



MARIANAS NAVY AND MARINE CORPS DESIGN AND CONSTRUCTION STANDARDS

2025 EDITION



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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 SYSTEMS COMMAND MARIANAS (NAVFACMAR) responsibility for providing technical criteria for design and construction projects in Guam. DOW agencies should contact NAVFACMAR for document interpretation and improvements.

This document replaces the MDACS 2017 edition 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 Standard that provides design and construction guidelines, based on a unified, locally-influenced, consistent strategy for the design of physical improvements in Guam. The MDACS 2025 Edition represents an update to the MDACS 2017 Edition, a regional design guideline that has been successfully used by NAVFAC’s industry partners – both designers and constructors – 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 region-specific guideline in conjunction with the local installation standards and criteria.

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 overarching Department of Defense (DOD) Criteria. Adherence to the requirements of the United Facilities Criteria (UFC) or Facilities Criteria (FC) is expected. It is also understood that there are instances where extreme local conditions will necessitate a more robust system than what is required in the UFC and FC. In this case, the more stringent requirement shall be utilized. 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”, “avoid” or “should”, the written instruction is optional. Where “must”, “will” 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. Ensure 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 \$6,708,000.00 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 whenever possible, consistent with mission, budget and client requirements.
- 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 DOW criteria. Exceptions or waivers to DOW Unified Facilities Criteria (UFC) and Facilities Criteria (FC) must be processed in conformance with MIL-STD 3007.

MDACS exceptions or waivers that do not otherwise violate overarching DOW criteria require written approval by the NAVFACMAR Chief Engineer or his/her designee.

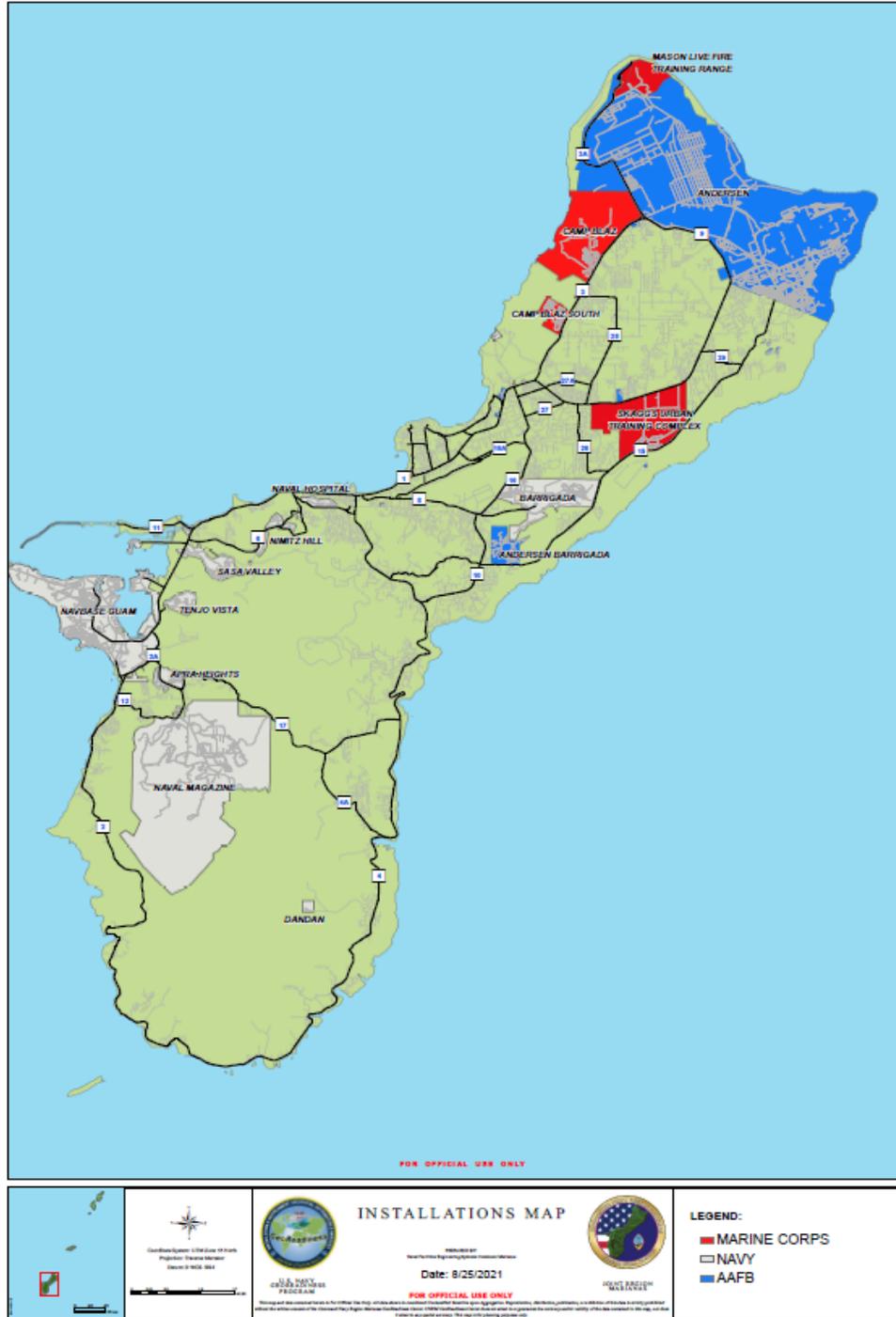
Exemption or waiver request(s) shall be resolved at the earliest practicable stage prior to completion of the Final Request for Proposal (RFP) solicitation documents. Substitution or variance requests submitted after award of the construction contract involving exceptions shall be similarly processed.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

DOW 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 miles per hour (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 mph. 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 and Standards

Unless specifically stated otherwise, all codes and regulations used shall be the editions adopted and/or amended for use by the DOW thru applicable UFCs.

- 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
- The Masonry Society Book (TMS 402/602-16) – 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 (NEC)
- 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 <https://www.wbdg.org/DOW/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 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 (DB) projects, wherever American Society for Testing and Materials (ASTM International) 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 Design-Bid-Build (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, IBC, and ASCE 7 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 A706 should be specified. DOR should be aware that ASTM A706 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 the Marianas. Reinforced concrete and/or precast prestressed concrete are the construction materials to be used for its durability. Where concrete-based systems are not feasible, the use of metal framing and components may be used as noted (e.g., aluminum, stainless, hot dipped galvanized, galvanized, and steel coated per UFGS 09 90 00).

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 exposed building components and assemblies, fasteners, anchors, miscellaneous metal fabrications, and other exterior applications. 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 or cut, specify the low-carbon content type, usually designated with the letter "L" following the number, e.g., type 316L or 304L.
- Hot dipped galvanized with high performance epoxy coatings per UFGS 09 96 00 or UFGS 09

97 13.27 shall be used at non-conditioned spaces where the use of aluminum or stainless steel is not feasible. These include long span structures, garages, motor pool bays, vehicle repair bays, storage warehouses, and other locations as noted in this document.

- For interior conditioned spaces, use galvanized steel (zinc coating applied by electroplating) or carbon steel with coatings similar in performance to Waterborne Light Industrial Coating system for exterior metal, or Alkyd coating system for metal in high-humidity areas (UFGS 09 90 00) as applicable. Hot dipped galvanized steel may also be used if more corrosion protection is necessary.

Exterior chain link fencing shall be hot-dipped galvanized steel. Ultraviolet (UV) resistant vinyl coating of fence shall be considered as an added measure.

Corrosion prevention and control is also required for buried structures. 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:

- 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.
- Unless completely shielded by non-metallic structures, exposed or partially exposed facility equipment and systems shall be positioned opposite (not fronting) prevailing winds to minimize corrosive impacts from inherently high salt water vapor levels in the atmosphere.
- Isolate dissimilar materials to prevent galvanic action.

Hot dipped galvanized steel is preferred over electroplating zinc metal spraying or other methods of providing zinc coating to ferrous metals. Galvanized steel (zinc coating applied by electroplating) can react and be subject to a rapid galvanic reaction if in direct contact with stainless steel or copper, especially in the presence of salty air/water. This is because zinc is more electrochemically active than both stainless steel and copper. Verify metal compatibility before specifying metals in direct contact with each other. See [Figure 4](#) and [Figure 5](#).

When two different metals are in contact and exposed to a common electrolyte, one of the metals experiences accelerated corrosion while the other is protected. This type of accelerated corrosion between dissimilar metals is referred to as galvanic corrosion. Because galvanic corrosion can occur at a high rate under certain circumstances, it is important to evaluate the combination of galvanized steel with other metals to determine if galvanic corrosion is of concern.

[Figure 4](#) - Metals and alloys nearer the top of the series have a greater negative electrical potential than the more noble or stable metals below. The further two metals are away from

each other on the galvanic series as shown on Figure 4- the stronger is the galvanic reaction between them and those metals shall not be used in direct contact without proper separation.

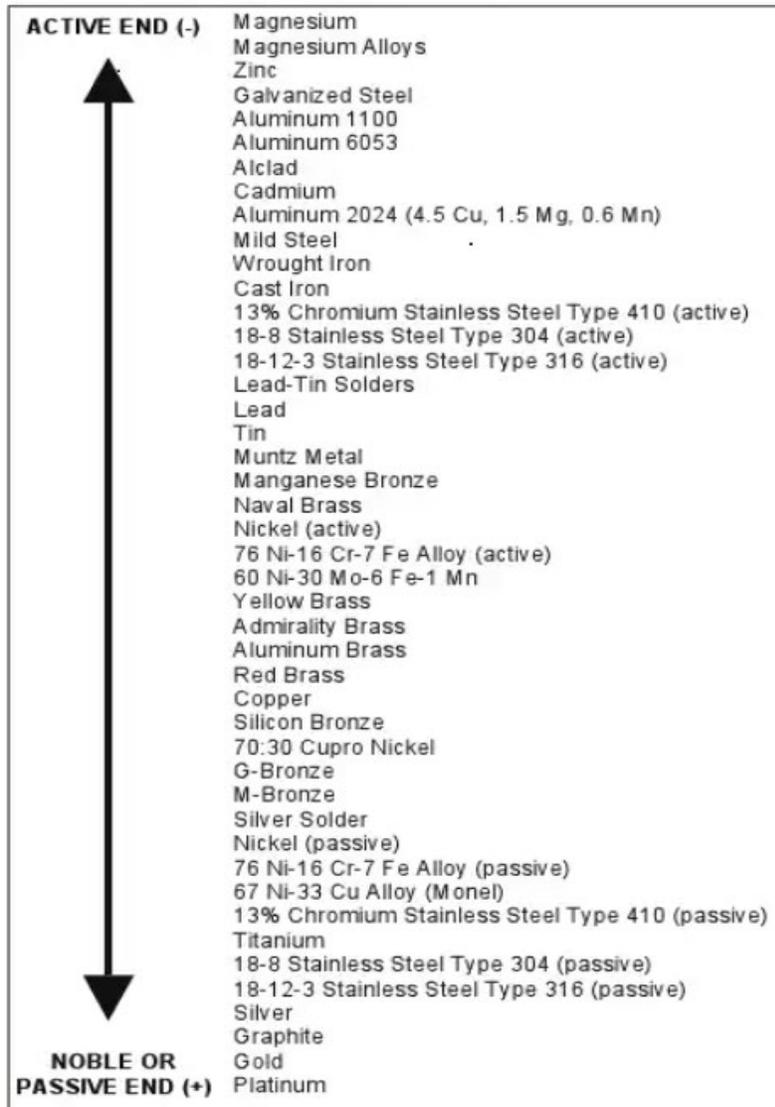


Figure 4: Galvanic series of various metals in seawater (Source: NRCA)

TABLE VALUES OF GALVANIC COUPLES OF THE MAIN METALS, expressed in millivolts (mV)																					
METAL	PLATINIUM	GOLD	STAINLESS ST 316	SILVER	MERCURY	NICKEL	COPPER	ALU BRASS	BRAS	BRONZE	TIN	LEAD	SOFT STEEL	ALUMINIUM	HARD STEEL	CADIUM	PUR IRON	CHROMIUM	GALVANIZED ST	ZINC	MAGNESIUM
PLATINIUM	0	130	250	350	350	430	570	600	650	770	800	840	1000	1090	1095	1100	1105	1200	1200	1250	1950
GOLD	130	0	110	220	220	300	440	470	520	640	670	710	870	960	965	970	975	1070	1100	1200	1820
STAINLESS ST 316	250	110	0	100	110	180	320	350	400	520	550	590	750	840	845	850	855	950	950	980	1700
SILVER	350	220	100	0	0	80	220	250	300	420	450	490	650	740	745	750	755	850	950	970	1600
MERCURY	350	220	110	0	0	80	220	250	300	420	450	490	650	740	745	750	755	850	950	970	1600
NICKEL	430	300	180	80	80	0	140	170	220	340	370	410	570	660	665	670	675	770	800	970	1520
COPPER	570	440	320	220	220	140	0	30	80	200	230	270	430	520	525	530	535	630	700	825	1380
ALU BRASS	600	470	350	250	250	170	30	0	50	170	200	240	400	490	495	500	505	600	700	720	1350
BRAS	650	520	400	300	300	220	80	50	0	120	150	190	350	440	445	450	455	550	650	650	1300
BRONZE	770	640	520	420	420	340	200	170	120	0	30	70	230	320	325	330	335	430	550	630	1100
TIN	800	670	550	450	450	370	230	200	150	30	0	40	200	290	295	300	305	400	500	600	1150
LEAD	840	710	590	490	490	410	270	240	190	70	40	0	160	250	255	260	265	360	400	560	1100
SOFT STEEL	1000	870	750	650	650	570	430	400	350	230	200	160	0	90	95	110	105	200	300	400	950
ALUMINIUM	1090	960	840	740	740	660	520	490	440	320	290	250	90	0	5	10	15	110	200	310	860
HARD STEEL	1095	965	845	745	745	665	525	495	445	325	295	255	95	5	0	5	10	105	200	305	855
CADIUM	1100	970	850	750	750	670	530	500	450	330	300	265	110	10	5	0	5	100	200	300	850
PUR IRON	1105	975	855	755	755	675	535	505	455	335	305	265	105	15	10	5	0	95	160	295	845
CHROMIUM	1200	1070	950	850	850	770	630	600	550	430	400	360	200	110	105	100	95	0	30	200	750
GALVANIZED ST	1200	1100	950	950	950	800	700	700	650	550	500	400	300	200	200	200	160	30	0	5	650
ZINC	1250	1200	980	970	970	970	825	720	650	630	600	560	400	310	305	300	295	200	5	0	550
MAGNESIUM	1950	1820	1700	1600	1600	1520	1380	1350	1300	1100	1150	1100	950	860	855	850	845	750	650	550	0

	ASSOCIATION OF METALS INDIFFERENT TO GALVANIC CORROSION
	ACCEPTABLE ASSOCIATION OF METALS WHICH CAN OVERTIME LEAD TO CORROSION IN CORROSIVE ENVIRONMENT
	ASSOCIATION OF METALS WILL LEAD TO CORROSION

Figure 5: Table Values of Galvanic Couples of the main metals

PRESSURE-TREATED WOOD and METALS:

The chemicals used for wood pressure treatment are typically alkaline copper quaternary (ACQ) and copper azole (CA), which are both active corrosion materials. Common metal parts used with pressure treated wood are connector plates, joist hangers, bracing plates, and fasteners of all types. All of these parts should be fabricated using stainless steel type 316 to withstand the corrosively of the treated wood. When appropriate – isolating the steel from the wood with water resistant barrier materials is an extremely effective way to minimize corrosion issues with the treated wood. Such materials would include polymer tapes, masking, and lining materials.

CONCRETE and NON-FEROUS METALS:

Non-ferrous metals such as copper, zinc, aluminum and lead (and alloys), may be subject to rapid corrosion when embedded or in-surface contact with fresh concrete, caused by direct oxidation in strong alkaline solutions that normally occur in fresh concrete and mortar, or due to presence of soluble chlorides. Do not embed those metals in fresh concrete unless mitigating actions are considered in advance.

Recommended Fastener Guide ¹									
Metal	Fastener Material								
	Zinc-plated Steel Screws ²	Organic-coated Steel Screws ²	Hot-dipped Galvanized Steel Nails ³ and Screws	Zinc-alloy Head Steel Screws	Stainless Capped Head Steel Screws	Aluminum ⁶	Copper and Copper Alloys	300 Series Stainless Steel	400 Series Stainless Steel
Unpainted Galvanized Steel	Yes ⁴	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Painted Galvanized Steel	Yes ⁴	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Unpainted Galvalume [®] Steel	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Painted Galvalume [®] Steel	Yes ⁴	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Aluminum	No	No	No	No	No	Yes	No	Yes	No
Copper and Copper Alloys	No	No	No	No	No	No	Yes	Yes	Yes
Stainless Steel	No	No	No	Yes	Yes	No	No	Yes	Yes
Zinc Alloy	No	No	No	No	No	No	No	Yes	Yes

Notes:

- The performance of compatible fasteners shown in this table matches the expected service life of the metal material. However, in highly corrosive environments, such as heavy industrial, coastal marine, high airborne pollutants or salt spray, preservative treated lumber or fire-retardant lumber, the compatibility of certain fasteners with metal materials may be affected. In these types of applications, the manufacturers of the fastener and metal will have specific recommendations.
- Screws should be plated/coated per ASTM F1941
- Nails should be galvanized per ASTM A153
- Not recommended for coastal and heavy industrial environments
- Commercial availability of threaded aluminum fasteners is limited because of their lower torsional, tensile and shear properties

Figure 6: Recommended Fastener guide to avoid galvanic reaction. (Source: NRCA)



Figure 7: Corroded bolt

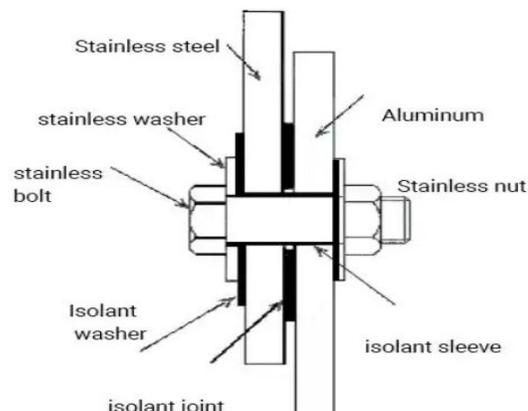


Figure 8: Insulating dissimilar metals

4.6 Sustainability Criteria

Projects shall comply with applicable sustainability requirements to include UFC 1-200-02, High Performance and Sustainable Building Requirements.

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 website, located at http://www.wbdg.org/references/pa_DOW_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) NAVFACMAR, b) Commander Naval Region (COMNAVREG) Guam, and c) Guam Division of Vocational Rehabilitation.

4.9 Anti-Terrorism (AT)

DOW projects shall comply with UFC 4-010-01, DOW Minimum Antiterrorism Standards for Buildings.

AT compliance can significantly impact site and building layout and design. As a result, AT measures shall be considered early in the design process of all projects. Attention is focused first on 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. AT 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 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

DOW projects shall determine, develop, and document total Security Engineering requirements in accordance with UFC 4-020-01, DOW 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 Director of Central Intelligence Directives (DCID) 6/9 Manual - Physical Security Standards for Sensitive Compartmented Information Facilities. 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 specifying impermeable or semi-impermeable vapor barriers/retardants that trap moisture hidden within construction systems is essential to mitigating moisture and mold problems. Per IECC – vapor barriers/retardant Class I and II are not allowed in Climate Zone 1 and 2. All interior surfaces must be breathable (permeable/Class III vapor retardant for climate zone 1) or installed to prevent the entrapment of moisture. 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 (vinyl) 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 vapor barrier unless a minimum 6.35 mm ($\frac{1}{4}$ ") 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 need to be addressed. Structural failure has occurred in Guam's corrosive environment due to improper corrosion protection for framing, connections, etc. See Section 4.5 Corrosion Prevention and Control Criteria.
- d. Air-conditioned spaces need special attention. 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. For additional measures, refer to UFC 3-410-01 HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS
- 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 Navy and Marine Corps shore-based facilities located in Guam, Micronesia, and locations covered under NAVFAC Marianas Area of Responsibility (AOR).
 - f. Guam's tropical location results in a high UV environment year-round, posing unique challenges for the design and maintenance of DOW facilities. To ensure durability and efficiency, Facilities should incorporate UV-resistant materials, fenestration systems with UV-blocking glazing, and UV-resistance design strategies to further mitigate the impact of UV radiation while supporting DOW sustainability goals.

