Facilities Condition Assessment
Guam Memorial Hospital
Tamuning, Guam

08 April 2020

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The U.S. Department of the Interior, Office of Insular Affairs, requested the assistance of the U.S. Army Corps of Engineers (USACE) with conducting an onsite facilities infrastructure assessment of the Guam Memorial Hospital (GMH). The USACE Assessment Team was tasked to conduct a site investigation of the facility and determine short-term (maintenance repairs) and long-term recommendations (upgrades to meet current applicable Joint Commission Standards and guidelines promulgated by the Centers for Medicare and Medicaid Services (CMS) and applicable Codes (e.g., International Building Code, National Fire Protection Association, Facilities Guidelines Institute) for the facility with associated rough order of magnitude costs.

On 18-22 November 2019, architects and engineers from the USACE Honolulu District, Huntsville Engineering Center Medical Facilities Center of Expertise and Standardization, USACE Walla Walla District Cost Estimation Branch, and the USACE Japan District Structural Engineering Branch conducted the facilities infrastructure assessment survey.

The following major items of infrastructure concern are listed below:

- Failure of the roof and exterior window assemblies
- Z wing has structurally failed and is unsafe, A and B wings need structural analyses
- Noncompliant aged electrical distribution system
- Incomplete fire sprinkler protection throughout the facility
- Incomplete firewall barriers and fire zone separation
- Corrosive failure of mechanical air distribution systems
- Improper air pressurization of the facility
- Inadequate sizing of inpatient rooms, ADA Noncompliant, lack of medical air, and emergency power outlets
- Many inpatient rooms are shared, lack of privacy and HIPAA concerns
- Medical equipment is antiquated and in need of repair by replacement
- Lack of parking for patients and visitors, parking lot needs to be expanded

The current infrastructure of the GMH facility is in an overall state of failure due to age, environmental exposure, lack of financial resources to support pre-planned capital infrastructure replacements, and lack of previous facilities design adherence to building codes. Extensive repair and/or replacement of all GMH facility sections is required to ensure renewed compliance with hospital accreditation standards and to protect the life, health, and safety of staff, patients, and visitors.

The existing facility is incapable of providing enough space to meet the long term needs of the patient population. Further degradation of the infrastructure will result in additional non-compliance with standards and will result in denial of CMS accreditation. The failure of GMH to provide essential services will degrade the delivery of care to the population of Guam.

GMH will require $21M immediately for repairs to support the reaccreditation of the facility and eliminate hazards to life, health, and safety. These repairs consist of: roof replacement, exterior building repairs, HVAC repairs, life safety repairs, and fire sprinkler repairs. The options below are proposed for end-state facilities infrastructure capital investment.

Option A: Construct a new multi-story hospital of equivalent size on a suitable site on the island. The estimated cost for a new hospital is $743M, including $21M to support reaccreditation. This would entail the construction of a new facility in compliance with current building code and hospital accreditation criteria. This assessment did not address any requirements related to land transfer, upgrades to island infrastructure, or a feasibility study that addresses potential impacts on patient travel to a new facility. This estimate does not address potential clinical space deficiencies nor meet the future end-state of clinical services that must be resolved prior to design.

Option B: Repair the infrastructure of the current facility (312,351 SF), to include the demolition and recapitalization of the “Z” Wing and a parking garage over the existing parking lot. The estimated construction cost is $761M. This involves retrofitting all infrastructure to meet current building code and hospital accreditation criteria, to include immediate correction of deficiencies in the architectural, electrical, fire protection, mechanical, and structural systems. Repair of the current facility will require numerous utilities outages and interim life safety measures that will impact the delivery of immediate patient care services. While individual systems could be brought up to current code standard through repair, this may not fully address the existing space deficiencies, meet the future end-state of services. There is a high risk of encountering differing site conditions which would further escalate the cost and complexity of repairs.

The recommendations provided in this report support the **REPLACEMENT** of the existing facility (Option A). Major repair to the current GMH structure without expansion will provide enhancement to the environment of care but is the suboptimal solution with no expansion capacity for clinical operations. The current hospital campus lacks critical expansion space to support replacements to the central utility plant, enhancements to the existing hospital wings, and will not support additional parking without the construction of parking structures (garages). Additional space will also be required within the already crowded campus to support construction material storage, swing space, and contractor parking. The optimal solution to enhancement of health care services on Guam is the construction of a new medical campus on a site to be determined.

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1. **Background:** On 18-22 November 2019, the U.S. Army Corps of Engineers (USACE), Honolulu District (POH) and the USACE Medical Center of Expertise and Standardization (MX), along with support from the USACE Japan District (POJ) and the USACE Walla Walla District (NWW) conducted a facilities condition assessment of the Guam Memorial Hospital. This survey was in support of a request from the Office of Insular Affairs (OIA). The results of this assessment will be used to estimate the cost of renovating and modernizing the current facility and/or constructing a new facility in compliance with national healthcare accreditation standards.

   The Guam Memorial Hospital is a 161 bed acute care hospital, with a working footprint of approximately 312,351 square feet. The campus has an approximately 300,000 sf. of non-working space (parking lots, loading dock etc.). The Z wing was the earliest building constructed. It is scheduled for demolition and is no longer in service. The main hospital building A and B wings were constructed in 1978. In 1989 a major expansion added the B, C, D, M, S, G, and entry wings. In 2014 the emergency department expansion was added along with an expansion of the critical care unit (CCU) and the intensive care unit (ICU).

   Assessment Team Qualifications: In order to meet the requirements of the above, the USACE assembled a team of subject matter experts. These individuals included senior architect and engineers from the USACE Medical Center of Expertise and Standardization (MX) under the Command of Huntsville Center (HNC). Specialized support for seismic analysis was provided by (POJ) and cost estimation support was provided by (NWW). All team members have professional licensure and have established personnel competencies through direct participation in the Department of Defense Medical Military Construction (DODM MILCON) Program and the Department of Veterans Affairs Major Project Execution Portfolio. The individual team members are identified in Appendix A.

2. **Technical Approach:** The assessment team spent a week at GMH. The technical team of architect and engineers conducted a complete facilities assessment of GMH to include interstitial areas and occupied clinical and administrative areas. The visual tour was an assessment of facilities compliance with governing building criteria, to include, but not limited to, compliance with such standards as recommend by the Centers for Medicare and Medicaid Services (CMS), the American Society for Heating, Refrigeration, and Air-

Conditioning Engineers (ASHRAE), the Facilities Guideline Institute (FGI) for Architectural Standards, and the National Fire Protection Association (NFPA).

The main body of this report will be a condition assessment of the existing facility followed by an analysis of the estimated cost to repair and upgrade the existing hospital as compared to the construction of a comparable new facility. In order to delineate the hierarchy of repair priorities, the following definitions will be used to highlight the importance of the recommendation to remediate a failing condition.

- Emergency Repair: A repair action required immediately due to a hazard impacting life, health, and/or safety. The repair action is assumed to be addressable within current budget, manpower, and local contracting capabilities.
- Priority Repair: A repair action required within <1 year due to a high risk of failure associated with capital infrastructure that may eventually impact life, health, or safety.
- Major Scheduled Replacement (MSR): A repair action required within 1-5 years normally anticipated with the end of lifecycle and programmed replacement of a capital infrastructure component.

3. **Facility Condition Assessment:** With the help of extensive site investigation and interview encounters with the staff of the GMH, the team evaluated the various fire protection, life safety, architectural, mechanical, electrical, and structural systems. The current condition of these systems is discussed below. There are many systems that need to be repaired and upgraded to meet current facility standards for healthcare.

Architectural Observations:

- Roof, Slope, and Drains: The existing roof system has exceeded its useful life. The roof is composed of foam tapered insulation, with a top membrane and ½ inch thick concrete toping with painted top coat. The slope is minimal to non-existent in most areas with the exception of the more recent Emergency Department (ED) and Intensive Care Unit (ICU) additions. Poor water drainage and ponding is quite evident. Appropriate roof slope is ¼ inch per foot minimum with ½ inch per foot ideal for positive drainage. The primary drainage is provided by roof drains. Scuppers which drain down the side of the building provide backup. The roof drain caps are corroded, broken, or even missing. The top coat does not appear to be flashed or sealed properly. Major cracking has occurred throughout the top layer which the facility has attempted to patch. The roof leaks excessively causing major interior damage to ceilings, walls, and equipment. Water damage to the interior can lead to mold growth and infection control issues. The roof has major degradation and requires total replacement. This would be a priority repair as defined above.

- Exterior Envelope (Walls, Flashing, and Expansion Joints): The exterior walls are in fair condition but need significant repairs (caulk, flashing, paint). The building envelope is severely compromised with numerous penetrations, open joints, failed caulk/sealant/expansion joints, and openings not sealed. There are numerous abandoned air transfer grilles through the exterior walls that are allowing moist humid air to infiltrate the building. Many locations have been observed where the ceilings were stained, warped, or corroded from moisture infiltration or condensation. There are numerous locations around the facility where utility piping are penetrating the exterior wall/eave/frieze and are not sealed. The exterior envelope requires repair. Recommend sealing all penetrations with appropriate materials and vapor/air barrier to minimize air infiltration. This would be a priority repair as defined above.

- Exterior Windows: The exterior windows are in poor condition. The windows are generally single pane (fixed glass) in aluminum framed systems (punched and storefront systems. Window seal/gaskets are failing, frames do not appear to be thermally broken and weeps at exterior are either not existent or sealed/caulked over. There is significant evidence of water damage/deterioration at the majority of the windows and knee walls. Recommend replacing the windows with true thermally broken window frames with insulated glazing/low e. This would prevent the transfer of temperature through the system eliminating any condensation. This would be considered a priority repair.

- Medical Equipment: The majority of the medical equipment is outdated, showing signs of significant wear. The Magnetic Resonance Imaging (MRI) has quenched, has not been recharged (helium) or used in the last 5 years. Future planning removes the MRI for repurpose of this area. The team encountered 15-20 year old radiology equipment, compressors and other equipment which are approaching their end of useful life. The facility has replaced some equipment such as the Computed Tomography (CT) units and Mammographic unit since 2014.

- Building Interior Spaces: The interior room sizes, layout, departmental flow and adjacencies are obsolete and no longer providing efficiency. From obsolete semi-private and private inpatient wards, OR’s / LDR / Neonatal ICU rooms to insufficient sterile processing layout; the size of these rooms are small and inadequate for patient care which does not meet current standards. Other issues observed were inefficient patient flow with department adjacencies and travel distances which do not meet current code criteria to include the Facilities Guidelines Institute Standards for Hospitals (FGI) and the National Fire Protection Association Standard for Health Care Facilities (NFPA 99), Life Safety Code (NFPA 101) and American Disability Act (ADA)/Architectural Barriers Act (ABA) Accessibility Standards. The interior spaces require modernization through design and renovation. This would be considered a major scheduled replacement.

