 mPa minimum compressive strength 7 days after casting. Provide 3" (77 mm) minimum floor or wall waste outlet, copper alloy body drain cast integral with terrazzo, with polished stainless steel strainers. Service sink faucet shall have a maximum floor rate of 7.6 Lpm (2 gpm) at 414 kPa (60 psi). Provide lever handles where required for accessibility.

D2010.11 Drinking Fountains and Coolers

Wall mounted drinking fountains shall be stainless steel with bubbler and push button control. Electric water coolers shall be ARI 1010, wall mounted, bubbler style, air cooled condensing unit, 15.4 Lph (4.0 gph) minimum capacity, stainless steel receptor, double wall heat exchanger, and all stainless steel cabinet. Provide ASME A112.6.1M concealed wall hangers with thru-bolts and back plates. Provide water filtration system. Drinking fountains and electric water coolers shall be accessible where required.

D2010.12 Shower/Bathtubs

ASTME A112.19.1M white enameled cast iron, can be recessed type, minimum dimensions of 1524 mm wide by 762 mm by 406 mm high (60" x 30" x 16") with drain outlet for above-the-floor drain installations. For residential and housing projects, provide porcelain steel or an engineered material composed of porcelain bonded to enameling grade metal. All bathtubs to have accessible grab bars for fall protection. Consider installing large shower without bathtub in master bathrooms when another bathroom has a bathtub. Shower and tub faucets shall have a maximum 7.6 Lpm (2.0 gpm) flow rate at 414 kPa (60 psi). Provide single lever handle pressure balanced temperature control valve.

D2010.13 Floor Drains

All floor drains shall have trap primers. Floor drains with trap primers located on the interior sides of exterior entrances shall be provided to prevent typhoon wind driven rain from flooding the interiors. Floor drains with trap primers shall also be located in locker rooms, rest rooms, shower rooms, bathrooms, laundry rooms, janitor closets, hot water tank areas, commercial kitchens, condensate drains, large interior spaces behind overhead roll-up doors, and other

areas where water can over flow from the outside during typhoons or where water is used to clean the floors. Floor drains shall be covered during construction to prevent clogging.

Provide rectangle shape floor drains with trap primers close to entrance doors to drain any wind driven rain that may enter the building during a typhoon. This would normally occur at 1st floor entrances.

D2020 DOMESTIC WATER DISTRIBUTION SYSTEMS

- a. Hard-drawn copper pipes and fittings with wrought copper or cast bronze solder joint fittings, Type L aboveground, Type K underground. Provide pipe adapters or dielectric unions as required. Provide termite barrier at all floor penetrations.
- b. Water meters shall be compatible for advanced metering.
- c. Solar hot water heating panels shall be secured to withstand design wind speeds in accordance with the IBC and ASCE 7 latest adopted edition.
- d. All water heating equipment shall be mounted on a housekeeping concrete pad and secured to the building structure with stainless steel strapping.
- e. Insulate all cold water piping in un-conditioned spaces to prevent condensation. Insulation shall be moisture resistant.
- f. Washing machine and dishwasher connection shall utilize flexible hoses to facilitate maintenance
- g. Guam has hard water issues. Water softening or other methods should be developed to deal with the hard water issues that lead to water using equipment failure.
- h. Hybrid heat pump water heaters shall be alternative to solar water heating system.

D2030 SOIL, WASTE & VENT SYSTEMS

Hubless cast iron pipes and fittings for piping aboveground, PVC or ABS Type DWV pipes and fittings aboveground. Provide pipe adapters or dielectric unions as required. Provide termite barriers at all floor penetrations. Consider installing a “black” water backflow preventer valve and clean-out on facility sewer lateral to help prevent sewer water backing up into the facilities floor drains, toilets, sinks, showers and so forth during Guam heavy rains.

D2040 ROOF DRAINS

ASME A112.21.2M, with stainless steel or bronze dome and integral flange, and shall have a device for making a watertight connection between roofing and flashing. Provide overflow drains or scuppers as required by latest adopted edition of IBC and IPC. Where water use is significant, integrate roof drainage system into a rain catchment system for use in water closets and urinals in the building to reduce water consumption and achieve sustainability goals. Roof drains are not allowed to pass through any interior space of a building.

D2090 OTHER PLUMBING SYSTEMS

D2090.1 Radon Mitigation

Radon mitigation should always be considered in the design of facilities, especially in the northern region of Guam and due to prolonged power outages caused by typhoons which could create inadequate ventilation within occupied facilities.

Passive type using Schedule 40 perforated PVC pipes and fittings or CPVC piping where exposed to sun. Provide an active radon mitigation system if required to treat areas with elevated Radon levels.

D2090.2 Backwater Valve

Provide an approved type backwater valve in the main waste line of the facility or housing unit preventing sewage from backing up into the building from an obstructed public sewer. The backwater valve shall be accessible and located at the exterior of the building. The backwater valve is not a substitution for a cleanout-to-grade.

D30 HVAC

Sustainable Design Strategies

- a. Refer to UFC 1-200-02 High Performance and Sustainable Building Requirements and the UFC 3-440 series on passive and active solar building and hot water systems.
- b. Design energy efficient, high-performance HVAC systems to reduce energy consumption and emissions and improve indoor environmental quality by employing an integrated design approach, to the building siting, exterior envelope, lighting and appliance selection, HVAC and controls.
- c. In terms of HVAC, do not oversize cooling systems, consider part-load performance in equipment selection, use of modular HVAC equipment rather than sizing for future expansion capacity, and implement a building commissioning program.
- d. Use catchment water collection to supply cooling towers and specify water conserving cooling towers.
- e. For non-residential facilities, collect air handler condensate water for flushing WC, urinals, vehicle washing, etc. Choose this option first before considering rain water harvesting. Sustainability Report states no permanent potable water irrigation and Guam's rain fall is enough that irrigation is not required for landscaping.
- f. Use chemical-free condenser water treatment to reduce cooling water make-up.
- g. Use non-CFC-based refrigerants in HVAC&R systems to reduce stratospheric ozone depletion.
- h. Use thermal pipes to improve air-conditioning system efficiency without additional use of energy.
- i. Meet or exceed current ASHRAE standards: Thermal Environment Conditions for Human Occupancy, including continuous humidity control with established ranges per Guam's climate zone; and Ventilation for Acceptable Indoor Air Quality.
- j. Use variable air volume controls where appropriate.

- k. Provide individual control over employee's thermal and ventilation environment where possible.
- l. Use equipment that meets or exceeds ENERGY STAR®, FEMP and current ASHRAE 90.1 criteria. All motors shall be premium efficiency type motors.
- m. Use Direct Digital Controls (DDC) for energy efficient operations and monitoring of the air-conditioning and ventilation systems.
- n. Use carbon dioxide (CO₂) sensors that regulate outside air dampers to optimize energy use for outside air while maintaining acceptable indoor air quality per ASHRAE 62.1.
- o. Use ultraviolet lights to improve indoor air quality and maintain cooling coil heat transfer efficiency.
- p. Provide dedicated outside air units to pre-treat all outside air to the HVAC systems for humidity control and improved indoor air quality.

D3030 COOLING GENERATING SYSTEMS

All mechanical equipment that is exposed to the exterior shall be ground mounted on reinforced concrete pads, surrounded by solid 6" (153 mm) reinforced concrete walls or 8" (204 mm) reinforced fully grouted CMU walls with gate (s) that protects mechanical equipment from typhoon flying debris. All walls, gate(s) and anchored mechanical equipment shall meet Guam's wind speed and seismic requirements.

- a. Air conditioning and its components shall be designed in accordance with the requirements provided in UFC-3-440-5N Tropical Engineering.
- b. For new construction projects there shall be no exposed exterior ductwork. For renovation projects exterior mounted ductwork shall be on a case by case basis. If exterior ductwork equipment must be used it shall be approved by the Base and NAVFAC prior to installation.
- c. There shall be no roof mounted HVAC equipment.
- d. Use equipment that can be serviced and maintained on island. Products and equipment specified shall have a local service organization.
- e. Do not use economizer cycles in Guam.
- f. For buildings requiring AT/FP measures, provide an emergency shutdown switch to shut down the entire HVAC system in the event of an HVAC emergency. The shutdown shall close all automotive motorized dampers. All outside air intakes shall be at least 3 m (10') high.
- g. All exterior mechanical equipment shall be provided with corrosion protection including manufacturer's marine grade corrosion coating, type 316 stainless steel screws, and stainless steel exposed parts/hardware.
- h. Due to Guam's hot humid climate and mold problems, the Air Conditioning System shall address controlling indoor humidity including considering separate dehumidification's systems for smaller facilities and housing with AC package units.

There shall be no roof mounted equipment. All air conditioning equipment shall meet the minimum efficiency requirements per ASHRAE 90.1 or Energy Star appliances shall be specified.

D3030.01 Ducted Split Systems, 0.75 To 5 Tons

For Sustainment, Repair, Modernization projects, ductless split unit systems with wall or ceiling mounted evaporator coil-fan, may be considered where ducted system is determined to be infeasible. Minimum SEER shall be in accordance with latest UFC.

D3030.1 Ducted Split Systems, 1.5 To 5 Tons

FS OO-A-374. Provide separate assemblies designed to be used together. Base ratings on the use of matched assemblies. Minimum SEER/EER shall be in accordance with latest UFC.

D3030.2 Ducted Split Systems, Over 5 Tons

FS OO-A-374. Provide separate assemblies designed to be used together. Base ratings on the use of matched assemblies. Minimum SEER/EER shall be in accordance with latest UFC.

D3030.3 Package Cooling Units, 1.5 To 5 Tons

FS OO-A-373, except as modified herein. Factory packaged cooling units. Provide units suitable for outdoor installation. Minimum SEER/EER shall be in accordance with latest UFC.

D3030.4 Package Cooling Units, Over 5 Tons

FS OO-A-373, except as modified herein. Factory packaged cooling units, suitable for outdoor installation. Minimum SEER/EER shall be in accordance with latest UFC.

D3030.5 Chiller, Water Cooled**a. Scroll, Reciprocating, or Rotary Screw Type**

Chiller shall be Premium Efficiency rated in accordance with AHRI 550/590, conform to ASHRAE 15 & 34, and shall include the following components.

- 1) Refrigerant and oil
- 2) Structural base
- 3) Chiller refrigerant circuit
- 4) Controls package (BACnet compatible)
- 5) Scroll, reciprocating, rotary screw
- 6) Compressor driver, electric motor
- 7) Compressor driver connection
- 8) Water cooler (evaporator)
- 9) Air or Water-cooled condenser coil
- 10) Receiver

b. Centrifugal or Rotary Screw Type

Chiller shall be Premium Efficiency constructed and rated in accordance with AHRI 550/590, conform to ASHRAE 15 & 34 and include the following components:

- 1) Refrigerant and oil
- 2) Structural base
- 3) Chiller refrigerant circuit
- 4) Controls package (BACnet compatible)
- 5) Centrifugal or rotary screw compressor
- 6) Compressor driver, electric motor
- 7) Compressor driver connection
- 8) Water cooler (evaporator)
- 9) Air or Water-cooled condenser coil
- 10) Receiver
- 11) Purge system for chillers which operate below atmospheric pressure

D3030.6 Air Cooled Condensers

Condenser shall be a factory-fabricated and assembled unit, consisting of coils, fans, and condenser fan motors, constructed and rated in accordance with AHRI 460.

a. Condenser Casing

Condenser casing shall be hot-dip galvanized steel not lighter than 18 gauge, with vertical, upblast air discharge.

b. Coil

Extended-surface fin-and-tube type constructed of seamless copper tubes with compatible copper fins. Utilize type 316 stainless steel coils at locations in close proximity to the ocean. Coils shall be circuited and sized for a minimum of 5 degrees F subcooling and full pumpdown capacity. Factory leak and pressure tested after assembly per ASHRAE 15 & 34. Coil shall be entirely coated with the manufacturer's standard corrosion resistant epoxy, vinyl coating, or phenolic coating.

c. Fans

Propeller type, direct or V-belt driven, statically and dynamically balanced.

D3030.7 Cooling Towers

Cooling towers shall be protected from typhoon wind loading by a screen walled enclosure. The enclosures would be similar to those specified for smaller mechanical equipment but at a larger scale. The screen walls may consist of concrete or masonry breeze blocks with supporting reinforced concrete columns, beams, and wind girders. The enclosures shall be

designed to resist typhoon and earthquake loading conditions as specified in Chapter 4 Design and Construction Criteria.

a. Description

Factory assembled, induced mechanical draft type, shall include frames and casings, louvers, drift eliminators, partitions, windbreak baffles, drift-check walls, cold water basin equipment, fans and fan walls, blowers, drives, electric motors, access doors, working platforms, inspection plates, and panels.

b. Construction

Tower shall withstand a wind pressure of not less than 30 psf on any external surface. Fan deck shall be constructed to withstand a live load of not less than 60 psf in addition to the concentrated or distributed loads of equipment mounted on the fan deck. The hot condenser water distribution system shall be of the open basin gravity feed type or the pressurized spray header type design.

c. Tower frame and louvers

FRP (Fiberglass Reinforced Plastic) or stainless steel. Intermediate structural members shall be provided for rigidity and support of casings, louvers, fill, distribution systems, fan decks, and other equipment. Inlet air louvers shall permit free air passage but no splashout, and shall be designed to prevent debris and sunlight from entering the cold water basin.

d. Fill

Polyvinyl chloride fill suitable for inlet temperatures to 125 degrees Fahrenheit (F) on cross flow type units and temperatures to 130 degrees F on counterflow type units.

e. Drift eliminators

Assembled in easily removable sections for counterflow induced mechanical draft tower.

f. Cold water basin equipment

Provide cold water basins and casings suitably sealed and flashed at joints and connections to ensure watertight construction. Include sump with removable screen and vortex breaker, float valves, and necessary pipe connections and fittings within the tower.

g. Fans, blowers and drives

Propeller-type fans having not less than four metal blades or squirrel-cage, centrifugal-type blowers. Fans and blowers shall be designed and constructed to withstand 50 percent overspeed above normal maximum operating speeds. Provide cooling tower with a variable frequency drive to control condenser water supply temperature.

h. Interior Tower piping

Schedule 40 plastic piping conforming ASTM D 2996.

i. Vibration cutout switch

Provide vibration cutout switch in a protected position and most effective location. Interlocked with the fan wiring to electrically open the motor circuit under excessive fan vibration.

j. Performance

Cooling Tower Institute certification that the cooling tower will perform thermally at the rating published by the tower manufacturer in his copyrighted literature.

k. Water softening

Provide water softening system for cooling tower condenser water supply.