4.13 System Safety Engineering

Projects shall develop System Requirements Hazard Analysis in accordance with MIL-STD-882 and NAVFACPAINST 5100.4D in addressing all hazards identified in project planning documents.

4.14 Industrial Control Systems (ICS) Engineering

DOW projects shall develop comprehensive Cybersecurity Engineering requirements in accordance with applicable UFCs and the NAVFACMAR Public Works Utilities & Business Processes (PWUC-BP), and in compliance with NAVFACMAR Command Information Office (CIO) requirements. Coordinate project requirements for all new or modified industrial controls systems (e.g., Advanced Metering Infrastructure (AMI), Supervisory Control and Data Acquisition (SCADA), Direct Digital Controls (DDC)) with NAVFACMAR CIO together with the project sponsor's IT/communications department in order to obtain requirements that are to be included in the RFP package prior to solicitation. The goal of joint-development is to identify and ensure agreement on responsibility for these requirements (e.g., coordination, Post Construction Award Services (PCAS) support, component-specific or proprietary system requirements, funding for and in support of such systems, etc.).

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 NAVFACMAR CIO.

Navy/Marine Corps and Air Force projects shall be in compliance with the most current Marianas Requirements for ICS/FRCS Cybersecurity and Engineering (RICE) Guidance (refer to Appendix C). For all other projects, consult with CIO on the application of RICE requirements together with the project sponsor's IT/communication systems department.

Mission critical infrastructure and associated communications and controls systems may have a need for system redundancies to ensure continuous, reliable mission operations. Consult with PW10 - Critical Infrastructure Services (CIS) along with the project sponsor's IT/communications department to determine requirements."

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

ESS Compliance shall be in accordance to the latest Secretary of the Navy (SECNAV) Memorandum on Explosive Safety Risk Acceptance within Joint Region Marianas (JRM). Refer to Appendix D for most current SECNAV MEC memorandum. When exemption is not applicable, ESS compliance is mandatory where any ground penetration and construction activity (clearing, digging, grading, excavating, planting, etc.) is to be performed. Applicable reference documents:

1. Explosive Safety Submission Munitions Response Sites, Guam Construction Support (Current Amendment at time of Contract or Task Order award)
2. Chief of Naval Operations (CNO) ES Exemption E1-16 for COMMAND JOINT-REGION (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 IAP as appropriate (see [4.11 Installation Appearance Plan](#) for additional requirements.)

5.1 Site and Landscape Design

Site and landscape design shall be in accordance with the applicable Base IAP and the Final Guam Landscaping Guidelines as appropriate.

Landscaping in Guam presents challenges unique to tropical climates. Landscaping practices should benefit the environment and generate long-term cost savings. It is Navy policy to:

- Use regionally native plants for landscaping
- Design, use and promote construction practices that minimize adverse effects on natural habitat
- Prevent pollution by reducing fertilizer and pesticide use, integrated pest management practices, recycling green waste (composting) and minimizing runoff
- Implement efficient water practices
- Prevent the introduction of invasive species.

5.2 Architecture

The primary goal of this section 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.



Figure 9 – Example of massing



Figure 10 – Existing building colors

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. Concrete horizontal and vertical construction joints (concrete, precast concrete, tilt up concrete) may have a concrete step detail that prevents water from being driven directly through the joint. Concrete vertical joints may 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 walls or the 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 batt 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. Another type of wall insulation that shall not be used in Guam's humid and hot climate is the spray foam insulation, closed cell or open cell. Closed spray foam insulation has low permeability (<1 perms) which classifies it as a Class II vapor retardant (0.1 >1 perms). Class I and Class II vapor retardant are not permitted for use by International Energy Conservation Code (IECC) in climate zone 1 (tropical) and climate zone 2, because it will trap moisture vapors from escaping the interior and will not allow the vapors to dry out. As a result, condensation will occur at the interior side of the vapor barrier.

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 Concrete Masonry Unit (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 use the most corrosion-resistant metal materials as noted in Section 4.5.

Provide vapor barriers under and around slabs 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, specifically UFC 3-300 STRUCTURAL AND SEISMIC DESIGN 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 Exterior Insulation and Finish System (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 Exterior Finish System (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 Construction Management Engineer (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.



MILDEW RESISTANT PAINT



EFS SANDBLAST TEXTURE

Figure 11: 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 12: 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.

Louvers shall be certified by the manufacturer for resistance to high velocity wind-driven rain. Provide structural mullions as required to meet specified wind load and wind-borne debris impact resistance requirements.

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 structures designated as essential facilities within risk category III or IV (according to IBC Table 1604.5). Additionally, typhoon shutters shall be installed at all glazed fenestrations of dwelling facilities. 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.

Ensure that the shutter assembly is seamlessly integrated with the building architecture and does not appear as an add-on. The finish of the entire exposed shutter assembly shall be compatible with the applicable Base IAP or approved housing color scheme. Stainless steel hardware and fasteners shall be concealed to the maximum extent possible.

Acceptable types of typhoon shutter 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 13: 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.
- Accordion-type typhoon shutters: Provide dark bronze anodized shutters with aluminum allow for tracks and slats, 6063-T5/T6 or 6005-T5/T6, with heavy duty non-key locking device, locked from the outside. Locking from the inside is acceptable for inaccessible locations. Provide locking pins or mechanisms to secure the folded shutters in place when not in use. For Doors, embed base track, flushed to finish floor, with removable cover plate. The complete shutter assembly and design must be certified.



Figure 14: Typhoon Shutter Side Hinged

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



Figure 15: 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 aluminum does not provide the required performance characteristics. 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. Polyvinyl Chloride (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 16: 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 DOR shall coordinate the use of recessed entry 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 and recessed entry floor mats are recommended 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.



Figure 17 - Examples of building entrances



Figure 18 – Example of covered walkway

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 DOW 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 19: 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 double pan window system with thermal breaks incorporated into the frame, meeting latest adopted edition of IBC and ASCE7 for hurricane and windborne flying debris. At minimum, exterior glazing shall be minimum 6.35 mm ($\frac{1}{4}$ ") thick laminated glass with minimum 0.75mm (1/32") thick Polyvinyl Butyral (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 3ft x7ft.
- 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. Doors to have accessible rated weather sealed thresholds and automatic door bottoms or door shoe with drip. 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.

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



Figure 20: 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 corrosion-resistant materials. Door leaves shall be either stainless steel type 316 or hot dip galvanized. Door components (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.

Other door systems must be approved in advance on a case-by-case basis through an exemption or 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 21: 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, specifically UFC 3-110-03 ROOFING, 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 (Division 07 – MESH REINFORCED ELASTOMERIC COATING (MREC), Section 07 56 00.60), 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 warranted 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, MREC shall have a minimum thickness of 60 mils Dry Film Thickness (DFT).

For the replacement or repair of existing fluid-applied roof coatings, the new MREC shall have a minimum thickness of 60 mils DFT.

For re-covering (MREC) over existing fluid-applied roofing systems, the new coating shall have a minimum thickness of 45 mils DFT.

In all MREC applications, the new coating must be compatible with existing roof surfaces, including concrete decks, fluid-applied roof coatings, crack sealants, and other unique roof conditions. Compatibility must be verified with an adhesion or pull test report.

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 102 mm (4") high x 305 mm (12") wide.

Figure 22: Roof Style

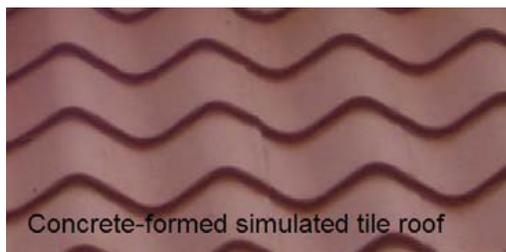
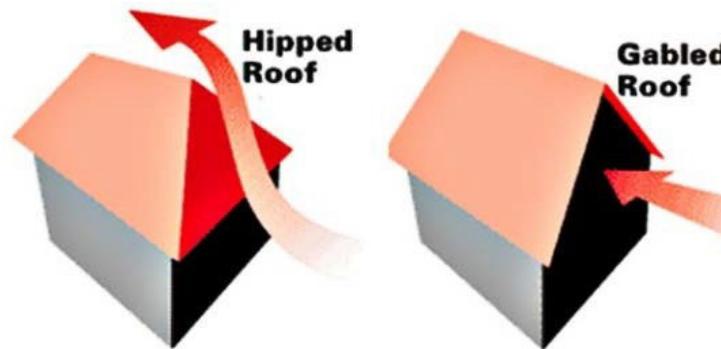


Figure 23: Concrete-formed Simulated Tile Roof

Fully grouted and mechanically fastened concrete or clay tile roof systems may be considered for certain types of projects. Formed 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 maximum slope of 4:12 unless otherwise required by functional criteria. Sloped roofs may have various than geometries. Gable or hip style roofs are preferred. Severely steep sloped roofs of greater 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.

5.2.4.2 Low Sloped Roofing Systems

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

5.2.4.3 Roof Insulation Systems

Roof Insulation Systems: Insulate concrete roof slabs and ceilings/attics with insulation applied to the underside of the roof slab to improve thermal performance and occupant comfort. If required by code, install a thermal barrier to cover the insulation.

For re-roofing projects, the existing above-deck insulation shall be replaced with insulation on the underside of the roof deck, with fluid-applied roof system (MREC) applied to the roof deck, provided that the existing roof deck meets the required slope to facilitate proper drainage.



Figure 24: 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 51 mm (2") below the wall-roof-gutter connection joint.

Gutters and downspouts size shall be calculated based on the median rainfall intensity in Guam, roof drainage area and roof slope in order to prevent overflow of the water drainage system.

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, etc.)

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 wind turbines, other electrical equipment, and mechanical equipment at ground level (see Chapter 6, D3030, D50).
- Do not use interior ladders to roof hatches. Incorporate wall-mounted ladders complying with AT/FP requirements (lockable access, located within a controlled area)



Figure 25: 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

Photovoltaics (PV) and solar water heating provide many benefits specific to Guam. Guam has a good solar resource and solar energy can offset the high electricity rates on Guam, oftentimes making a project financially attractive. Most of Guam's power is generated using imported fuel oil and deploying solar energy technologies reduces the risks and costs associated with imported fuel. Installing PV can offer energy resiliency benefits if combined with Battery Energy Storage Systems (BESS). Guam has well-qualified solar installers that have completed many successful installations that have withstood typhoon-level winds. New construction on Guam should be designed to include rooftop PV, or be designed to be solar ready at minimum. More information on designing buildings to be solar ready can be found in the two reports listed below.

- Solar Ready: An Overview of Implementation Practices
- Solar Ready Buildings Planning Guide

There are specific challenges to installing solar on Guam. Guam regularly experiences seismic events that can cause bolted joints to loosen over time. Guam is a corrosive environment due to being surrounded by the ocean and special attention must be paid to ensuring potential corrosion issues are minimized. Seismic and corrosion issues relevant to solar energy systems are not covered in this section because they are covered in detail in other sections of this document. Guam is located in American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Climate Zone 0A, which is characterized as being extremely hot and humid. Due to the extreme heat, inverters shall not be placed on the roof, but shall be located inside a building or in a shaded area to minimize heat gains. Furthermore, any equipment with Liquid-Crystal Display (LCD) or LED displays (e.g., inverters, advanced electrical meters) shall be located inside buildings or in a shaded area to avoid damage to the displays caused by direct sunlight.

PV panels and solar hot water panels can be damaged by high winds and flying debris during a high-wind events. It is important to mitigate this potential damage by implementing storm-hardening measures that will be discussed in detail in a following section. When PV panels are

located on the roof the racking shall be mechanically fastened to the roof structure and the fasteners shall be sealed to meet roof penetration standards. Solar photovoltaic panels/modules shall not be installed unless a licensed Civil or Structural Engineer submits stamped calculations indicating that the support frame and PV panel/modules meet the standards for Guam wind loads per UFC, ASCE 7, IEC 61215, Underwriters Laboratories (UL) 1703 and Structural Engineers Association of California (SEAOC) PV 2-2017 criteria.

Guidance on Siting & Installing PV in High Wind Locations

High wind events such as typhoons regularly occur in Guam and additional measures need to be taken to ensure PV systems are storm hardened to minimize damage during high wind events. General PV placement and wind loading guidance is summarized below.

Wind Loading Guidance

For ground-mounted PV systems, fixed-tilt systems are recommended for Guam given that wind events cause significant issues with tracking systems.

Systems shall be designed in accordance with either ASCE 7-22 or a previous version of ASCE 7 combined with SEAOC PV 2-2017.

It is recommended that ground-mounted PV systems are directly connected to the earth with concrete.

For roof-mounted PV systems, low pitched concrete roofs where the PV racking system can be bolted directly into the concrete are preferred. PV panels should be installed at a lower tilt angle (e.g., 5°) to minimize wind loading and row-to-row shading, and panels should not be installed completely flat (i.e., 0°) because dirt and debris is more likely to collect on panels and reduce energy output.

Ensuring drainage on flat roofs is free of any potential clogging issues is important to ensure there is no flooding on the low slope roof, which can cause significant damage to a PV system.

PV can be considered on pitched roofs, but materials (e.g., racking systems for pitched roofs), installation, and maintenance costs are typically higher when compared to flat roofs. PV installed on pitched roofs is also more visible and therefore affect the aesthetics of a building. Pitched roofs with complex roof geometry (e.g., many gables, many rooflines) or clay tile roofs are not preferred when installing PV.

Carport PV systems require significant steel structures to withstand Guam's high wind events and these system types can be costly due to the structural requirements.

Focusing on the bolted joints in a PV system, especially the module-racking interface, is key to ensuring PV systems survive high-wind events with minimal damage. PV system designs that use top-down T-clamps should be avoided because they typically use the force from one

module to secure the adjacent module. In this type of design, a high-wind event that causes the loss of one PV panel commonly leads to the loss of the entire row due to a cascading/domino failure. Through-bolting the modules directly to the racking system is a preferred way to secure PV panels. A combination of through-bolting and top-down T-clamps can be considered for additional panel-to-racking system strength.

During installation, ensure that all bolts are torqued to specifications, which requires training installers to use torque wrenches. The torque on bolts should be checked during a pre-commissioning site audit performed by a third party. Perform a maintenance regime where the torque on bolts is regularly verified is recommended as bolts can loosen over time.

Various bolted joint solutions can mitigate the modes through which bolts can loosen. Wedge-lock washers lock into place and resist loosening when tightened and they also resist vibrational loosening. Rivet-lock bolts, also known as huck bolts, are one-time assembly locking bolts that also mitigate joint loosening, but a special tool is required for installation and removal. Belleville washers are conical washers that hold tension and mitigate preload relaxation. Applying thread lock to joints is another method for mitigating joint loosening.

Through-bolt pull out can also be an issue during high wind events. Washers should be large enough to cover the pre-drilled holes in the PV module frame. Installing PV modules with thicker frames is preferred, but this could be difficult because the PV industry is moving towards lighter frames to save on materials and shipping costs.

PV modules with holes that are wide and close to the edge of the frame should be avoided because this design is more likely to experience issues with bolts pulling through the frame during high wind events.

The design wind speed for Guam is 195 mph. The standard uplift rating of PV modules is 2400 Pascal (Pa) but installing PV modules with an uplift rating of 5000 Pa or higher is recommended for Guam. There are very few PV modules currently being manufactured to the 5000 Pa or higher uplift rating. 60-cell PV modules are recommended over 72-cell PV modules because the smaller size will deflect less under wind loading.

The way in which PV modules are attached to the racking system impacts the uplift tolerance of the PV module, and using additional clamps or a higher surface area or clamps is recommended. Using a three-rail racking system with six evenly spaced clamps or through-bolts per module, as opposed to the standard two-rail racking system, is recommended for Guam as this will provide for a more robust racking system to mitigate the effects of high wind events. The use of a continuous rail module attachment systems is also recommended. Specifying higher uplift rated PV modules and three-rail or continuous rail racking systems increases the cost of PV systems on Guam. Wind load calculations should be performed at the perimeter modules and not averaged over the entire PV array because the perimeter modules experience the highest wind loading, as defined in ASCE 7-22 and SEAOC PV 2-2017.

Commonly used cold rolled steel "C" or "U" channel PV racking is not recommended for Guam

because the strength of these racking systems is largely along one axis and wind load can affect all axes. Anodized aluminum racking systems with 316 stainless steel bolts are recommended materials suitable for Guam's marine environment.

A regular maintenance regime occurring every 3 to 4 months is highly recommended in Guam given that bolted joints can loosen, especially given the high wind and seismic activity in Guam. Regular maintenance should include verifying electrical components and expected energy output, checking for corrosion, checking wire management, and retorquing all bolted joints to specification. If needed, washing the PV panels should be considered in the regular maintenance regime. Avoid the use of high-pressure washing systems, which can damage PV systems.

Tracking PV systems are not recommended for Guam because high wind events cause significant issues with these types of systems.

Other items to consider:

- The prevailing wind direction on Guam is from the east, so it is preferred to install PV on more western buildings that may have some wind shielding from adjacent buildings.
- The tilt angle of ground-mounted systems should be around 12 degrees. Lower tilt angles are more susceptible to resonant effects and higher tilt angles will have to withstand higher static loads.
- To achieve the lowest wind pressures racking hardware for flush-mounted solar arrays should be designed to produce a gap between modules of at least 0.75 inches (19 mm) and a maximum height of panels above the roof of 5 inches (127 mm)."
- In the case of ground mount, installing PV systems lower to the surface (may require more regular vegetation management.)
- Perform a soil analysis for ground-mounted PV systems. For sites with varied terrain, perform soil analysis on multiple locations throughout the site.
- PV cable connectors – the electrical connections on the wires connected to the panels themselves should be inspected to ensure a strong electrical connection is achieved. Use PV connectors from the same manufacturer for all connections.
- Installation: Wire management. During installation, care should be taken that no wiring is able to be pulled against sharp edges of modules or conduit that could wear down the wire coating over time. Wires should be routed under modules with purpose built metal clips (not plastic ties) so they are not hanging loose susceptible to movement in the wind. PV wires should not be allowed to come in direct contact with the roof.

Heavy Rain and Flooding Guidance

Heavy rains and post-storm flooding after typhoons and tropical storms can also greatly impact PV systems, leading to electrical failures requiring repairs or replacements. Flooding can also limit or prevent site access, leading to additional PV system downtime. Weatherproofing electrical equipment is required in Guam and all electrical system components (e.g., inverters, combiner boxes, and electrical boxes) should be installed above the 100-year flood design

levels.

Ensure all electrical boxes are sealed to National Electrical Manufacturers Association (NEMA) Level 4X. Conduit should enter from the bottom side of enclosures and enclosures should have weep holes to allow an egress path for water.

Provide proper drainage to the site to minimize potential flooding and soil washout, including ensuring flat rooftop systems have adequate drainage.

Care should be taken to ensure that water cannot easily enter conduit of a PV system and that if it does, it will not be able to flow downhill into any critical electrical components.

General Shading Considerations Specific to Guam

In general, shading will not be a considerable issue in Guam given the low latitude. A sensitivity analysis of ground/roof orientation and pitch/tilt was done to determine the sensitivity on electricity generation in Guam. The results of this sensitivity analysis are given in Figure X. The percentages shown are the percent reductions in solar energy production by varying orientation and pitch. As shown, the sensitivity to solar electricity generation increases as the PV panel orientation moves further from due south. Sensitivity to solar electricity generation increases as the PV panel tilt increases when also accounting for PV panel orientation. Panel tilt should be 12 degrees or less to minimize wind loading.