- Building Interior Finishes: The hospital interior finishes throughout (floors, walls, base, doors, door frames, ceilings, corner guards, handrails, crash rails, etc.) are all in GOOD to FAIR condition. However, there are numerous areas with damage to walls and door frames from equipment, water/moisture infiltration and a few areas with floor slab degradation. The facility has an extensive ceiling tile replacement program but the ceiling grids are starting to rust. The finishes are well maintained but old, outdated and showing signs of significant wear, damage and age. These repairs should be considered priority repairs

- Floor to floor height: A standard commercial building may have a floor to floor height of 12 feet, while a hospital is more preferred at 16 feet or greater depending on critical overhead space needs like an Operating Room (OR)/surgical suite, which may increase to 20 feet. The higher floor to floor heights allow sufficient vertical allocation for the necessary placement and maintenance of duct work, plumbing, cable trays and other utilities needed for healthcare facilities. Some DoD and VA projects also have a separate and designated interstitial space for the distribution of utilities and terminal equipment. Designated interstitial space offers advantages by maximizing utility access and maintenance and providing future building flexibility while minimizing disruptions to patients, staff or medical services. For GMH, the first and second levels are 17 feet floor to floor, falling into the normal range. However, the third and fourth levels (floor to floor height) is only 13'-0". Much less than industry standard for healthcare occupancies. This significantly limits the above ceiling installation of utilities (duct work, cable tray, sprinkler, water piping, etc.).

- Exterior wall/interior drywall damage: There is significant evidence of moisture, water damage and mold at the majority of the exterior walls near window locations which needs to be repaired and/or replaced. The drywall has bubbles or delaminating, paint peeling, drywall fastener pops possibly due to rust, corner bead cracking, holes and mold. This appears to have been caused by a number of different factors: (1) possible water infiltration from the exterior windows, (2) water leaks from roof or exterior wall penetrations and/or (3) building negative pressure drawing the moisture into the building as discuss above in previous line items. This would be a priority repair.

- Exterior wall finish/cleaning/painting: The majority of the buildings have a significant amount of mold growth, peeling paint and discoloration on the exterior surface. The exterior wall itself appears to be in GOOD condition. Guam is located in a tropical extreme humid location. Although some of the mold may be located on the surface, other areas appear to be more significant. Mold feeds on organic materials, such as wood, paper, many fabrics, and even some types of glue. It literally eats away at these materials, causing them to rot and fall apart. Outside mold does not always stay outside. It will eventually find its way thru the envelope and into the building. Outside mold does carry health risks, but the risks are not as great as with inside mold. Although the concentration of mold will be less outside in the open air than it would be indoors. However, that doesn't mean exterior mold cannot lead to health problems. If someone does spend time outdoors in areas with significant amounts of mold, one's health can be at risk. Children are particularly susceptible to mold-related health problems. This mold may be caused from the moist humid conditions/environment, low quality paint, from an inferior, damaged or missing vapor barrier or simply the exterior materials used. Another influence, could be negative pressure rooms located at/near the exterior wall drawing the moisture into the building. Buildings in general should be positively pressured. The GMH facility is actually under negative pressure. Recommend that the entire exterior of the facility be sprayed with chemicals to kill the mold, power washed, sealed, caulked, and painted with a high quality mold resistant paint. This would be a major scheduled replacement repair.

- Exterior doors: Exterior doors have a mixture of either aluminum or hollow metal. Majority of the original building doors are in GOOD condition. Typical door frames are hollow metal. The only issue identified are failed seals probably due to exposure and corrosive environment. A couple of the overhead doors at the central utility plant also needs to be replaced due to condition and damage. Recommend replace all door seals, recondition hardware to either full replacement of overhead coiling Central Utility Plant (CUP) doors to reconditioned (oil/lubricate) to replace latches, wheels, bearing and coil springs. This would be considered a priority repair.

- Front entrance vestibules: The hospital front entrance vestibules has both an exterior and interior single sliding door configuration with possible break away feature. However, the door separation depth is only about 6 feet. Both sliding doors open simultaneously when someone approaches at either side (ingress or egress) allowing the hot, humid, moist outdoor air to gust/enter into the building. The arrangement, operation and separation does not function properly as both sets of doors are open simultaneously the majority of the time (duration of the day) due to the traffic conditions. The mechanical air curtain installed does not provide any assistance. The main contributor is that the second set of entrance doors, opposite side of the front entrance, are not in operation. This also significantly increases the egress capacity/occupant load at this single vestibule.

  Vestibules are typically required for all medical facilities located at primary entrances. The depth of the vestibules shall comply with ABA requirements and should be sufficient depth to allow the outside doors to close before the inside doors are opened when someone passes through. ABA specifies the distance between two hinged or pivoted doors in series shall be 48 inches minimum plus the width of the door swinging into the space or about 10 feet. ASHRAE 90.1 also requires a minimum distance of 7'-0" between closed interior and exterior vestibule doors. These minimum separation distance requirements are typically NOT sufficient. The automatic closing speeds of these doors can have a significant impact on door function, timing/sequence and passage. The distance separating the doors combined with a large number of personnel passing through, especially at shift change, can results in both sets of doors staying open continually. Vestibules are provided to reduce infiltration losses (or gains) from wind and stack effects by creating an air lock entry. This has been a recurring problem with most facilities. Recommend (1) a building traffic study be completed to include "rush hour" entry and exit volumes to properly configure and size vestibules such that the automated doors are not continuously open. (2) both vestibules will need to be modernized to a greater depth (10 feet +/-) and install new doors, sensors for more ideal operation or sequence and possibly offset of doors/ opening (diagonal) in lieu of aligning. Alternative option for consideration would be a large revolving door with an emergency man door located at both entrances. Recommend that the current closed, second vestibule be fixed and placed back in operation so one is dedicated to ingress traffic and the other egress. This would split the usage between two entrances, in lieu of one, reducing the wear and tear and air infiltration until they can be redesigned, reconfigured and updated. This would be considered a priority repair.

- OR layout: Although the current or existing OR room are functional, they are not compliant with today's newer standards for size, layout, clearance, equipment or flow as the design is outdated and does not comply with current codes or FGI guidelines. Recommend redesign of entire surgical suite/department for better flow, adjacencies, space allocation and upgraded OR's to current codes, standards and codes. This would be considered a major scheduled replacement.

- NICU Layout: Although the current or existing NICU rooms are functional, they are not compliant with today's newer standards for size, layout, clearances, equipment, light levels (controls) or flow as the design is outdated and does not comply with current codes or FGI guidelines. Recommend redesign of entire NICU suite/department for better flow, adjacencies, space allocation and upgraded nursery to current codes, standards and codes. This would be a major scheduled repair.

- Elevators: Two of the four elevators for the facility were down, not working and under significant repair. Another was down for a short time for maintenance related repairs. The facility did have interim life safety measures (ISLM) in place for the elevators. There is a current awarded project to modernize and replace the existing elevators (motors, gears, ropes, controls, etc.) and update the car/cabs to current standards. (LS03.01.50, NFPA, IBC, etc.) Recommend getting this project started as soon as possible to get all elevators up in operation. Elevators are essential for moving patients to/from upper floors and critical departments. Keep all ILSM's in place throughout the construction phase. This would be classified as a priority repair.

- Environment of care deficiencies: Numerous environment of care deficiencies were noted during the walk through. Some examples are improper storage, wall and ceiling damage, missing light covers, and missing cover plates. Please see Architectural appendix for detailed description and discussion.

- Single occupancy toilet rooms: There are a number of existing single occupancy toilet rooms throughout the facility that do not comply with ADA standards Section 213, that ALL toilet rooms provided, each shall comply with 603. The only exception applicable would be item 4. Where multiple single user toilet rooms are clustered at a single location, no more than 50 percent of the single user toilet rooms for each use at each cluster shall be required to comply with 603. Recommend modernization due to the age of the facility the existing conditions are more than likely grandfathered in. However, if any alterations or renovations are provided to the facility, they will be required to comply with current codes. This is considered a major scheduled replacement.

- Interior finishes floors: Vinyl composite tile, sheet vinyl and some tile are generally used throughout the facility. Condition is GOOD to FAIR condition but appear to be old, brittle and wearing excessively. Some areas have concrete slab divots projecting through the material. Rubber base in some areas delaminating off walls or missing. Harsh chemicals from disinfecting and housekeeping over time has severely impacted these finishes. Recommend complete removal of flooring and base throughout facility with the installation of new healthcare quality products due to age. Grind high spots in concrete slab and/or use self-leveling floor compound to patch existing concrete slab prior to installation of new finishes. Ensure that the correct materials are used with respect to flexibility, durability, clean ability, and maintainability with correct finish for the room's purpose. This is considered a major scheduled replacement repair.

- Interior finishes paint: Interior surfaces are in GOOD to FAIR condition. Some areas of walls and other painted surfaces are worn limiting the protective properties as they are damaged, scuffed, peeling or have mold growth. There are a number of other areas throughout the facility that have been patched which are not finished. Drywall mud has not been sanded, walls primed and not painted. Selection of interior construction and finishes must consider the need for aseptic environments. Use smooth, nonporous, seamless materials to minimize contamination and reduce housekeeping requirements. Smooth, seamless wall and floor coverings facilitate cleaning. Cabinetry should be designed and installed without gaps behind or underneath base units. At a minimum, these areas shall be designed for ease of housekeeping, with elimination of materials or surfaces that could harbor contamination and to minimize maintenance. Painted surfaces should be durable, cleanable and maintained on a continuous basis to include annual maintenance plans. Recommend chemically cleaning and paint of all walls, doors and gypsum board ceilings throughout the facility. Areas where mold is found, perform in depth investigation as to extent, causes and treatment. Remove and replace drywall as necessary and finish. Facility should have a campus wide interior painting plan with a 2 to 5 year life expectancy as well as one for repairs. This is considered a major scheduled replacement repair:

- Interior Doors: Interior doors are typically laminated with hollow metal frames. The majority of the doors and frames are in GOOD condition. None appeared to need replacing. Recommend replacing doors as needed that are damaged, chipped, delaminating, stained and/or failing. Currently the majority of the doors appear to be in good shape. This is considered a major scheduled replacement repair.

Electrical Observations:

- Primary Power Arrangement: There are two 13.8kV primary circuits (P401 and P403) entering a single pad-mounted switch. One is an overhead line, and the other is an underground line, and the two are fed from separate switching stations. The pad-mounted switch feeds a single pad-mounted transformer that is the sole normal power source for the entire facility. The single switch and single transformer each represents a single point of failure that could render the hospital without utility power for an extended period.

- Main Distribution Equipment in Poor Condition and Inadequate for Hospital: Because there is presently only one service transformer, the existing main switchboard 'MS' has only a single service feeder that terminates at the center of the board and splits into two buses that serve five main breakers between them. No redundancy exists in this type of switchboard. The fundamental components of the electrical distribution system are far beyond their reasonable lifespan. The Main Switchboard ‘MS’ and much of the other electrical equipment in the Power Plant area are over 40 years old. The harsh tropical climate, combined with much leaking over the years, have taken a great toll on the components of all of the normal and emergency electrical equipment in many areas of the hospital. In the Power Plant area in numerous locations, old electrical equipment no longer in use is still utilized for routing feeders to new equipment. Electrical equipment such as breakers, panelboards, and disconnect switches have been “bolted on” to existing equipment because of lack of space in the equipment or lack of free wall space. Many of these installations violate electrical code, and they could be overloading the equipment to which they are connected.