D3030.8 Pumps

Pumps shall be the electrically driven, non-overloading, centrifugal type selected at or within 5 percent of peak efficiency. Consider the use of variable frequency drive pumps where applicable.

a. Construction

Casing designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 862 kPa. Pump casing and bearing housing shall be close grained cast iron.

b. Mechanical shaft seals

Single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide or ceramic sealing face.

D3040 DISTRIBUTION SYSTEMS**D3040.1 Air Handling Units**

Factory-fabricated single-zone draw-through type units. Units to include fans, coils, airtight insulated casing, prefilters, secondary filter sections adjustable V-belt drives, belt guards for externally mounted motors, access sections, combination sectional filter-mixing box, pan vibration-isolators, and appurtenances required for specified operation. Provide vibration isolators.

a. Casings

- 1) 50 mm double wall type, constructed of minimum 1.3 mm galvanized steel.
- 2) Furnish casings with access sections, inspection doors, and access doors, all capable of opening a minimum of 90 degrees.

- 3) Insulated, fully gasketed, double-wall type inspection and access doors, of a minimum 1.3 mm outer and one mm inner panels made of galvanized steel.
- 4) Double-wall insulated type drain pan constructed of 1.4 mm type 316 stainless steel, conforming to ASHRAE 62.1.
- 5) Casing insulation that conforms to NFPA 90A with not less than 50 mm of the same insulation specified for single-wall casings. Foil-faced insulation is not an acceptable substitute for use with double wall casing. Double wall insulation shall be completely sealed by inner and outer panels.

b. Cooling Coils

Fin-and-tube type coils constructed of seamless copper tubes and copper fins. Provide casing and tube support sheets that are not lighter than 16 gauge galvanized steel, formed to provide structural strength. Coils with more than 50% outside air flow shall be provided with a phenolic coating for corrosion protection.

c. Air Filters

50 mm depth, sectional, disposable type filters of the size indicated with a MERV of 8 when tested in accordance with ASHRAE 52.2.

d. Fans

Double-inlet, centrifugal type with each fan in a separate scroll, dynamically balanced.

e. Access Sections and Filter/Mixing Boxes

Provide access sections. Construct access sections and filter/mixing boxes in a manner identical to the remainder of the unit casing and equip with access doors. Design mixing boxes to minimize air stratification and to promote thorough mixing of the air streams.

f. Dampers

Provide manual dampers at return and outside air connection. Provide motorized dampers as required by ATEP criteria.

g. UVC Lights

Provide UV lights downstream of cooling coil. Provide UV lights with a shut-off and door interlock switch.

h. Variable Frequency Drive (VFD)

Provide VFD for Variable Air Volume (VAV) Air Handling Unit motors over 3.7 kW (5 HP) in capacity. Variable frequency drive shall be protected and located in a well ventilated or air conditioned space. Specify with integral disconnect, bypass feature, and BACnet compatible.

D3040.2 Ventilation**a. In-Line Centrifugal Fans**

Provide in-line fans with centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Use wall type only. Roof mounted fans are not allowed.

b. Centrifugal Type Power Ventilator

Direct or V-belt driven centrifugal type fans with backward inclined, non-overloading wheel. Provide fans with birdscreen, disconnect switch, gravity dampers.

c. Ceiling Exhaust Fan

Centrifugal type, direct driven suspended cabinet-type ceiling exhaust fans. Provide egg-crate design or louver design integral face grille. Mount fan motors on vibration isolators. Furnish unit with mounting flange for hanging unit from above. Provide U.L. listed fans. Provide integral backdraft damper. Provide adjustable control mounted inside fan for balancing.

D3040.3 Air Distribution Equipment**a. Diffusers, Grilles, Registers**

Aluminum. Provide opposed blade type volume dampers for all diffusers and registers, except linear slot diffusers. Provide linear slot diffusers with round or elliptical balancing dampers. All diffusers, grilles and registers shall be aluminum factory painted white with anti-smudge devices and with stainless steel factory painted white on exposed fasteners.

- 1) Diffusers: Aluminum ceiling mounted units with anti-smudge devices. Provide return or exhaust units that are similar to supply diffusers.
- 2) Perforated plate diffusers: Adjustable one-way, two-way, three-way, or four-way air pattern controls. Diffuser faceplates that do not sag or deflect.
- 3) Registers and grilles: Return and exhaust registers with fixed horizontal or vertical louver type similar in appearance to the supply register face. Provide opposed blade dampers at face of registers as required.
- 4) Supply Registers: Double-deflection supply registers. Provide opposed blade dampers at face of registers as required.

b. Variable Air Volume (VAV) Boxes

Suitable for single duct system applications with actuators and controls. Enclosures of galvanized steel not lighter than 0.85 mm.

c. Variable Air Volume Ceiling Diffusers

Consider use of variable air diffuser with integral temperature control and actuator where only a few diffusers (up to four) are connected to a variable air volume system. Ensure variable air diffusers are selected to minimize noise and draft problems over the design pressure range.

d. Ductwork And Insulation For Air-Conditioning

Galvanized steel sheets fabricated and erected in with SMACNA Metal Duct Construction Standards with fiberglass duct external duct insulation, flexible duct insulation wrap where duct is concealed, and rigid insulation where exposed and visible, 51 mm (2") minimum thickness, 24.0 kg/m³ (1.5 lbs/cu.ft.) density. Insulate supply, return and outside air ducts. All ductwork insulation is on the exterior of the ductwork for prevention of mold growth inside ductwork, for better indoor air quality and for easier cleaning of interior ductwork. The installer of the ductwork shall provide a ductwork cleaning plan to maintain indoor air quality and the cleaning plan shall be easy to do. Ductwork installer is to provide access panel to the vertical ductwork and other panels as necessary for ease of cleaning during the periodic ductwork cleaning.

If exterior duct is utilized, it shall be type 316 stainless steel if exposed to the weather.

During Construction, all ductwork openings shall be taped closed to prevent construction dust from entering ductwork. The installer shall clean the ductwork and replace the filters after construction and just prior to turnover of facility.

All ductwork is to be installed in conditioned spaces to prevent condensation problems. All outside fresh air intakes are to be directly ducted to the air handler. The outside air intake and exhaust outlets shall be provided with a motorized damper that shall close upon shutdown of the HVAC system to prevent infiltration of moist humid air into the space. Seal all openings through the wall to prevent moisture penetration.

All soffits and concealed spaces above suspended ceiling including attics shall be conditioned to prevent moisture problems and maintain positive pressure inside the building envelope.

All ductwork shall be located in conditioned spaces.

All showers, locker rooms, restroom, bathrooms, mechanical rooms, janitor closets, closets, etc. shall be conditioned spaces with return air to prevent mold growth and indoor corrosion.

All heat producing equipment, such clothes dryers, shall be located at exterior walls to directly exhaust out the heated air. Do not put ducts for heated air in unconditioned soffits as this causes moisture and mold problems.

D3040.4 Chilled Water Piping System, Valves and Insulation

Piping shall be Schedule 40 black steel pipe with screwed fittings for pipes 2" (51 mm) and smaller, welded or mechanical joints for bigger pipes. Valves, 2" (51 mm) and smaller shall

be ball valves, bronze, bigger than 2" (51 mm) shall be butterfly valves wafer or lug type, cast iron with bronze trim. Insulation shall be cellular glass.

Insulation thickness shall be as follows:

| Pipe dia (D) | Insulation Thickness |
|-----------------------------|----------------------|
| D < 25 mm (1") | 38mm (1-1/2") |
| 25mm (1") ≤ D < 100mm(4") | 50mm (2") |
| 100mm (4") ≤ D < 200mm (8") | 62mm (2-1/2) |
| 200mm (8") ≤ D | 75mm (3") |

Exterior insulated piping shall be provided with a stainless steel jacket.

All insulated piping shall be provided with a vapor barrier and protective jacket.

D3040.5 Condensate Drain

Type M hard-drawn copper with wrought copper soldered joint fittings and 1" (25 mm) thick flexible elastomeric cellular insulation.

Consider condensate collection for re-use in cooling tower make-up on toilets and urinals.

D3050 TERMINAL AND PACKAGE UNITS

D3050.1 Fan coil unit

If individual fan coil units are utilized, incorporate considerations for humidity control including but not limited to the use of pre-cooled outside air, dehumidified outside air, or use of a split coil fan coil unit with one section of the coil dedicated to cooling outside air continuously. Use modulating chilled water control valves in lieu of 2-position valves. Fan coil units shall be fully insulated and provided with secondary drain pans when located over areas sensitive to leaks. Select fan coil units with considering noise factors and locate in areas that provide adequate maintenance access. Provide fan coil units with 3 speed fan control. Where possible, locate the fan coil unit in a lockable closet that is easily accessible. Provide auxiliary drain pans under piping and condensate drains to reduce leak potential.

D3060 HVAC CONTROLS

D3060.1 Programmable thermostats

7-Day programmable thermostat to provide the following:

- 7-day programmable clock with 4 time periods per day
- Holiday scheduling

- c. Cooling Operation LED
- d. Four hour set-back override
- e. Non-volatile memory without the need for batteries
- f. 5-minute compressor cycling protection
- g. Adjustable set point
- h. External input
- i. Pre-occupancy purge
- j. Remote room temperature sensor capability

D3060.2 Direct Digital Control Systems

BACnet Direct Digital Control (DDC) of air conditioning, ventilation system, and other building systems complying with ANSI/ASHRAE Standard 135-2004, "BACnet – A Data Communication Protocol for Building Automation and Control Networks".

D40 FIRE PROTECTION

Sustainable Design Strategies

- a. Use non-ozone depleting products in the fire suppression system.

D4010 FIRE ALARM AND DETECTION SYSTEMS

Refer to UFC 3-600-01 Fire Protection Engineering for Facilities.

Provide combination fire alarm/interior mass notification panels in buildings which can be tied into the existing or future base wide exterior radio controlled mass notification system.

Connect fire alarm control/mass notification system to the base control command center. Coordinate with the installation specific interconnection requirements.

D4020 FIRE SUPPRESSION SYSTEMS

For cross connections, hydraulic calculations must include a minimum drop across backflow preventers of 82.7 kPa (12 psi), or the actual drop, whichever is greater, regardless of type or size.

D4020.1 Wet

When building footprint exceeds 4,645 square meters, provide two remotely located interconnected fire department connections. Where multiple computer or electronic equipment rooms are located such that power to all computer and electronic equipment rooms are disconnected simultaneously, the entire area may be protected by one sprinkler system and one subfloor extinguishing system.

Piping in non-conditioned areas shall be copper.

D4020.2 Dry

Dry Pipe Systems - each dry pipe system shall not exceed 2,839 liters [750 gallons] regardless of delivery time or devices attached. Do not use shop air or compressed gas cylinders for system pressurization.

Piping in non-conditioned areas shall be type 'K' copper.

D4020.3 Pre-action/deluge systems

A releasing panel, independent of the building fire alarm system panel, is required to activate the system. Galvanized piping can be used in deluge systems.

D4020.4 Fire pumps

Fire pumps must be sized so that maximum sprinkler demand plus hose stream allowance will not exceed 140% of rated pump capacity.

Horizontally split fire pumps shall be provided (vertically split case fire pumps are not allowed unless cognizant authority having jurisdiction provides approval).

Number of fire pumps shall be in accordance with UFC-3-600-01

D50 ELECTRICAL

Sustainable Design Strategies

Refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, EO 13423 Technical Guidance-Renewable Energy & Green Power and UFC 3-530-01, Design: Interior and Exterior Lighting and Controls.

- a. Photovoltaic (PV) panels are currently not constructed to withstand damage by wind-borne debris during typhoons in Guam as determined by the latest adopted edition of ASCE and the IBC. If used, they shall be ground mounted and must be protected by a concrete enclosure with chain link screening and wind abatement screen fabric to protect from typhoon wind uplift on PV panels. PV system size requirements and availability of project space must be evaluated to determine feasibility. Refer to Section 5.5 for roof mounting requirements.
- b. Building integrated photovoltaic (BIPV) systems cannot meet typhoon wind criteria in Guam as determined by the latest adopted edition of ASCE and the IBC. The use of thin-film or roof membrane BIPV material adhered to acrylic and urethane fluid-applied roof coating systems is currently undergoing testing by EXWC and will be allowed only if R&D testing concludes it can meet ASCE and IBC requirements.
- c. Source power and reduce peak energy demand by using other energy-efficient power generation systems such as wind-turbines, micro-turbines, biomass, fuel cells and distributed energy resources (DER).
- d. Maximize use of renewable energy technologies that contribute to building energy efficiency: solar water heating, heat pumps, solar-powered exterior lighting fixtures, etc.
- e. Provide advanced metering for electricity consumption, similar to and capable of being integrated with existing advanced metering system components. Provide communications pathways to electrical meters from communications service entrances (usually a building's communications closet/room). Integrate consumption meters for other commodities (e.g. water, steam) as applicable with electrical meters via communications pathways.
- f. Use Building Automating Systems/Energy Management Systems/DDC for lighting systems.
- g. Install energy-efficient systems. Use ENERGY STAR® appliances and lighting and controls that meet or exceed Federal Energy Management Program (FEMP) standards.
- h. Use premium efficiency motors that meet the required efficiency levels (NEMA Premium label).
- i. Provide lighting auto dimming controls, accessible manual controls and glare control.

D5010 ELECTRICAL SERVICE AND DISTRIBUTION

Electrical service and distribution system shall conform to the NAVFAC Marianas Public Works Utilities Criteria, For Design and Construction: Electrical, Sewer and Water, latest approved edition.

Use type 316 stainless steel for all exterior equipment and components; if not manufactured for a particular item, use the next highest corrosion-resistant material.

D5010.1 Pad mounted transformers

Pad mounted distribution transformers shall be in accordance with Section G40, Site Electrical Utilities, paragraph G40.1.1.

D5010.2 Service voltage

For service voltage selection guidelines refer to UFC 3-520-01, Interior Electrical Systems, paragraph 2-1.