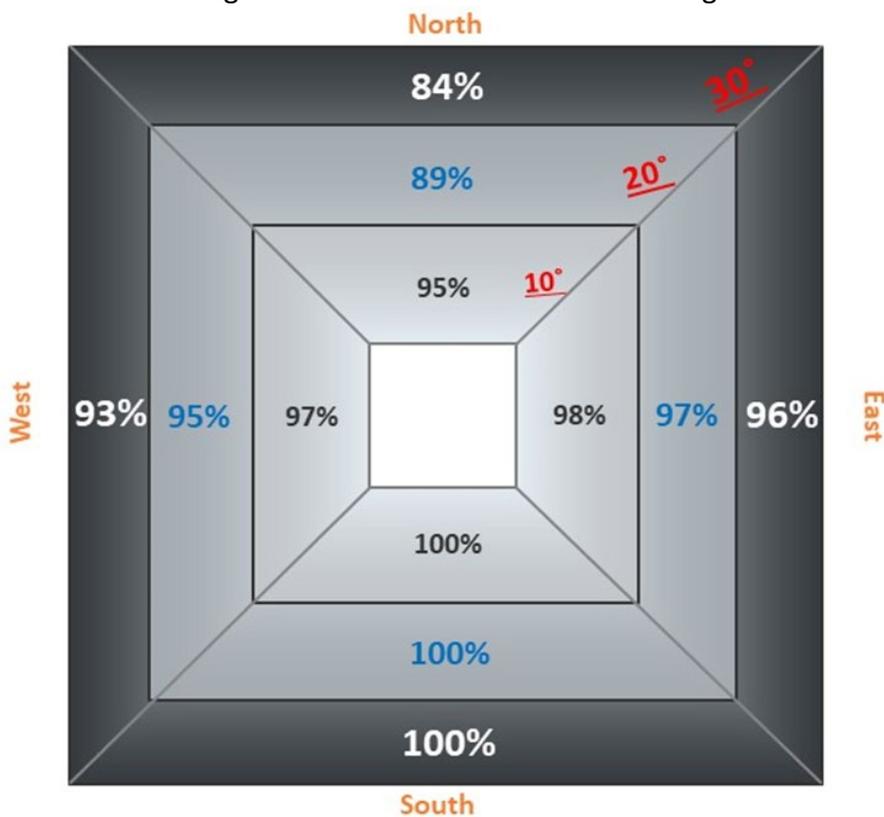


Figure 26. PV Orientation and Panel Angle Sensitivity Analysis

References for “5.5 Solar Hot Water Panel and Photovoltaic Panel Systems”

Solar Ready: An Overview of Implementation Practices.

<https://www.nrel.gov/docs/fy12osti/51296.pdf>

Solar Ready Buildings Planning Guide.

<https://www.nrel.gov/docs/fy10osti/46078.pdf>

Solar Photovoltaics in Hurricanes and Other Severe Weather.

https://www.energy.gov/sites/prod/files/2018/08/f55/pv_severe_weather.pdf

Solar Under Storm Part I: Designing Hurricane Resilient PV Systems.

[https://rmi.org/wp-](https://rmi.org/wp-content/uploads/2018/06/Islands_SolarUnderStorm_Report_digitalJune122018.pdf)

[content/uploads/2018/06/Islands_SolarUnderStorm_Report_digitalJune122018.pdf](https://rmi.org/wp-content/uploads/2018/06/Islands_SolarUnderStorm_Report_digitalJune122018.pdf)

Solar Under Storm Part II: Select Best Practices for Resilient Roof-Mount PV Systems with Hurricane Exposure.

<https://rmi.org/solar-under-storm-part-ii-designing-hurricane-resilient-pv-systems/>

Wind Design for Solar Arrays PV2-2017.

<https://www.seaoc.org/store/viewproduct.aspx?id=10228815>

Solar Photovoltaics in Severe Weather: Cost Considerations for Storm Hardening PV Systems for Resilience.

<https://www.nrel.gov/docs/fy20osti/75804.pdf>

For additional criteria, refer to UFC 3-440-01 FACILITY-SCALE RENEWABLE ENERGY SYSTEMS and UFC 3-540-08 Utility-Scale Renewable Energy Systems

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 (specifically UFC 3-530-01 Interior and Exterior Lighting Systems, with all Changes) 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 UFC 1-200-02, High Performance and Sustainable Building Requirements, for applicable publication date
- 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 ANSIESNA RP8-2000 for full cutoff.

- 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 27: Combination Photovoltaic & LED Streetlight



Figure 28: Standard Street Lights and Poles



29: Solar powered street Lights and Poles

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

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.

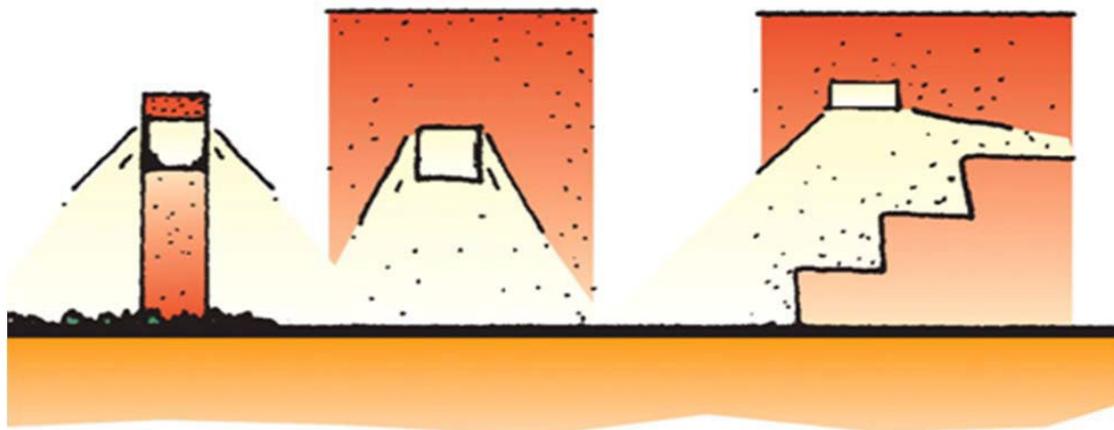


Figure 30: Low Level Lighting Types



Bollard – down light



Bollard – 360° light distribution



Niche Light - recessed in concrete pedestal



Niche Light – recessed in wall

5.6.2 LANDSCAPE LIGHTING

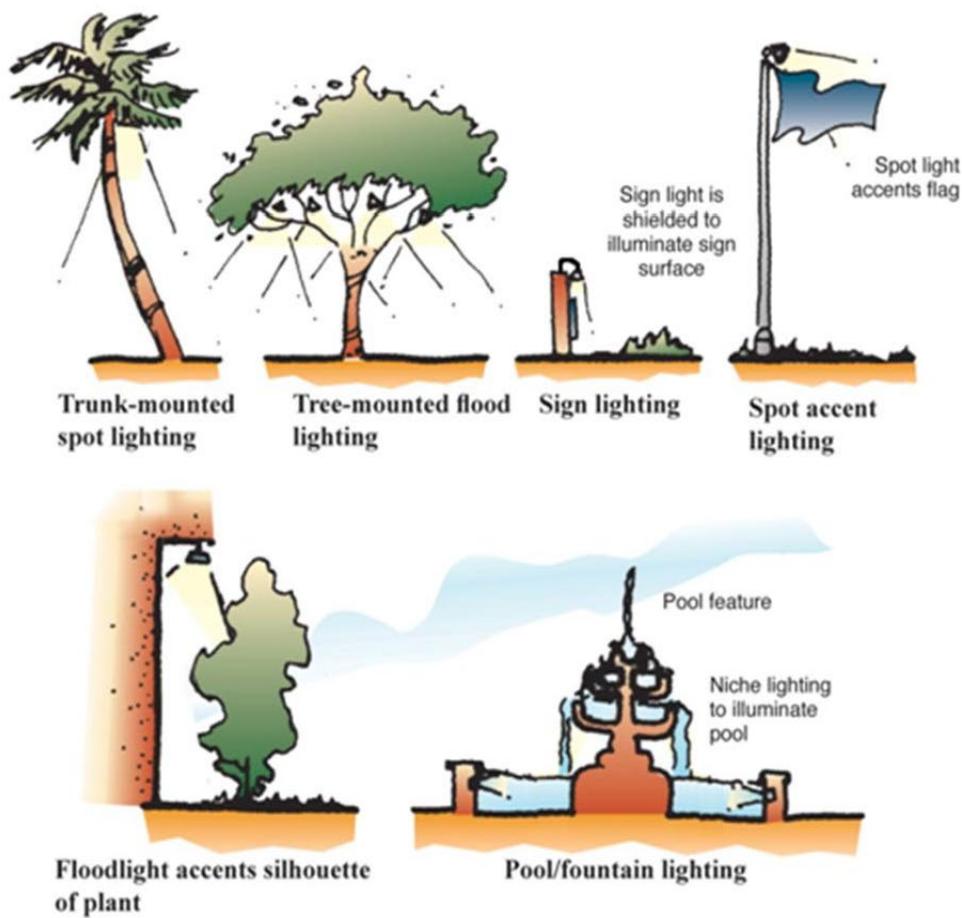


Figure 31: Landscape Lighting

5.6.3 STREET AND PARKING LIGHTS

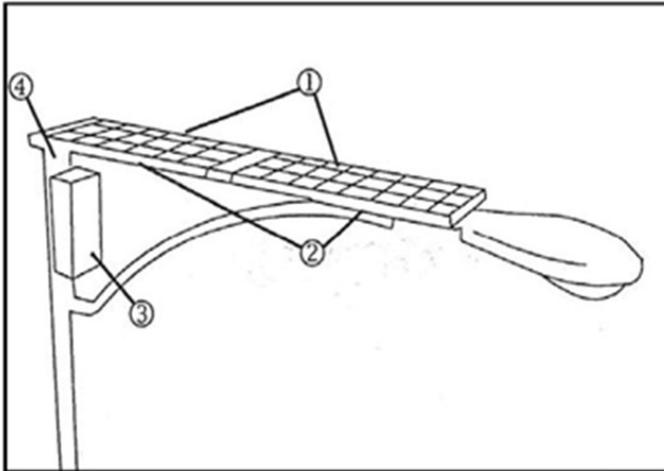


Figure 32: Street and Parking Lights

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

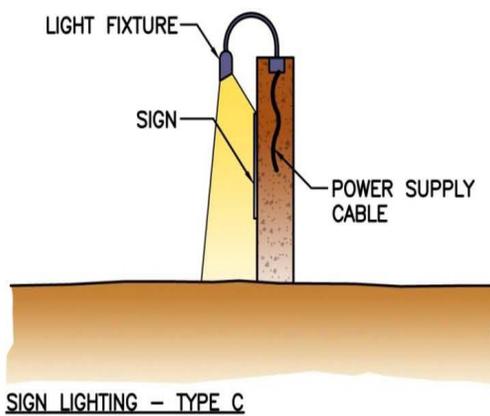
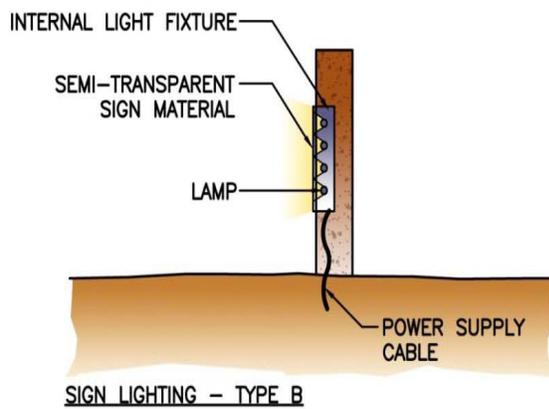
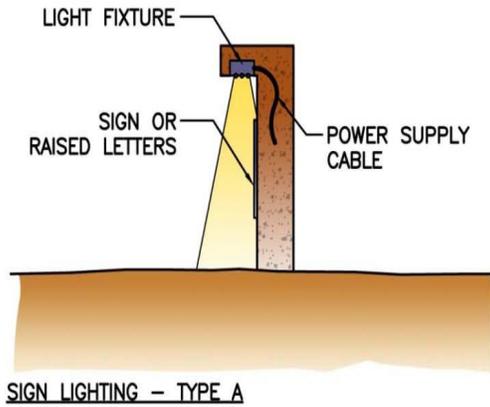


Figure 33: Sign Lighting

5.6.5. LED LIGHTING



Figure 34: LED Lighting

5.6.6. SOLAR (PHOTOVOLTAIC) POWERED LIGHTS



Figure 35: Solar powered lights

Note: The designs shown above may not meet wind, seismic, and corrosion criteria. The 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.

For additional measures, refer to UFC 3-120-10 Interior Design

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 UFCs, 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-Es are required to submit Structural Interior Design (SID) and Comprehensive Interior Design (CID) packages for approval by Contracting Officer (KO) 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.
- 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. Strict preparation of the subsurface, moisture testing, and the use of moisture-resistant adhesives, sealants, and other installation considerations must be implemented.
- 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 vapor barrier trapping moisture within construction and cause mold growth. Ensure that all adhesives used with all wall coverings are breathable (vapor retardants Class III, perm 1>10). 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 Volatile Organic Compound (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.

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 casework, cabinets and furnishing.

For additional measures, refer to UFC 3-300 STRUCTURAL AND SEISMIC DESIGN SERIES

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. Use low VOC admixtures.
- d. Use recycled plastic fillers.

- e. Retain the exposed concrete floor finish (sealed) to reduce material use. The design of concrete floors, especially on grade, shall address Moisture Vapor Transmission (MVT) 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.
- f. Detail vapor retarder or waterproofing membrane under the slab to control migration of soil gas emissions such as radon into the building interior.
- g. 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 Regional Officer In Charge of Construction (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 concrete slabs on grade

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 geo-membrane vapor barrier that meets ASTM E 1745 (Class A), ASTM E 96/E 96M, 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 thickened foundations 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 DOR 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 to resist

hydrostatic pressure and moisture intrusion 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 pound per square inch (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 kips per square inch (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 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 125 mm (5") for exterior slabs and 115 mm (4- 1/2") 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 153 mm (6") 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 27.6 MPa (4,000 psi) for pneumatic tire traffic and 34.5 MPa (5000 psi) for steel tire traffic.

A1030.3 Heavy Traffic Slab on Grade

Minimum slab thickness shall be 204 mm (8"). 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.

The most corrosion-resistant metal materials for building components and assemblies shall be used as noted in Section 4.5. These include, but not be limited to, (in descending order of preference) anodized aluminum, stainless steel, and hot-dipped galvanized steel. 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), [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.

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

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

Steel is allowed for long span conditions such as hangars where concrete systems are not feasible. See Sections 4.5 and B10 for limitations and coating requirements. Structural steel framing shall not be directly exposed to exterior condition, unless written approval is provided by the NAVFACMAR Chief Engineer.

Steel frames shall be designed as space trusses, 2-dimensional trusses, and girder or purlins with moment resisting frames. Minimum structural steel strength shall be 36 ksi. Specify recycled content framing. To the greatest extent possible, fabricate hot-dip galvanized steel framing in shorter lengths and field erect with bolted connections to avoid damage to hot dip galvanized coating.

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.

f. Structural Connectors Used in Reinforced Concrete or Precast Concrete

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. All other steel structural connectors not exposed to weather shall, at a minimum, be hot dipped galvanized in accordance with ASTM A153/A153M. Be mindful of galvanic reaction between galvanized and stainless steel - two incompatible metals.

B1010.2 Floor Decks and Slabs

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

Minimum slab thickness is recommended to be 153 mm (6") 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 153 mm (6") 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 76 mm (3") 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 153 mm (6") 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. 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 76 mm (3") minimum thickness 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

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 allowed for long span conditions such as hangars where concrete systems are not feasible. See Sections 4.5 and B10 for limitations and coating requirements. Structural steel framing shall not be directly exposed to exterior condition, unless written approval is provided by the NAVFACMAR Chief Engineer.

Steel frames shall be designed as space trusses, 2-dimensional trusses, and girder or purlins with moment resisting frames. Minimum structural steel strength shall be 36 ksi. Specify recycled content framing. To the greatest extent possible, fabricate hot-dipped galvanized steel framing in shorter lengths and field erect with bolted connections to avoid damage to hot-dipped galvanized coating.

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.

f. Structural Connectors Used in Reinforced Concrete or Precast Concrete

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. All other steel structural connectors not exposed to weather shall, at a minimum, be hot dipped galvanized in accordance with ASTM A153/A153M. Be mindful of galvanic reaction between galvanized and stainless steel - two incompatible metals.

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). 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 thickness 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. For exterior conditions, use adhesive anchors and stainless steel bolts for corrosion protection. 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), [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 NAVFACMAR Chief Engineer and steel is designed for Guam's corrosive environment by incorporating guidelines of UFC 3-301-01, Appendix A, A-5.4.

The DOR 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 MVT as a cause for floor sealers to floor covering failures. If appropriate, consider the use of breathable concrete sealers, 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, American Architectural Manufacturers Association (AAMA) 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. Be aware of the galvanic reaction between zinc coated steel and stainless steel when placed together.

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 may 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 may have lapped joints. All joints shall be properly prepared and sealed.

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

Minimum wall thickness shall be 153 mm (6") 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 153 mm (6") 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 153 mm (6") 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 204 mm (8") and reinforced in each direction. Minimum compressive strength for CMU walls shall be 1,500 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

Provide dark bronze anodized shutters with aluminum alloy for tracks and slats, 6063-T5/T6 or 6005-T5/T6, with heavy duty non-key locking device, locked from the outside. Locking from the inside is acceptable for inaccessible locations. Provide locking pins or mechanisms to secure the folded shutters in place when not in use. For doors, embed base track, flushed to finished floor, with removable cover plate. The complete shutter assembly and design must be certified. Ensure that the shutter assembly is seamlessly integrated with the building architecture and does not appear as an add-on.

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 Americans with Disabilities Act (ADA) and Architectural Barriers Act (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 DOR 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 with integrated thermal breaks in the frame; conform to ANSI/AAMA/Window and Door Manufacturers Association (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. The aluminum frame shall be with integrated thermal breaks.

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 44 mm (1-3/4") thick, minimum 915 mm (3'-0") wide, 2134 mm (7'-0") 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 E283.
- f. To protect against water infiltration, provide a vestibule wherever possible and weather strip 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, wind loading, impact resistance or other requirements.

Hot dipped galvanized steel doors and frames shall be ANSI A250.8. Doors may be specified to be insulated. Hot dipped 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 (High Density Polyethylene (HDPE) or Medium-Density Polyethylene (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 DOR 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 ADAAG.
- 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.

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), [4.5](#) (corrosion), and [4.12](#) (hot humid climate design) which are critical in successfully addressing Guam's challenging environment.

Roofing systems for new construction and roofing removal and replacement shall comply with UFC 3-110-03 ROOFING warranty requirements. They shall provide a minimum 20 year, no dollar limit, full system materials and installation workmanship water tightness warranty.

Roofing appearance shall meet the appropriate Base IAP.

Place insulation under structural decks. Provide thermal barrier over the insulation where required by code.

Provide gutters and downspouts or overflow scuppers as appropriate to the roofing system. Sizer of gutters and downspouts shall be calculated based on the median rainfall intensity in the region, roof drainage area and roof slope in order to prevent overflow of water drainage system.

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 Index (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 (LID) 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 slope of 4:12 unless otherwise required by functional criteria.

A Mesh Reinforced Elastomeric Coating (MREC) directly applied to a concrete roof deck is the preferred roofing system. The types of elastomeric roofing membrane to be considered are: Mesh-Reinforced self-cleaning silicone type or polyurethane 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. Acrylic MREC will not be accepted.

Roof systems that will be significantly damaged by Guam's typhoon wind forces and become wind-borne flying debris shall not be used for new construction. 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.

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 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 SRI 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).

Concrete tile roof systems shall be with factory-applied sealer to prevent water/moisture absorption. Concrete roof tiles shall be installed in a staggered/interlocking pattern over a full mortar bed and individually attached directly to the concrete roof slab with type 316 stainless steel fasteners with no less than 25 mm (1") of embedment into the concrete roof deck.

Clay tiles show inability to resist projectile impact during stronger wind loads, so this type of roof system may be allowed on a case by case.

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, no dollar limit, warranty. Between formed and pre-formed metal roof systems – the formed metal system is preferred as it utilizes interlocking seams, while the fasteners used in the pre-formed metal panels tend to corrode rapidly and leave the metal panels loosely anchored. The 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 PV panels.

B3010.2 Low Slope Roof Systems

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

Low sloped roofing systems generally are 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.

Metal roofing on low sloped roofs shall require an exemption or waiver per Section 2.3

To reduce heat island effect, use roof coating having SRI of equal to or greater than 78

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.
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. Calculate the appropriate size of the gutters and downspouts, based on the average rainfall intensity in the region, the roof slope and the size of the drainage area in order to prevent overflow of the drainage system.