- Emergency Power System in Poor Condition and Not a Code-Compliant Essential Electrical System (EES): In most places, the system does not have an Essential Electrical System (EES) with Life Safety, Critical, and Equipment branches, as required by NFPA 72 and 99. The original electrical system was comprised of only a Normal system (with no generator backup) and an Emergency system (with generator backup). The present system is a combination of several generations of modifications, each of which attempted to make the hospital’s emergency systems more compliant with code. These efforts have not resulted in a code-compliant system. Rather, the system is an overly complicated, non-code-compliant system with inconsistent segregation of loads.

  The fundamental components of the Emergency Power System are beyond their reasonable lifespan. The Generator Switchboard ‘ES’ is over 40 years old. The diesel generators ‘EG-1,’ ‘EG-2,’ and ‘EG-3’ are not as old as the main distribution equipment, but as generators go, they are very old (1992, 2005, and 1996, respectively) – especially for a tropical environment.

There are presently three generators and three Automatic Transfer Switches (ATSs #1, #2, and #4R) that feed mixed combinations of Life Safety, Critical, Equipment, and Non-Essential loads. There was a fourth ATS (ATS #3) for Life Safety, but it was taken out of commission by a typhoon, and its life safety loads were moved to the ATS #1, which also serves most of the Critical Branch loads. Generally, one generator is associated with one of the three ATS's, but a process has been implemented by the electrical maintenance staff to provide some level of redundancy. The process involves kirk-key backup procedures for electrical maintenance staff to execute during an outage when one of the three generators fails, but it is non-automatic, cumbersome, and somewhat complicated to perform during a crisis.

None of the ATS's have bypass/isolation capability, which would allow their load to still be fed if the ATS failed or needed maintenance. The Emergency equipment is not installed in a dedicated space. Rather, it is located in the Power Plant room with the normal power switchboard and the central mechanical equipment and is immediately adjacent to a 20,000-gallon water tank.

Some areas have only Normal and Emergency, while other areas have Life Safety, Critical, and Equipment branch panelboards. These panelboards, installed at different periods over 40-plus years, have very inconsistent naming conventions. Some even have color coding that is misleading as to their purpose, such as Normal system panels being painted red. This has resulted in many circuits fed by panels on the wrong system - Emergency panelboards serving Normal loads, Equipment Branch panelboards serving Critical loads, etc.

- Code violations in the power plant and throughout the facility: In the power plant, old electrical equipment no longer in use is still utilized for routing feeders to new equipment. Electrical equipment such as breakers, panel boards, and disconnect switches have been "bolted on" to existing equipment because of lack of space in the equipment or lack of free wall space. Many of these installations violate electrical code, and they could be overloading the equipment to which they are connected. The main normal and emergency equipment is not installed in dedicated spaces. Rather, they are located in the power plant room with all of the central mechanical equipment and are immediately adjacent to a 20,000 gallon water tank.
- Power System Not Selectively Coordinated: Selective coordination has apparently not ever been considered. Selective coordination is a vital component of the design and operation of a code-compliant hospital electrical system. This requires the system to be modeled and a short circuit analysis to be performed by the designer. The circuit breakers of the system must be selected to coordinate with each other in all load conditions, so that the most downstream breaker will open on a fault. The requirement for selective coordination also requires that adjustable-trip breakers be specified for the new distribution equipment.

- Recommendations for repair upgrades to existing facility for new construction option:
    1. Provide a second pad-mounted switch or replace the existing switch, so that a second transformer may be served.
    2. Provide a second pad-mounted transformer and a concrete-encased service ductbank to one end of the new switchboard. The existing service feeder will need to be terminated at the other end of the new switchboard; conduit must be reused where possible, and new conductors must be provided.
    3. Provide a new Main Electrical Room, following the intent, approach, and level of detail of the 2019 Electrical Design except as noted herein regarding separate rooms for generators and for the Emergency Power Supply System (EPSS).
    4. Provide a double-ended service switchboard, with full drawout construction, following the intent, approach, and level of detail of the 2019 Electrical Design.
    5. The new switchboard must supply normal power to all of the facility's equipment requiring electrical power, including the transfer equipment for the EES, the fire pump controller, the Non-Essential Electrical System, and all existing and new normal power distribution equipment. The design shall follow the intent, approach, and level of detail of the 2019 Electrical Design.
    6. Replace the older of the two 1.6 MW generators in kind. Provide repairs and/or upgrades to the two remaining generators as needed to give the hospital a satisfactory emergency power supply to support the EES for the 7-10 years or more before occupancy of the new hospital.
    7. The generators must connect to a common switchgear, following the intent, approach, and level of detail of the 2019 Electrical Design. The switchgear must be designed to connect to a permanent load bank and a load bank used for annual testing.
    8. Provide an EES for the hospital, fed by the Generator Switchgear, following the intent, approach, and level of detail of the 2019 Electrical Design except as noted herein. The scope of the work shall follow the intent of that design from the Generator Switchgear downstream, including transferring loads to proper branches, but shall also extend to electrical equipment provided by projects that were executed after the 2019 design was completed. The Generator Switchgear and transfer switches must be located in a dedicated room, separated from the Main Electrical Room, per NFPA 110-7.2.
    9. The contract that will perform the electrical design for the repairs/upgrades should include a short circuit analysis, selective coordination study, and arc flash analysis for all new work, and must extend downstream as far as the knowledge of installed conditions allows, to include at least the projects completed after the 2012 As-Built documents were generated.

- Recommendations for significant upgrade to existing facility option:

    1. Provide the Guam Power Authority owned and operated pad-mounted switchgear, two new pad-mounted service transformers, and two concrete-encased service ductbanks – one from each transformer to one end of the new switchboard described in the following section, following the intent, approach, and level of detail of the 2019 Electrical Design.

2. Provide a new Main Electrical Room, following the intent, approach, and level of detail of the 2019 Electrical Design except as noted herein regarding separate rooms for generators and for the EPSS.
3. Provide a double-ended service switchboard, with full drawout construction, following the intent, approach, and level of detail of the 2019 Electrical Design.
4. The new switchboard must supply normal power to all of the facility's equipment requiring electrical power, including the transfer equipment for the EES, the fire pump controller, the Non-Essential Electrical System, and all existing and new normal power distribution equipment. The design shall follow the intent, approach, and level of detail of the 2019 Electrical Design.
5. Replace the existing generator plant with two or more new diesel generators that will operate in parallel upon loss of utility power. The generators must be in a dedicated room per NFPA 110-7.2.
6. The generators must be of equal capacity and rating, and each generator must be sized to serve the combined loads of the Life Safety and Critical Branches, medical air compressor(s), medical-surgical vacuum pumps, fire pump(s), generator fuel pumps, and other generator set accessories plus 20 percent.
7. Provide a separate day tank for each generator, sized for a minimum of 4 hours runtime at full load. The fuel system must be redesigned as necessary to automatically supply fuel to the day tanks from the fuel storage tanks.
8. Provide a set of duplex transfer pumps for each main storage tank. Each fuel transfer pump must be sized to accommodate all generator sets. Provide fuel filtration system per recommendations of the generator set manufacturer, to meet NFPA 110 and maintain the integrity of on-site fuel.
9. The generators must connect to a common switchgear, following the intent, approach, and level of detail of the 2019 Electrical Design. The switchgear must be designed to connect to the permanent load bank and the load bank used for annual testing.
10. Provide an EES for the hospital, fed by the Generator Switchgear, following the intent, approach, and level of detail of the 2019 Electrical Design except as noted herein. The scope of the work shall follow the intent of that design from the Generator Switchgear downstream, including transferring loads to proper branches, but shall also extend to electrical equipment provided by projects that were executed after the 2019 design was completed. The Generator Switchgear and transfer switches must be located in a dedicated room, separated from the Main Electrical Room, per NFPA 110-7.2.
11. The contract that will perform the electrical design for the renovation must include a short circuit analysis, selective coordination study, and arc flash analysis for all new work, and must extend downstream to all remaining electrical equipment.

Information and Communications Systems Observations:

- HIPAA data protection: Cyber security practices are lacking risking care disruption and liability concerns. Recommend increased information technology (IT) security measures for protection of patient data in accordance with the Health Insurance Privacy and

Portability Act (HIPPA).

Methodologies for HIPAA compliance vary depending on the confidentiality, integrity, and availability of electronic protected health information. Recommend utilization of two factor authentication such as personal identity verification (PIV) card and user pin for access to HIPAA data. The PIV is required by the Federal Information Processing Standard (FIPS) – 201 and is an industry best practice.

Department of Defense Inspector General form 2018 included military findings on improper HIPAA protection. Recommend using the lessons learned from this report.

Staff training is a major component of HIPAA protection. Logical controls and user training should limit possibilities for patient data to transit by means other than approved devices. For example, USB thumb drives are convenient but present difficulty in maintaining integrity and confidentiality of data.

- Security of IT equipment and spaces: IT switches are located throughout the facility in areas lacking physical security such as offices, conference rooms, and mechanical and electrical spaces. Presence of IT equipment in electrical and mechanical spaces could cause disruption to each service during maintenance and renovations and could shorten lifespans of IT equipment. Numerous switches are wall mounted and do not appear seismically compliant. Recommend that the excess storage rooms be repurposed as proper telecommunication rooms. Excess storage poses a risk for future joint commission findings. Lack of 3’ clearance between front of electrical panels and IT equipment can also lead to a joint commission finding. Modernization of IT equipment such as electronic health records, security cameras (TJC finding) will require additional space.

  Estimated size of telecommunications spaces is approximately 150 sf per 150,000 sf of hospital space. Current spaces are overpopulated. The new server room is an excellent upgrade. However, it was undersized for the number of equipment cabinets. Rear access to cabinets requires rolling it into the aisle which poses significant seismic risk. This can result in a loss of service and/or electrical hazards.

  Recommend access control systems for IT spaces be added for monitoring, logging and authorization rather than physical keys. Access control can utilize the same PIV cards mentioned in the data protection section for access to TRs and clinical wards.

- Network segregation: Recommend physical (preferred) or logical separation of IT functions within the facility. A possible solution would be networks for clinical (HIPPA data), administration (web, email, research), building management (chillers, utility monitoring), and patient/guest wi-fi/TV. DoD and the federal government are tending toward this approach to customize cybersecurity confidentiality, integrity and availability.

- Nurse call, infant protection, and Real Time Location Systems (RTLS): Overall the clinical staff were pleased with the current nurse call system. Staff indicated some rooms were currently inoperable. Recommend checking the installation design with vendor for possible addition of corridor zone lights. These would point staff into the direction of the call without having to check the master station. This can save valuable seconds in critical situations such as code blue.

  Recommend a hospital expansion or major upgrade include a modern infant protection system. These systems sometimes referred to as "Code Pink" can provide value considering the high operation tempo of the current labor and delivery ward. Modern code pink systems track infants with radio frequency identification (RFID) tags. Tags are paired with approved parent and staff tags to detect anomalous movement.