D5010.3 Primary service from overhead distribution

Shall be in accordance with Section G40, Site Electrical Utilities

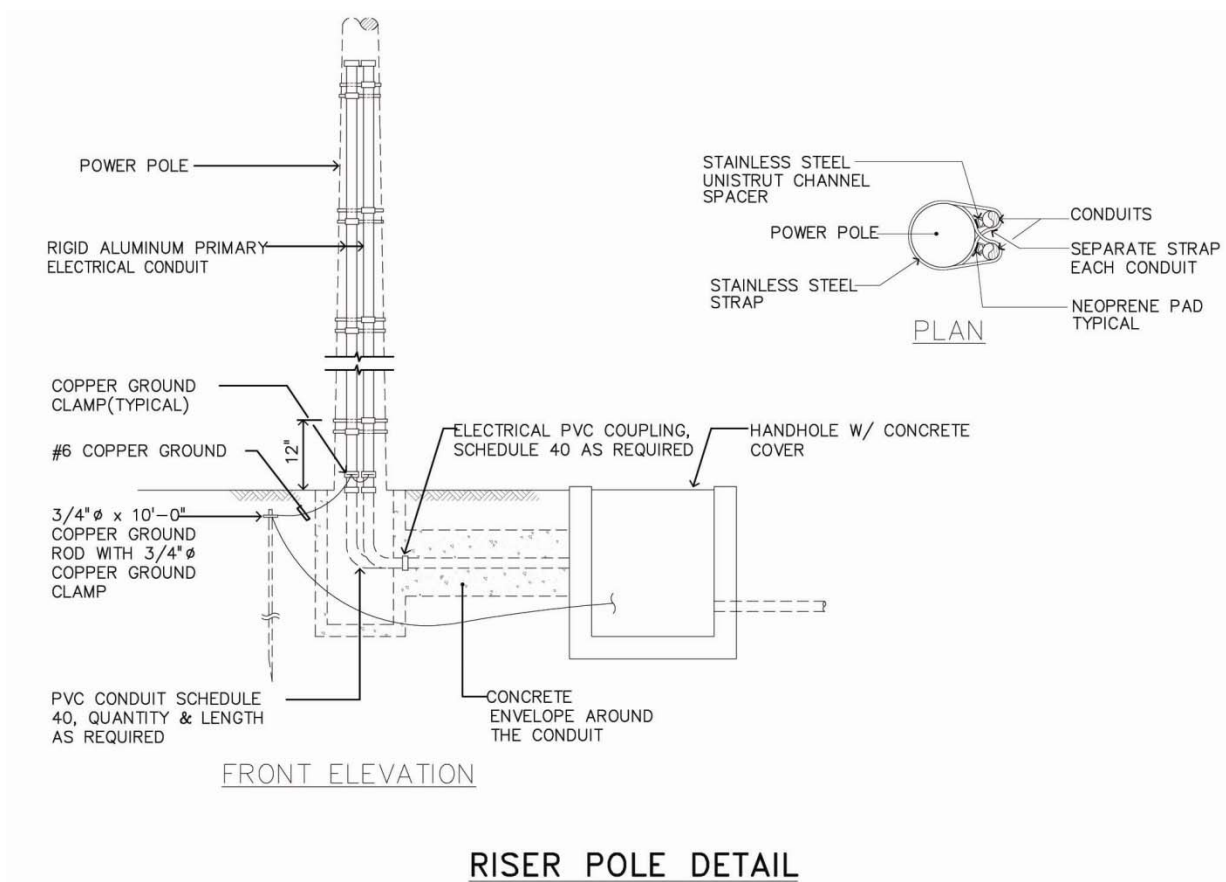


Figure 30: Riser Pole Detail

D5010.4 Secondary service cables

200 A minimum service for dwelling units.

Copper, 600V, Type USE, RHW OR XHHW installed in conduit

Conduit – PVC Schedule 40, encased in concrete.

D5010.5 Power metering system

Automated Meter Reading (AMR) meters, complying with ANSI / NEMA C12.1 Code for Electricity Metering.

Stainless steel NEMA 3 meter base, factory painted.

D5010.6 Transient Voltage Surge Suppression (TVSS)

Provide TVSS at the service entrance equipment. Install as close as practical to the main breaker/lugs.

Comply with UFC 3-520-01 Interior Electrical Systems

D5010.7 Distribution System

Power cables: Copper, 600V: RHW or XHHW insulation for feeders and THHN/THWN insulation for branch circuits

D5010.8 Conduit systems**a. PVC conduit**

- Schedule 40
- Under floor slab and embedded in concrete walls and roof

b. Rigid aluminum or fiberglass conduit

Exposed exterior installation

c. Galvanized rigid steel conduit

Exposed interior locations where rigid aluminum conduit is not allowed

d. EMT

Exposed EMT allowed in air-conditioned interior locations as long as not subject to physical damage and in furred walls and ceilings. Use compression fittings.

D5010.8.5 Intermediate Metallic Conduit (IMC)

Exposed IMC to be allowed in air conditioned interior spaces.

D5010.9 Panelboards

- Copper bus with separate ground bus
- All facilities other than family housing units shall be bolt-on type
- Family housing or inside the living units of dormitory buildings
 - a. Load center with plug-in type circuit breakers
 - b. Emergency type panel with dual mechanically interlocked main circuit breakers for generator power distribution in family units. Refer to Generator provisions for family housing above
 - c. Locate panels in utility room where easily accessible

D5010.10 Dry type transformers

- Refer to UFC 3-501-01 Electrical Engineering and UFC 3-520-01 Interior Electrical Systems for technical requirements.
- Use transformers with a 220 degree C insulation system not to exceed an 80 degree C rise at maximum ambient temperature of 40 degrees C.

D5020 LIGHTING SYSTEM

Refer to UFC 3-530-01 Design: Interior and Exterior Lighting and Controls and UFC 4-711-01 Family Housing.

D5020.1 Indoor lighting

- a. General illumination for office type facility – linear fluorescent light fixtures with parabolic lens. Fluorescent fixtures shall utilize T5 fluorescent lamps. Where specific fixture type selection is not available with T5 lamps, T8 lamps will be acceptable.
- b. Compact fluorescent for small ceiling mounted and wall sconce light fixtures.
- c. Incandescent lighting for supplemental lighting only.
- d. Corrosion resistant housing
- e. Provide dual switching for energy conservation.
- f. Daylighting
 - 1) Maximize daylighting.
 - 2) Provide automatic lighting control to dim or turn off light fixtures when sufficient daylight is available.

D5020.2 Exterior lighting

- a. All lighting must comply with AT/FP requirements (UFC 4-010-01).
- b. Building exterior wall mounted light fixtures shall be used in lieu of post mounted to illuminate areas adjacent to buildings.

- c. Corrosion resistant construction with stainless steel fasteners and hardware.
- d. Exterior lighting system including fasteners and foundation shall be designed to withstand wind load per section [4.3](#) Wind Speed Criteria.
- e. High impact acrylic or high performance glass lens. Polycarbonate lens shall be used if appropriate.
- f. LED, compact fluorescent lamp or HID lamp. Parking area shall utilize LED light fixtures.
- g. Consider solar powered exterior lights in areas with substantial exposure to direct sunlight.
- h. To minimize light pollution, use shielded and full cut-off fixtures, low lighting levels, low luminance ratios and high uniformity where not required for heightened security. Avoid up-lights and globe-type lights.

D5020.3 Automatic lighting control

- a. Exterior lights for facilities other than dwelling units shall be controlled by combination of photocell and photocell activated timer.
- b. Outdoor sports field and courts shall be controlled by combination of photocell, cycle timer, and manual push button switch. Photocell will prevent unnecessary operation of lights during daylight hours. To turn ON the lights manual push button must be depressed to activate the time delay off timer. Lights will automatically turn OFF upon expiration of preset time delay or at sunrise, whichever comes first. Lights could also be turned OFF by manually pressing the OFF button. If additional play time is desired, pressing the ON button will reset the timer.
- c. Provide occupancy sensor and daylighting system control where required in Table 5-5, UFC 3-530-01 and other UFC facility type criteria.

D5030 ELECTRICAL DEVICES

Refer to UFC 3-501-01, Electrical Engineering

D5040 TELECOMMUNICATIONS SYSTEMS

Cabling shall be protected from unauthorized access and accidental damage by placement in conduit, raceways, elevated cable trays, and /or lockable enclosures. Color coordinate all cables and label both ends of each cable to correlate with design drawings and wiring diagrams, and to facilitate easy identification and troubleshooting.

D5040.1 Telephone System

Refer to UFC 4-711-01, Family Housing and UFC 3-580-01 Telecommunication Building Cabling Systems Planning and Design.

D5040.2 Cable Television System

Refer to UFC 4-711-01, Family Housing and UFC 3-580-01 Telecommunication Building Cabling Systems Planning and Design.

D5040.3 Local Area Network (LAN) Computer Station Outlets

Refer to UFC 3-580-01 Telecommunication Building Cabling Systems Planning and Design.

D5040.4 Advanced Metering Infrastructure (AMI)

Install meters and network infrastructure that are compatible with the applicable data collection system that will be used for billing. Compatibility is determined by conformance to existing network architecture and communications methods that are in use.

Implement hardwired communications pathways and electrical power circuits to integrate metering equipment with the existing data collection system, as required by the NAVFAC Marianas Public Works Utilities Criteria.

Provide dedicated lockable enclosures for AMI networked devices. Enclosures are required to have communications pathways to the facility telecommunications room or the facility fiber entrance patch panel where applicable.

D5040.5 Supervisory Control and Data Acquisition (SCADA)

Install controls equipment and network infrastructure that are compatible with the applicable SCADA system that will be used to remotely monitor and control process equipment. Compatibility is determined by conformance to existing network architecture and communications methods that are in use.

Implement hardwired communications pathways and electrical power circuits to integrate SCADA equipment with the existing SCADA system, as required by the NAVFAC Marianas Public Works Utilities Criteria.

Provide dedicated lockable enclosures for SCADA networked devices. Dual-compartment lockable enclosures are acceptable for areas where AMI and SCADA equipment are collocated and where the different systems are maintained in separate lockable compartments. Enclosures are required to have communications pathways to the facility telecommunications room or the facility fiber entrance patch panel where applicable.

D5090 OTHER ELECTRICAL SERVICES

D5090.1 Emergency Power

a. Diesel engine driven generators

- 1) Refer to UFC 3-540-04N Diesel Electric Generating Plants.
- 2) Comply with UFC 3-520-01 Interior Electrical Systems, for emergency generator design criteria.

- 3) Provide alternator winding heater.
- 4) Install generator inside within a concrete building that meets typhoon wind load design criteria per latest adopted editions of ASCE and IBC. Building shall be designed to allow the generator to operate during typhoons. Comply with code required clearance around generator. Shall have good sound attenuation. See Appendix B – Drawings, for Emergency Generator Enclosure conceptual design.
- 5) Consideration should be made to use base mounted fuel tank. If larger tank is required, underground fuel tank meeting EPA requirements shall be used.

b. Automatic and Manual Transfer switches

- 1) Specify Open Transition transfer (Break Before Make) unless closed transition type is functional requirement of the facility.
- 2) Provide switched neutral.
- 3) Provide in-phase transfer monitor.
- 4) Do not install transfer switches outdoor.
- 5) Refer to UFC 3-520-01 for technical requirements.

c. Fuel storage capacity

Provide 2 days minimum of fuel for normal load condition. Refer to National Electrical Code, UFC 3-520-01 and UFC 3-540-04N for Critical facilities requiring larger storage capacity.

d. Generator provisions for family housing

Provide 120/240V, 50A, twist lock outlet, NEMA 4X and matching plug with 12" long -3-#8, 1#10 ground cable.

Provide manual transfer switch, 2P60A double throw switch. Minimum generator load:

- 1) Smoke detectors
- 2) Interior lights
- 3) Living room and corridor receptacles
- 4) Refrigerator
- 5) Freezer
- 6) One kitchen counter top receptacle
- 7) Ceiling fans
- 8) Radon
- 9) Garage door opener
- 10) Dehumidifier.

D5090.2 Emergency lighting

Exit lights shall be red in color, Lights Emitting Diode (LED) type.

Emergency lighting on back-up emergency battery shall be provided in dwelling hallways.

D5090.3 Lightning Protection

Provide lightning protection systems in accordance with NFPA 780, UL96A, and MIL-HDBK-1004/6 criteria. Provide a UL Master label for the facility.

E20 FURNISHINGS

E2010 FIXED FURNISHINGS

E2010.1 Window Treatments

Consider safety for children and pets particularly at residential projects. Provide safety features to avoid potential strangulation hazards using rigid wands, automatic operators or other strategies. Ensure that all vanes and elements that may be in contact with humans and animals do not contain toxic materials such as lead, other toxic elements or poisons.

Standardize vane color to the extent feasible. Vane should be as light in color as feasible to maximize glare-free daylight penetration into spaces. Vane color should be as neutral as possible to harmonize with any future color changes in room finishes.

Select between fabric or solid vinyl vertical vanes based on user function and durability. Select between sheer fabric and opaque fabric vertical vanes as well as standard or S-shaped vanes based on whether filtered light or black-out light blocking is desired for room function.

a. Horizontal mini-blinds

Install at all windows and glass doors where specified, FS AA-V-00200, Type II, one inch slats. Provide matching valance. Standard: Levelor, Riviera or equal. Lengths and widths as required for installation between jambs. Aluminum (or the most corrosion-resistant materials available without having to custom fabricate) vanes for venetian mini-blinds.

b. Vertical louver blinds

Install at all windows and glass doors where specified. Vertical blinds with 3 1/2" (89 mm) vanes fabric or vinyl vanes. Opens fully and closes tightly and will rotate 180 degrees. Provide matching valance and valance end panels.

c. Roller shades

Some building design proposal may require interior automated sun control devices (roller shades) during portions of the day to minimize heat gain and glare from the rising and setting sun on the south, east and west elevations.

F20 SELECTIVE BUILDING DEMOLITION

Sustainable Design Strategies

Refer to UFC 3-210-10N, Low Impact Development for strategies to maintain and restore the natural hydrologic functions of a site, reduce water pollution, and increase groundwater recharge. Generally, sustainable site preparation strategies include:

- a. Maintain existing building structure
- b. Reuse existing interior non-structural elements
- c. Divert construction and demolition debris from disposal in landfills and incinerators; and redirect as recyclable resources.

F2010 BUILDING ELEMENTS DEMOLITION

a. Building Deconstruction:

Use a building deconstruction process, or selective dismantling of building components for reuse, recycling and waste-diversion including soft-stripping non-structural elements and structural elements such as lumber and concrete.

b. Building Re-use:

Extend the life-cycle of existing building materials and reduce waste by retaining building structure and interior elements and reusing non-hazardous components such as doors, hardware, floor decking, ceiling systems, and cabinetry.

F2020 HAZARDOUS COMPONENTS ABATEMENT

Refer to UFC 3-800-10N, Environmental Engineering for Facility Construction.