Concrete gutters cast integrally with the roof slab shall be used to the maximum extent possible. Concrete gutters shall be designed with a minimum slope of 1% to prevent ponding. Specify roof drains with integral flanges for secure connection to the concrete gutter. Coordinate the flange width of the roof drain with the depth of the concrete gutter section. 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 153 mm (6") 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 American Wood Protection Association (AWPA) C20 or AWPA C27 for fire-retardant treatment; and preservative treated in accordance with AWPA 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 Environmental Action Plan (EAP) and DOW 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 A653/A653M G90 hot dipped 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 C955.

Install in accordance with ASTM C1007. 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 13 mm (1/2") to prevent water wicking up during potential flooding during typhoons.

At all perimeter walls and at wet locations, provide 102 mm (4") 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. Provide rigid board (no voids or air gaps, all joints sealed) insulation between the furring channels, and paperless gypsum wallboard as the finish material. For walls requiring ceramic tile finish, provide cementitious tile backer board with a waterproof membrane, instead of gypsum board.

b. Interior stud partitions

Interior stud partitions shall be constructed of minimum 92 mm (3-5/8") G90 metal studs with painted paperless gypsum wallboard board on each side, except provide cementitious tile backer board with waterproof membrane 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 A250.8. 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 25.4 mm (1") above finished floor for return air and door swing to clear tenant added carpets.

C1020.4 Aluminum Doors, Frames and Storefront

Aluminum doors and frames including framing members, transoms, sidelites, and accessories shall be fabricated in accordance with ASTM B221, 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 44 mm (1-3/4") thick, with a minimum wall thickness of 3.2 mm (0.125"), except beads and trim, 1.27 mm (0.050"). 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 E152. 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 highest corrosion resistant material, such as stainless steel, solid plastic or 153 mm (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 (1"). 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 Fire stopping Penetrations

a. Fire-stopping

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 considered 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.

d. Waterproofing Membrane at Toilet, Shower, Laundry, Utility and Wet Areas

For Toilet, Shower, Laundry, Utility and/or Wet areas at Second Floor and/or at Multi-floor buildings, provide waterproofing membrane between floor tile and concrete slab. This will act as a protective barrier against moisture, preventing water from seeping through and damaging the subfloor or surrounding areas.

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), [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 U.S. Environmental Protection Agency (US EPA) and DOW 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 3.18 mm (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 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 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 MVT 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. Tile floor shall meet ANSI A3263.3 American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Flooring Materials. 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 8 mm (5/16") thick with a maximum of 6 mm (1/4") grout width with cushioned edge. Tile shall have a minimum breaking strength of 202 kg (300 pounds), 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 8 mm (5/16") thick with a minimum of 3 mm (1/8") 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 6 mm (1/4") thick with a maximum of 1.6 mm (1/16") 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 12.7 mm (1/2") thick tiles with a maximum of 6mm (1/4") grout width. Tile shall have a minimum breaking strength of 158kg (350 pounds), 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% 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 3 mm (1/8") and a wear layer thickness of 3 mm (1/8") 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 manual.

- a. Where required for high traffic areas, resilient vinyl tile shall be 2.5 mm (0.1") thick, with a vinyl wear layer of 0.9mm (0.035"). 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 3 mm (1/8") and a wear layer thickness of 3 mm (1/8") 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 0.281 inch, low 0.187 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 Carpet and Rug Institute (CRI) Green Label Plus certified.
- k. All Carpets shall be certified National Science Foundation (NSF)/ANSI Standard 140, gold for Commercial Carpets and Rugs.

C3020.5 Wall Base Finishes

Wall base shall be in accordance with Federal Specification FS SS-W-40:
Wall Base: Rubber, and Vinyl Plastic, Types I and II, Styles A and B.

Base shall be 100 mm (4") minimum high, 3.2 mm (1/8") 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 C423, Method of Test and ASTM E1264, Acoustical Ceiling Product.
- b. **Suspension System**

Exposed powder-coated aluminum grid type in accordance with ASTM C635, 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 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 to reduce the potable water demand, such as: infrared controls, metering faucets or dual flush toilets.
- b. Eliminate materials that are lead-polluting on renovation projects.
- c. 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.
- d. Implement a highly efficient hot water heating system to minimize energy consumption and environmental impact. Options include heat recovery from chillers, solar hot water, dedicated heat recovery systems, and heat pump water heaters (hybrid, air-source, or water-source). System selection shall be based on a life cycle cost analysis considering site constraints, system efficiency, total cost of ownership, project goals, and sustainability targets.

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 Waterless Urinals

Waterless Urinals are not acceptable due to concerns regarding maintenance and sanitary conditions.

D2010.2 Drinking Fountains and Coolers

Wall mounted drinking fountains shall be stainless steel with bubbler and push button control. Electric water coolers shall be Air-Conditioning and Refrigeration Institute (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. Where drinking fountains or electric water coolers are specified, an Energy Star labeled bottled water dispenser filling station should also be considered, based on the location and user needs. All drinking water fixtures (drinking fountains, electric water coolers, and bottled water dispensers) shall be accessible where required.

D2010.3 Floor Drains

All floor drains shall have trap primers. Floor drains with trap primers shall be located in locker rooms, restrooms, shower rooms, bathrooms, laundry rooms, janitor closets, hot water tank areas, commercial kitchens, condensate drains, large interior spaces behind overhead roll-up doors, mechanical rooms, pump rooms, fire protection riser rooms, and other areas where water can overflow. For Air Handling Units (AHUs) and other HVAC equipment condensate drains, a floor sink with indirect connection to the drainage system should be considered.

For exterior entrances, provide water intrusion protection measures as coordinated with the architect, such as, but not limited to, rectangular floor drains with trap primers located on the interior sides of entrance doors to drain wind-driven rain. Floor drains shall be covered during construction to prevent clogging.

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. Civil shall provide and specify AMI water meters for overall water usage. Plumbing shall provide and specify sub-water meters monitored by the DDC System.
 - c. All water heating equipment shall be mounted on a housekeeping concrete pad and secured to the building structure with stainless steel strapping.
 - d. Insulate all cold water piping in un-conditioned spaces to prevent condensation. Insulation shall be moisture resistant.
 - e. Washing machine and dishwasher connection shall utilize flexible hoses to facilitate ease of maintenance
 - f. Guam has hard water issues. Water softening or other appropriate methods shall be implemented in building occupancies with significant water heating requirements or where domestic water is used for potable purposes, cooling towers, or other sensitive equipment susceptible to hard water scale buildup. Examples of such occupancies include galleys, BEQs, and facilities with commercial laundry equipment.

D2030 SOIL, WASTE & VENT SYSTEMS

PVC or Acrylonitrile Butadiene Styrene (ABS) Type Drain, Waste and Vent (DWV) pipes and fittings shall be permitted for both aboveground and underground piping. Provide pipe adapters or dielectric unions as required. Provide termite barriers at all floor penetrations. Consider installing a 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 International Plumbing Code (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. During the planning stage, the decision to utilize an active or passive radon mitigation system shall be made.

For all new construction, a passive radon mitigation system shall be installed, with provisions for future activation of an active system. Passive systems shall use Schedule 40 perforated PVC pipes and fittings or Chlorinated Polyvinyl Chloride (CPVC) piping where exposed to the sun.

After new construction is complete, radon testing and reporting are required. If radon levels exceed 4 picocuries per liter (pCi/L), an active mitigation system shall be installed.

For new HVAC system overhauls, replacements, and retrofits, radon testing shall be conducted before and after construction to ensure and maintain adequate pressurization and radon mitigation effectiveness.

RADON-RESISTANT NEW CONSTRUCTION (RRNC) REQUIREMENTS

RRNC is required for all new construction at Remote Procedure Call (RPC) 1 installations or sites and within the construction of new, long-term lease buildings (e.g., leases, limited partnerships, and international use agreements; see Section 2.8) in which the Navy/Marine Corps will be responsible for Navy Radon Assessment and Mitigation Program (NAVRAMP) implementation.

Regardless of the RPC, RRNC is also required in all newly constructed or renovated buildings with a Sensitive Compartmented Information Facility (SCIF). It is important to note that in 2012, EPA initiated a voluntary consensus-based standards initiative with the radon industry (<https://www.epa.gov/radon/radon-standards-practice>). The subsequent standards produced by this partnership have superseded and consequently replaced the previous EPA standards and guidance documents. These standards can be viewed or purchased on-line at <https://standards.aarst.org/>

It is important to note that the incorporation of RRNC features into a building's construction does not mean that the building is "Radon Proof".

Buildings equipped with RRNC features still must be tested as required along with other buildings which do not have RRNC.

For additional information, refer to: NAVY RADON ASSESSMENT AND MITIGATION PROGRAM GUIDEBOOK FOR NAVAL SHORE INSTALLATIONS

D2090.2 Backwater Valve

The installation of an approved type backwater valve in the main waste line of the facility or

housing unit should be considered to prevent sewage from backing up into the building from an obstructed public sewer. If a backwater valve is installed, it shall be accessible and located at the exterior of the building. The backwater valve is not a substitution for a cleanout-to-grade.

D30 HEATING, VENTILATION, and AIR CONDITIONING (HVAC)

Sustainable Design Strategies

- a. 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.
- b. 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.
- c. Indoor design conditions for conditioned spaces during comfort cooling operation shall be 23.9 degrees Celsius (75 degrees Fahrenheit) dry bulb temperature and 50% relative humidity.
- d. Use catchment water collection to supply cooling towers and specify water conserving cooling towers.
- e. Use chemical-free condenser water treatment to reduce cooling water make-up.
- f. Use thermal pipes to improve air-conditioning system efficiency without additional use of energy.
- g. Use Variable Air Volume (VAV) controls where appropriate.
- h. Provide individual control over employee's thermal and ventilation environment where possible.
- i. Use DDC for energy efficient operations and monitoring of the air- conditioning and ventilation systems.
- j. 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.
- k. Use ultraviolet lights to improve indoor air quality and maintain cooling coil heat transfer efficiency.
- l. Where possible, provide the outdoor mechanical HVAC enclosure on the **Leeward** side of the building opposite of the prevailing or trade winds that carry salt-laden air that would speed up the corrosion process.

D3030 COOLING GENERATING SYSTEMS

The following requirements shall govern the design and installation of cooling generating systems:

- a. 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.
- b. There shall be no roof mounted HVAC equipment.
 - c. Use equipment that can be serviced and maintained on island. Products and equipment specified shall have a local service organization.
 - d. Do not use economizer cycles in Guam.
 - e. 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.
 - f. Due to Guam's hot humid climate and mold problems, the Air Conditioning (AC) System shall address controlling indoor humidity including considering separate dehumidification's systems for smaller facilities and housing with AC package units.
 - g. Provide fall protection measures, such as safety rails or equivalent systems, for exterior mechanical equipment that is 1219 mm (48") or taller where maintenance activities pose a fall hazard. Manufacturer-rated or integral fall protection measures are preferred. The selection of appropriate fall protection should also consider the equipment's location, potential fall distances, available space for maintenance personnel, and the feasibility of manufacturer-rated or integral solutions.
 - h. Provide air-cooled chillers in lieu of water-cooled chiller systems where Life Cycle Cost Analysis (LCCA) supports the use of air-cooled chillers. It is recommended that only facilities with on-site HVAC technicians available to monitor water quality frequently have water-cooled chiller systems. Designer shall coordinate with the appropriate Department of Public Works to determine if these services are or will be available for facilities with water-cooled chiller system designs.
 - i. All mechanical equipment exposed to the exterior, excluding equipment less than 5-tons (e.g., mini-splits, residential packaged Air-Conditioning Units (PACU), etc.), shall be ground-mounted on reinforced concrete pads. These pads shall be surrounded by solid 153 mm (6") reinforced concrete walls or 204 mm (8") reinforced fully grouted CMU walls with gate(s) to protect the mechanical equipment from wind-driven flying debris. These walls shall be a minimum of 2438 mm (96") above the finished floor. To comply with ATFP requirements, a concrete canopy or fence above the mechanical enclosure may be required, at the discretion of the design engineer. Any fence provided shall be removable to allow for HVAC equipment hoisting. Concrete canopies should be considered for equipment other than condensers, cooling towers, and condensing units. All walls, gate(s), and anchored mechanical equipment shall meet Guam's wind speed and seismic requirements.

D3030.1 Ducted Split Systems

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. Provide separate assemblies designed to be used together. Base ratings on the use of matched assemblies.

D3030.2 Package Cooling Units

Provide units suitable for outdoor installation.

D3030.3 Chiller, Air or Water Cooled

Air-cooled chiller systems should strongly be considered in lieu of water-cooled chiller systems as the primary type of chiller system on Guam due to the historical evidence of shortened life cycle of water cooled chillers on Guam. Water-cooled systems still may be considered when LCCA makes sense, usually for larger tonnage systems (200-tons and up) or district cooling systems. However, if a water-cooled chiller system is to be specified, then a detailed LCCA must be provided to the NAVFACMAR Chief Engineer via letter with rationale for the selection for verification and acceptance of the following LCCA considerations.

LCCA should include a full accounting of potential costs and savings for the system proposed. On Guam, in the past, LCCAs have often excluded full consideration of the actual conditions on Guam. Therefore, the following considerations shall be verified for inclusion in LCCAs to ensure local conditions are properly captured: water-cooled chiller systems along with their ancillary equipment such as cooling towers, condenser water pumps, and water treatment systems and associated Operating and Maintenance (O&M) costs including make-up water and chemical treatment costs as well as full consideration of potential cost savings associated with air-cooled chillers such as initial costs, maintenance costs, reduced building size, historical data on actual lifecycle for equipment on Guam, reduced efficiency of evaporative cooling in tropical environments, reduced efficiency of water cooled chillers due to water quality on Guam, and expected lifecycle when required equipment coatings such as the 10,000-hour corrosion coatings are utilized shall be included in the LCCA. Actual O&M costs of similar tonnage systems on Guam shall be provided by the government and used for accurate comparisons in the LCCA since theoretical O&M costs could be subject to bias. If actual O&M cost data is not available and cannot be provided by the government, then the best available information may be utilized to estimate actual O&M costs on Guam.

a. Scroll, Reciprocating, or Rotary Screw Type

Chiller shall be Premium Efficiency rated in accordance with Air-Conditioning, Heating, and Refrigeration Institute (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 (BAC-net 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

D3030.4 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, up blast air discharge.

b. Coil

Extended-surface fin-and-tube type coils shall be constructed of seamless copper tubes with copper fins for equipment greater than 15 tons. For equipment less than 15 tons, coils shall be aluminum/copper, aluminum/aluminum, or copper/copper. Type 316 stainless steel coils shall be used at locations in close proximity to the ocean. Coils shall be circuited and sized for a minimum of 5 degrees F sub-cooling and full pump down capacity. Factory leak and pressure tested after assembly per ASHRAE 15 & 34. All coils for equipment greater than 15 tons shall be entirely coated with electrophoretic coating (E-coat). All coils for equipment less than 15 tons shall be entirely coated with the manufacturer's standard corrosion-resistant epoxy, vinyl coating, or phenolic coating, and shall meet a minimum corrosion resistance rating of 10,000 hours per ASTM B117."

c. Fans

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

D3030.5 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.

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.

Construction

Tower shall withstand a wind pressure of not less than 30 pounds per square foot (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.

Tower frame and louvers

Fiberglass Reinforced Plastic (FRP) 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 splash out, and shall be designed to prevent debris and sunlight from entering the cold water basin.

Fill

PVC fill suitable for inlet temperatures to 125 deg F on cross flow type units and temperatures to 130 F on counter flow type units.

Drift eliminators

Assembled in easily removable sections for counter flow induced mechanical draft tower.

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.

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% over speed above normal maximum operating speeds. Provide cooling tower with a variable frequency drive to control condenser water supply temperature.

Interior Tower piping

Schedule 40 plastic piping conforming ASTM D2996.

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.

Performance

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

Equalization Line

In configurations utilizing multiple cooling towers or cells, interconnected basins with an appropriately sized equalization line are required. The equalization line size shall be determined based on the system flow rate and the manufacturer's recommendations.

Water softening

Provide water softening system for cooling tower condenser water supply.

D3030.6 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% of the total, but not less than 862 kiloPascal (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.

D3030.7 Corrosion Protection Coating

a. Unitary Air-Conditioning Equipment:

For unitary air-conditioning equipment located outdoors, including air-cooled condensing units and packaged units:

- Equipment Under 15 Tons: Coils shall be aluminum/copper, aluminum/aluminum, or copper/copper. These units must have a condenser coil with a 10,000-hour salt spray test rating per ASTM B117 standard or better. The cabinet casings, chassis, and internal components must also have a 10,000-hour salt spray test rating per ASTM B117 standard or better. An ultra violet (UV) top coat shall be applied to all coated surfaces to prevent UV degradation. Spray-on application of the coating is acceptable by a certified applicator for the coating product inside a shop in a controlled environment; no field or job site coating application is allowed. Provide with stainless steel fasteners only.
- Equipment 15 Tons and Above (Including Air-Cooled Chillers): Coils shall be constructed of seamless copper tubes with copper fins, and entirely coated with electrophoretic coating (E-coat) that meets a 10,000-hour salt spray test rating per ASTM B117 standard or better. The cabinet casings, chassis, and internal components must also have a 10,000-hour salt spray test rating per ASTM B117 standard or better. An ultra violet (UV) top coat shall be applied to all coated surfaces to prevent UV degradation. Spray-on application of the coating for the cabinet casings, chassis, and internal components is acceptable by a certified applicator for the coating product inside a shop in a controlled environment; no field or job site coating application is allowed. Provide with stainless steel fasteners only.

b. Dedicated Outdoor Air Systems (DOAS):

For all packaged Dedicated Outdoor Air Systems (DOAS), follow the coil material and coating requirements specified in D3030.7.a. In addition, an ultra violet (UV) top coat shall be applied to the coating to prevent UV degradation on both coils if AHU UV lights are used. Provide a 10,000-hour ASTM B117 standard spray-on application coating for the cabinet casings, chassis, and internal components by a certified applicator for the coating product inside a shop in a controlled environment; no field or job site coating application is allowed. Provide with stainless steel fasteners only. For a split-system DOAS, provide the same as above for the outdoor unit and the same 10,000-hour coating with a UV top coat for the evaporator coil and a 10,000-hour coating or better for the indoor air handling-unit cabinet casings and internal components if located in an unconditioned mechanical room.

c. Miscellaneous Exterior HVAC Related Equipment (Pumps, Expansion TANKS, POT FEEDERS, ETC.):

For all other HVAC related equipment such as pumps that are exposed to the exterior, provide a 10,000-hour salt spray test or better per ASTM B117 standard coating. Spray-on application is acceptable by a certified applicator for the coating product inside a shop in a controlled environment. No field or job site coating application allowed. Provide with stainless steel fasteners only.

D3040 DISTRIBUTION SYSTEMS

D3040.1 Air Handling Units (AHU)

Factory-fabricated single-zone draw-through type units. Units to include fans, coils, airtight insulated casing, pre-filters, 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. 51 mm (2") double wall type, constructed of minimum 1.3 mm (0.05") 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 (0.05") outer and 1 mm (0.04") inner panels made of galvanized steel.
4. Double-wall insulated type drain pan constructed of 1.4 mm (0.06") type 316 stainless steel, conforming to ASHRAE 62.1.
5. Casing insulation that conforms to NFPA 90A with not less than 51 mm (2") 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

For equipment 15 tons and above, provide fin-and-tube type coils constructed of seamless copper tubes with copper fins, and entirely coated with electrophoretic coating (E-coat) that meets a 10,000-hour salt spray test rating per ASTM B117 standard or better. For equipment less than 15 tons, coils shall be aluminum/copper, aluminum/aluminum, or copper/copper, and shall have a 10,000-hour salt spray test rating per ASTM B117 standard or better. Provide casing and tube support sheets that are not lighter than 16 gauge galvanized steel, formed to provide structural strength. Type 316 stainless steel coils shall be used at locations in close proximity to the ocean. An ultra violet (UV) top coat shall be applied to all coated surfaces to prevent UV degradation. Spray-on application of the coating is acceptable by a certified applicator for the coating product inside a shop in a controlled environment; no field or job site coating application is allowed. Provide with stainless steel fasteners only. The cabinet casings, chassis, and internal components must also have a 10,000-hour salt spray test rating per ASTM B117 standard or better.

c. Air Filters

Provide a filtration system utilizing 51 mm (2") depth, sectional, disposable type filters of the size indicated. The system shall include a pre-filter with a Minimum Efficiency Reporting Value (MERV) 8 rating and a final filter with a MERV 13 rating, both 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 air connections. Provide motorized dampers at outside air supply and exhaust air outlet connections.