  RFID tags can also be used for RTLS for equipment, patients, and staff for communication and location. These types of systems require integration among different subsystems such as public address and access control. They have been shown to increase business efficiency and quality of care however, they are not required by code.

- Cable support, abatement and design: Removal of unused/abandoned cable is always problematic for older facilities. Health care facilities have greater constraints than most due to infection control risk analysis requirements. A major renovation effort should include removal of all unused cabling as per NFPA 70, 800.25. Furthermore, a major renovation should include installation of proper cable pathways (trays and/or conduit). Proper cable pathway design helps prevent IT cables from penetrating smoke/fire barriers which is a common TJC finding.

  Recommend that future substantial renovations or additions require stamped approval form a Registered Communication System Designer (RCDD). The RCDD professional would verify cabling requirements along with industry best practices. For example, the dedicated TR within the ICU has backbone fiber with unneeded and excessive bends. Proper design could adjust placement to avoid risks associated with strains on the fiber. The new exterior fiber pathway lacked an adequate number of pull boxes. This will make future cable removal or additions difficult due to the number of bends along the path.

- Security cameras: During the visit, staff indicated most security cameras are at end of life. The industry has largely migrated to power over Ethernet (PoE) security cameras. Recommend consultation for major upgrades with a RCDD and/or electronic security systems expert. Balancing tradeoffs between number of cameras, storage, staffing, access control points, and usability is a complex balancing act.

Structural Observations:

- Structural Evaluation: Perform structural evaluation of Buildings A & B since this is a major part of the complex and As-Built drawings are not available. This evaluation is critical to confirm present structural integrity and future expansion options.

- Existing Conditions: The GMH buildings have experienced typhoons, earthquakes, and an aggressive corrosive environment. As part of the facility survey, the exterior and the interior where accessible were inspected.

  Z-wing is the oldest building over 50 years old. Several 1st floor concrete columns have extensive spalling with exposed corroded vertical bars and ties. Some columns had no ties or ties spaced more than 12 inches apart. There are numerous smaller areas of spalling and cracks in columns and beams throughout the structure. There were also numerous areas of spalling in eaves and under roof slab. The concrete guardrail on the 2nd floor had a number of large cracks. The west side guard rail had been replaced with a steel pipe railing, however it has corroded and failed and is now lying on its side. Due to extensive first floor column damage the building is unsafe and may fail in a strong earthquake. It is still being used for storage and has a communications room which needs to be moved. This building should not be routinely occupied.

  A and B wing have the majority of concrete corrosion damage, however, compared to the entire complex the damage appears to be small. There are cracks and spalls in columns and walls. There appears to be delamination at the top of the balcony slabs. There is cracking and spalling in the precast concrete balcony railings. Concrete stair railing adjacent to the A-wing has corroded exposed rebar. Northeast corner of the B-wing, third floor has a large vertical crack and 4th floor has a lot of corrosion. The solarium parapet walls have cracking where water has been seeping through. Overall concrete corrosion damage in A & B wings is minor. There is evidence of seismic damage, 8" CIP walls have been pushed out by as much as 1 inch. Also the floor at the expansion joint at E-wing has settled by ¼ inch compared to B-wing and is sloping toward A-wing. However, seismic damage is still within acceptable limits and will not require repair.

  P-wing on the Northwest corner has standing water. Standing water will infiltrate into the concrete and reach the rebar. The floor should be redesigned to eliminate standing water.

  The exterior stair areas between A and B-wings and courtyards are very dirty. Since the courtyard is not being used this area appears to be neglected. The scum on the wall seems to collect moisture and maybe detrimental to the concrete. Eventually moisture will infiltrate the concrete and reach the rebar which will then start to corrode. This seems to be the same problem with scupper areas, where the scum is allowed to grow. These areas should be power washed to not allow the scum to grow.

Much of the steel railings and equipment supports are extremely corroded. The most extensive corrosion occurs at the base of the post, some posts are not connected to the base. Much of the steel railings would be considered unsafe. Railings should be replaced, possibly with stainless steel.

The roofing in A, B, and E wings (2nd and 4th floor roofs) needs to be replaced immediately, the original roofing which is 40+ years old has never been replaced. The roofing appears to be filled with moisture and drains are corroded or missing. The present roof is flat and has poor drainage. The roofing over the power plant should also be replaced as it was constructed sometime between 1978 and 1989. Except for C-wing, all roofing of the buildings built in 1989 (A-wing addition (D-wing), entry wing, S-wing, G-wing, and M- wing) should be replaced. C-wing roofing was replaced in 2000. Once the existing roofing is removed, existing concrete cracks and spalls must be repaired. Also the new roofing and equipment on equipment on the roof must be designed to resist high wind uplift pressures.

Corrosion through window condensation is currently a problem. Existing windows are of a single pane design. New windows should be IGU, outer pane and inner pane, to relief the condensation problem. To meet IBC 2009 for wind borne debris region glazing needs to be impact resistant.

- Recommendations: In review of the available plans and survey of GMH campus and existing conditions an additional 25 year life span is reasonable provided the following items are completed.

  Structural Evaluation: No available plans for existing Buildings A, B and connecting stairs, however records indicate they were constructed in 1978. Connecting stairs were open and later were enclosed between 1978 and 1989, also no available drawings. Immediate detailed structural evaluation is necessary to make wise future plans. Prior to evaluation, unless “As-Built” drawings can be located, non-destructive and destructive testing will be required to ascertain concrete strengths, reinforcing, foundation sizes, reinforcing steel sizes and spacing. Structural evaluation shall be made to resist gravity, seismic and wind loads in accordance with the International Existing Buildings Code (IEBC). Analysis shall be based on the current condition of the building, current live loading and added modifications. Deficiencies shall be identified with a retrofit plan. Evaluation shall also include the addition of a 5th story and additional two stories at the B-wing, East side. Evaluation shall be performed by a new structural engineer experienced in seismic retrofit design, with an independent technical reviewer. If plans are made to add a 5th story or add two stories at B-wing, structural engineer involved in the evaluation should also be part of the design team.

  Deficient Structural Design: Existing 2014 structural plans have an incorrect importance factor, which results in lower seismic design force 50% less than required. Hospital requires a higher standard than normal buildings, importance factor should be 1.5, not

1.25. Contact the original structural engineer to verify if his or her design is sufficient to resist the 1.5 importance factor.

Family Birthing Center structural drawings were based on a higher allowable soil bearing than the soils report. Please have the design engineer verify with soils engineer and provide changes if required.

Original structural engineer's work shall be reviewed by an independent technical reviewer.

Lack of maintenance in an aggressive corrosive environment will reduce the life span of the building.

Priority Repair: Power wash all interior courtyards and scupper areas on quarterly basis. A survey of concrete cracks and spalls shall be made on all GMH buildings to include but not limited to columns, walls, slabs, parapets, railings and precast fascia. Plans shall be provided for typical repair details, and surveys to take place every 2-3 years. Replace windows with impact resistant glazing according to IBC 2009. Replace roofing at A, B & E-wings (2nd and 4th floor roofs) immediately.

Emergency Repair: Another survey shall be taken of all corroded metal items to include but not limited to decks, railings, ladders, post, bracing, and supports. Corroded metal shall be replaced or repaired if more cost effective. New metal items shall be surveyed every 2-3 years and repaired as necessary. Damaged or leaking expansion joints shall be repaired.

Major Scheduled Repair: Roofing at the P-wing, A-wing addition (D-wing), Entry Wing, S-wing, G-wing and M-wing need to be replaced within 5 years.

Fire Protection Life Safety Observations:

- Fire suppression: There is no automatic sprinkler protection under the canopy over the entrance to the Emergency Department and "A" wing. Recommend extending automatic sprinkler protection to the exterior under the canopy.

  Several pairs of automatic sprinklers have been installed less than six feet from one another. For example, one location where this occurs is room B125 (Pharmacy Storage). Recommend moving automatic sprinkler protection such that the minimum distance between sprinklers is maintained.

  Upright sprinklers are installed more than 22 inches below ceilings in several communications rooms where room ceiling is considered to be obstructed construction for example, see room B236 (Electrical Room). Recommend moving upright sprinklers such that the maximum distance below the ceiling is maintained.

  There are several lengths of piping for automatic sprinkler protection where the unsupported lengths exceed the maximum length permitted by NFPA 13. For example, room 108 (Corridor) and room A125 (Corridor). Recommend adding support to piping for automatic sprinkler protection such that the maximum distance between hangers or other acceptable means of support complies with NFPA13.

The existing flow meter on the piping at the fire pump is inadequate since the new fire pump is rated at 750 Gallons per Minute (GPM). For instance, a new flow meter must be able to account for the minimum requirement to test it to 150% of its volumetric water flow rating. Recommend replacing the existing flow meter with on that has a range of at least 1,500 GPM.

There are extra control valves provided for the automatic sprinkler system that serve no purpose and should be removed. For instance, there is a backflow preventer installed downstream of the new fire pump when there already is one installed at the connection to the water tank. In order to reduce long-term operations and maintenance costs associated with unnecessary equipment and appurtenances, recommend removing such unnecessary equipment.

Portions of piping for automatic sprinkler protection are being used to provide support for non-system components, like acoustical ceilings and runs of cables and wires above the suspended ceilings throughout the hospital. Recommend adding independent means of support where non-system components (as mentioned above) have been erroneously attached to piping for automatic sprinkler protection.

Automatic sprinkler protection has not been provided in Rm P101 (Power Plant). Recommend providing an adequate supply of spare sprinklers with respect to the types and number of sprinklers actually installed.

The fire pump is not protected from the remainder of Rm P101 (Power Plant). This violates Section 4.12 (Equipment Protection) of NFPA 20. Also, Section 4.12.1.1.4 of NFPA 20 states, “rooms containing fire pumps shall be free from storage, equipment, and penetrations not essential to the operation of the fire pump and related components.” Recommend reviewing Section 4.12 of NFPA 20 and providing adequate protection in accordance with Table 4.12.1.1.2 of NFPA 20. It is recommended that automatic sprinkler protection simply be extended to protect Rm P101 and that automatic fire detection (i.e., heat detectors) be decommissioned and removed.

A minimum vertical clearance of 18 inches from automatic sprinklers is not being maintained in a few areas in the hospital, e.g., Rm B125 (Pharmacy Storage). Recommend removing storage materials, to maintain this minimum vertical clearance from automatic sprinklers.

- Life safety and means of egress: The self-closing device has been removed from the door to Rm B152 (Storage). Recommend taking the necessary actions to make this a self-closing door. A door closer is a labeled device that, where applied to a door and frame, causes an open door to close by mechanical force.

There are unsealed penetrations of smoke and fire separations. For example, see Rm B293 (Communications), Rm A110 (Storage Space), and the area above the ceiling in Rm A308 (Corridor) between hazardous rooms. Recommend reviewing all penetrations [through-penetrations and membrane penetrations] of smoke separations and fire separations and seal them with the proper firestopping assemblies. Apply the requirements in Section 8.3.5 of NFPA 101 for penetrations of fire-rated separations and the requirements in Section 8.4.4 of NFPA 101 for penetrations of smoke partitions and Section 8.5.6 of NFPA 101 for penetrations of smoke barriers.