G10 SITE PREPARATIONS

Prior to site preparations, the DOR shall research and obtain all available site data to identify existing site conditions that may impact the project site design and construction procedures. This may include but are not limited to the following:

- a. Drainage and Flood Control
- b. Groundwater Management Protection Zones and Wellhead Protection Zones
- c. Existing utilities (antenna, communication lines)
- d. Fault lines
- e. Historical, Architectural and Cultural Sensitive areas
- f. MECs (Munitions of Explosive Concern) or UXO (Unexploded Ordnance), complying with the Explosives Safety Submission and the Department of Defense Explosives Safety Board (DDESB)

- g. Landfill areas
- h. Guam EPA for water, sewer and storm water management
- i. Any Natural or Man-made constraints
- j. All applicable permitting and Agency review and/or approvals

Sustainable Design Strategies

Refer to UFC 3-210-10, Low Impact Development for strategies to maintain and restore the natural hydrologic functions of a site, reduce water pollution, and increase groundwater recharge. Generally, sustainable site preparation strategies include:

- a. Grade to encourage storm water sheet flow and lengthen flow paths.
- b. Maintain natural drainage divides to keep flow paths dispersed.
- c. Preserve the naturally vegetated areas and soil types that slow runoff, filter out pollutants, and facilitate infiltration.
- d. Strip and stockpile existing topsoil wherever possible where soil is viable for planting beds. Limit the height of the stockpile to preserve micro-organisms.

Comply with all applicable Federal, State and local mandated cultural resource mitigation agreements, which include but is not limited to, standard operating procedures (SOP) and discovery procedures with appropriate Government notifications when any archaeological, architectural or cultural objects are discovered during drilling or coring efforts.

Comply with the latest amended Explosives Safety Submission (ESS) for MEC requirements during any drilling, sampling and/or testing on the project site. Additional MEC clearance that may be required (eg., deep footings, foundations) to be included in project contingency and the Contractor shall coordinate and report to the COR, NTR (Navy Technical Representative for MEC Clearance and MEC QA for NAVFACMAR.

The Contractor shall provide and follow a Coconut Rhinoceros Beetle (CRB) Management Procedures.

G1010 SITE CLEARING

G1010.1 Debris Disposal

All waste materials shall become the property of the Contractor unless directed otherwise by the Contracting Officer, and shall be transported, disposed of and recycled in accordance with the Contractor's approved C&D Waste Management Plan and Navy's C&D Waste Management Plan.

G1030 SITE EARTHWORK

Earthwork activities shall follow the Guam Environmental Protection Agency Guam Soil Erosion and Sediment Control Regulations and it's Manual. In addition, the following Best

Management Practices (BMPs) shall be incorporated, at the minimum, to prevent storm water pollution:

- a. Prevent or reduce the discharge of pollutants to storm water from dewatering operations by using sediment controls.
- b. Prevent or reduce the discharge of pollutants from paving operations using measures to prevent run-on and runoff pollution and properly disposing of wastes.
- c. Sequence earthwork activity to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.
- d. Carefully plan preservation of existing vegetation to minimize the potential of removing or injuring existing trees, vines, shrubs, and/or grasses that serve as erosion control.
- e. Locate potential sources of sediment so that they minimize the discharge of pollutants.
- f. Provide grass seeding and/or tree/shrub/vine planting to provide long term soil stabilization.
- g. Mulch to temporarily or permanently stabilize cleared or freshly seeded areas.
- h. Use geotextile mats (natural or manmade) to temporarily or permanently stabilize soil.
- i. Utilize dust control measures to stabilize soil from wind erosion, and reduce dust generated by construction activities.
- j. Provide temporary stream crossings such as temporary culvert or bridge across a waterway to provide for temporary access for construction purposes.
- k. Provide construction road stabilization for access roads, housing area roads, parking areas, and other on-site vehicle transportation routes immediately after grading to prevent erosion and dust control.
- l. Provide protection of stockpiles to control the emission of air-borne dust, drainage runoff or erosion problems.

G1030.1 Excavation, Fill & Borrow

See Section G1030 for general earthwork practice associated with excavation and fill.

G1030.2 Soil Treatment

Follow all local and federal laws pertaining to soil treatment for termite control. Provide stainless steel mesh termite barrier system at slab penetrations for buildings with extensive wood cabinets, casework, and furnishings.

G1040 HAZARDOUS WASTE REMEDIATION

The Contractor will be responsible for hazardous material and wastes generated by the project from building demolition, including their testing, manifesting and disposal. Hazardous wastes generated by contractors as a result of improper use and storage of hazardous materials (e.g. spills) shall also be the responsibility of the contractors.

Contractors shall test, manifest, and dispose of their hazardous wastes in accordance with applicable Federal, DoD and Government of Guam regulations. For non-Contractor generated hazardous waste (i.e. from building demolition or pre-existing contamination), the Government will sign the hazardous waste manifest.

G20 SITE IMPROVEMENTS

Site Design follow comply with requirements and guidance in the following documents:

- a. NAVFAC Marianas Public Works Utilities Criteria, For Design and Construction: Electrical, Sewer, And Water
- b. CNMI and Guam Stormwater Management Manual
- c. Guam Storm Drainage Manual, U.S. Army Corps of Engineers
- d. 22 GAR-GEPA, Div. II, Chapter 7
- e. UIC Permit Determination Flow Chart Developed by GEPA
- f. Guam Landscaping Guidelines, June 2011

Sustainable Design Strategies

Refer to UFC 3-210-10N, Low Impact Development and UFC 1-200-02 High Performance and Sustainable Building Requirements.

General Strategies

- a. Use locally-extracted, processed and manufactured aggregate for base course.
- b. Permeable Pavement: Either asphalt or concrete (without fines) over a layer of clean, uniformly graded gravel, underlain with a geotextile fabric. The DOR shall verify the use of permeable pavement with the COR prior to implementation in design.
- c. For pedestrian walkways within the roadway corridor, permeable pavers (running bond pattern) or permeable pavement are preferred.
- d. For pedestrian walkways outside the roadway corridor (i.e. between buildings, in parks, etc.), permeable pavers (running bond pattern) or permeable pavement are preferred.
- e. Best Management Practices (BMPs) shall be incorporated to the final design and during construction activities to the maximum extent practicable to prevent storm water pollution and environmental/public health hazards (e.g. reduced water quality, mosquito breeding).
- f. The DOR shall conform to the UIC Permit Determination Flow Chart developed by GEPA for UIC.
- g. Direct runoff into or across vegetated areas to help filter runoff and encourage groundwater recharge.

- h. Provide small-scale stormwater collection/distribution features and devices to mitigate stormwater impacts such as: bio-retention basins filter strips, grassed swales and infiltration trenches.

Landscape Design Strategies

There are a variety of sustainable landscape design strategies that can help mitigate the adverse environmental impacts of development. The strategies listed below shall be considered on each project for their potential benefit and their reduction of life-cycle costs

- a. Strip and stockpile existing topsoil wherever possible where soil is viable for planting beds. Limit the height of the stockpile to preserve micro-organisms.
- b. Maintain natural stormwater flows by maintaining existing patterns of drainage and respecting natural drainage features like wetlands or streams.
- c. Use vegetated or bioswales to collect and infiltrate water in numerous areas over the site to avoid concentrating flow and adding to the demand for an underground stormwater utility system.
- d. Maintain natural stormwater flows by promoting infiltration with garden roofs, water harvesting, pervious paving, vegetated filter strips, and bioswales.
- e. Vegetated or bioswales shall have a maximum side slope of 3:1 and an average longitudinal slope between 1% and 5%. Plants shall be selected for their deep root systems, ability to withstand periodic inundation, mature height of less than 4 feet, uptake water quickly, and their ability to filter out impurities or pollutants.
- f. River rock or other rock mulch may be used in Bio-swales to retard the growth of weeds while maintaining a stable base during stormwater flushes. Avoid using lightweight or bark mulch in swales.
- g. Planting green walls, screens, hedges, vines on trellises, or green walls can assist in defining outdoor spaces, guide pedestrians towards walkways or entrances, assist in cooling microclimate areas and be a graffiti deterrent.
- h. Only temporary irrigation systems using non-potable water are allowed to establish new landscaping to maximum extent possible. If no non-potable water is available, then the temporary irrigation system may use a potable water source with the approval of the COR.
- i. Use highly efficient irrigation systems that deliver more of the water directly to the plants and lose less to evaporation, wind, or overspray onto paved surfaces. Irrigation monitoring equipment such as rain sensors, moisture sensors and wind sensors may help further reduce water use. Consider irrigation controllers with a seasonal adjustment feature to reduce water consumption in the rainy season.

- j. Collect stormwater from adjacent building roofs, parking lots, streets or other paved surfaces for use in an irrigation system or to passively irrigate planting areas to the maximum extent possible.

G2010 ROADWAYS

Asphaltic Concrete (AC) Pavement: Minimum standard thickness shall be two inches (2" or 50 mm) asphaltic concrete over minimum eight inches (8" or 200 mm) thick compacted base course or as recommended by the project soils engineer, whichever is higher. Asphaltic concrete pavement material shall be designed in accordance with OICC Marianas 123C Specifications and applicable UFC and UFGS references. Asphalt cement binder shall conform to AR-8000.

G2010.1 Curbs & Gutters

- a. Unless existing site conditions require compatibility with existing curb and gutter, curbs shall be six inches (6" or 152 mm) as measured from the gutter flow line and provided with a twenty-four inch (24" or 610 mm) wide gutter. When gutters do not terminate at storm drains, catch basins, or other outfall, a cutout shall be provided in the gutters to allow them to drain.
- b. The use of curbs and gutters shall be minimized to encourage overland flow and conform to LID BMP's and IMP's
- c. Roads and parking lots shall be designed with curb openings or inlets integrated with green street amenities.
- d. Curb cuts shall be provided at street intersections and as necessary from handicapped parking spaces

G2010.2 Marking & Signage

- a. Refer to the latest approved edition of the Manual on Uniform Traffic Control Devices (MUTCD) as the primary guidance for signage and markings
- b. Painted pavement markings shall be used for parking stalls, traffic direction indicators, centerlines, handicapped accessible routes, and loading zones. Refer to Federal Specification FS-TT-P-1952D Paint, Traffic and Airfield Marking, Waterborne, FS-TT-B-1325C Beads Reflective , and/or thermoplastic reflectorized pavement marking compound material.
- c. Raised reflective markers shall be used for roadway centerlines and for fire hydrant indicators. Provide pavement edge markers for roads without curbs.
- d. The use of High Build Acrylic Coating (HBAC) shall not be considered for pavement marking.
- e. All signage shall be aluminum or type 316 stainless steel.

- f. Signage shall be securely anchored and fastened to withstand design wind pressures per Section [4.3](#) Wind Speed Criteria.

G2020 PARKING LOTS

Parking lot design shall conform to:

- a. UFC 3-201-01 Civil Engineering
- b. National Fire Protection Agency (NFPA) Regulations for minimum dimensions of roads, fire lanes, parking lot stalls, and parking lot lanes
- c. UFC 4-010-01, DoD Minimum Anti-Terrorism Standards for Buildings

Asphaltic Concrete (AC) Pavement: Minimum standard thickness shall be two inches (2" or 50 mm) asphaltic concrete over minimum eight inches (8" or 200 mm) thick compacted base course or as recommended by the project soils engineer, whichever is higher. Asphaltic concrete pavement material shall be designed in accordance with OICC Marianas 123C Specifications and applicable UFC and UFGS references. Asphalt cement binder shall conform to AR-8000.

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- d. The use of High Build Acrylic Coating (HBAC) shall not be considered for pavement marking.
- e. Signage shall be securely anchored and fastened to withstand design wind pressures per Section [4.3](#) Wind Speed Criteria.
- f. All signage shall be aluminum or type 316 stainless steel.

G2030 PEDESTRIAN PAVING

G2030.1 Pedestrian Paved Surfaces

If permeable pavers or permeable pavement cannot be used, use paver blocks or stamped concrete as follows:

- a. Paver Blocks: Running bond pattern, with ½" (13 mm) thick sand cushion over 6" (153 mm) thick compacted base course.
- b. Stamped Concrete: Four-inch thick stamped (running bond pattern) concrete over 6" (152 mm) thick compacted base course.

G2030.2 Sidewalks & Ramps

If permeable pavers or permeable pavement cannot be used, use four inch (4" or 102 mm) thick concrete with broom finish and smooth troweled edges with control joints at four feet (4' or 1220 mm) on center, over six inch (6" or 152 mm) thick compact base course.

G2030.3 Jogging / Bicycle Paving

For bike paths outside the roadway corridor, minimum standard shall be two inches (2" or 51 mm) thick asphalt-concrete pavement over four inches (4" or 102 mm) thick compacted base course.

Eleven-foot (3.4 meter) wide jogging/bicycle path design shall comply with AASFTO Guide for the Planning, Design and Operation of Bicycle Facilities, latest edition.

G2040 SITE DEVELOPMENT

Site furniture, playground equipment, fencing, signage, and other outdoor equipment including frames and fasteners shall be designed, manufactured and secured to meet wind load criteria in Section [4.3](#) Wind Speed Criteria.

All exterior metal hardware, frames, anchors, plates, fasteners, etc., shall be made with ASTM type 316 stainless steel. For playground equipment not available in stainless steel, those parts shall be hot dipped galvanized with high-quality corrosion-resistant coating.

G2040.1 Fences & Gates

Perimeter fences shall be aluminized (aluminum coated steel) fencing components, including fence fabric in accordance with ASTM A-491, post, rails, braces and gates in

accordance with ASTM B211-03 and verified by the COR for appropriate locations. Polyvinyl chloride (PVC) coatings shall be in color and a minimum thickness of 2 mm (0.10 inches). Verify if top and/or bottom tension wires and top and/or bottom rails are to be provided; where tying into an existing fence, match fencing system.

Provide an ornamental or decorative fence of aluminized (aluminum coated) steel with a colored vinyl or other approved coating for recreational or housing fences as verified and approved by the COR. Polyvinyl chloride (PVC) coatings shall be in color and a minimum thickness of 2 mm (0.10 inches). An optional decorative fence type is hot-dipped galvanized steel with a colored vinyl coating, which shall be verified with the COR.

For the security fence, provide a minimum of one single line fence surrounding the restricted area. Provide security clear zones as required. Ensure that the fabric height is at least 2.1 m (7 feet) high. Provide outriggers and three strands of barbed wire.

Perimeter and security fences shall conform to the applicable base installation appearance plan as appropriate (see [4.11](#)) and be reviewed by the PAO or Base Security officer.