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 VAV AHU motors over 3.7 kW (5 HP) in capacity. VFD shall be protected and located in a well ventilated or air conditioned space. Specify with integral disconnect, bypass feature, and BAC-net 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 bird screen, 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

All diffusers, grilles, and registers shall be 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. To minimize the risk of condensation, avoid locating supply air devices near entry/exit doors. All diffusers, grilles, and registers shall be factory painted white with anti-smudge devices and with stainless steel fasteners, factory painted white, on exposed surfaces.

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 (3.35”).

c. Variable Air Volume (VAV) Ceiling Diffusers

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

d. Ductwork and Insulation for Air-Conditioning

Galvanized steel sheets shall be fabricated and erected in accordance with SMACNA Metal Duct Construction Standards, with external fiberglass duct insulation. Flexible duct insulation wrap shall be used where ductwork is concealed, and rigid insulation where exposed and visible, with a 51 mm (2”) minimum thickness and a 24.0 kg/m³ (1.5 lbs/cu.ft.) density. All ductwork shall be installed in conditioned spaces to the greatest extent possible to prevent condensation problems. Otherwise, exterior ductwork exposed to the weather shall be type 316 stainless steel.

Insulate supply, return, and outside air ducts. Exhaust ducts shall be insulated if located in spaces where the temperature differential between the exhaust and surrounding air may lead to condensation buildup on or within the ductwork. All ductwork insulation shall be applied to the exterior of the ductwork to prevent mold growth inside the ductwork, promote better indoor air quality, and facilitate easier cleaning of the interior ductwork.

The ductwork installer shall provide a ductwork cleaning plan to maintain indoor air quality. The cleaning plan shall be practical and easy to implement. The ductwork installer shall provide access panels to vertical ductwork and other panels as necessary to facilitate periodic ductwork cleaning.

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

All outside fresh air intakes shall 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 humid air into the space. Seal all openings through the wall to prevent moisture penetration.

Restrooms, shower rooms, locker rooms, bathrooms, mechanical rooms, and janitor closets located within conditioned buildings shall also be conditioned. The need for conditioning in other spaces shall be evaluated based on occupancy type, usage patterns, and potential for moisture buildup, at the discretion of the design team.

All heat-producing equipment, such as clothes dryers, shall be located at exterior walls, if possible, to allow direct exhaust of heated air to the exterior. Add a duct cleanout access door or filter box at all dryer exhaust points of connection.

D3040.4 Chilled Water Piping System, Valves and Insulation

Piping shall be Schedule 40 black steel pipe with screwed fittings for pipes 51 mm (2") and smaller, welded or mechanical joints for bigger pipes. Valves, 51 mm (2") and smaller shall be ball valves, bronze, bigger than 51 mm (2") 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 Diameter (D)	Insulation Thickness
D < 25 mm (1")	38 mm (1-1/2")
25 mm (1") ≤ D < 100 mm(4")	51 mm (2")
100 mm (4") ≤ D < 200 mm (8")	62 mm (2-1/2)
200 mm (8") ≤ D	75 mm (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

Condensate drain lines shall be either Type M hard-drawn copper with wrought copper soldered joint fittings or Schedule 40 PVC for indoor applications. Outdoor condensate drain lines shall be Type M hard-drawn copper with wrought copper soldered joint fittings. All condensate drain lines, regardless of material, shall be insulated with 1" (25 mm) thick flexible elastomeric cellular insulation.

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:

- a. 7-day programmable clock with 4 time periods per day
- b. 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 (DDC) Systems

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

D3070 HVAC Installation, Start-up, Testing, Equipment Commissioning, and Training

a. 20-Tons and Above:

For all Air Conditioning Equipment 20-tons size or larger, provide a Manufacturer's Representative to supervise the installation, startup and commissioning of the equipment. Manufacturer's Representative must be an employee of the equipment manufacturer with a minimum of 15 years' experience with installation, startup, commissioning and maintenance of the similar equipment to that proposed.

b. Below 20-Tons:

For all Air Conditioning Equipment smaller than 20-tons size, an approved manufacturer-trained technician shall supervise the installation, startup and commissioning of the equipment. The manufacturer-trained technician must have a minimum of 15 years' experience with installation, startup, commissioning and maintenance of the similar equipment to that proposed.

c. Training:

Training on the operation and maintenance of the system shall be conducted by a factory-trained technician for equipment smaller than 5-tons. For equipment 5-tons are larger, training will be conducted by the approved Manufacturer's Representative.

D40 FIRE PROTECTION

D4010 FIRE ALARM AND DETECTION SYSTEMS

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

Provide integrated fire alarm and mass notification systems, compatible with the existing base fire reporting system and existing base wide mass notification system, in inhabited buildings (as defined by UFC 4-010-01 DOW Minimum Antiterrorism Standards for Buildings).

Follow all standard operating procedures for creating, testing, and activating fire alarm accounts as required per the JRM Regional Dispatch Center (RDC) and Andersen Air Force Base Fire Alarm Shop. Provide all labor and programming necessary to build fire alarm accounts. Subscriber Detail Report, Signal History Report, and fire alarm control panel event history from Pre-Final Testing shall be submitted to the NAVFAC Marianas Fire Protection Engineer when requesting to schedule Final Acceptance Testing.

Seal all electrical conduit/raceway penetrating exterior wall to prevent moisture intrusion in accordance with NFPA 70 Article 225, Section 27.

Locate fire alarm control panels and supplemental control panels in a year-round climate controlled space within facilities

D4020 FIRE SUPPRESSION WATER SUPPLY AND EQUIPMENT

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

Final hydraulic calculations shall be based on a hydrant flow test performed no more than 6 months prior to submission of the calculations, under the direction of the Qualified Fire Protection Engineer, the Fire Protection DOR (QFPE). An outage request shall be submitted to DZSP or Andersen Air Force Base Water Shop not less than 3 weeks in advance to conduct a water flow test.

BACKFLOW PREVENTERS

Incoming sprinkler service shall be provided with a backflow preventer, as applicable. Hydraulic calculations must include a minimum pressure drop across backflow preventers in accordance with UFC 3-600-01. New system risers and new backflow preventers shall be interior of buildings.

FIRE PUMPS

Fire pumps must be sized in accordance with UFC 3-600-01. Fire water demand must be considered in sizing fire pumps if the fire pump water supply system also serves fire hydrant(s).

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.

When fire pump is connected to suction tank(s), the suction piping must be designed so that the pump can be tested at NFPA 20's 150% overflow condition.

FIRE WATER TANKS

Fire water tanks must be sized to meet fire water demand in accordance with UFC 3-600-01. Usable water volume inside the tank must be calculated by accounting for pressure loss through suction piping section at NFPA 20's 150% overflow condition and hydraulic arrangement between tank discharge and fire pump suction. Pump suction piping system must be designed to maintain the positive suction pressure at the pump inlet in accordance with NFPA 20. On the storage tank, the base of usable water level must be marked.

D4040 SPRINKLER SYSTEMS

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

WET PIPE SYSTEMS

Locate inspector's test connection(s) as directed by the NAVFACMAR Fire Protection Engineer. Test connection discharge locations shall be chosen to minimize damage to landscaping and interference with normal egress paths.

DRY PIPE SYSTEMS

Dry pipe systems shall not exceed 2839 L (750 gallons) regardless of delivery time or devices attached. Do not use shop air or compressed gas cylinders for system pressurization. Provide nitrogen generation systems. Other corrosion protection systems can be considered and installed upon approval from the NAVFACMAR Fire Protection Engineer.

PRE-ACTION/DELUGE SYSTEMS

A releasing panel, independent of the building fire alarm system panel, is required to activate the system.

D50 ELECTRICAL

Sustainable Design Strategies

Refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, UFC 3-500 SERIES - ELECTRICAL, EO 13423 Technical Guidance-Renewable Energy & Green Power and UFC 3-530-01, Design: Interior and Exterior Lighting and Controls.

- a. Maximize use of renewable energy technologies that contribute to building energy efficiency: solar water heating, heat pumps, solar-powered exterior lighting fixtures, etc.
- b. 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.
- c. Use Building Automating Systems/Energy Management Systems/DDC for lighting systems.
- d. Install energy-efficient systems. Use ENERGY STAR® appliances and lighting and controls that meet or exceed FEMP standards.
- e. Use premium efficiency motors that meet the required efficiency levels (NEMA Premium)
- f. Provide lighting occupancy/vacancy sensors, daylighting controls, accessible manual controls and glare control.

D5010 ELECTRICAL SERVICE AND DISTRIBUTION

Electrical service and distribution system shall conform to the NAVFACMAR PWUC-BP, 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

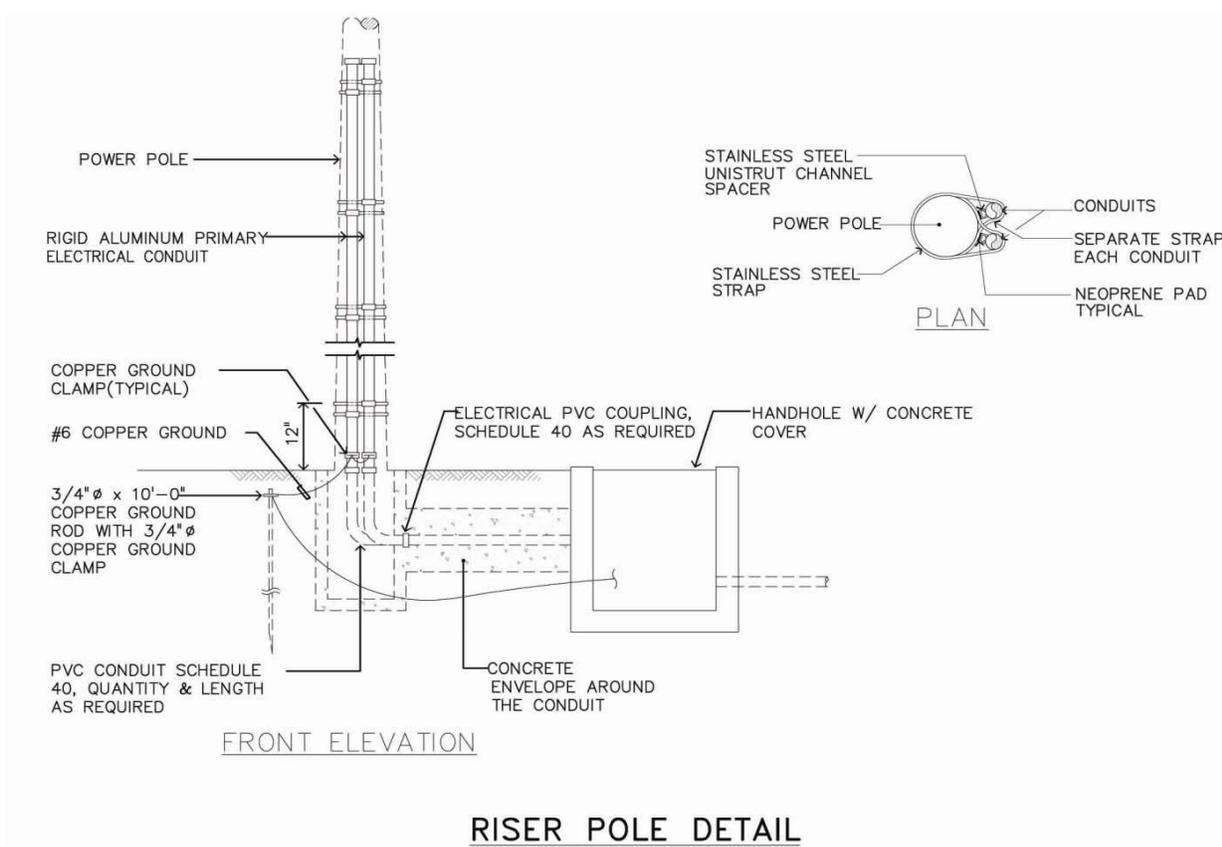
Pad mounted distribution transformers shall be in accordance with Section G40, Site Electrical Utilities, paragraph G40.1.1.

D5010.2 Service voltage

For service voltage selection guidelines refer to UFC 3-520-01, Interior Electrical Systems, and paragraph 2-1. Refer to PWUC, approved & latest edition for system voltages & configuration

D5010.3 Primary service from overhead distribution

Shall be in accordance with Section G40, Site Electrical Utilities.



D5010.4 Secondary service cables

200 A minimum service for dwelling units.

Copper, 600V, Type USE, RHW OR XHHW installed in 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 Panel boards

- 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
 - 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 Interior and Exterior Lighting Systems, and UFC 4-711-01 Family Housing.

D5020.1 Indoor lighting

- a. General illumination for office type facility – linear suspended or lay-in LED fixtures. No fluorescent fixtures. Refer to UFC 3-530-01, Interior and Exterior Lighting Systems.
 - b. For renovation projects, remove all fluorescent and incandescent fixtures and replace with LED type fixtures.
 - c. Corrosion resistant housing
 - d. Provide dual switching for energy conservation.
 - e. Daylighting
1. Maximize daylighting.
 2. Provide automatic lighting control to dim or turn off light fixtures when sufficient daylights are 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 lamps only. Parking area shall utilize LED light fixtures. Use energy efficient LED lighting
- 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 Information and Communications Technology Infrastructure Planning and Design.

Mission critical infrastructure and associated communications and controls systems may have a need for system redundancies to ensure continuous, reliable mission operations. Consult with PW10 - CIS along with the project sponsor's communications department to determine requirements

D5040.2 Cable Television System

Refer to UFC 4-711-01, Family Housing and UFC 3-580-01 UFC 3-580-01 Information and Communications Technology Infrastructure Planning and Design

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

Refer to UFC 3-580-01 UFC 3-580-01 Information and Communications Technology Infrastructure 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 DAS (Data Acquisition System), as required by the NAVFACMAR PWUC-BP.

Provide dedicated lockable enclosures for AMI networked Cabinet and/or enclosure. 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 front-end, as required by the NAVFACMAR PWUC-BP.

Provide dedicated lockable enclosures for SCADA networked devices. 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

Projects involving Mission Critical Infrastructure Systems may require power system redundancies (e.g., generators, transformers, etc.) to ensure continuous, reliable mission-critical operational functions. Obtain specific requirements directly from NAVFACMAR PW10 - CIS and the project sponsor's IT/communications department.

a. Engine Driven Generators

1. Refer to UFC 3-540-01 Engine-Driven Generator Systems for Prime and Standby Power Applications
2. Comply with UFC 3-520-01 Interior Electrical Systems, for emergency generator design
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. Refer to PWUC, approved and latest edition for utility generator building requirements.

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 mitigation system
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 UFC 3-575-01, Lightning and Static Electricity Protection Systems. Provide a UL Master label for the facility.

D60 FACILITY CRANES

D6010 DESIGN

Navy/Marine Corps facility crane design shall conform to:

- a. Navy Crane Center Instruction (NAVCRANECENINST) 11450.2A Design of Weight Handling Equipment
- b. P-307 NAVFAC Navy Crane Center (NCC) Weight Handling Program Management Manual
- c. UFGS Specification 41 22 13.15 Bridge Cranes, Overhead Electric, Under Running Trolley

Ensure the RFP requires the construction contractor to turnover documentation outlined in Appendix F -NAVFACMAR New Facility Crane In-Servicing Checklist.

D6020 WORK PERFORMANCE AND ACCEPTANCE TESTING

Consult with the Public Works Department (PWD) Weight Handling Equipment Division to determine if work and acceptance testing on facility cranes must be performed by NCC P-307-certified (or other) contractor personnel."

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, 25 mm (1") 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 89 mm (3 1/2") 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 (LID) 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 a 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.

F2020.1 Asbestos Containing Material (ACM)

- a. Confirm in iNFADS the status or history of any mitigations performed on existing facilities. Installation Asbestos Program Managers maintain surveys and management plans for facilities that contain ACM or have been mitigated. Require asbestos testing and abatement only after verifying need with the Installation Asbestos Program Manager.
- b. Disposal of ACM: All ACM (friable and non-friable) wastes shall be disposed of on-island at a Guam EPA-permitted landfill.

G10 SITE PREPARATIONS

The DOR shall research and obtain all available site data in accordance with the National Society of Professional Surveyors (NSPS) Model Standards, Section E, Subsection 7 “Data” and Subsection 9 “Optional Items”. All items listed in these subsections shall be located and shown on a topographic map unless specifically excluded by the Design Manager (DM). For more information, refer to MDACS G50 Design & Construction Surveying.

Other items or features that shall be located and shown on the topographic map that may not be listed in the NSPS Model Standards include the following:

- a. Encroachment on non-Commander, Naval Installation Command (CNIC) controlled property
- b. Existing utilities (antenna, communication lines, electrical duck lines, and POL lines) and abandoned underground utilities (water, sewer, stormwater)
- c. Fault Lines

- d. Munitions of Explosive Concern (MEC) or Unexploded Ordnance (UXO), compliance with SECNAV Policy on Explosive Safety Risk Acceptance Within JRM, or the most current ESS and Department of War Explosives Safety Board (DDESB)
- e. Any natural or man-made constraints.

This may further include the following, which shall be coordinated with the Installation Environmental Office and addressed in the RFP when encountered:

- a. Drainage and Flood Control
- b. Groundwater Management Protection Zones and Wellhead Protection Zones
- c. Historical, Architectural and Cultural Sensitive Areas
- d. Landfill Areas
- e. Guam EPA for water, sewer, and stormwater management
- f. Applicable permitting and Agency review and/or approvals
- g. Chlordane-impacted soils underneath foundations constructed prior to 1988
- h. Chlordane or other hazardous material capped underneath surface areas as part of prior mitigation
- i. Contaminated sites identified through the Installation Restoration (IR) or Munitions Response (MR) Programs
- j. Potentially contaminated sites based on historical facility operations not covered under IR or MR environmental programs
- k. Encroachment on/from conflicting site activities of on-going or near future construction
- l. Environmental studies or other analysis not completed or completing concurrently with pre-construction award design and RFP development efforts.

As applicable, comply with current SECNAV policy regarding Explosive Safety Risk Acceptance within JRM or when applicable, the latest amended ESS for MEC requirements during any drilling, sampling, and/or testing on the project site.

Sustainable Design Strategies

Refer to UFC 3-210-10, Low Impact Development (LID) 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 (e.g., deep footings, foundations) to be included in project contingency and the Contractor shall coordinate and report to the Contracting Officer Representative (COR), Navy Technical Representative (NTR) for MEC Clearance and MEC Quality Assurance (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 Construction and Demolition (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, DOW 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. NAVFACMAR PWUC-BP, For Planning, Design and Construction: Electrical, Sewer, and Water
- b. Commonwealth of Northern Mariana Islands (CNMI) and Guam Stormwater Management Manual
- c. Guam Storm Drainage Manual, U.S. Army Corps of Engineers (USACE)
- d. Title 22 of the Guam Administrative Rules and Regulations Chapter 7- Water Resources Development and Operating Regulations.
- e. Title 22 of the Guam Administrative Rules and Regulations Chapter 9 - Guam UIC Regulations
- f. UIC Permit Determination Flow Chart Developed by Guam Environmental Protection Agency

(GEPA)

- g. Guam Landscaping Guidelines, June 2011
- h. UFC 3-201-01 Civil Engineering
- i. Military Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) Pamphlets 55-8 (Traffic Engineering Study), 55-15 (Entry Control Facilities), and 55-17 (Traffic Engineering Design)

Sustainable Design Strategies

Refer to UFC 3-210-10N, Low Impact Development (LID) 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 the design.
- c. For pedestrian walkways within the roadway corridor, permeable pavers (running bond pattern) or permeable pavement. The DOR shall verify the use of permeable pavers or permeable pavement with the COR prior to implementation in the design.
- d. For pedestrian walkways outside the roadway corridor (i.e., between buildings, in parks, etc.), permeable pavers (running bond pattern) or permeable pavement. The DOR shall verify the use of permeable pavers or permeable pavement with the COR prior to implementation in the design.
- e. The DOR shall conform to the UIC Permit Determination Flow Chart developed by GEPA for UIC.
- f. Direct runoff into or across vegetated areas to help filter runoff and encourage groundwater recharge.
- g. 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 storm water 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.