The door at the exterior exit from the back of Rm C112 (Kitchen) could not be opened and thus was not readily available from the egress side during the site survey. Recommend making the necessary repairs to this exit from the kitchen.

Stair No 4, which is an interior exit enclosure, discharges onto a corridor on the ground floor at the level of exit discharge. This violates Section 7.1.3.2 (Exits) and Section 7.7 (Discharge from Exits) of NFPA 101. Recommend reviewing the means of egress, where Stair No 4 discharges onto the ground floor, and developing alternative methods to address and resolve this important egress issue that bring the means of egress into compliance with NFPA 101. At least one option to consider would be to extend the bottom of Stair No 4 with an interior exit passageway to the exterior exit discharge, which would provide a protected pathway for occupants during an emergency.

Fire-rated door assemblies, which have been provided with self-closers, throughout the hospital have been propped open with wedges and other similar obstructions. Recommend maintaining a constant surveillance program and removing such obstructions, plus reinforce this instruction into the existing safety program to educate staff.

Labels on several fire-rated door assemblies throughout the hospital have either been painted over or simply removed. Where labels have been removed (or are no longer legible), the listing of such doors is invalidated. For example, see door in Rm B183 (Corridor), where label has been pried from door and removed. Recommend maintaining a constant surveillance program and remove paint over labels on fire-rated door assemblies. Replace door assemblies where labels have been removed.

While no life safety plans were made available to the survey team, it appears that the ground floor may be considered to have a single-occupancy classification of business in accordance with NFPA 101. In particular, since GMH staff indicated that provisions for smoke compartments were added during the last major rehabilitation project, where health-care occupancies from other floors were temporarily relocated to the ground floor (as swing spaces only), it may be possible to declassify existing smoke compartments and their accompanying components. This would be a cost savings in terms of long-term operations and maintenance.

There is an intervening room issue in Labor and Delivery Department, where exit access from one space passes through two intervening rooms. Consider removing one or more doors such that no more than one intervening room is present.

- Fire Alarm and Fire Protection: The public address system interface with the facility's system for fire alarm and fire detection does not comply with Section 24.4.2.28 of NFPA 72. According to GMH staff, voice messages for emergency communications (e.g., fire alarm and mass notification) are delivered on the newer public address system, which is not interconnected with the existing system for fire alarm and fire detection. Section 23.1.5 of NFPA 72 requires compliance with Chapter 24 where in-building fire emergency voice/alarm communications systems are used. Recommend retaining the services of an emergency communications system designer to review and evaluate the current installation, programming, and interface between the two systems (i.e., one for fire alarm and the other for public address). See Section 24.4.2.27 of NFPA 72.

  All visual notification appliances provided throughout the hospital have been set at 15 candelas (cd) regardless of the area or space being served or covered. This procedure (which must have occurred during installation) appears to have been arbitrarily set. Thus, the current level of coverage for visual notification does not consistently comply with the minimum requirements of NFPA 72, especially Section 18.5.4.3 (Spacing in Rooms) and Section 18.5.4.4 (Spacing in Corridors). Recommend retaining the services of fire protection engineer to review and evaluate the current layout and distribution of visual notification throughout the hospital and then provide a report [to document that evaluation] along with recommendations to comply with NFPA 72.

- Fire extinguishment: The tops of some portable fire extinguishers have been installed over the maximum permitted height of five feet (or 60 inches). For example, see Rm C112 (Kitchen) and Rm A112 (Physical Therapy Corridor). Recommend making the necessary adjustments to ensure tops of PFEs do not exceed five feet.

  The room housing the defunct magnetic resonance imaging (MRI) apparatus ("Old Nuclear Medicine") is being used for storage. Also, there are damaged ceiling tiles and other unsealed penetrations such that an enclosed volume for the clean agent fire extinguishing system is no longer present. Enclosure inspections are required by NFPA 2001 to occur at least once per year. Recommend decommissioning this clean agent fire extinguishing system, which uses the clean agent, HFC-227ea, and is more commonly referred to as FM-200, and remove it from the three rooms currently being protected by this one system. It is also recommended to decommission and remove the other systems using FM-200 currently in use as well. Then, ensure automatic sprinkler protection is maintained in each space where these clean agent fire extinguishing systems have been removed.

Mechanical Observations

- Infection control and HVAC: No outbreaks were reported by the staff. Nosocomial infection rates were reported as stable and as would be expected. There have been local cases (on the island) of Dengue fever within the past year after 75 years of none. The single most significant HVAC observation that would relate to infection control was the lack of appropriate building pressure control. As a result of nearly all outside air systems being taken out of service (discussed later), the building is significantly negative. This negative pressure is demonstrated by the wind tunnel of incoming air through entry doors while they are open. Since the outside air is being forcibly drawn into the building through open doors, and cracks in the building envelope typically around windows or at building expansion joints, this air is not being conditioned or filtered. Effectively the HVAC system is bringing the great outdoors directly into the facility. The end result is high humidity, high temperatures, condensation, and in some areas mold within the building envelope. Finally, the negative building pressure makes maintaining pressure relationships between spaces within the building problematic. The facility has 14 certified Airborne Infection Isolation (AII) rooms and 45 negative pressure capable rooms. All the AII rooms assessed were functioning correctly as evidenced by the pressure monitor in spite of the negative building pressurization.

  The filtration in all of the in-patient systems investigated was not in compliance with current industry guidelines (FGI/ASHRAE STD 170). Only one bank of MERV 8 filters was installed. This bank was located upstream of all coils. ASHRAE STD 170 requires two sets of filters for all inpatient areas; a minimum MERV 7 upstream of all coils, and a minimum MERV 14 downstream of all wetted coils and supply fans. The installed filter meets the requirements of the first filter bank; however, no second filter bank is provided. It is important to note that even the most recently renovated areas (ICU/ED), based on the as-builts, do not have ASHRAE STD 170 compliant filtration.

  At the time of the survey, space temperature and humidity conditions within the patient care areas were mostly compliant with industry criteria (FGI/ASHRAE). In the areas that have not been recently renovated, the staff did mention that during extreme weather the humidity would often get high. This is most likely due to the extreme latent load, during extreme weather, being imposed on the ward space cooling HVAC systems from the unconditioned outside air being drawn in as mentioned above.

  With the exception of the recently renovated areas (ICU/ED), all outside air supply systems were non-functional. In all cases observed, this was a result of extreme corrosion, and the systems were blanked off and taken out of service. Without outside air, odor and contaminant dilution cannot take place and CO_2 levels are not controlled. This violates Joint Commission requirements and the specific ventilation requirements of ASHRAE STD 170. In addition, the lack of sufficient outside air, to balance out the mandatory exhaust from the building, causes the building to be negatively pressurized as mentioned above. Of particular note is the inoperative kitchen makeup air unit. The kitchen area has significant exhaust for cooking operations. Without the makeup air system operating, the space is severely negative and must pull air from surrounding areas. This negative pressure causes excessive door forces at the entrance to the cafeteria, and is a life safety issue.

The majority of HVAC equipment has exceeded its useful life. The condition is FAIR to POOR and in need of significant replacement. Accelerated corrosion due to the tropical marine environment has significantly reduced the useful life. The boilers have been re-tubed several times, one is currently out of service for re-tubing. The air cooled condenser coils for the critical back-up chiller are significantly corroded. All sections of fresh air ductwork observed exhibited significant corrosion to the point that the ductwork is no longer usable. At a minimum, all ductwork handling outside air needs to be evaluated and failed sections repaired. A capital investment plan/program for replacement should be developed for any continued long term operation of the facility.

- Recommendations: The local climate with its high temperatures, extreme humidity, and salt spray presents a high risk of condensation with the resultant microbial growth. It also subjects any exterior equipment and any equipment handling outside air to salt spray and its resultant brutal corrosion. As a result there are recommendations common to all courses of action. Any new construction (or renovation) must fully address critical design elements and features to mitigate the harsh climate and meet infection control requirements. The following is an abbreviated list of critical design features that should be incorporated into either a replacement facility or renovation of the existing facility:

    1. HVAC system must be designed to comply with prudent tropical design criteria. UFC 3-440-05N is an example of such criteria and could be utilized.
    2. The most conservative 99.6% and 0.4% ambient conditions must be used, especially for outside air. Both the 0.4% dehumidification dewpoint/MCDB and 0.4% enthalpy conditions must be considered for conditioning of outside air.
    3. Dedicated outside air systems should be considered to control outside air humidity before it enters the recirculating units. Outside air ductwork and air handling units starting at the air intakes and continuing through the cooling coil sections must be constructed of stainless steel.
    4. Designs must analyze any airstreams (outside and mixed) passing through pre-filters and measures incorporated to avoid filter wetting (and mold).
    5. Cooling coils should be provided with ultraviolet treatment to limit mold growth on the coils and drain pans.
    6. Direct expansion (DX), also known as split systems, should be avoided.
    7. All equipment (HVAC, Med gas, plumbing, etc.), to include both equipment within the facility and within the central plant, must be installed in a conditioned (dew-

point controlled) environment.

8. Building pressurization must be incorporated.
9. Building envelope design must control moisture and outside air infiltration.
10. All mechanical insulation must be carefully installed to ensure that all pipes, components, or equipment, operating below or within 5F degrees of the prevailing dewpoint, are protected from condensation by a continuous vapor barrier.
11. Condensate drainage must be addressed to ensure drain pans readily drain water (i.e. appropriate trap design). Condensate drain pans must be stainless steel.

Due to the age and condition of the mechanical systems in the facility, significant repair/renovation is required. Since nearly all the existing HVAC systems are outdated designs and not compliant with current healthcare facility standards, a total HVAC renovation of most areas within the facility is recommended. Following is a list of recommendations for the existing facility:

1. The non-compliant light gauge galvanized ductwork needs to be removed from the kitchen exhaust and replaced with 16 ga. welded black steel to comply with NFPA 96.
2. The kitchen make-up air system needs to be repaired and placed back in service.
3. All HVAC systems need to be evaluated and renovations/repairs made to provide ASHRAE STD 170 minimum outside ACH rates.
4. All HVAC systems need to be evaluated and renovations/repairs made to provide the minimum filtration levels required by ASHRAE STD 170.
5. The HVAC systems serving the patient wards, with the exception of the newly renovated areas, need to be completely replaced with a ducted return system. This, along with items 4 and 5 above, necessitate a complete HVAC remodel for these areas.
6. The back-up chiller condensing units require replacement. Any long term solution should consider providing robust automated redundancy of the chilled water system.
7. The steam boilers require replacement. Due to the age of the steam system, a complete steam system replacement should be considered.
8. The surgical department needs a complete HVAC renovation to provide the air change rates, filtration levels, and sterile field delivery concept required by ASHRAE STD 170. An analysis of system psychrometrics is required to keep OR humidity within limits without the use of portable dehumidifiers. A supply air dewpoint of 47F is recommended.
9. The central sterile department is in need of a complete HVAC renovation to provide sufficient cooling for the sterilization equipment, appropriate pressure differentials across the spaces, and adequate exhaust of the sterilizer equipment space to comply with ASHRAE STD 170. The renovation should be in conjunction with an architectural renovation to comply with current FGI requirements.