G2040.2 Retaining Walls & Freestanding Walls

The Designer of Record shall verify the type of retaining or freestanding wall with the Contracting Officer to be designed. The walls shall either be made of cast-in-place concrete, concrete masonry unit (CMU), or concrete rubble masonry (CRM). The retaining walls and freestanding walls shall meet the requirements in Chapter 3, for all appropriate wind, seismic and lateral loading affects.

G2040.3 Security Structures

Vehicular barriers shall be made of either precast reinforced concrete or Class B, Type 2 w-beam or three beam barrier system with non-corrosive paint coat. Fasteners shall be made of hot-dipped galvanized or type 316 stainless steel.

Permanent Bollards shall be installed in pipe sleeves embedded in concrete and filled with non-shrink grout or quick setting anchoring cement. The bollards shall be made of either hot-dipped galvanized Schedule 40 or type 316 stainless steel pipe, concrete filled and painted with a non-corrosive paint.

G2050 LANDSCAPING

Landscape shall be in accordance with the applicable base installation appearance plan as appropriate (see [4.11](#)).

G30 SITE CIVIL/MECHANICAL UTILITIES

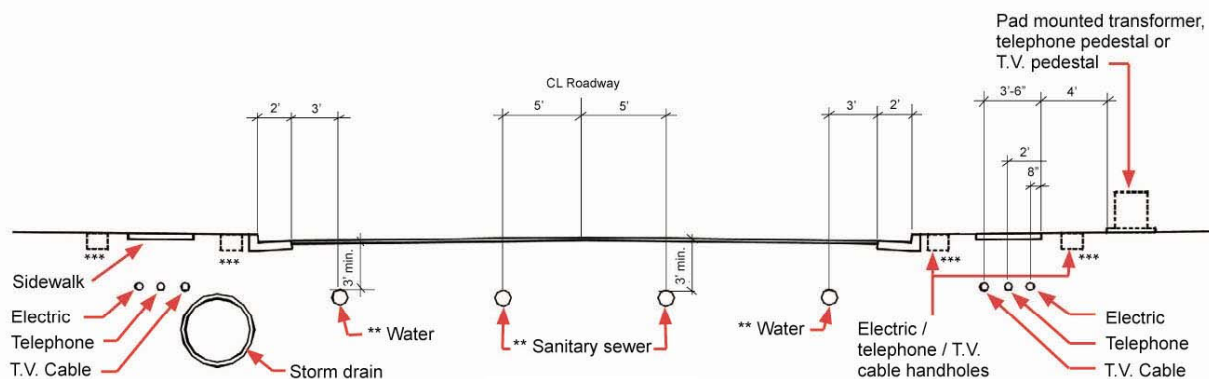
In general, civil and mechanical utilities should be designed to minimize visual impacts, maintenance and repair. The Designer of Record shall comply with NAVFACMAR PW Utilities Criteria, For Design and Construction: Electrical, Sewer, and Water, latest approved edition for all utility design.

Sustainable Design Strategies

The environmental impacts of concrete construction can be reduced by employing strategies such as:

- Refer to UFC 3-210-10, Low Impact Development and UFC 4-030-01, Sustainable Development for site and utility sustainable strategies.
- Use potable water efficiently by eliminating leaks; caulking around pipes and plumbing fixtures; and conducting annual checks of hoses and pipes.
- Reuse or recycle water onsite.
- Collect rainwater from roofs with cisterns.
- Use roof water, groundwater from sump pumps, and non-sewage wastewater for on-site activities such as landscape irrigation, cooling tower make-up and other industrial uses and processes, fire sprinkler systems, and sewage conveyance.
- The Designer of Record (DOR) shall coordinate with NAVFACMAR for placement of utilities outside the traveled roadway when available to the maximum extent possible.

Typical roadway utility location



Notes:

1. Mainline utilities shall have a minimum cover of 2.5' (762mm) unless otherwise specified
2. * Whenever possible the storm drain shall have a minimum cover of 3.0' (914mm)
3. ** Alternate location of utilities
4. *** Locate handholes to keep sidewalk smooth and clean

Figure 31: Typical Roadway Utility Location

G3010 WATER SUPPLY

- Refer to UFC 3-230-03A, Design: Water Supply for design of water supply systems on the Installation.
- Refer to UFC 3-230-04A, Design: Water Distribution for design of water distribution systems on the Installation.

- c. Guam EPA Administrator's design approval of the water system is needed at the 30%, 90% and Final design stages
- d. All lines should be underground.
- e. Above-ground appurtenances should be screened to blend with the surrounding environment.
- f. Treatment facilities should be screened from view of major roads and other Installation facilities by landscape, berms, walls and/or fences.
- g. Access for maintenance and repair vehicles shall be provided to minimize disruption to circulation systems.
- h. Pipe and appurtenance materials should be selected to withstand Guam's tropical climate and seismic conditions.
- i. Seismic restraints shall be provided for all connections and supports.
- j. Water distribution mains indicated as 100 through 400 mm (4 through 16 inches) diameter pipe sizes shall be polyvinyl chloride (PVC) plastic pipe, and as an option ductile-iron may be considered. Provide high density polyethylene (HDPE) pipe for 400 mm (16 inch) diameter or larger pipe sizes. Verify with NAVFACMAR for the appropriate use of HDPE as water distribution mains. The designer shall have the option of selecting High Density Polyethylene (HDPE) Plastic Piping, but shall verify if there are any adverse effects with long term exposure to chlorinated water on HDPE pipe. Pipe, tubing, and heat-fusion fittings for High Density Polyethylene pipe shall conform to AWWA C906, ASTM D 3035 and ASTM D 3261. The designer shall have the option of selecting Fusible Polyvinyl Chloride (PVC) Pipe, conforming to AWWA C-900/C-905, but shall verify with the Contracting Officer prior to designing.
- k. The following materials for water piping will not be allowed: filament-wound or centrifugally cast reinforced thermosetting resin pipe (RTRP), reinforced plastic mortar pressure pipe (RPMP), reinforced and prestressed concrete pipe, acrylonitrile-butadiene-styrene (ABS) plastic pipe, or steel pipe
- l. Air/vacuum valves and blow-off assemblies on high and low points of pipelines shall be installed at locations determined by the DOR (Designer of Record).
- m. Copper tubing shall not be installed in the same trench with ferrous piping materials.][Where nonferrous metallic pipe, e.g. copper tubing, cross any ferrous piping, provide a minimum vertical separation of 300 mm (12 inches) between pipes.]

G3010.1 Potable Water Storage

Refer to UFC 3-230-09A, Design of Water Storage Systems, for design of water storage tanks on the Installation.

A water storage tank can serve as an Installation landmark and provide visual strength in its form.

Access for maintenance and repair vehicles shall be provided to minimize disruption to circulation systems.

G3010.2 Fire Protection Water Distribution

Fire hydrants should be highly visible and free of any screening.

Fire hydrants shall be of uniform design throughout the Installation.

G3020 SANITARY SEWER

- a. Refer to UFC 3-240-04A, Design of Wastewater Collection System, for design of wastewater collection systems on the Installation.
- b. Guam EPA Administrator's design approval of the water system is needed at the 30% and 90% design stages.
- c. All lines should be underground.
- d. Above-ground appurtenances should be screened to blend with the surrounding environment.
- e. Treatment facilities should be screened from view of major roads and other Installation facilities by landscape, berms, walls and/or fences.
- f. Access for maintenance and repair vehicles shall be provided to minimize disruption to circulation systems.
- g. Pipe and appurtenance materials should be selected to withstand Guam's tropical climate and seismic conditions.
- h. Seismic restraints shall be provided for all connections and supports.
- i. The use of polyvinyl chloride (PVC) C-900 pipe may be permitted for use as pressure pipe and the Designer of Record shall verify with the Contracting Officer.
- j. The following materials for sewer piping will not be allowed: concrete pressure pipe, clay pipe, concrete gravity pipe, ductile iron gravity pipe, ABS composite pipe, ABS solid wall pipe, reinforced plastic mortar pipe (RPMP), and reinforced thermosetting resin pipe (RTRP).
- k. Where the location of the sewer is not clearly defined by dimensions on the drawings, do not lay sewer line closer horizontally than 3 m (10 feet) to a water main or service line. Install pressure sewer lines beneath water lines only, with the top of the sewer line being at least 0.60 m (2 feet) below bottom of water line. Where sanitary sewer lines pass below water lines, lay pipe so that no joint in the sewer line will be closer than 0.9 m (3 feet), horizontal distance, to the water line. Where the location of the sewer is not clearly defined by dimensions on the drawings, do not lay sewer line closer horizontally than 3 m (10 feet) to a water main or service line. Install pressure sewer lines beneath water lines only, with the top of the sewer line being at least 0.60 m (2 feet) below bottom of water line. Where sanitary sewer lines pass below water lines, lay pipe so

- that no joint in the sewer line will be closer than 0.9 m (3 feet), horizontal distance, to the water line.
- l. Where sanitary sewer lines pass above water lines, encase sewer in concrete for a distance of 3 m (10 feet) on each side of the crossing, or substitute rubber-gasketed pressure pipe for the pipe being used for the same distance.
 - m. The Contractor shall provide CCTV testing of sewer main piping to be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.
 - n. For precast sewer manholes, cleanouts, lift and pumping stations and septic tanks, the use of Type I cement is not acceptable for any structure to be constructed in a marine environment. Cements marked Type II or Type I/II may be used for these structures provided that they comply with all criteria for ASTM C 150/C 150 M Type II.
 - o. For all underground structures, the designer shall check for buoyancy effects of all underground structures in high water table locations.

G40 ELECTRICAL UTILITIES

Sustainable Design Strategies

Refer to UFC 1-200-02, High Performance and Sustainable Building Requirements.

- a. Install ENERGY STAR® lighting and controls that meet or exceed FEMP standards.
- b. Solar or wind powered light fixtures are preferable alternatives for signage, street, building mounted and walkway lighting. Motion sensors may also be added so that lights will power on only when people are present.
- c. To reduce energy consumption LED lamps shall be substituted for other lamp types while maintaining required lighting levels.
- d. Photovoltaic systems used to power building loads shall be provided with interactive grid-tie inverter providing utility grade AC power.

G4010 ELECTRICAL DISTRIBUTION

Refer to UFC 3-501-01 for technical requirements and standards and UFC 3-550-01 Exterior Electrical Power Distribution. All outside transformers, switchgear and other electrical equipment shall be ground mounted on reinforced concrete pads, surrounded by solid 6" (153 mm) reinforced concrete walls or 8" (204 mm) reinforced fully grouted CMU walls and gate(s) that protects mechanical equipment from typhoon flying debris. All walls, gate(s) and anchored mechanical equipment shall meet Guam's wind speed and seismic requirements.

Electrical service and distribution system shall conform to the NAVFAC Marianas Public Works Utilities Criteria, For Design and Construction: Electrical, Sewer and Water, latest approved edition.

G4010.1 Pad Mounted Transformers

- a. Dead front construction
- b. Entire transformer assembly, including tank and radiator, base, enclosure, and metering enclosure shall be fabricated of stainless steel conforming to ASTM A 167, type 316 for pad-mounted transformers installed in coastal areas. Exterior pad-mounted transformers installed in areas except along coastal areas shall be of stainless steel construction. The cabinet and base shall be fabricated of stainless steel conforming to ASTM A 167, type 316. Fasteners used to secure the transformers shall be stainless steel. Factory paint entire transformer assembly. Refer to Section [5.3 Color Standards](#).
- c. Transformers shall meet efficiency standards determined by the Department of Energy (DOE) – Distribution Transformers Energy Conservation Standards Rulemaking, 72 FR 58190.
- d. Refer to UFC 3-501-01 for technical requirements.
- e. Refer to Section [5.1 Site and Landscape Design](#), for screen walls/enclosures required around all above ground, pad mounted, electrical equipment.

G4010.2 Pad Mounted Switchgear (Switches)

- a. Apply pad-mounted switchgear when switching, isolation, or electrical protection for downstream circuit is required or anticipated.
- b. Provide SF6 or oil insulated, vacuum break, dead-front switches.
- c. Entire assembly, including tank, base, and enclosure shall be fabricated of stainless steel conforming to ASTM A 167, type 316L. Factory paint entire assembly. Refer to Section 4.3 Color Standards.
- d. Refer to UFC 3-501-01 for technical requirements.
- e. Refer to Section [5.1 Site and Landscape Design](#), for screen walls/enclosure required around all above ground, pad mounted equipment electrical equipment.

G4010.3 Underground Distribution

a. Underground Ducts

- 1) PVC schedule 40 concrete encased ducts for primary and secondary distribution feeders
- 2) Secondary branch circuit may be direct buried PVC schedule 80.
- 3) Minimum burial depth – 24" (610 mm)

b. **Medium voltage cables:**

Copper conductor EPR with 133% insulation level.

G4010.4 Underground Distribution

Consider all electrical, cable and telephone incoming services inside exterior closets with locks and keyed for maintenance personnel only. Exterior electrical panels in closets shall be stainless steel and incoming cable/ telephone service connection are in impact resistant cabinets with stainless steel fasteners and hardware.

All exterior hardware, fasteners, exterior internal fasteners and connections, electrical panels, disconnects, etc. shall be stainless steel. Garage areas, enclosed bay areas with overhead roll-up doors, exterior closets, exterior utility rooms and similar unconditioned spaces are considered outside and will require all exterior hardware, fasteners, internal fasteners and connections, electrical panels, etc. shall be stainless steel.

G4020 SITE LIGHTING

All lighting must comply with AT/FP requirements (UFC4-010-01).

Complete assembly including light fixture, pole, solar panel and battery used for area lighting shall be rated to withstand the required wind loads.

All exterior lighting to have anodized aluminum or stainless steel housing, stainless steel hardware and fasteners, impact-resistant glass lenses, and photo cells and motion sensor (where appropriate)

G4020.1 Streetlights

- a. Round pre-cast concrete poles with two feet (2'-0" or 610 mm)) to three feet (3'-0" or 915 mm)) cantilever arm, aluminum finish with photocell electric switches. Light fixture heads should have a flat lens (not convex) to reduce wind exposure. The entire assembly shall meet the wind loading criteria.
- b. Fixtures shall be full cut-off or dark-sky compliant to reduce glare and light trespass.

G4020.2 Parking Lights

- a. Pole mounted can-lights with short arm dark bronze aluminum anodized finish securely mounted on concrete footing foundation.
- b. Lamps – HID, LED or compact fluorescent
- c. Fixtures shall be full cut-off or dark-sky compliant to reduce glare and light trespass.
- d. Light poles shall be offset staggered location with tree planning.