G2010 ROADWAYS

Asphaltic Concrete (AC) Pavement: Minimum standard thickness shall be 50 mm (2") AC over minimum 200 mm (8") thick compacted base course or as recommended by the project Soils Engineer, whichever is higher. AC pavement material shall be designed in accordance with Officer In Charge of Construction (OICC) Marianas 123C Specifications and applicable UFC, UFGS, and SDDCTEA Pamphlets 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 153 mm (6") as measured from the gutter flow line and provided with a 610 mm (24") 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) and SDDCTEA Pamphlet 55-17 as the primary guidance for signage and markings, whichever is stringent
- 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. SDDCTEA Pamphlet 55-17
- c. National Fire Protection Agency (NFPA) Regulations for minimum dimensions of roads, fire lanes, parking lot stalls, and parking lot lanes
- d. UFC 4-010-01, DOW Minimum Anti-Terrorism Standards for Buildings

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

G2020.1 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

G2020.2 Marking & Signage

- a. Refer to the latest approved edition of the Manual on Uniform Traffic Control Devices (MUTCD) and SDDCTEA Pamphlet 55-17 as the primary guidance for signage and markings, whichever is stringent
- 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. 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 13 mm (1/2") thick sand cushion over 153 mm (6") thick compacted base course.
- b. Stamped Concrete: 102 mm (4") thick stamped (running bond pattern) concrete over 153 mm (6") thick compacted base course.

G2030.2 Sidewalks & Ramps

If permeable pavers or permeable pavement cannot be used, use 102 mm (4") thick concrete with broom finish and smooth troweled edges with control joints at 1220 mm (4') on center, over 153 mm (6") thick compact base course.

G2030.3 Jogging / Bicycle Paving

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

3.4 meter (11') wide jogging/bicycle path design shall comply with American Association of State Highway and Transportation Officials (AASHTO) 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. PVC coating may be considered, but shall coordinate with Installation personnel prior to implementation in the design. PVC coatings shall be in color and a minimum thickness of 2 mm (0.10”).

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. PVC coatings shall be in color and a minimum thickness of 2 mm (0.10”). 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') 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 Public Affairs Officer (PAO) or Base Security officer.

G2040.2 Retaining Walls & Freestanding Walls

The DOR shall verify the type of retaining or freestanding wall with the KO to be designed. The walls shall either be made of cast-in-place concrete, 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

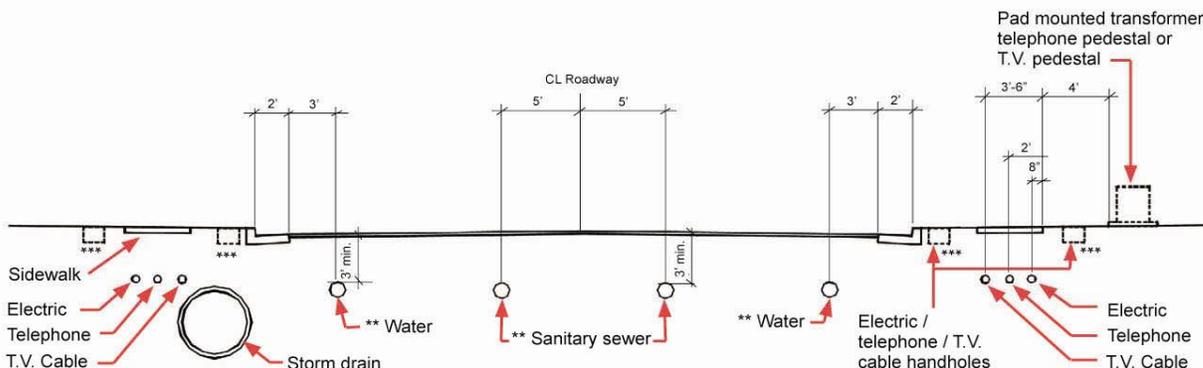
In general, civil and mechanical utilities should be designed to minimize visual impacts, maintenance and repair. The DOR shall comply with the latest approved edition of the NAVFACMAR PWUC-BP for all utility design and construction of Electrical, Water and Sewer

Sustainable Design Strategies

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

- a. Refer to UFC 3-210-10, Low Impact Development (LID) and UFC 4-030-01, Sustainable Development for site and utility sustainable strategies.
- b. Use potable water efficiently by eliminating leaks; caulking around pipes and plumbing fixtures; and conducting annual checks of hoses and pipes.
- c. Reuse or recycle water onsite.
- d. Collect rainwater from roofs with cisterns.
- e. 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.
- f. The 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 utility shall have a minimum cover of 2.5" for non-traffic areas, and minimum cover of 3.0" for roadways.
2. *Whenever possible, the storm drain shall have a minimum cover of 3.0"
3. **Alternate location of utilities
4. ***Locate handholes to keep sidewalk smooth and clean.

Figure 36: Typical Roadway Utility Location

G3010 WATER SUPPLY

- a. For planning, design, and construction, refer to UFC 3-230-02 O&M, Design: Water Supply Systems for design of water supply systems on the Installation.
- b. New water projects or projects that make significant alterations to water systems require Guam EPA Administrator approval. Designs shall be submitted to GEPA at the 60%, 100% Pre-Final, and Final design stages.
- c. To the greatest extent possible - All lines should be underground. In situations where putting water lines below ground is not possible, above ground pipes and fittings shall be Ductile iron and shall be coated with epoxy paint.
- 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. Water distribution mains indicated as 100 mm through 600 mm (4" through 24") dia. pipe sizes shall be PVC plastic pipe, and as an option ductile-iron-pipe may be considered, but shall coordinate with Installation personnel prior to implementation in the design. Use of HDPE may be considered on Pipe sizes 400mm (16") or larger. See G3010.1. Verify with NAVFACMAR for the appropriate use of HDPE as water distribution mains. The designer shall have the option of selecting 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 HDPE pipe shall conform to AWWA C906, ASTM D 3035 and ASTM D 3261. The designer shall have the option of selecting Fusible PVC Pipe, conforming to AWWA C-900/C-905, but shall verify with the COR prior to designing.
 - j. 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.
 - k. Air/vacuum valves at high points and blow-off assemblies at low points of pipelines shall be installed at locations determined by the DOR. Flushing hydrants may also be used for low points of water pipelines and at unavoidable dead-ends of the water system.
 - l. 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") between pipes.

G3010.1 Potable / Non-Potable Water Distribution and Storage

This includes planning, design, and construction of piping (underground & aboveground), valve boxes, valves and storage tanks/reservoirs.

Potable water system is for consumption.

Non-potable water system is not for consumption, such as irrigation and raw water (from reservoir, lakes, springs, etc.) to treatment facilities.

PVC pipe shall conform to AWWA C900. Pipes 4 inches through 24 inches shall have a minimum pressure class 305 (DR14) with ductile iron outside diameter. Pressure class for pipe sizes above 24 inches shall be the highest pressure class available for the pipe size.

Ductile iron pipe and fittings shall conform to AWWA C151. Four (4) inch diameter mains shall be thickness class 53 (minimum). Mains six (6) inches in diameter and larger shall be thickness class 52 (minimum). Loading and pressure considerations shall determine if a higher class is required. Flanged pipe shall conform to AWWA C115, and flanged fittings shall conform to AWWA C110 or AWWA C153. Pipe and fittings shall have cement-mortar lining conforming to AWWA C104, standard thickness.

Water storage tank must be of concrete construction, can serve as an Installation landmark and provide visual strength in its form.

Installation potable water distribution & storage tank can be utilized to serve the installation fire flow/demand requirement.

Access for maintenance and repair vehicles shall be provided.

G3010.2 Water Well Systems

This includes planning, design, and construction of water wells and all the components necessary including drilling, installing casings, pumps, valves, etc.

Planning, design, & construction must meet Guam EPA requirements & applicable codes/standards.

G3010.3 Fire Protection Water Distribution & Storage

This includes planning, design, and construction of dedicated water piping and storage for Installation fire protection system only. This does not include potable water distribution systems that are used as a water source for fire protection systems.

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

Fire hydrants shall be of uniform design throughout the Installation.

G3010.4 Water Pumping / Booster Pump Stations

This includes planning, design, and construction of pumps, valves, and piping.

Pumps must be in a concrete pump house/room.

Provide a minimum of two pumps at each pump station. System can be designed with more than two pumps (e.g., triplex). Pumping capacity must be able to discharge the peak flow with the largest pump out of service.

Installation water pumping / booster pump system can be utilized to serve the installation fire flow/demand requirement.

G3010.5 Water Treatment Plants

This includes planning, design, and construction of water treatment plants/systems.

Water treatment plants are used to purify water to make it safe for drinking. Water treatment includes, but not limited to filtration, disinfection, contaminant removal and other required systems.

Water treatment plants structure shall be of concrete construction.

G3020 SANITARY SEWER

- a. For planning, design, and construction - Refer to UFC 3-240-01 Wastewater Collection and Treatment, UFC-240-03 Operation and Maintenance: Wastewater Treatment, NAVFACMAR PWUC-BP and applicable codes/standards.
- b. New sanitary sewer projects or projects that make significant alterations to sewer systems

require Guam EPA Administrator approval. Designs shall be submitted to GEPA at the 60%, 100% Pre-Final, and Final design stages.

- c. All lines should be underground.
- d. PVC/ABS piping is the preferred pipe material for an underground sanitary waste system.
- 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. The use of PVC C-900 pipe may be permitted for use as pressure pipe and the DOR shall verify with the KO.
- k. 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, RPMP, and RTRP.
- l. 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') 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') 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'), 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') 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') 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'), horizontal distance, to the water line.
- m. Where sanitary sewer lines pass above water lines, encase sewer in concrete for a distance of 3 m (10') on each side of the crossing, or substitute with AWWA approved rubber-gasketed pressure pipe, rated at 150 psi tested in place without leakage prior to backfill for the pipe being used for the same distance.
- n. The Contractor shall provide Closed-Circuit television (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.
- o. 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 C150/C150 M Type II.
- p. For all underground structures, the designer shall check for buoyancy effects of all underground structures in high water table locations.

G3020.1 Sanitary Sewer Piping

This includes planning, design, and construction of piping for collection of sewage. Piping can be gravity lines or force mains. Piping system shall meet required pressure ratings, material, slope, flow, velocity, bedding, cleanouts & safety provisions.

G3020.2 Sanitary Sewer Manholes, Valve Structures and Cleanouts

This includes planning, design, and construction of manholes, cleanouts and valve structures in sewage collection systems.

Manholes shall be either pre-cast or cast-in-place reinforced concrete.

Traffic rated manholes and valve structures shall be required in all areas and be located in serviceable vehicle corridors or roadways, especially in family housing areas.

Gravity line cleanouts assemblies shall be constructed of cast iron (no-hub) pipe with high-strength, corrosion resistant couplings (sometimes called “portable hubs”), or stainless steel couplings.

If isolation valves are installed in a pressure main, install pressure cleanouts immediately downstream of the isolation valve.

G3020.3 Lift Stations and Pumping Stations

This includes planning, design, and construction of sewage lift stations/pump stations, piping, pumps, and equipment.

Lift stations/pumping stations structure shall be of concrete construction.

Lift stations/pumping stations with duplex pumping units shall be designed with 100 percent pumping redundancy which allows for one pump to be removed for servicing with the remaining pump fully capable of handling the peak hydraulic pumping demand.

Lift stations/pumping stations with more than two pumps shall be similarly designed with redundant pumping capability – they must be able to handle the peak hydraulic pumping demand with its largest pumping unit out of service.

G3020.4 Wastewater Treatment Plants

This includes planning, design, and construction of wastewater treatment plants.

Wastewater treatment plants shall be of concrete construction.

Wastewater treatment plants shall meet Guam EPA requirement & applicable codes/standards.

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.

G4010 ELECTRICAL DISTRIBUTION

- a. For planning, design, and construction - Refer to UFC 3-501-01 Electrical Engineering, UFC 3-550-01 Exterior Electrical Power Distribution, UFC 3-550-07 Operation and Maintenance: Exterior Power Distribution Systems, NAVFACMAR PWUC-BP and applicable codes/standards.
- b. All outside transformers, switchgear and other electrical equipment shall be ground mounted on reinforced concrete pads, surrounded by solid 153 mm (6") reinforced concrete walls or 204 mm (8") reinforced fully grouted CMU walls and gate(s) that protects mechanical equipment from typhoon flying debris.
- c. All walls, gate(s) and anchored mechanical equipment shall meet Guam's wind speed and seismic requirements.
- d. Electrical service and distribution system shall conform to the NAVFACMAR PWUC-BP.
- e. Follow UFC 3-550-04 Resilient Installation Micro-grid Design in incorporating micro-grid controller in the power grid for instrumentation & control (I&C) and distributed energy resource (DER)

G4010.1 Substations

This includes planning, design, and construction of primary and secondary substations.

New substations (primary and secondary) structure shall be of concrete construction and must comply with PWUC, approved and latest edition. Due to Guam's environment that is subject to a salt corrosive environment, high humidity, high wind velocities and strong seismic forces, the use of outdoor substations would seem not appropriate. 

Switchgear room shall be air conditioned. If water based fire protection is provided, the switchgears shall be housed in an outdoor type enclosure.

G4010.2 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 A167, 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 A167, type 316L. 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, and electrical equipment.

G4010.3 Pad Mounted Switchgear (Switches)

- a. Apply pad-mounted switchgear when switching, isolation, or electrical protection for downstream circuit is required or anticipated.
- b. Provide high fire point liquid insulation and vacuum bottle interruption, dead-front with stainless steel tank.
- c. Entire assembly, including tank, base, and enclosure shall be fabricated of stainless steel conforming to ASTM A167, type 316. 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.
- f. Apply use of sectionalizing cabinets for primary distribution at the end of primary circuits, where no additional connections are expected to be made.

G4010.4 Overhead Power Distribution

This includes planning, design, and construction of overhead power distribution system. Minimum size of new primary lines shall be #2 (Solid). Utilize concrete power poles that can withstand 180 miles per hour wind and loading criteria.

G4010.5 Underground Power Distribution

This includes planning, design, and construction of underground power distribution system.

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

- b. Medium voltage cables:
 - Copper conductor EPR with 133% insulation level.
- c. Electric manholes:
 - Electric manholes shall be either pre-cast or cast-in-place reinforced concrete.
 - Manhole cover shall be traffic rated.

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 type 316. 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 requirements (UFC 4-010-01).

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 610 mm (2') to 915 mm (3') 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 – LED
- 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. DOR to coordinate with Installation personnel to ensure uniformity.
- b. Lamp – LED

G4020.4 Signage Lights (Flood Lights)

- a. Dark bronze aluminum anodized floodlights securely mounted on concrete footing.
- b. Lamp – LED

G4030 COMMUNICATIONS SYSTEMS

Refer UFC 3-580-01 Information and Communications Technology Infrastructure Planning and Design

G50 DESIGN & CONSTRUCTION SURVEYING

All projects within the NAVFACMAR AOR shall reference UFC 3-201-01. Sections 2-4.2 “Surveying” and Section 2-4.2.1 “Topographic Surveys” refer to technical publications related to surveying requirements which are addressed below.

For all Navy and Marine Corps projects within the NAVFACMAR AOR, FC 1-300-09N are also applicable.

Referenced Technical Publications

1. Bossler, John D. and Federal Geodetic Control Committee (1984) *Standards and Specifications for Geodetic Control Networks*. Available at https://www.ngs.noaa.gov/FGCS/tech_pub/1984-stds-specs-geodetic-control-networks.pdf (Accessed: 22 September 2025).
2. National Society of Professional Surveyors (2002) *Model Standards*. Available at <https://nsps.us.com/page/ModelStandards> (Accessed: 22 September 2025).
3. Facilities Criteria for Navy and Marine Corps Design Procedures FC 1-300-09N (17 May 2024). Available at <https://www.wbdg.org/dod/ufc/fc-1-300-09n> (Accessed: 22 September 2025).
4. Unified Facilities Criteria UFC 3-201-01 (20 December 2022) *Civil Engineering*. Available at <https://www.wbdg.org/dod/ufc/ufc-3-201-01> (Accessed: 22 September 2025).
5. Federal Register / Vol. 85, No. 193 / Monday, October 5, 2020 / Notices, pages 62698-62708 *Deprecation of the United States (U.S.) Survey Foot*. Available at <https://www.govinfo.gov/content/pkg/FR-2020-10-05/pdf/2020-21902.pdf> (Accessed: 22 September 2025).

Definitions

1. Design Surveyor – the design surveyor is the licensed land surveyor performing pre-design property, boundary, or topographic surveying and developing base maps for use by the DOR.
2. Construction Surveyor – the construction surveyor is the licensed land surveyor performing pre-construction surveys such as survey control verification, construction staking, incremental quality control surveying, or as-built topographic surveying.
3. Internal Contractor’s Surveyor (ICS) – this surveyor is an employee of the contractor who has the equivalent of at least 60 cumulative months of full time field experience in field surveying for construction layout, as-built surveying, and quality control checks of construction staking. This employee reports to the Quality Control Manager as the responsible person supervising the performance of the ICS.

G5010 ACCURACY STANDARDS

Accuracy standards should be defined for each project by the Design Manager (DM) in accordance with the Standards and Specifications for Geodetic Control Networks (FGCC 1984). Refer to Section 2.1 “Horizontal Control Network Standards” and 2.2 “Vertical Control Network Standards”. If the DM does not define the accuracy standards, refer to UFC 3-201-01, Section 2-4.2 for minimum classifications. The Design Surveyor is required to provide the DM with the necessary calculations to confirm compliance with the defined accuracy standards. These calculations shall be provided in the Basis of Design.

G5020 MODEL STANDARDS FOR SURVEYING

In accordance with UFC 3-201-01, Section 2-4.2.1 “Topographic Surveys”, the DOR shall first determine if there are survey requirements defined by the Customer, State, or Host Nation. If not, the DOR shall comply with the National Society of Professional Surveyors (NSPS) MODEL STANDARDS.

For projects located on Guam, the DOR shall comply with the National Society of Professional Surveyors (NSPS) MODEL STANDARDS.

The DOR shall provide all project survey control data, calculations, references, and other applicable data in the Basis of Design.

The subsections listed below apply to each NSPS Model Standards section and provide further guidance or clarification specifically related to performance of surveying services as they pertain to the NAVFACMAR AOR. These notes are additive to the NSPS Model Standards and shall not be construed as replacement or acceptable alternatives.

G5020.1 Section A - Introduction

For projects designed on Guam, the Designer of Record shall use the 1993 Guam Geodetic

Network (GGN 93) and the 2004 Guam Vertical Datum (GUVD 04).

Do not use the World Geodetic System 1984 (WGS 84) for civil construction. However, the use of this datum is required for Soil Investigation reporting and MEX/UXO reporting. The KTR is responsible for converting to WGS 84 prior to submitting to the government.

G5020.2 Section B – Property Surveys

1. Monuments –
 - a. Design Surveyor shall indicate on the Survey Drawing if monuments were found or set.
 - b. In the Basis of Design, the Design Surveyor shall show the northing, easting, and elevations for each monument as obtained by the Department of Land Management (or equivalent government surveyor office). If the units are metric, the Design Surveyor shall provide the conversion factors and results to convert to International Survey Feet. International Survey Feet is the only acceptable conversion to imperial feet as of January 1, 2023. Please refer to the Federal Register article *Deprecation of the United States (U.S.) Survey Foot*.
 - c. The Design Surveyor shall indicate in the Basis of Design the type of surveying equipment used to establish project control.
 - d. If using RTK GPS Equipment, The Design Surveyor shall indicate in the Basis of Design the approximate time they held the rod at each existing monument, how many epochs, and the result of averaged northing, easting, and elevation for each monument point survey.
 - e. The Design Surveyor shall use a minimum of three existing monuments with known record history to establish project control.
 - f. The Design Surveyor shall set at least two or three control points near the project site for the construction surveyor to use when laying out the project.
2. Survey Drawing and Certification
 - a. The Design Surveyor shall specify a basis of bearing between two existing monuments with known record history. The basis of bearing cannot be based on any set monuments – only on found monuments with recorded history.
 - b. The Design Surveyor shall specify the bearing and distance from the monuments used for the basis of bearing and at least two set project control points.
 - c. The Design Surveyor shall indicate the survey is based on International Survey Feet.
 - d. If a geoid is applied that deviates from the GGN 93, the Design Surveyor shall so indicate on the survey drawing and the Basis of Design.

G5020.3 Section C – Classification and Accuracy Standards

This section is superseded by the FGCC 1984 as listed in Section G5010.