10. The facility management should monitor the status of the new USP 800 and revised USP 797, and affect the necessary modifications as these significantly revised standards become applicable.
11. An additional medical gas master alarm panel needs to be installed. This would typically be installed in the office of the personnel responsible for the maintenance of the medical gas system.
12. An Emergency Oxygen Supply Connection needs to be installed on the exterior of the building.
13. Domestic water systems should be evaluated for potential of legionella. This would include monitoring of disinfectant residual. Based on the configuration of the domestic water supply, secondary disinfectant treatment is likely required. ASHRAE STD 188 is the standard for addressing the risk of legionella in water systems. In addition the CDC has a toolkit on their website.

Cost Estimates for Replacement and Refurbishment:

The following table shows the estimated cost of a like in kind replacement, a rehabilitation of the existing facility and the cost of the immediate minor, major, and life safety items that need to be addressed.

Course of Action	**Estimated Costs ($M)**	**Risk to Clinical Delivery**	**Advantages**	**Disadvantages**
Option A: Construct a new replacement hospital. (Includes minor/major repairs and life safety costs.)	• $743 M	Some minor risk due to repairs to short term sustain the existing facility during construction of the new facility.	A new facility can be sized and shaped to meet the projected healthcare needs of the island. New fully code compliant facility.	New site is to be determined.
Option B: Rehabilitate the existing facility with limited expansion. (Includes the minor/major, and life safety costs)	• $761 M	High risk due to construction on an active care site.	Some planning work has been completed and some work could begin as soon as funding is available.	Very high risk of cost and schedule growth due to unforeseen / unknown conditions.
Minor/major repairs, and Life Safety costs	• $21M	Required for accreditation		

Estimated Cost of Building a New Hospital:

The estimated total cost of construction for a new hospital similar in size to the existing facility (315k SF) is estimated to be $743M based on current clinical operations and inflation cost factors associated with 5-year future construction costs. The estimate has no consideration for potential obstacles that could be present on the to-be-determined location, does not include facilities demolition of the existing hospital, and would be for a more typical "clear" or "green field" construction using a design-bid-build acquisition strategy.

This cost is developed on the basis of a typical DOD Military type cost estimate using the Parametric Area Cost Estimating System Software (PACES) with the following assumptions:

A 5 year future midpoint of construction date.

The to-be-determined site has adequate power, water, and telecommunications infrastructure within a 2 mile radius to support the facility.

No land acquisition costs are considered or included.

A 20% of the estimated construction cost allowance is assumed for new hospital equipment and furnishings.

9.7% allowance for design and construction oversight is included.

A cost of $21M to make the Minor, Major, and life safety repairs to extend the existing hospitals life while the new facility is constructed is included in the estimate.

A 15% overall contingency is added based on the very preliminary information.

Estimated Cost of Completing all Renovations Necessary to Modernize the Hospital:

The estimated renovation cost necessary to restore the hospital is $761M referred to as Option B; the rough order of magnitude calculation is provided in this section. These costs represent the amount to fully rehabilitate the existing facility and extend its useful service life for at least 25 years. The cost estimate is based on the following assumptions and scope:

This assumes that seismic evaluation of the structure is sound and that it will not require seismic retrofit.

Demolition of the Z-wing structure and replacement with a new 14200sf building.

Full rehabilitation of the existing hospital to include full electrical, HVAC, and roofing replacement to meet current codes and standards.

New parking garage over the existing parking lot with a pedestrian bridge.

Replacement of supporting facilities to include: power transformers, water storage and treatment, backup generators, Liquid Oxygen (LOX) systems, fuel storage, paving, and sidewalks.

A 15% allowance for replacement medical equipment and furnishings.

A 9.7% allowance for design and construction management costs

A $15M allowance for transitional/swing space costs during construction.

Cost Discussion of Renovation and Replacement Options:

The estimates developed represent point estimates for costs with fixed contingency values. No Cost and Schedule risk analysis (CSRA) was specifically conducted on the two options and the contingency assigned is 15% based on estimator judgment. A typical rule of thumb in DOD for rehabilitation is 75% of the cost of a new structure (excluding any seismic abnormalities work). In this case the rehabilitation cost new construction cost are nearly equal. This is due to the harsh island conditions causing the significant deterioration of the existing facility that are much worse than are usually seen. The level of effort required to rehabilitate the facility is significantly higher than normal and poses significantly higher risks than normally encountered. The rehabilitation approach empirically has significantly more cost and schedule risk than a new replacement and could grow beyond the contingency assigned.

Construction of a new facility would provide several advantages in that the replacement facility would be optimized to meet the projected needs of the island for health care and could provide some areas for cost savings by designing to separate outpatient and inpatient facilities that have significantly different occupancy/construction code requirements. New construction versus a rehabilitation of the existing structure also poses significantly less risk in cost and schedule growth due to unforeseen conditions that may be encountered. Any adverse results from the proposed seismic study of the existing structure most likely would eliminate rehabilitation of the existing structure as a viable option. Even if the results are favorable there may be deficiencies due to undetected deterioration and or latent construction defects that may not be discovered until rehabilitation starts. These can cause significant cost and schedule growth.

4. Conclusions: The required clinical services to support the present and future health care needs of Guam support the **REPLACEMENT** of the existing facility. Due to the extensive deterioration and questionable seismic strength of the facility, a service life extension/rehabilitation may not be the best option to meet the islands long term needs. Remodeling the existing facility will introduce a higher level of risk to patients and staff with exposure to mold, dust, and other harmful contaminants during construction. Even if the decision is made to construct a new facility, immediate repairs to the existing roof, HVAC, and critical life safety items with an estimated cost of $21M must be undertaken to address the critical infrastructure needs to re-obtain accreditation and continue operations during construction.

Appendix A
Assessment Team

Appendix A:

Army Assessment Team Members, 18-22 November 2019:

Name	Office	Position
Mr. Brian Prediger, P.E., CHFM	USACE, MX	Team Leader
Mr. Donald Schlack	USACE, POH	Onsite District Project Manager
Mr. Scott Neyhart, P.E.,	USACE, MX	Project Director
Mr. Brendan Dingman, P.E.	USACE, MX	Senior Mechanical Engineer
Mr. Charles Buchanan, P.E.	USACE, MX	Senior Electrical Engineer
Mr. Douglas Kohns, R.A.	USACE, MX	Senior Architect
Mr. Bruce Abell, P.E.	USACE, MX	Fire Protection, Life Safety
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Key:

CHFM – Certified Healthcare Facilities Manager
NWW – Walla Walla District
P.E. – Registered Professional Engineer
POH – Honolulu District
POJ – Japan District
R.A. – Registered Architect
USACE – U.S. Army Corps of Engineers

Appendix B
Architectural

Appendix B, Architectural
Guam Memorial Hospital – Facilities Condition Assessment 18-22 November 2019

<u>Architectural Summary:</u>
The Guam Memorial Hospital (GMH) is a licensed 161-bed general acute care hospital, which provides outpatient, urgent care and emergency care services as well as a separate 40-bed long-term care Skilled Nursing Unit (SNU) in Barrigada Heights. GMH's main hospital facility in Oka, Tamuning has an approximate footprint of 312,351 square feet, constructed originally in the mid 1970's and attained full operation in 1978. The facility is a four story concrete framed structure, flat roof with precast, poured concrete and/or stucco framed exterior which has undergone a number of major renovations over the years. The facility is certainly approaching the end of its serviceable life cycle (50 years).

The ground floor is comprised of administration and fiscal departments, dietary services (C-Wing), central sterile supply, pharmacy, BioMedical and Morgue (B-Wing), admissions, medical records (D-Wing), physical therapy, gift shop and special services (A-Wing) and power plant/General Storage. The second floor houses the maternity nursing unit, NICU and obstetrics (C-Wing), surgery, recovery and the main area for critical and intensive care (ICU/CCU) (B-Wing) radiology, urgent care, emergency department (A-Wing), and laboratory (D-Wing). The third floor houses the telemetry nursing unit (B-Wing), medical surgical nursing unit and respiratory care (A-Wing) and the inpatient hemodialysis unit (D-Wing). The fourth floor houses the pediatric unit (B-Wing) and surgical wards and additional business offices (A & D Wings).

GMH provides comprehensive, quality inpatient care and outpatient services for adults and children.
Services include acute adult and pediatric medical care; urgent care and 24-hour emergency services; Surgical services; obstetrics, labor/delivery and nursery; critical and intensive care (neonatal, pediatric and adult); skilled nursing care; laboratory; inpatient pharmacy services; telemetry and progressive care; radiology, angiography, and CT scan diagnostic services; respiratory care; catheterization laboratory; inpatient renal dialysis; cardiac rehabilitation, physical, occupational and recreational therapy, speech pathology; dietetic services; patient education and medical library; social services; and pastoral care services.

Roof, Slope & Drains: Existing roof system has exceeded its useful life. Condition is FAIR to POOR which needs significant replacement. The roof is composed of Styrofoam (tapered insulation), with some sort of top membrane then 1/2 inch thick concrete toping with painted top coat. The slope is very minimal to non-existent in most areas with the exception of the more recent ER and ICU additions. Poor water drainage and ponding is quite evident. Appropriate slope are minimum 1/4 inch per foot to more appropriate 1/2 per foot which is ideal for positive drainage. Roof drains consist of primary on roofs with scupper secondary which drain down the sides of the building. Drain caps are corroded, broken or even missing, top coat does not appear to be flashed or sealed properly with high risk of leaks. Major cracking has occurred throughout this top layer allowing moisture to infiltrate. The roof leaks excessively causing interior damage to ceilings, walls, equipment, etc. Failure of components is inevitable due to age, saturation of moisture and condition which can lead to leaky buildings, mold growth and infection control issues. **The roof requires modernization through replacement.**

Exterior Envelope (Walls, Flashing, and Expansion Joint): Exterior walls are in FAIR condition which needs significant repairs (caulk, flashing, paint). The building envelope is severely compromised with numerous penetrations, open joints, failed caulk/sealant/expansion joint to openings not sealed. Existing first floor has a combination of stucco and studs at admin (area C) and precast at the front entrance as well as areas A (PT/ER) and B (ICU, etc.). Existing (2^{nd}, 3^{rd} & 4^{th} Levels) all have exterior 6 inch precast concrete panel walls which have surface issues such as stains, mold growth and peeling. There is no curb provided at the bottom and cannot validate how this horizontal joint is sealed. This could be an area of concern with water infiltration adjacent to the exterior patios. Stair enclosure walls are poured in place concrete which have significant cracking and settlement. A project is currently underway replacing the glass block windows due to failure of rebar and leaks. The courtyard exterior walls have numerous abandoned air transfer grilles/ducts thru the exterior walls that the moist humid air infiltrates into the building. Along with other fresh air intakes for AHU on the upper floors, pharmacy exhaust, isolation room exhaust, etc. To include ones that have been closed off. All have impacts to the integrity of the exterior envelope. Many locations have been observed where the ceilings were stained, warped or corroded from moisture infiltration or condensation. Air or water infiltration results in larger HVAC loads or the need for additional supply air for pressurization of spaces impacting HVAC equipment longevity, utility failures and maintenance costs. **The exterior envelope requires modernization through repairs or repairs by replacement.**