G4020.3 Walkway / Jogging Path Lights

- a. Round or square, dark bronze aluminum anodized bollard or low pavement mounted fixtures securely mounted on concrete footing foundation.
- b. Lamp – Compact fluorescent or LED

G4020.4 Signage Lights (Flood Lights)

- a. Dark bronze aluminum anodized floodlights securely mounted on concrete footing.
- b. Lamp – Metal Halide, compact fluorescent or LED

G4030 COMMUNICATIONS SYSTEMS

Refer to UFC 3-580-01 Telecommunication Building Cabling Systems Planning and Design.

APPENDIX A – GEOTECHNICAL COMPONENTS

INTRODUCTION

This study report presents the various aspects of the Geotechnical Components for the Guam NMACS related to the general components of architecture and engineering designs and constructions of military facilities on Guam, for the Naval Facilities Engineering Command, Marianas, and Marine Forces Pacific.

This report will provide discussions primarily concerning the following aspects of geotechnical engineering:

1. General geology and subsurface soils of Guam, from an engineering standpoint.
2. Various types of foundation support schemes commonly adopted for the designs of vertical structures, including typical range of design subgrade soil values.
3. Specialty foundation considerations.
4. General site grading earthwork requirements such as engineering fill materials, placement and compaction procedures, and subgrade improvements when needed.
5. Construction considerations.
6. Unusual subsurface conditions that may be encountered during constructions.

The content of this study report is primarily based on past experience, actual designs and constructions of past projects on Guam in general terms only, and is not intended for specifically applicable to any project directly, nor is intended for use as recommendations for the design and construction of any project.

GEOLOGICAL CONSIDERATIONS

NORTHERN LIMESTONE

Guam is the southernmost of the Mariana Island Chain. It is primarily surrounded by submerged coral reef flats at various, shallow depths below sea level. Coral reefs are irregular with abundant voids among coral growth. The reef flats provide some protection to the coastal lines of Guam against severe wave actions generated from storms and typhoons which are quite frequent on Guam. Severe earthquakes can generate such tidal waves as well.

Geologically, the island of Guam is primarily divided into the northern limestone formations and the southern volcanic formations, with the narrow strip in the middle portion of Guam being transition zones.

The northern limestone is primarily the detrital facies of the Mariana limestone formation which consists primarily of rather homogeneous, mixtures of sands, gravels, cobbles and boulders

cemented to various degrees, and with various percentages of fine particles (generally silt particles) that may range from a few percent (by weight) to the high 20 and 30 percent. Larger sizes such as boulders and cobbles exist randomly and can range from 5 to 10 percent by volume to 80 to 90 percent, depending on the hardness and cementation of the limestone mass. In general, harder limestone are found in older formations that generally exhibit some crystallization, pinkish, tan, light gray color. The majority of limestone formations on Guam is the detrital limestone which is generally in the form of cemented sand and gravel particles with fines or silt inclusions that sometimes in the forms of silt tubes or pockets.

Other limestone formations are reef facies which is hard, irregular with sharp protrusions, numerous voids of various sizes up to large cavities and caverns, generally lack of fines and hard to excavate. Reef limestone occurred primarily along coastal lines that are exposed to several wind and wave environments.

Argillaceous or clayey limestone exists mostly in the transition zones of central Guam such as Sinajana, Ordot-Chalan Pago, Mangilao, Asan, and part of Yona. As its name implies, argillaceous limestone has high content of fines, and the fines are mostly clayey (which is finer grained than silt), more cohesive and less cementitious. Argillaceous limestone can still contain some hard boulders and cobbles to a much less percentage.

SOUTHERN VOLCANICS

The volcanic formations of southern Guam are primarily tuff in the form of tuffaceous siltstone and sandstone, and some shale; but generally in the range of silt and silty sand grains. When weathered or decomposed, they become generally clayey silt or sandy silt, silty fine sand with cohesion. One common characteristic of such materials is high moisture content, partly due to their fine-grained and cohesive nature, and partly resulted from moisture absorption when they were decomposed from rock forms. Because of high moisture absorption, these clayey silt, sandy silt, silty fine sand, and silty clay are expansive soils that can cause concrete slabs and pavements to heave and crack, if not treated properly.

In contrast with the generally lighter colors (light brown, white, tan, light gray) of the northern limestone, the volcanic soils and rocks generally have darker colors such as red-brown, dark gray, and often with multi-colors. The most common colors are dark red-brown-green-gray. Because of their high moisture contents, the volcanic soils are difficult to achieve high degrees of compacted densities, plus their expansive potentials, render them unsuitable for direct support beneath concrete slabs and asphalt pavements.

The southern volcanic rocks are generally easy to become weak and even decomposed once they are exposed to weathering, making them rather unstable without adequate overburden pressure or protection.

EARTHWORK

NATIVE SOILS

From the above discussion, native soils on Guam are primarily limestone origin silty sand and gravel soils, sandy silt and silty fine sand generated from decomposed limestone, generally abundantly available in the northern Guam. These soils are generally cohesionless, relatively coarse-grained, with relatively low moisture content in the range of less than 10 percent to about 20 percent by weight of dry densities. Their unit weights or dry densities are in range of 100 pounds per cubic foot (pcf) to 140 pcf, with heavy rocks that can approach 150 pcf which is more of exceptional. Because of their relatively low moisture content, coarser grained, cohesionless and nonexpansive, the limestone soils, except silt, are generally relatively easy to compact and attain high compacted densities such as 95 percent, or higher, of their maximum dry densities (determined from laboratory compaction tests). Therefore, they are good foundation and subgrade support soils

Native soils from central to southern Guam are mostly fine-grained, clayey sandy silt, silty fine sand, and silty clay. These soils are finer grained, cohesive, with high moisture contents, and potentially expansive, so they are not suitable for immediate subgrade supports. In addition, the volcanic, fine-grained soils are difficult to achieve high degrees of compaction such as 90 percent of the compacted soils' maximum dry densities. Therefore, designers and contractors normally would want to avoid using volcanic soils as backfill materials, except in non-structural areas.

In addition to the above, underground seepage or trapped water (not true ground water) are not uncommon in the volcanic soils, and between soils and rocks.

STRUCTURAL FOUNDATIONS

Commonly designed or used foundations for supports of structures such as buildings of various sizes or heights, retaining walls, bridges, and other structural elements can be classified into two main groups: Shallow foundations and deep foundations.

SHALLOW FOUNDATIONS

Spread footings - are the most economical and commonly utilized foundation supports for relatively light to moderately heavy structures such as up to a few stories high buildings. In shallow massive rock areas, either limestone or (competent, moderately hard to hard) volcanic rocks, heavier structures such as up to 10-12 stories high may still be supported on shallow spread footings bearing directly on rock mass or equivalent gravelly soils with or without concrete capping. Taller buildings may still be able to be supported on spread footings but often footings would be tied together with grade beams to increase their rigidity or underlain directly with a layer of low strength concrete fill.

Allowable bearing pressures for dead plus live loads for shallow spread footings may range from as low as 1,000 pounds per square foot (psf) for light buildings to as high as over 12,000 psf for heavy

structures, with total design loads including wind or seismic to be one-third to one-half higher than those for dead plus live loads.

Resistance to lateral loads such as from seismic or wind normally are from footing base sliding friction and passive soil resistance against the opposite side of the lateral load movements. The range of footing base sliding frictions is between 30 percent to 40 percent of total dead loads imposed at the bottoms of the footings, though higher values have been used for special considerations. Passive soil resistance values will depend on soil types, but can specify using better soil backfill (meaning limestone soil backfill) with a minimum width generally between 2 to 5 feet. Therefore, usually one would avoid backfill against footings with volcanic soils. Accordingly, lateral or passive soil resistance values are based on engineered, non-expansive, limestone sand/gravel fill that can be compacted to 95 percent of the maximum dry density of the backfill soils. For convenience, low-strength sand-cement mix can also be used to backfill around the foundation footings. Hence, passive soil resistance values may range from equivalent fluid pressure of 200 psf/foot of depth or pcf (pounds per cubic foot) to 400 pcf; higher values need to be evaluated.

It is commonly practice on Guam to provide a layer of compacted, base course aggregate between 4 to 8 inches and occasionally as much as 12 inches; the thickness will depend on the footing subgrades. This layer is not the same as an additional layer specifically to increase the footing bearing values, and is commonly known as engineered fill or non-expansive, or structural fill beneath the foundation footings, which can range from 12 inches to several feet thick, and usually extending side way that can be up to a few feet wider beyond the footing edges.

Rigid, grid footings – are continuous, beam type foundation footing for increased rigidity and spreading the structural loads throughout the grid footings. The subgrade preparations and backfills around the grid footings are similar to those for spread footings. Allowable bearing pressures are generally lower than spread footings, particularly on the high-end values. However, grid footings will have more load bearing surface areas.

Rigid, mat foundations – This is like a thickened concrete floor slab but heavily reinforced in order to spread the structural loads into uniform, equal concrete foundation loads. As a result, the spread out, uniform loads will be significantly lower than spread or grid footings but the loads will occupy the entire building foundation footprint. Concrete mat foundations are used when grid footings are not sufficient to resist foundation stresses or more rigid foundation is needed. Subgrade preparations for rigid, concrete mat foundations are similar to the subgrade preparations for spread footings and grid foundations.

DEEP FOUNDATIONS

Driven piles – are utilized where the subgrade soils are not capable of supporting the structures to be constructed and shallow spread footings, even rigid concrete mat foundations, cannot be used without risking unacceptable foundation settlements. Piles are either precast concrete, with or without prestressing, steel pipe, H-section steel. (Timber piles are rarely used now-a-day). Driving piles normally will require tall crane to handle and drive the piles, and therefore occupy fairly large space.

Typical driven piles on Guam are precast concrete, mostly prestressed, ranging from 12 inches to as much as 24 inches with the most common size being 16-1/2 inch octagonal, precast, prestressed, concrete piles. Pile capacities would range from about 30 tons to 200 tons per each pile for total design loads which are about 1/3 to 1/2 higher than dead loads plus live loads.

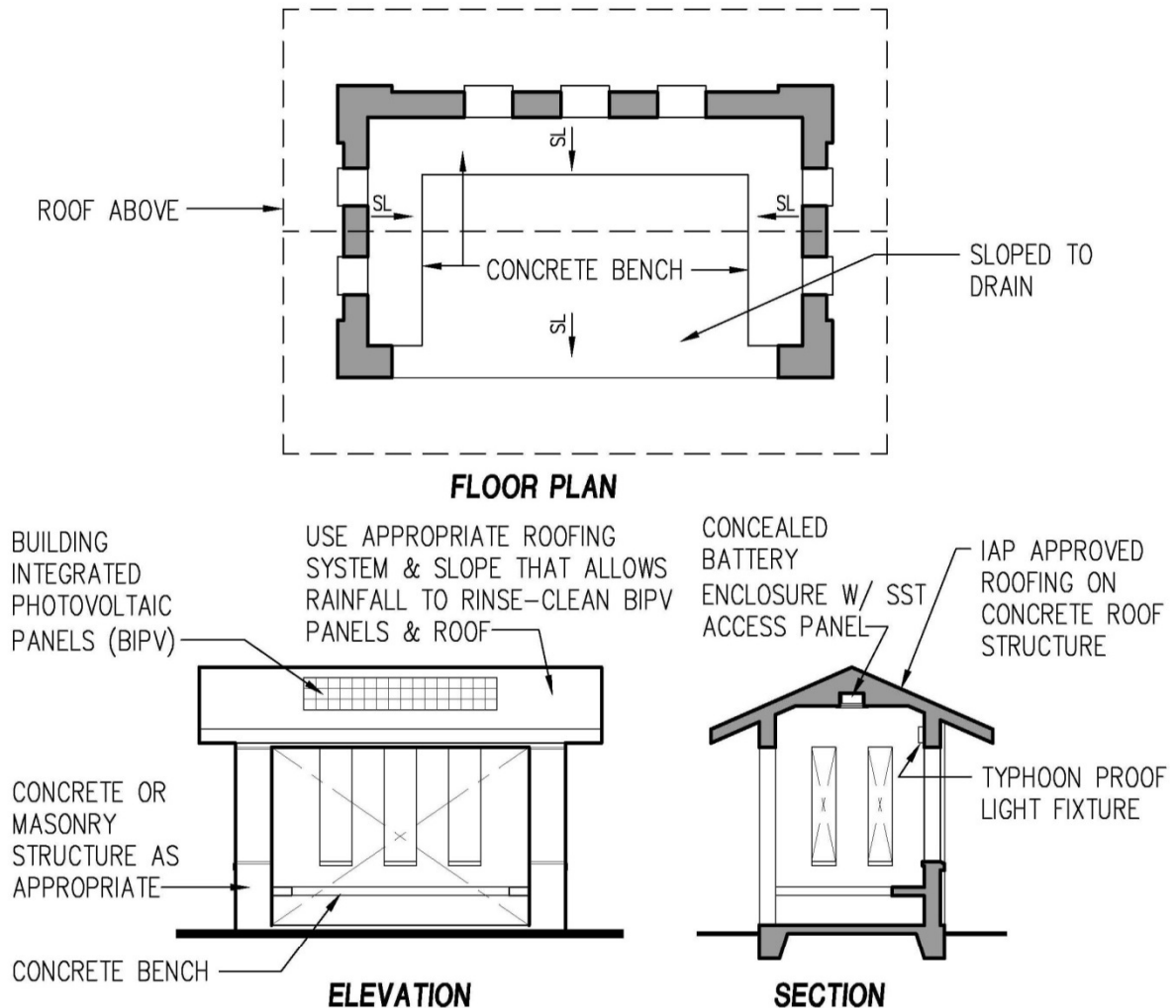
Drilled, cast-in-place concrete piers or piles – where driven piles are not practical to utilize and deep foundations are needed such as for up-lift resistance, too costly to replace compressible soils, too costly to mobilize pile-driving equipment and set-up for pile driving, lack of space to set-up and drive piles, or for noise control, deep foundations can be installed by drilled, cast-in-place concrete piers including installing steel reinforcement. If the cast-in-place concrete piers are deep, they will be called cast-in-place concrete piles. When the diameter of the cast-in-place concrete piers is big and the load-bearing capacities are high, the concrete piers may be called as concrete caissons.

Cast-in-place concrete piers or piles will require “clean drilled holes,” including relatively clean of loose soils and rock fragments at the hole bottoms in order to achieve fully concreted piers or piles with right sizes. Therefore, steel casing pipes are often used to prevent drilled holes from caving in or collapse. Concrete placement will need to be by tremie method from the hole bottoms rising up to the top of the holes without leaving any air void or air pocket within the concrete piers or piles.