G5020.4 Section D – Construction Layout Surveys

1. Survey Research and Analysis

- a. The Construction Surveyor shall verify all found and set monuments, project control points, survey equipment used, and surveying methods as provided by the Design Surveyor.
 - b. The Construction Surveyor shall confirm the set project control monuments are of such type and character that they will endure the duration of the construction project. If not, the Construction Surveyor shall re-establish localized project control using monuments of an appropriate type and character.
2. Construction Staking
- a. Do not set layout monuments or additional project control if there are any unresolved inconsistencies between the design survey and the construction survey check that do not comply with the prescribed accuracy standards.
 - b. Primary project control points, station lines, and other critical project control points shall be staked by a licensed Construction Surveyor. These may include project control points established from existing monuments with recorded history, ends of station lines, points of tangency along a station line, and project boundary lines.
 - c. Secondary project control points may be set by the Internal Contractor's Surveyor and reviewed by the Quality Control Manager for acceptance. These points may include infill of quarter and half stations along station lines, establishing additional temporary control points onsite, and other non-critical staking to support daily or weekly layouts.
3. Field Notes ("Cut Sheets")
- a. For EVERY construction survey performed, the Construction Surveyor or Internal Contractor's Surveyor shall provide the government, through the Quality Control Manager, a copy of a survey cut sheet that clearly defines the staking, survey hubs, calculations, and applicable drawings.
 - b. Cut sheets shall be provided to the government no later than 24 hours from the completion of each construction survey.
 - c. Cut sheets shall be easily interpreted and understood by the QC, QA, and other field personnel.
 - d. Cut sheets shall be signed by the surveyor performing the work
 - e. Cut sheets shall be reviewed by the QCM for completeness, accuracy, and acceptance.

G5020.5 Section E – Topographic Surveys

This section applies to both the Design Surveyor at pre-design and to the Construction Surveyor at post-construction.

1. Pre-Design. The Design Surveyor shall develop a topographic survey to provide a base map prior to engineering design. The initial design survey must establish at least two control points on site with accurate vertical and horizontal information for Construction Surveyor use in establishing control and layout. The control can be as simple as a nail in pavement near the project site that will not be disturbed by the proposed construction.

Provide a completion date for the topographic survey field/office work in the Survey Notes and date when the Surveyor signed the Topographic Survey Map. The maximum time between the completion date and the Surveyor's signature is 14 calendar days. See Section G10 for further reference.

2. Post-Construction

- a. The Internal Contractor's Surveyor and licensed Construction Surveyor shall develop an as-built topographic survey to develop record drawings of completed construction works. The licensed Construction Surveyor must establish control, project boundary, and layout of the new facility and pavement; sanitary sewer and storm drainage structures' invert elevations to ensure proper flow; provide cut sheets' documentation to the Engineering Technician (ET) for review; and stamp and sign the as-built survey.
- b. The Quality Control Manager shall review the as-built drawings for accuracy and acceptance prior to submission to the DOR for review and acceptance.
- c. For buried linear infrastructure such as pipelines, ductbanks, storm drains, or similar – prior to backfilling, the Internal Contractor's Surveyor or Construction Surveyor shall take survey measurements to record the northing, easting, and elevations at the top center of the pipe at every pipe node. Pipe nodes are defined as any change in angle, grade, connection, or reduction in size. A node for a ductbank is defined as any change in angle or grade.
- d. For critical compacted lifts (such as underneath a tank), the Internal Contractor's Surveyor or Construction Surveyor shall take survey measurements to record the northing, easting, and elevations where each compaction test was performed along with the results of the compaction test.
- e. For buried objects, the Internal Contractor's Surveyor or Construction Surveyor shall take survey measurements to record the northing, easting, and elevations of the known elements of the buried object to the best of their ability. For example, if an asbestos pipe is encountered and abandoned in place, the Internal Contractor's Surveyor or Construction Surveyor shall record the portion, size, type, orientation, and description of the portion of the abandoned pipe that was discovered.
- f. For buried tanks, the Internal Contractor's Surveyor or Construction Surveyor shall take survey measurements to record the northing, easting, and elevations of the top outside corners of the tank, a description of the tank, and the measured interior measurements of the tank.

G5020.6 Section F – Geographic Information System (GIS) Surveys

This section applies to the Prime Construction Contractor and the Construction Surveyor providing completed as-built drawings and maps.

1. Projects Outside of Guam

The Construction Surveyor shall submit a RFI to request the preferred datums for the project files to be integrated into the government's GIS database.

2. Projects within Guam

- a. The Construction Surveyor shall provide all as-built data for infrastructure and facilities constructed using on GGN 93 and GUV D 04 datums.
- b. The Construction Surveyor shall indicate in the as-built the northings, eastings, and elevations are metric or International Survey Feet.
- c. Soil investigation survey data shall be submitted to the government using WGS84 datums. Please refer to FC 1-300-09N.
- d. MEX/UXO survey data shall be submitted to the government using WGS84 datums. Please refer to FC 1-300-09N.

G5020.7 Section G – Positional Accuracy Definitions & Procedures

This section applies to both the Design Surveyor and the Construction Surveyor.

1. Although the means and methods are not defined by the government, the class of survey is defined by the government. It is the responsibility of the Design Surveyor, Internal Contractor's Surveyor, and the Construction Surveyor to provide details of procedures and equipment used to obtain the necessary survey measurements.
2. It is the responsibility of the surveyors to calibrate and maintain their equipment and provide such information at the request of the government.
3. All surveys performed require the surveyor to check the survey work and confirm the intended accuracy is achieved. The Quality Control Manager shall maintain all survey QC records. Copies of survey checks shall be provided to the government within 24 hours upon request.

G5020.8 Section H – Standards References

This section is provided for reference to support the NSPS Model Standards.

APPENDIX A – GEOTECHNICAL COMPONENTS

INTRODUCTION

This study report presents the various aspects of the Geotechnical Components for the Guam MDACS related to the general components of architecture and engineering designs and constructions of military facilities on Guam, for the Naval Facilities Engineering Systems 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. For additional measures, refer to UFC 3-220-01 Geotechnical Engineering, with Change 3.

GEOLOGICAL CONSIDERATIONS

NORTHERN LIMESTONE

Guam is the southernmost of the Mariana Islands archipelago. 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 non-expansive, 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 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% to 40% 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 to 400 pcf; higher values need to be evaluated.

It is common 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 pre-stressing, 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.

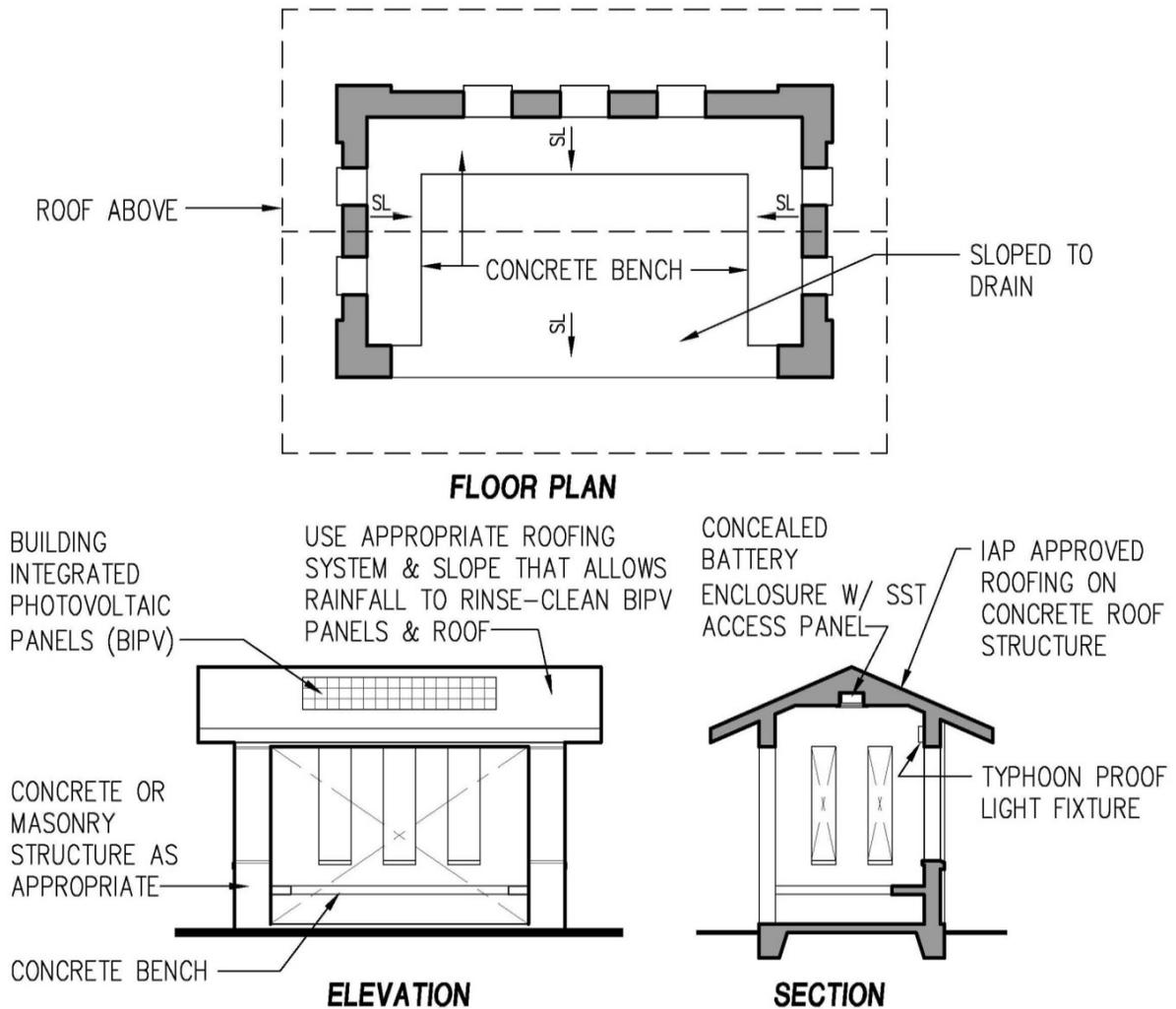
Drilled, cast-in-place concrete piers or piles – where driven piles are not practical to utilize and deep foundations are needed such as for up-lift resistance, too costly to replace compressible soils, too costly to mobilize pile-driving equipment and set-up for pile driving, lack of space to set-up 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 457 mm (18”) maximum dia. due to equipment availability locally.

APPENDIX B – DRAWINGS

Large Bus Shelter

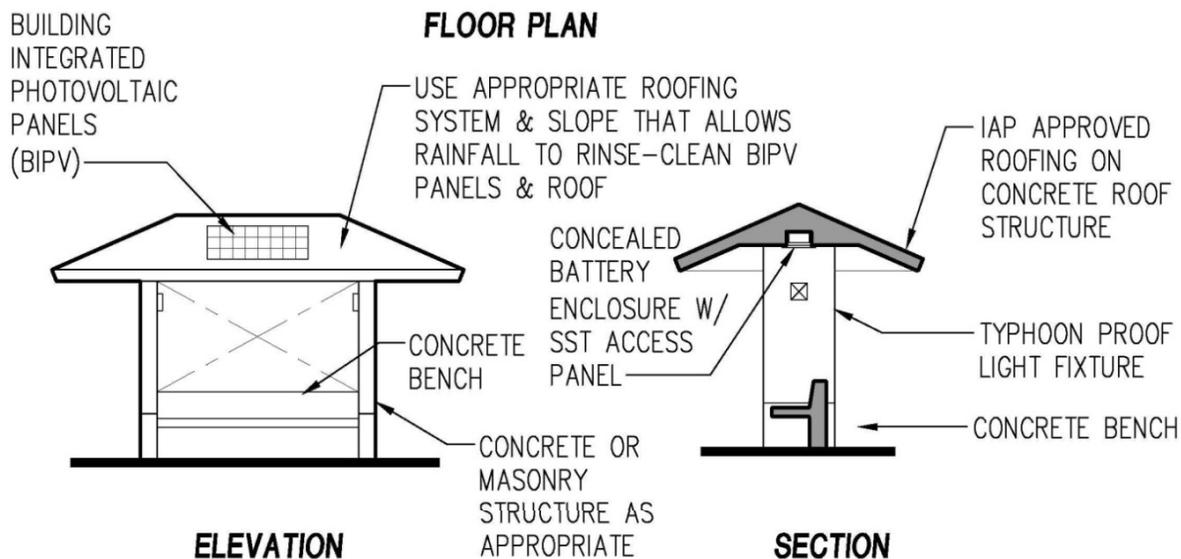
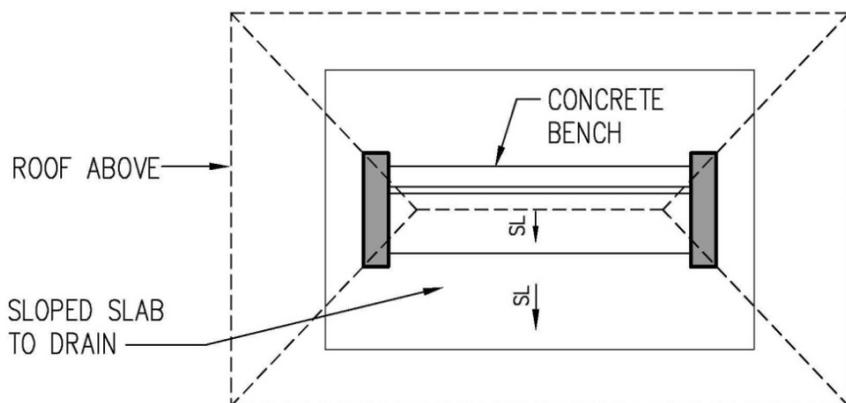


LARGE BUS SHELTER

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 37: Large Bus Shelter

Small Bus Shelter



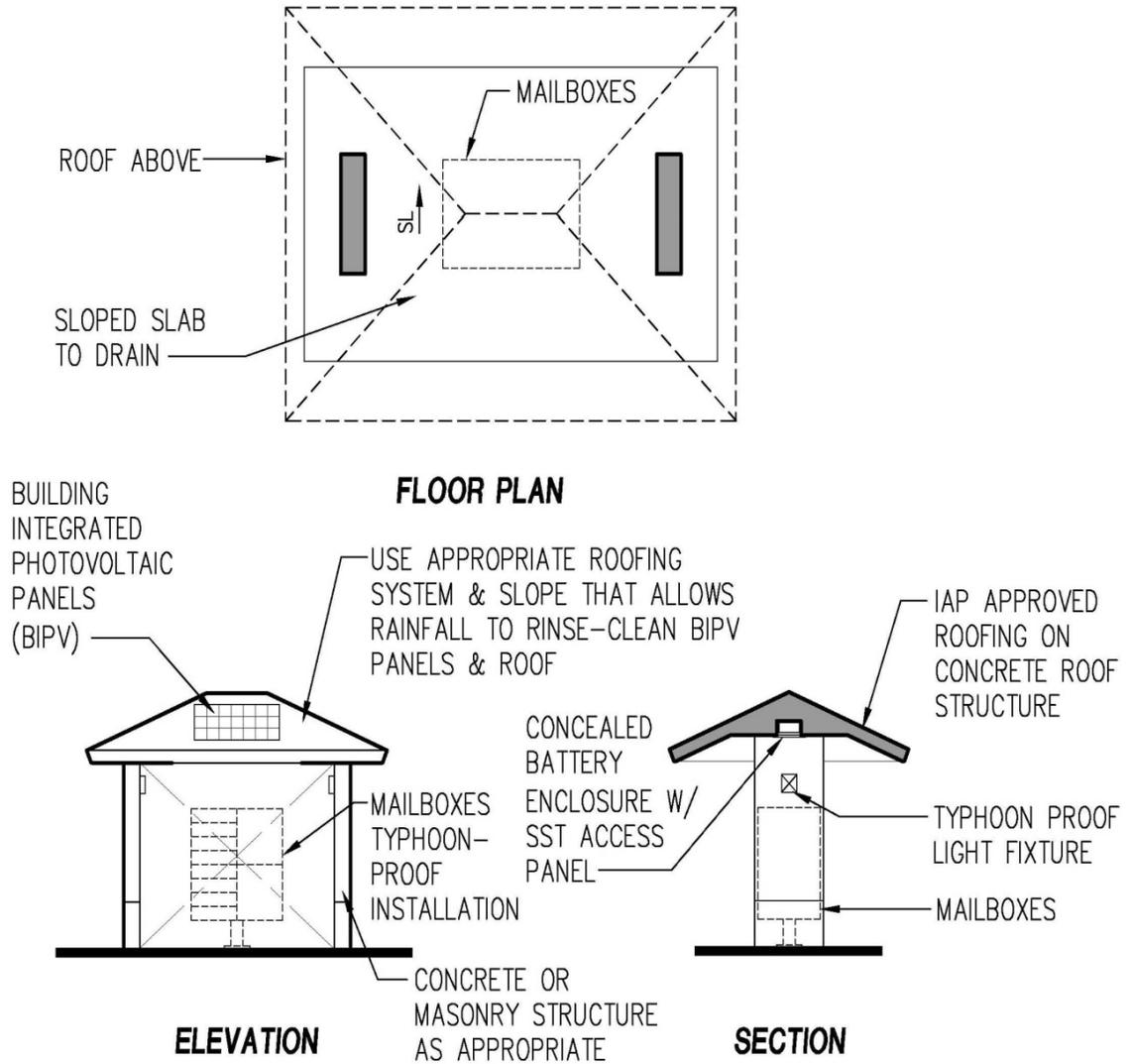
SMALL BUS SHELTER

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 38: Small Bus Shelter

Mailbox Shelter

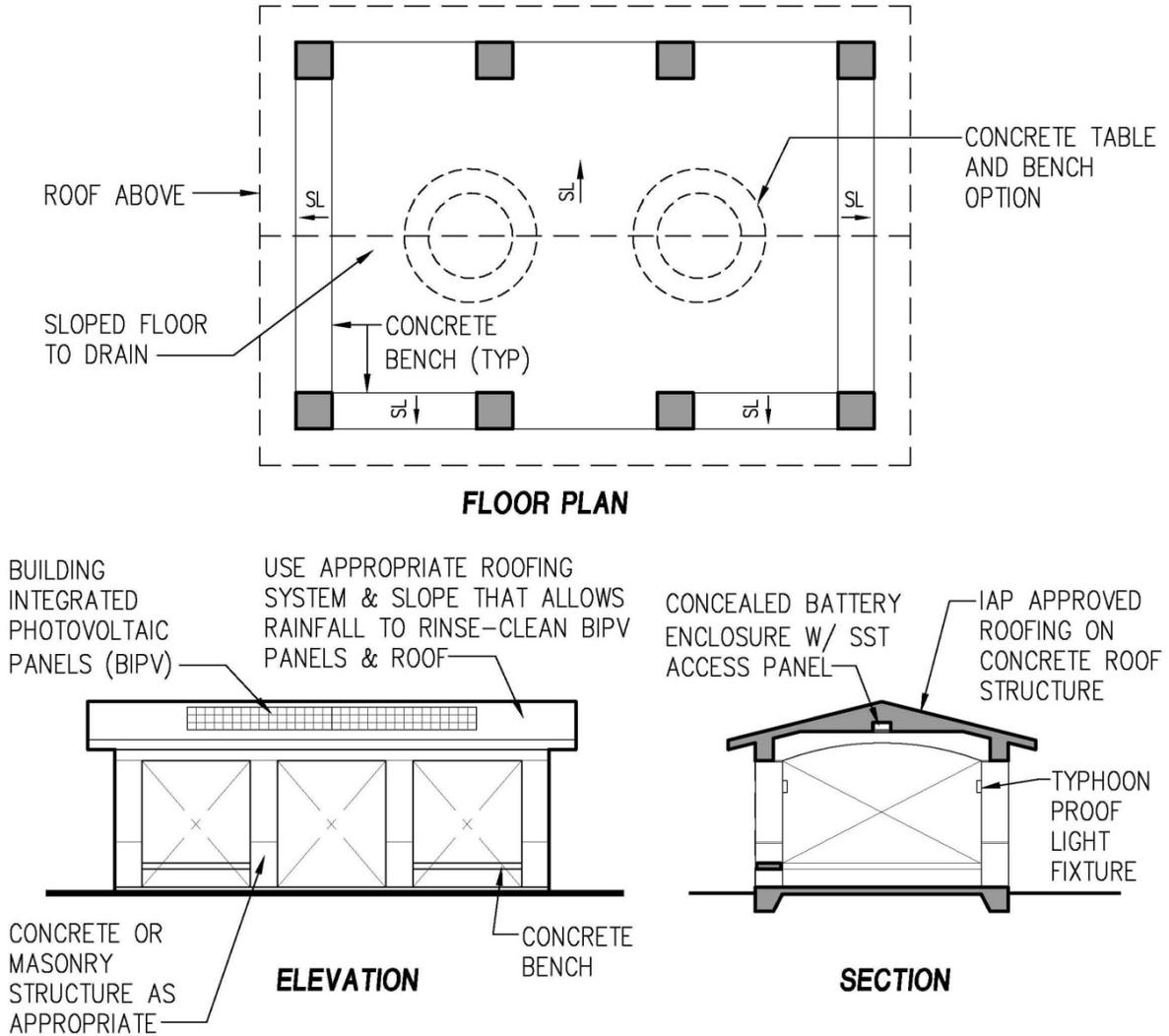
Figure 39: Mailbox Shelter



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.