Exterior Windows: Exterior windows are in POOR condition which needs significant replacement. Windows are generally single pane (fixed glass) in aluminum framed systems (punched and storefront systems) throughout portions of the buildings. Window seals/gaskets are failing, frames do not appear to be thermally broken and weeps at exterior are either not existent or sealed/caulked over. There are significant evidence of water damage/deterioration at the majority of the windows and knee walls which needs to be replaced. Ideally, the best recommended system is true thermally broken window frames with insulated glazing/low e. This would prevent the transfer of temperature thru the system eliminating any condensation. **The exterior windows requires modernization through replacement.**

Medical Equipment: The majority of the medical equipment is outdated, showing signs of significant wear and in FAIR condition. The MRI has quenched, has not been recharged (helium) or used in the last 5 years, which the facility no longer uses. Future planning removes the MRI for repurpose of area. The team encountered 15-20 year old radiology equipment, compressors and other equipment which is approaching there useful life. The facility has replaced some equipment such as the CT units and Mammographic unit since 2014. **The medical equipment requires modernization through replacement.**

Building Interior Spaces: The interior room sizes, layout, departmental flow and adjacencies are obsolete and no longer providing efficiency. From obsolete semi-private and private inpatient wards, OR’s / LDR / NICU rooms to insufficient sterile processing layout; the size of these rooms are small and inadequate for patient care which does not meet current standards. Other issues observed were inefficient patient flow with department adjacencies and travel distances. Which does not meet current code criteria to include the Facilities Guidelines Institute Standards for Hospitals (FGI) and the National Fire Protection Association Standard for Health Care Facilities (NFPA 99), Life Safety Code (NFPA 101) and ADA/ABA accessibility Standards. **The interior spaces requires modernization through design and renovation.**

Building Interior Finishes: The hospital interior finishes throughout (floors, walls, base, doors, door frames, ceilings, corner guards, handrails, crashrails, etc.) are all in GOOD to FAIR condition. However, there are numerous areas with damage to walls and door frames from equipment, water/moisture infiltration and a few areas with floor slab degradation. The facility has an extensive ceiling tile replacement program but the ceiling grids are starting to rust. The finishes are well maintained but old, outdated and showing signs of significant wear, damage and age. **The Interior finishes require modernization through repair by replacement.**

Floor to Floor Height: A standard commercial building may have a floor to floor height of 12 feet, while a hospital is more preferred at 16 feet or greater depending on critical overhead space needs like an OR/Surgical suite, which may increase to 20 feet. The higher floor to floor heights allows sufficient vertical allocation for the necessary duct work, plumbing, cable trays and other utilities needed for healthcare facilities. Some DoD and VA projects may also have a separate and designated interstitial space for the distribution of utilities and terminal equipment. This offers advantages by providing convenient installation, maximizing utility access and maintenance, future building flexibility while minimizing disruptions to patients, staff or medical services. For GMH, the first and second levels are 17 feet floor to floor, falling into the normal range. However, the third and fourth levels (floor to floor height) is only 13’-0”. Much less than industry standard for healthcare occupancies. This significantly limits the above ceiling installation of utilities (duct work, cable tray, sprinkler, water piping, etc.).

Codes References:

- **International Building Code (IBC)**, 2009 Edition
- **Guidelines for Design and Construction of Health Care Facilities**, 2012 Edition
- **NFPA 101 Life Safety Code**, 2012 Edition
- **ADA Standards for Accessible Design**, 2010 Edition
- **NFPA 13 Automatic Sprinkler Systems**, 2010 Edition

Definitions

Emergency Repair: A repair action required immediately due to a hazard impacting life, health, and/or safety. The repair action is assumed to be addressable within current budget, manpower, and local contracting capabilities.
Priority Repair: A repair action required within <1 year due to a high risk of failure associated with capital infrastructure that may eventually impact life, health, or safety.

Major Scheduled Replacement (MSR): A repair action required within 1-5 years normally anticipated with the end of lifecycle and programmed replacement of a capital infrastructure component.

BUILDING EXTERIOR

Roof: The roof is composed of Styrofoam (tapered insulation), with some sort of top membrane then 1/2 inch thick concrete toping with painted top coat installed over a flat structural concrete roof slab. Major cracking has occurred throughout this top layer allowing moisture to infiltrate. Moisture can cause roofing systems to degrade, lose adhesion, develop mold growth, curl and even lead to total system failure. Although the facility has attempted to repair, patch and recoat some of the damaged areas, the roof still leaks causing interior damage to ceilings, walls, equipment, etc. All Roofs should be replaced, to include the original A & B wings and E wing fourth floor. Roofing over the power plant as it was constructed sometime between 1978 and 1989. As well as all roofing of buildings built in 1989 (A-wing addition (D-wing), Entry Wing, S- wing, G-wing and M-wing) should be replaced. C-wing roofing was replaced in 2000 but may also want to be included to modernize the entire facility.




Roof Slope: The slope is very minimal to non-existent in most areas on the existing roof at the facility with the exception of the more recent ER and ICU additions (2014). Poor water drainage and ponding is quite evident with discoloration. Appropriate slopes are a minimum of 1/4 inch per foot to more appropriate and recommended 1/2 per foot which is ideal for positive drainage and potential rainfall for this region.

Roof Drains: Roof drains consist of primary on roofs with scupper secondary which drain down the sides of the building. Drain caps are corroded, broken or even missing, top coat does not appear to be flashed or sealed properly with high risk of leaks.

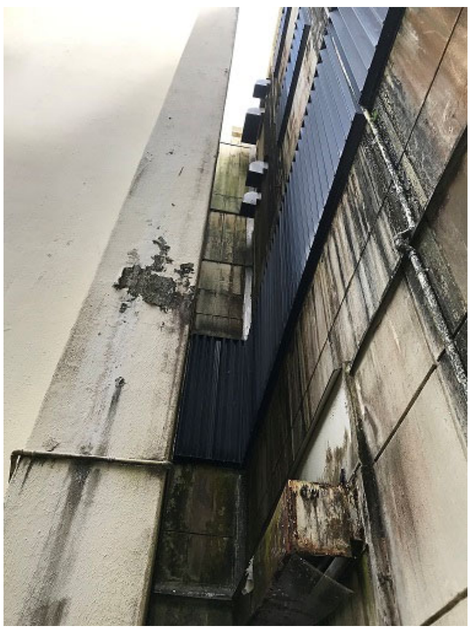
PRIORITY Repair: Recommend removing entire roof system down to structural slab. Dry, repair, caulk, seal, waterproof and skim coat structural slab for flat level surface. The roof system selection is an integral part of the overall building design and must take into account interior building usage and climate. When dealing with existing structures, weight, slope, existing and hazardous materials, and historic preservation may become constraints. For example, the thickness, weight, and reflectivity of the roof system has a major impact on roof/structure as already designed. Further, with an occupied building, construction noises, fumes, fire hazards, and roof access all take on increased importance. Other considerations that must be followed are determination of wind uplift pressures (corners, perimeter, or field), thermal expansion, environmental corrosive conditions, humid location based on ASHRAE climate zone, air and vapor barriers and integration with building envelope.

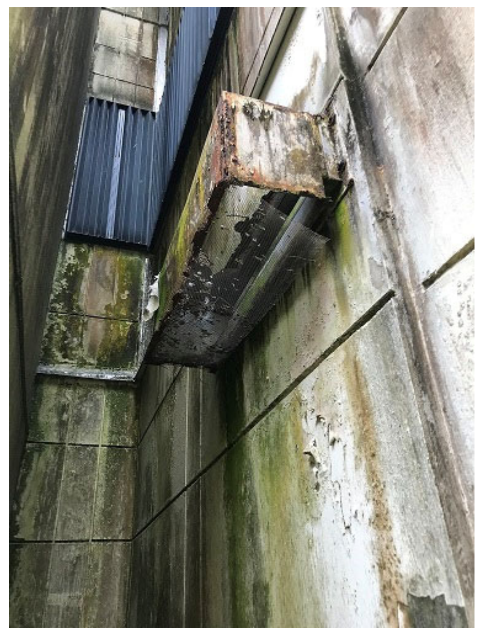
Install a new elastomeric membrane roofing system with new tapered rigid insulation a minimum of 1/2 inch per foot slope. When increasing slopes of existing roof decks, clearances for rooftop structures such as curbs, base flashing, access doorsills, etc. must be increased as well which can impact facility operations and increase cost.

ALTERNATIVE OPTION: In poorly drained low-slope roofs where the use of tapered insulation cannot improve drainage, the entire roof may be a candidate for conversion to a steep-slope system. This type of roof system are often much more expensive than in-kind roofing, but may offer the opportunity to convert to a system that requires less maintenance. Roof overbuild with new structural members, truss system, etc. could be installed to the existing structure establishing a newly created attic space. The existing roof would still be recommended to be removed, sealed, waterproofed and possibly added topping slab to maintain original roof water tightness. The existing roof drainage system to be disconnected. The new attic space shall comply with all code requirements to include sprinkler protection, ventilation or semi-conditioned. Although metal roofing is frequently selected for steep roof conversions other alternative materials shall also be explored which must meet ASHRAE climate zone, seismic and wind uplift requirements for the region. This new attic space can also provide the ideal location for new dedicated AHU's for each respective floor or departments as a mechanical penthouse. Vertical shafts would need to be installed and coordinated to supply the necessary ductwork and utilities, which would eliminate the numerous (90 plus) small above ceiling units throughout the facility. The existing elevator shafts already provide sufficient clearances and pre-planned door opening at the roof level for access. Having a dedicate penthouse would significantly improve efficiency and maintenance. This is certainly a great opportunity and legitimate consideration.

Roof Maintenance and Inspections: Highly recommend a full inspection of all roofs at least once annually and after significant storm events like high winds, typhoon, hail, heavy rain, etc. At a minimum, routinely conduct housekeeping, clear drainage system, secure loose fasteners, replace sealant and note conditions that require further attention. Pay special attention to flashing because most leaks originate at these locations. Make a detailed inspection of locations such as skylights, perimeter walls, roof penetrations, equipment curbs, drains, etc. Inspect the field of the roof for items such as surface wear, lap integrity, degradation, ponding, cracks, etc. Identify signs of weakness, unnecessary or improperly installed items, hazards and repairs needed. Maintenance is a proactive effort on a periodic schedule that is necessary to preserve the condition of the roof system, components and integrity as they were designated for their anticipated service life. With good maintenance, the longevity and service life of a roof can be extended and the life cycle cost of roofing is reduced.