Typical load-carrying capacities of drilled, cast-in-place concrete piers or piles are similar to the driving pile capacities in the range of approximately 30 tons to more than 100 tons for total design loads including wind or seismic. At the present time, drilled, cast-in-place concrete piers or piles locally on Guam are not commonly utilized and are limited to 18-inch maximum diameter due to equipment availability locally.

APPENDIX B – DRAWINGS

Large Bus Shelter

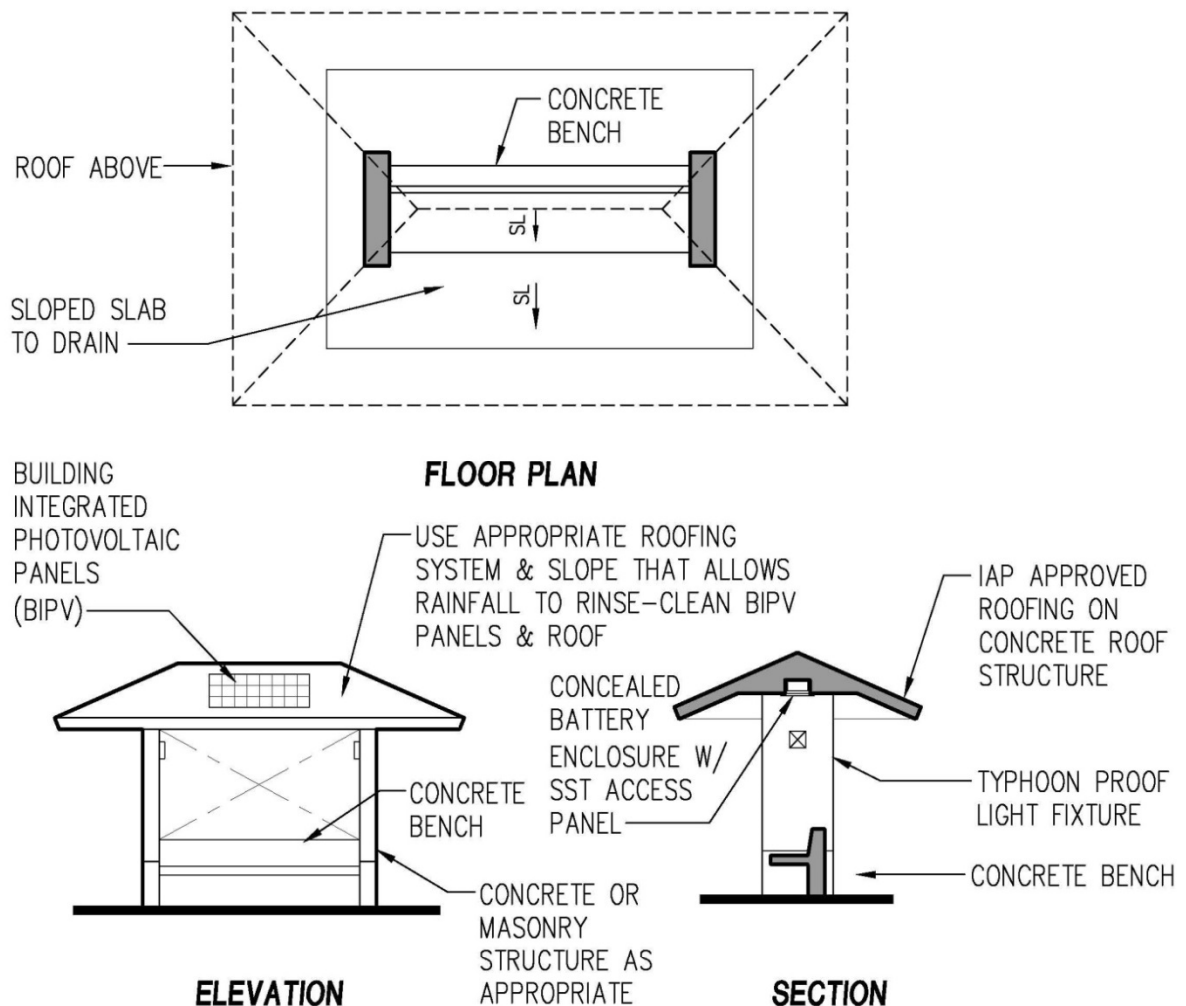


LARGE BUS SHELTER

1. THIS DESIGN IS CONCEPTUAL. COORDINATE AND CONFIRM WITH THE GOVERNMENT ALL ASPECTS OF THE REQUIREMENTS OF THE WORK. COMPLY WITH ALL APPROPRIATE CRITERIA.
2. UNLESS OTHERWISE SPECIFIED, TYPHOON FORCE MINIMUMS ARE DEFINED AS 170 MPH BASE WIND SPEED AS AMPLIFIED BY TOPOGRAPHIC AND BUILDING SPECIFIC LOCATION FACTORS.
3. ROOF TYPE AND PITCH AND EXTERIOR FINISHES ARE FOR ILLUSTRATIVE PURPOSES ONLY. CONFIRM REQUIREMENTS WITH THE GOVERNMENT AND THE APPROPRIATE BASE INSTALLATION APPEARANCE PLAN.

Figure 32: Large Bus Shelter

Small Bus Shelter

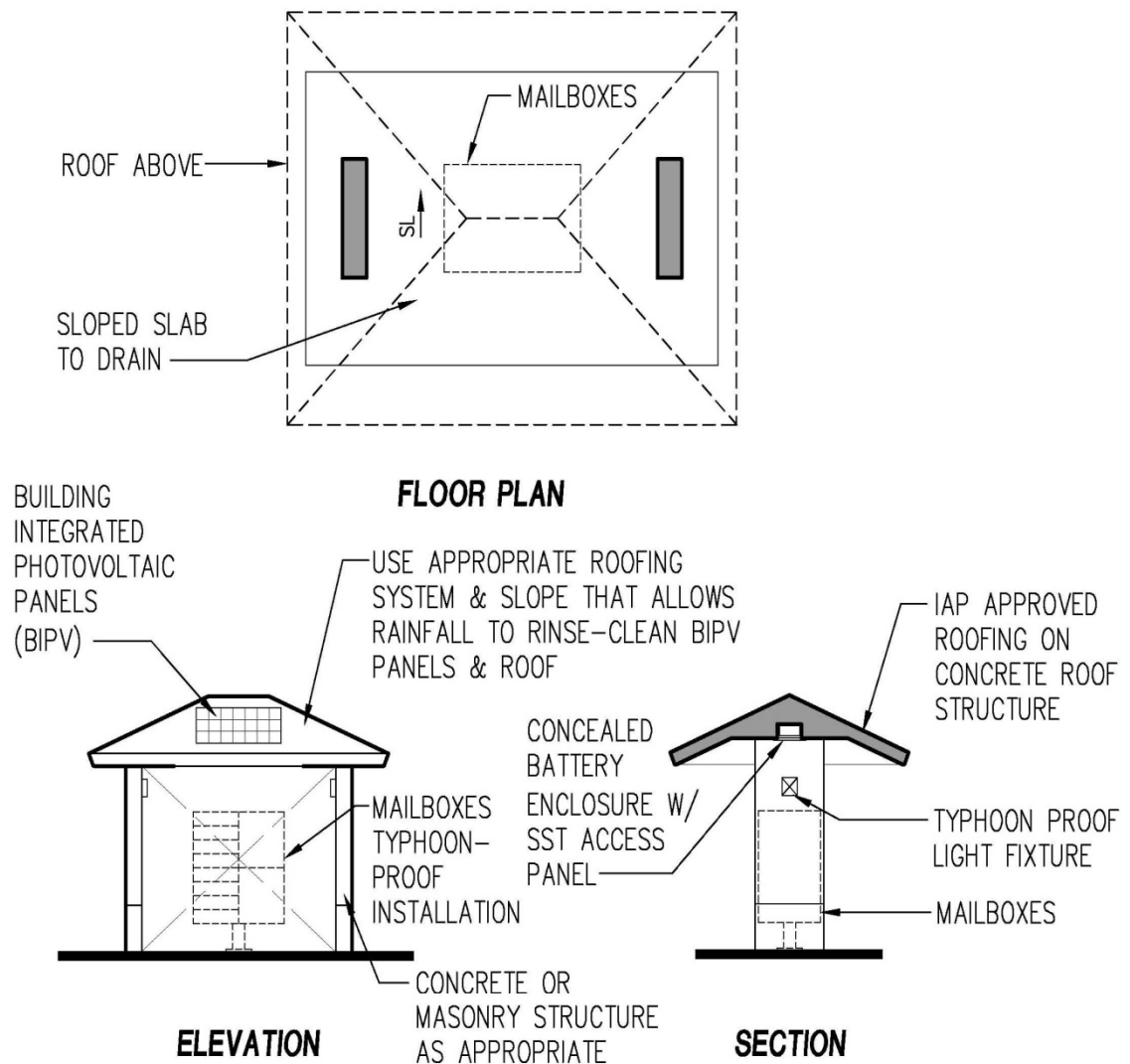


SMALL BUS SHELTER

1. THIS DESIGN IS CONCEPTUAL. COORDINATE AND CONFIRM WITH THE GOVERNMENT ALL ASPECTS OF THE REQUIREMENTS OF THE WORK. COMPLY WITH ALL APPROPRIATE CRITERIA.
2. UNLESS OTHERWISE SPECIFIED, TYPHOON FORCE MINIMUMS ARE DEFINED AS 170 MPH BASE WIND SPEED AS AMPLIFIED BY TOPOGRAPHIC AND BUILDING SPECIFIC LOCATION FACTORS.
3. ROOF TYPE AND PITCH AND EXTERIOR FINISHES ARE FOR ILLUSTRATIVE PURPOSES ONLY. CONFIRM REQUIREMENTS WITH THE GOVERNMENT AND THE APPROPRIATE BASE INSTALLATION APPEARANCE PLAN.

Figure 33: Small Bus Shelter

Mailbox Shelter

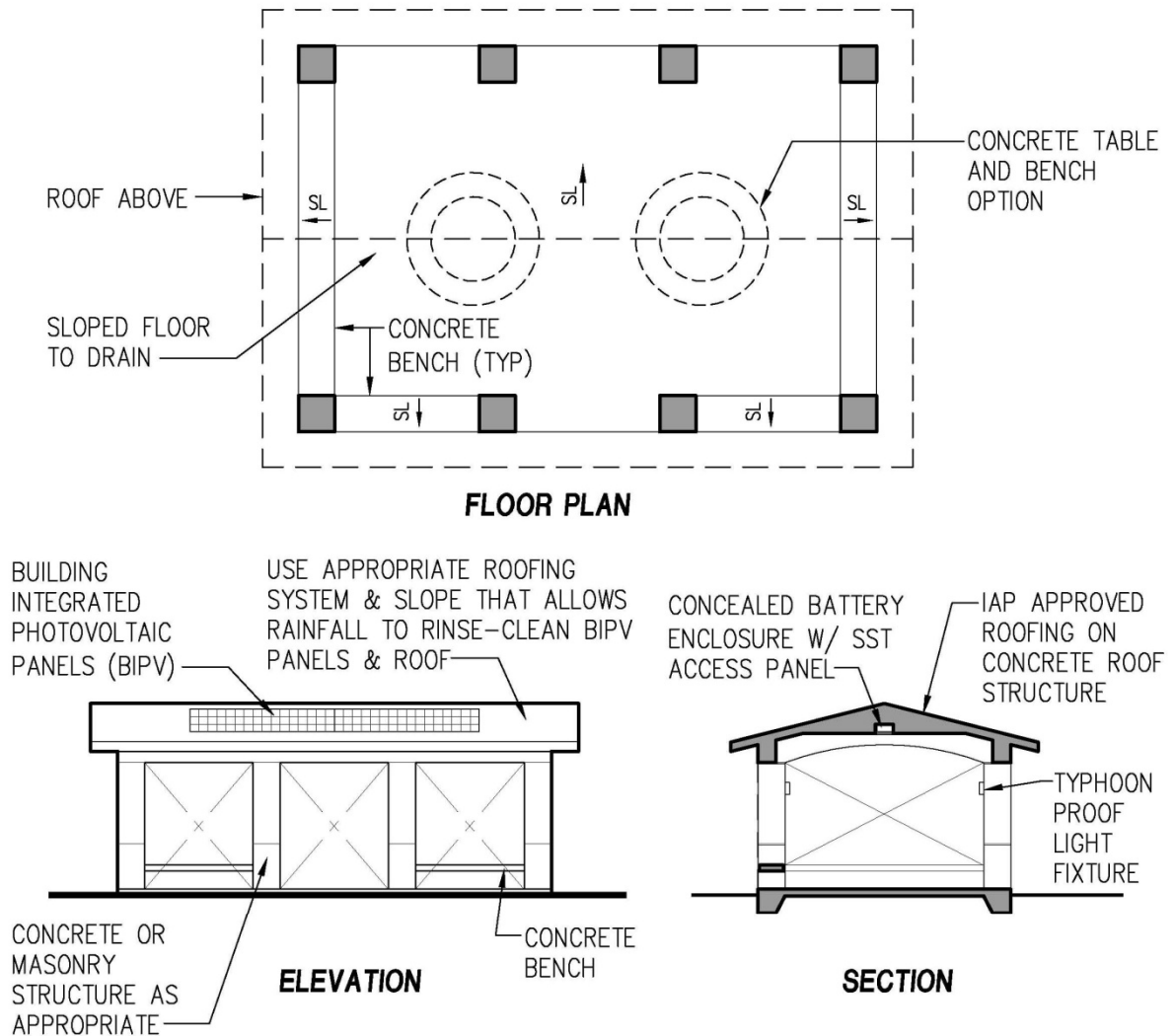


MAILBOX SHELTER

1. THIS DESIGN IS CONCEPTUAL. COORDINATE AND CONFIRM WITH THE GOVERNMENT ALL ASPECTS OF THE REQUIREMENTS OF THE WORK. COMPLY WITH ALL APPROPRIATE CRITERIA.
2. UNLESS OTHERWISE SPECIFIED, TYPHOON FORCE MINIMUMS ARE DEFINED AS 170 MPH BASE WIND SPEED AS AMPLIFIED BY TOPOGRAPHIC AND BUILDING SPECIFIC LOCATION FACTORS.
3. ROOF TYPE AND PITCH AND EXTERIOR FINISHES ARE FOR ILLUSTRATIVE PURPOSES ONLY. CONFIRM REQUIREMENTS WITH THE GOVERNMENT AND THE APPROPRIATE BASE INSTALLATION APPEARANCE PLAN.