Pavilion

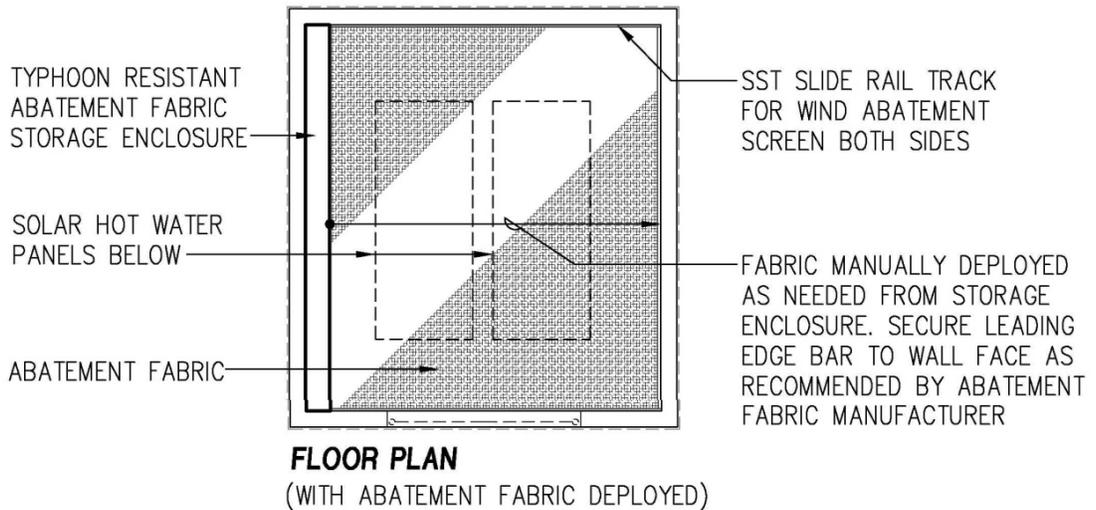
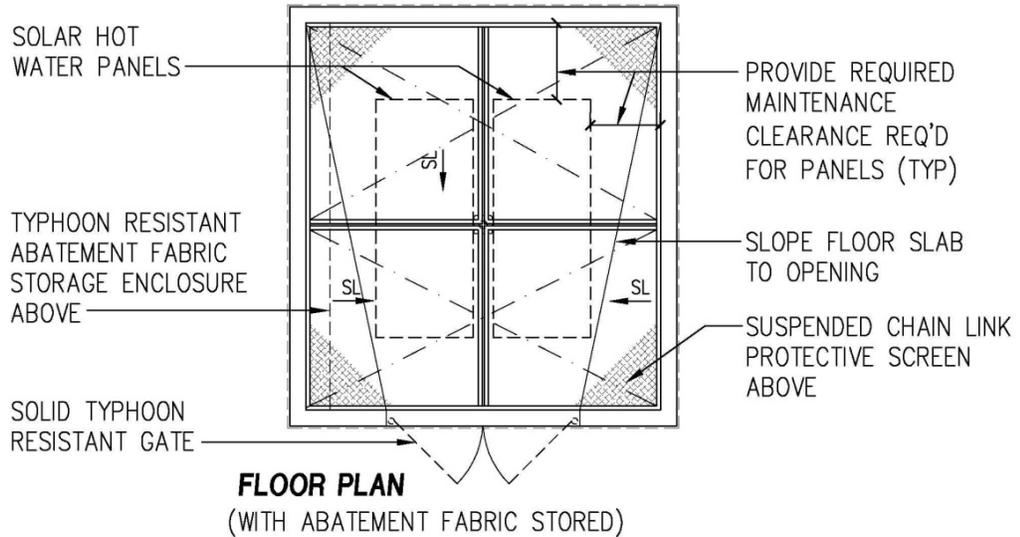


PAVILION

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 40: 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 41: Solar Panel Enclosure: Plan

Solar Panel Enclosure – Sheet 2

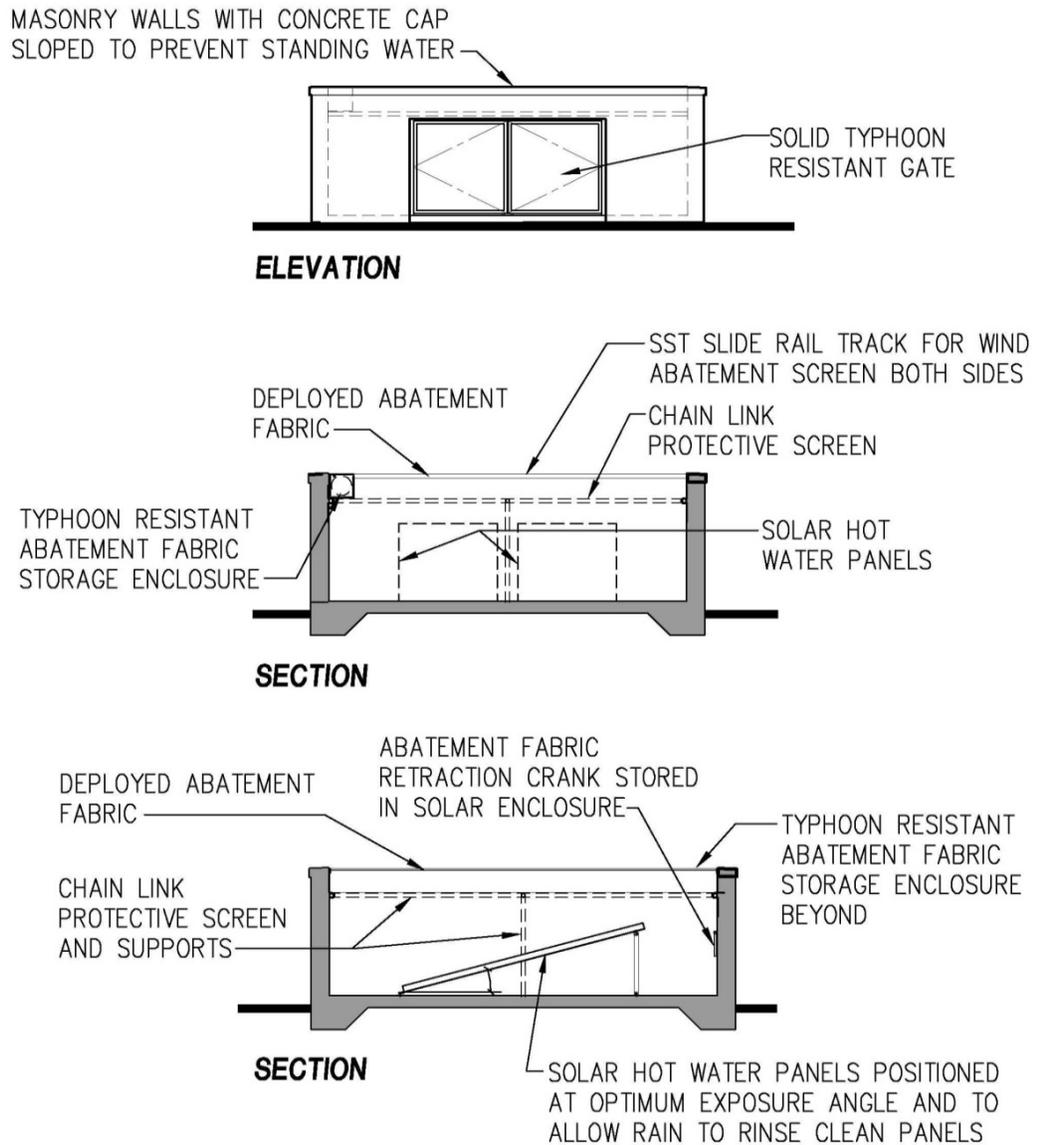


Figure 42: Solar Panel Enclosure: Section/Elevation

Emergency Generator Enclosure

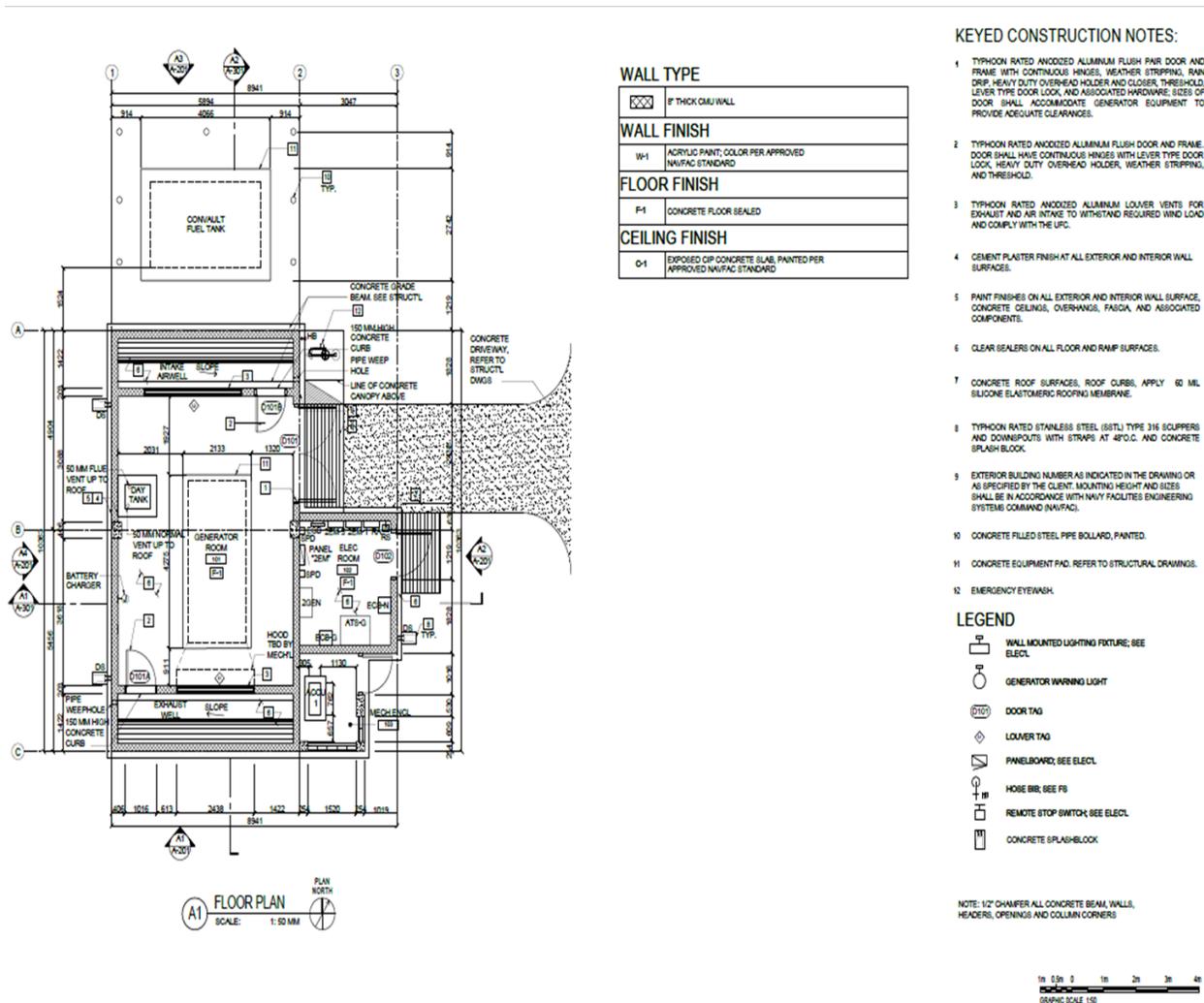
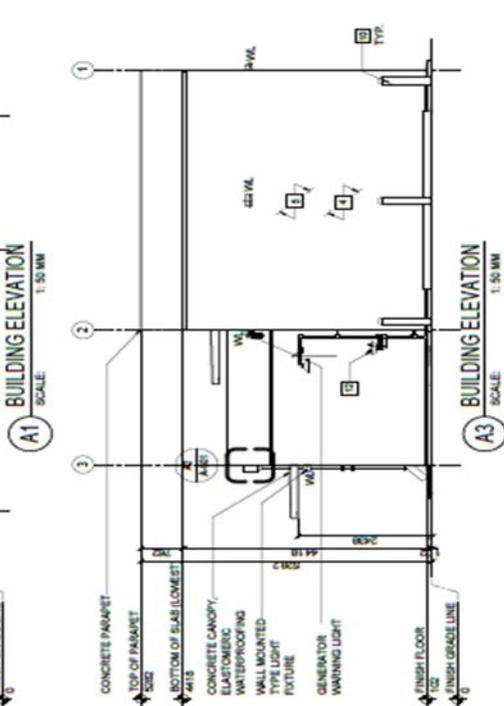
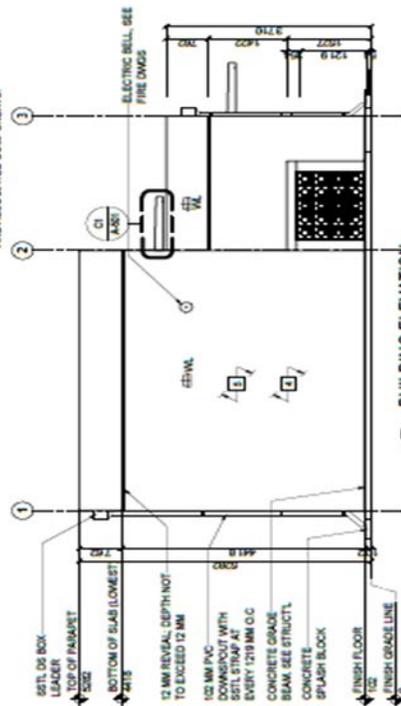
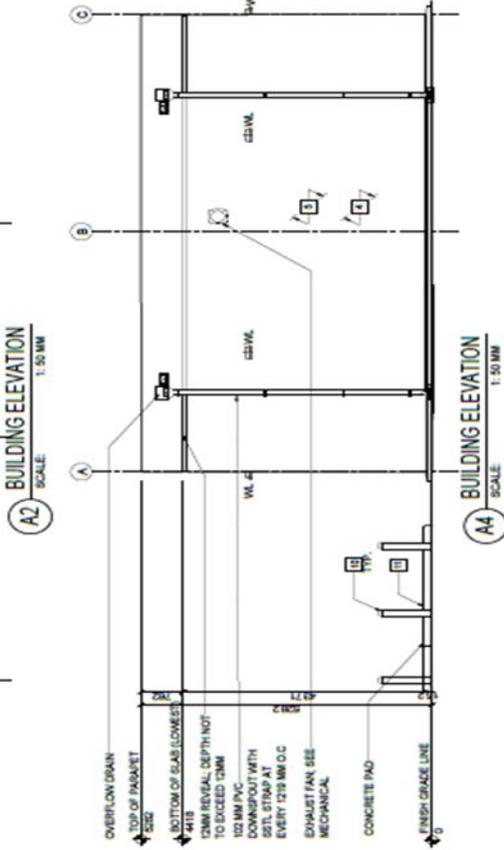
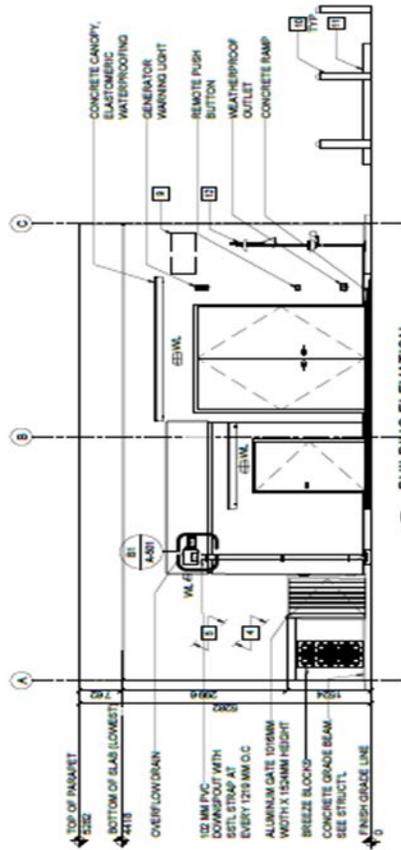


Figure 43: Emergency Generator Enclosure

KEYED CONSTRUCTION NOTES:

- 1 TYPHOON RATED ANODIZED ALUMINUM FLUSH PAIR DOOR AND FRAME WITH CONTINUOUS HINGES, WEATHER STRIPPING, RAIN DRIP, HEAVY DUTY OVERHEAD HOLDER AND CLOSER, THRESHOLD, LEVER TYPE DOOR LOCK, AND ASSOCIATED HARDWARE, SIZES OF DOOR SHALL ACCOMMODATE GENERATOR EQUIPMENT TO PROVIDE ADEQUATE CLEARANCES.
- 2 TYPHOON RATED ANODIZED ALUMINUM FLUSH DOOR AND FRAME DOOR SHALL HAVE CONTINUOUS HINGES WITH LEVER TYPE DOOR LOCK, HEAVY DUTY OVERHEAD HOLDER, WEATHER STRIPPING, AND THRESHOLD.
- 3 TYPHOON RATED ANODIZED ALUMINUM LOWER VENTS FOR EXHAUST AND AIR INTAKE TO WITHSTAND REQUIRED WIND LOAD AND COMPLY WITH THE UFC.
- 4 CEMENT PLASTER FINISH AT ALL EXTERIOR AND INTERIOR WALL SURFACES.
- 5 PAINT FINISHES ON ALL EXTERIOR AND INTERIOR WALL SURFACE, CONCRETE CEILING, OVERHANGS, FASCIA, AND ASSOCIATED COMPONENTS.
- 6 CLEAR SEALERS ON ALL FLOOR AND RAMP SURFACES.
- 7 CONCRETE ROOF SURFACES, ROOF CURBS, APPLY 60 MIL SILICONE ELASTOMERIC ROOFING MEMBRANE.
- 8 TYPHOON RATED STAINLESS STEEL (SSTL) TYPE 316 SCUPPERS AND DOWNSPOUTS WITH STRAPS AT 40°C.
- 9 EXTERIOR BUILDING NUMBER AS INDICATED IN THE DRAWING OR AS SPECIFIED BY THE CLIENT. MOUNTING HEIGHT AND SIZES SHALL BE IN ACCORDANCE WITH NAVY FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC).
- 10 CONCRETE FILLED STEEL PIPE BOLLARD.
- 11 CONCRETE EQUIPMENT PAD. REFER TO STRUCTURAL DRAWINGS.
- 12 EMERGENCY EYEWASH.



Notes:

1. Emergency Generator Enclosure drawings are conceptual only. Contractor DOR should design enclosure according to project requirements.
2. Enclosure concrete walls should be of 2-hour minimum fire-resistance rating.
3. Contractor DOR should determine if additional ventilation is required for when the generator is in operation. If required, D101A and D101B may be changed to louvered doors to provide sufficient ventilation.
4. Generator Day Tank Vents should have the means to prevent rainwater from entering such.
5. Generator Day Tank should be double-walled with 4" high minimum containment curb with hose bibb controlled drainage for incidental fuel spills.
6. Consideration should be made to use base mounted fuel tank. If a larger tank is required, above ground fuel tank meeting EPA requirements shall be used.
7. Water supply to Hose Bibb and Eyewash should be determined and coordinated with Installation Facility Operation Specialist.
8. "Generator in Operation" Warning Light should be at location with advantageous visibility for Personnel approaching the generator building.