Figure 34: Mailbox Shelter

Pavilion

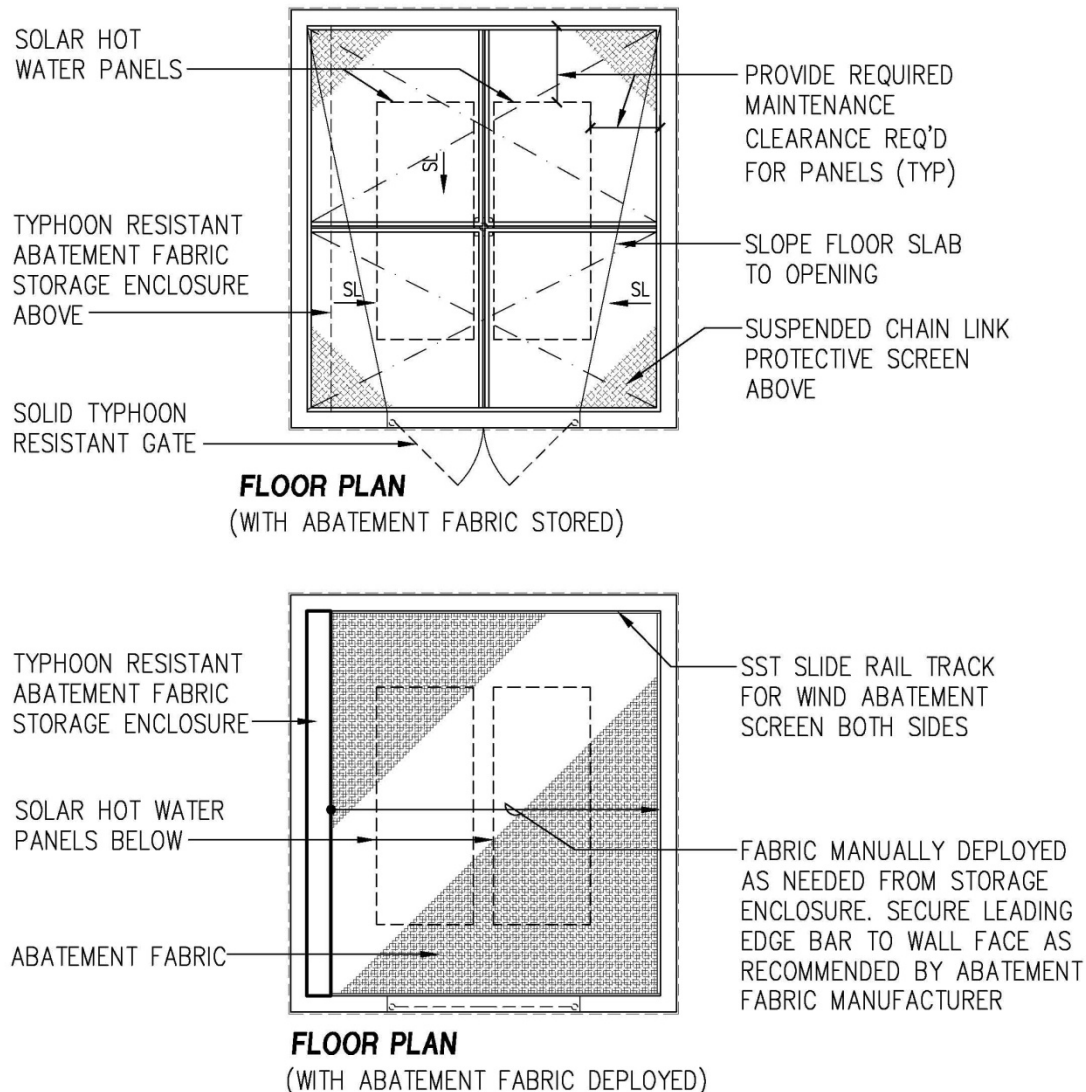


PAVILION

1. THIS DESIGN IS CONCEPTUAL. COORDINATE AND CONFIRM WITH THE GOVERNMENT ALL ASPECTS OF THE REQUIREMENTS OF THE WORK. COMPLY WITH ALL APPROPRIATE CRITERIA.
2. UNLESS OTHERWISE SPECIFIED, TYPHOON FORCE MINIMUMS ARE DEFINED AS 170 MPH BASE WIND SPEED AS AMPLIFIED BY TOPOGRAPHIC AND BUILDING SPECIFIC LOCATION FACTORS.
3. ROOF TYPE AND PITCH AND EXTERIOR FINISHES ARE FOR ILLUSTRATIVE PURPOSES ONLY. CONFIRM REQUIREMENTS WITH THE GOVERNMENT AND THE APPROPRIATE BASE INSTALLATION APPEARANCE PLAN.

Figure 35: Pavilion

Solar Panel Enclosure – Sheet 1



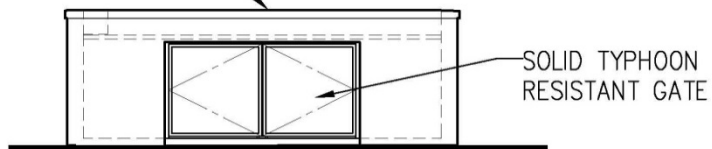
SOLAR PANEL ENCLOSURE NOTES

1. THIS DESIGN IS CONCEPTUAL. COORDINATE AND CONFIRM WITH THE GOVERNMENT ALL ASPECTS OF THE REQUIREMENTS OF THE WORK. COMPLY WITH ALL APPROPRIATE CRITERIA.
2. THIS DESIGN IS SPECIFIC FOR A TWO-PANEL SOLAR ENCLOSURE.
3. PROVIDE A WEATHER AND LIGHT-PROOF STORAGE ENCLOSURE FOR THE ABATEMENT FABRIC THAT IS WHOLLY WITHIN THE SECURED SOLAR ENCLOSURE PERIMETER.
4. UNLESS OTHERWISE SPECIFIED, TYPHOON FORCE MINIMUMS ARE DEFINED AS 170 MPH BASE WIND SPEED AS AMPLIFIED BY TOPOGRAPHIC AND BUILDING SPECIFIC LOCATION FACTORS.
5. PROVIDE DETAILS AND CALCULATIONS SEALED BY AN APPROPRIATE LICENSED ENGINEER FOR THE STRUCTURE INCLUDING BUT NOT LIMITED TO ANCHORAGE AND FASTENING SYSTEM FOR ALL BUILDING ELEMENTS APPROPRIATE TO THE TYPHOON FORCE REQUIREMENTS: THIS INCLUDES GATE SYSTEM, METAL CHAIN LINK FABRIC PANEL SYSTEM, ABATEMENT SCREEN FABRIC SYSTEM AND SOLAR PANEL SUPPORT SYSTEM.
6. ORIENT PANELS AND DETERMINE APPROPRIATE ENCLOSURE HEIGHT TO MAXIMIZE THE QUANTITY OF THE HOT WATER PRODUCED THROUGH MAXIMIZING DIRECT EXPOSURE OF PANEL FACES TO THE SUN THROUGHOUT THE DAY.

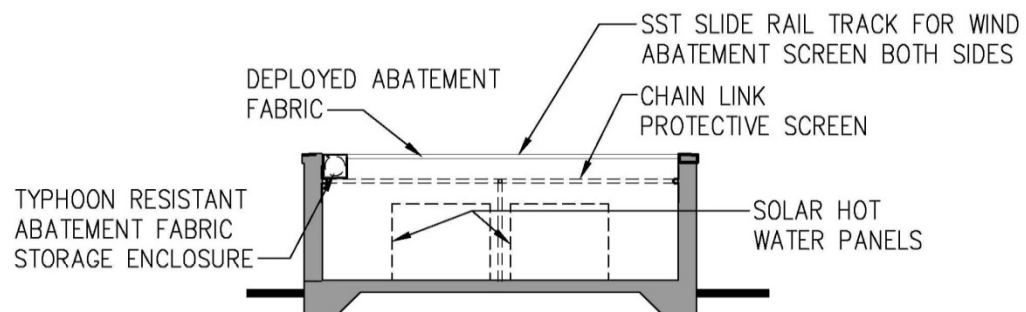
Figure 36: Solar Panel Enclosure: Plan

Solar Panel Enclosure – Sheet 2

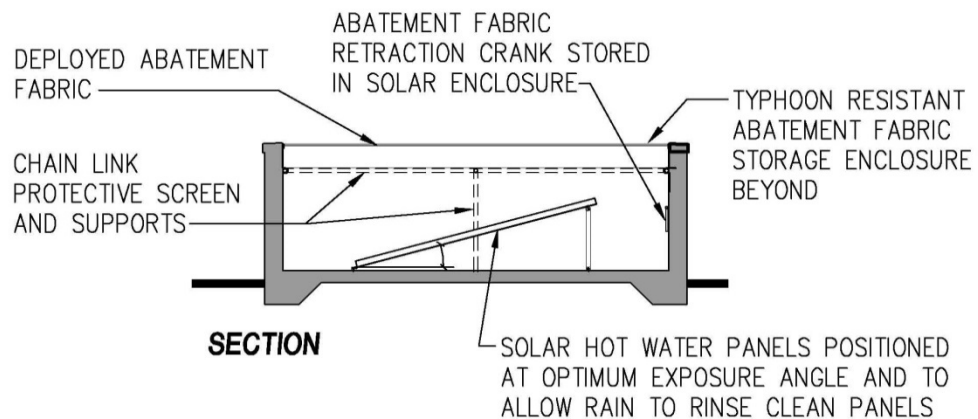
MASONRY WALLS WITH CONCRETE CAP
SLOPED TO PREVENT STANDING WATER



ELEVATION



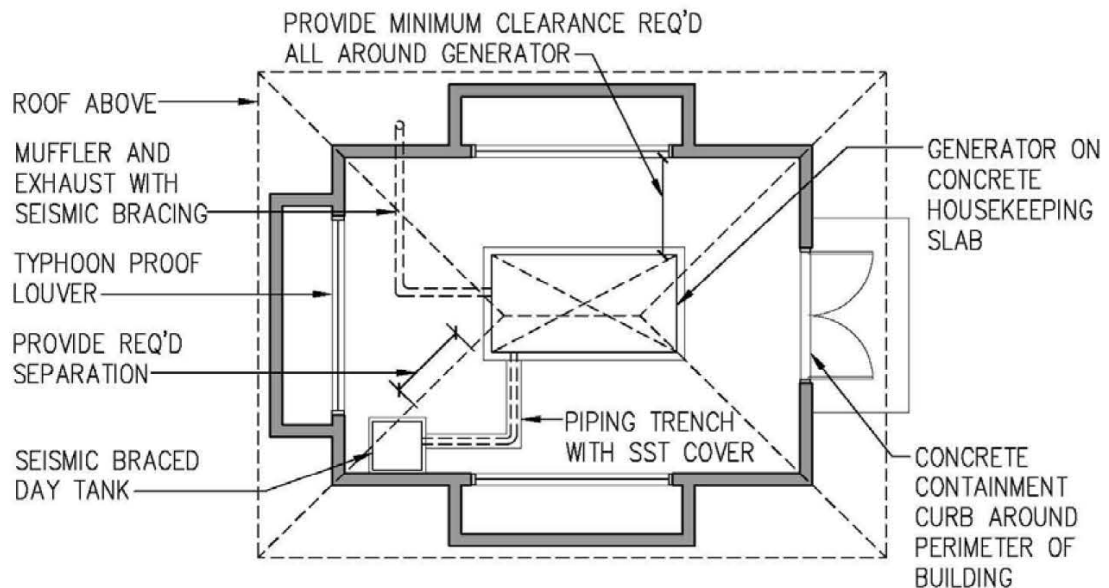
SECTION



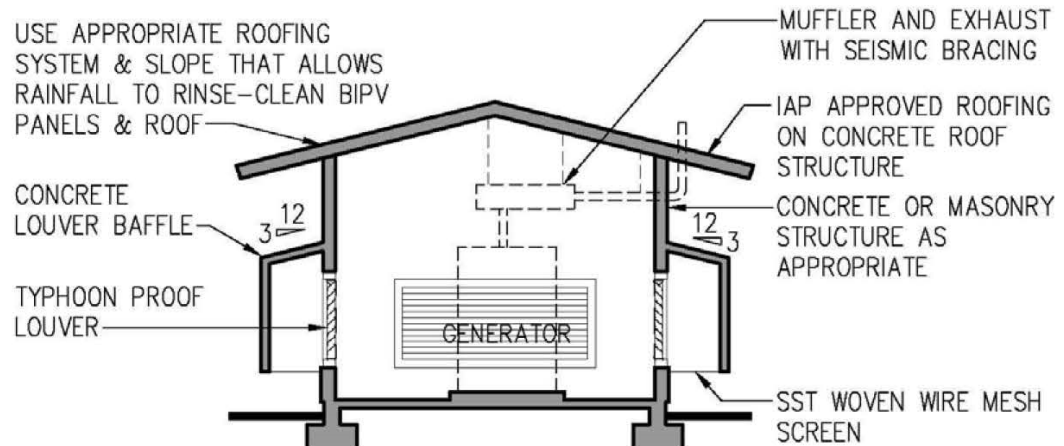
SECTION

Figure 37: Solar Panel Enclosure: Section/Elevation

Emergency Generator Enclosure



FLOOR PLAN



SECTION

EMERGENCY GENERATOR ENCLOSURE

1. THIS DESIGN IS CONCEPTUAL. COORDINATE AND CONFIRM WITH THE GOVERNMENT ALL ASPECTS OF THE REQUIREMENTS OF THE WORK. COMPLY WITH ALL APPROPRIATE CRITERIA.
2. OVERALL ENCLOSURE DIMENSIONS INCLUDING HEIGHT ARE SPECIFIC TO THE SIZE AND TYPE OF GENERATOR EQUIPMENT HOUSED WITHIN.
3. ROOF TYPE AND PITCH AND EXTERIOR FINISHES ARE FOR ILLUSTRATIVE PURPOSES ONLY. CONFIRM REQUIREMENTS WITH THE GOVERNMENT AND THE APPROPRIATE BASE INSTALLATION APPEARANCE PLAN.
4. DESIGN THE CONCRETE LOUVER BAFFLE TO MEET THE INTAKE AND EXHAUST REQUIREMENTS OF THE GENERATOR BUILDING.
5. PROVIDE SEALED CONCRETE FLOOR AND RAISED CONCRETE CURB AROUND THE GENERATOR FOR SPILL CONTAINMENT.
6. PROVIDE SLOPE AWAY FROM ENTRY DOOR TO PREVENT WATER INFILTRATION.

Figure 38: Emergency Generator Enclosure