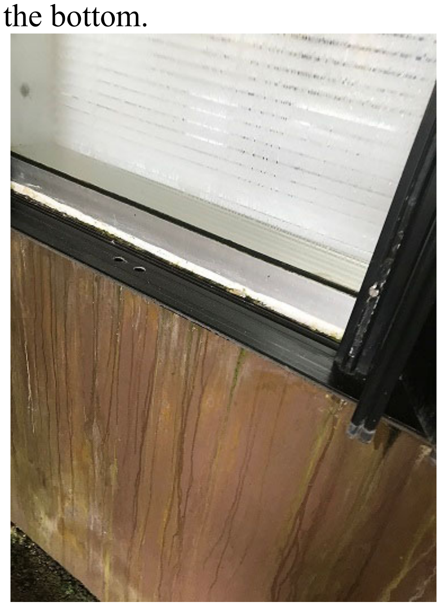
Exterior Wall Openings/Penetrations: The building envelope is severely compromised with numerous penetrations from fresh air intakes, abandoned intakes, exhaust (ISO), expansion joint to possible flashing failures. The corrosive environment has eroded not only the shroud/covering, the joint seal at the building opening and duct on almost every intake, but has also impacted the failure of the interior duct leg inside the building (5 to 20 ft). As a result, a number of the intakes exterior shroud/covering have been removed and then covered. The courtyard exterior walls have numerous abandoned air transfer grilles/ducts thru the exterior walls that the moist humid air infiltrates into the building. Along with other fresh air intakes for AHU on the upper floors, pharmacy exhaust, isolation room exhaust, etc. All have penetration impacts to the integrity of the exterior envelope. These openings allow hot humid/moist outdoor air to enter the plenum area or building. With the exterior wall not adequately sealed at these locations the AHU or occupied space cool air mixes with the hot humid air which generates moisture, condensation and mold growth above the ceiling, on the ceiling, within walls and throughout the building. **PRIORITY Repair: Recommend sealing all penetrations, replace fresh air intakes with more appropriate material for environment along with joint/seal, etc. See Mechanical for additional information.**





Exterior Windows: Exterior windows are generally in FAIR condition, constructed with single pane (fixed glass) aluminum framed systems either storefront or punched styles throughout the facility. All windows have a steel framed horizontal sliding metal (typhoon) accordion type shutter system at the exterior. Numerous window sills have rot/decay/deterioration/water damage which appear to be leaking and should be replaced. Others have failed seals or gaskets. Windows that fail or are improperly sealed can cause heat and humidity to seep in, resulting in a rise of interior temperature, which will cause air conditioners to work twice as hard to keep the environment cool. This also creates moisture issues that can lead to the growth of dangerous substances such as mold.

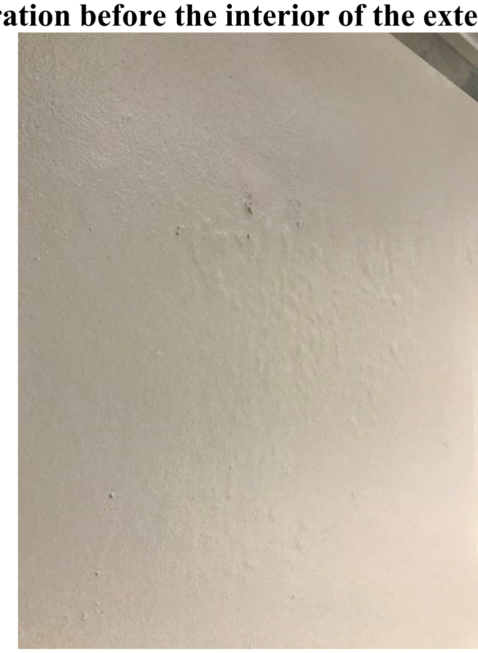
Exterior Windows (Flashing/Weeps/Caulk): Window sill flashing not provided and weeps at exterior are either not existent or sealed with caulk. Most architectural aluminum glazing system are not designed to be totally waterproof. Rather, most systems are designed to control water infiltration under extreme conditions and weep that water back to the exterior. Punched windows, storefront and curtainwall systems differ in many ways: appearance, profiles, wind loads, glazing, thermal performance and how they weep water. **Punched window** can be operable or fixed which are located in a hole-like or predefined opening within the exterior wall. The most important consideration to understand is whether the window system is a rain screen or barrier system. A rain screen system provides internal drainage (weeps) for water that infiltrates into the system while a barrier system assumes that no water will ever infiltrate and does not need internal drainage. Fixed windows of course off the best resistance to air infiltration or water penetration and require less maintenance. **Storefront systems** control water infiltration by directing all moisture to the sill pan. It is imperative that the sill pan be installed correctly. Most manufacturers have prefabricated or can provide custom sill pan components with integrated end dams. Without end dams, water will intrude into the jamb locations of the building. Window perimeters should have flashing (head and Jamb) that are integrated with the waterproofing at adjacent walls. Water deflectors must also be installed wherever a horizontal mullion occurs. These direct water over to the vertical mullion where it weeps out at the sill flashing. Deflectors are necessary to ensure that the water bypasses the glass lite. Without water deflectors, moisture is likely to settle on the top of the glass, allowing water to enter the interior and causing possible failure of the glass unit. **Curtainwall systems**, we want to prevent water from reaching the vertical mullions. Each horizontal mullion must have zone dams properly installed and sealed at the vertical members. Any water that makes its way to the vertical mullion will ultimately make its way to the interior of the building. Unlike storefront, which directs water to the sill, curtainwall weeps water at each individual lite of glass through holes in the pressure plate. Because curtainwall systems are used for taller elevations with higher wind loads, the amount of water entering the system is typically greater than the capacity of storefront systems. This is why each lite of glass is individually weeped. Since water is not diverted down the vertical mullions to the sill, curtainwall does not require sill flashing. However, extreme care must be taken into consideration when installing caulk joints at the sill. The exterior caulk joint must be behind the face cover since water is weeping out of the bottom.

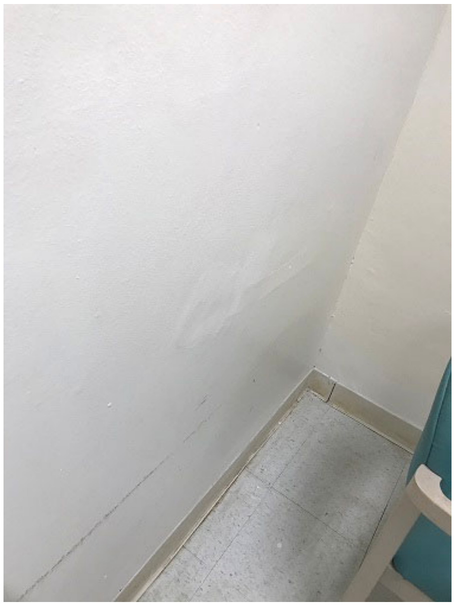


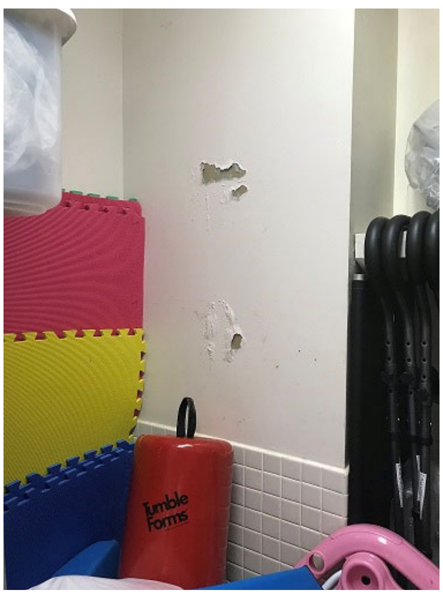
PRIORITY Repair: Recommend removing all of the existing windows across the entire facility and install newer high efficient non-operable (Fixed) Windows. High quality (marine grade, Kynar finish or stainless steel) aluminum framed windows are common, material is lightweight, strong, energy efficient and require little maintenance. Ensure that

the window framing system has a thermal break (i.e. nylon I beam) which prevents the frames from conducting heat/cold and eliminates condensation. Insulating laminated glazing units enhances acoustical performance, ultraviolet light protection and the laminated component is designed to remain integral in the opening should glass damage occur at the exterior layer. UV resistant and provide added protection for impact resistant glass for severe weather or blast protection. The glazing should have a low coefficient rating, multi-paned and low emissive glass (low-e coating) with glass panes bonded with a polyvinyl-butyral (PVB) interlayer.

Exterior Wall (Interior Drywall Damage): There is significant evidence of moisture, water damage and mold at the majority of the exterior walls near window locations which needs to be repaired and/or replaced. The drywall has bubbles or delaminating, paint peeling, drywall fastener pops possibly due ot rust, corner bead cracking, holes and mold. This appears to have been caused by a number of different factors: (1) possible water infiltration from the exterior windows, (2) water leaks from roof or exterior wall penetrations and/or (3) building negative pressure drawing the moisture into the building as discuss above in previous line items.
PRIORITY Repair: Recommend first and foremost that the exterior windows throughout the facility be replaced with better quality, energy efficient systems with properly installed flashing. As well as the AHU and building pressurization correction (positive). Once that is done, remove damage areas/sections or entire interior wall would be warranted based on severity of damage. The exterior envelope must be sealed with the correction of water infiltration before the interior of the exterior walls can be repaired/replaced.



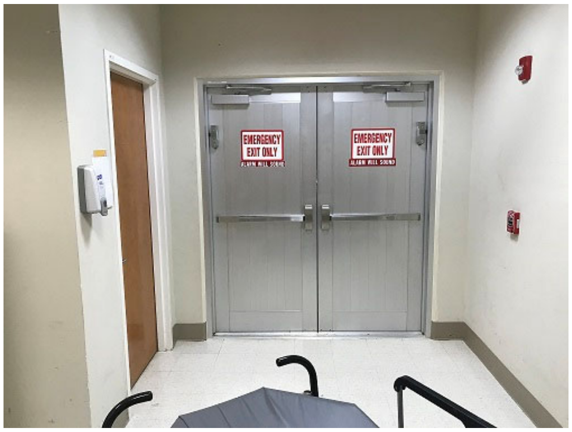




Exterior Wall Finish/Cleaning/Painting: The majority of the buildings has a significant amount of mold growth, peeling paint and discoloration on the exterior surface. The exterior wall itself appears to be in GOOD condition. Guam is located in a tropical extreme humid location. Although some of the mold may be located on the surface, other areas appear to be more significant. Mold feeds on organic materials, such as wood, paper, many fabrics, and even some types of glue. It literally eats away at these materials, causing them to rot and fall apart. Outside mold does not always stay outside. It will eventually find its way thru the envelope and into the building. Outside mold does carry health risks, but the risks are not as great as with inside mold. Although the concentration of mold will be less outside in the open air than it would be indoors. However, that doesn't mean exterior mold cannot lead to health problems. If someone does spend time outdoors in areas with significant amounts of mold, one's health can be at risk. Children are particularly susceptible to mold-related health problems.

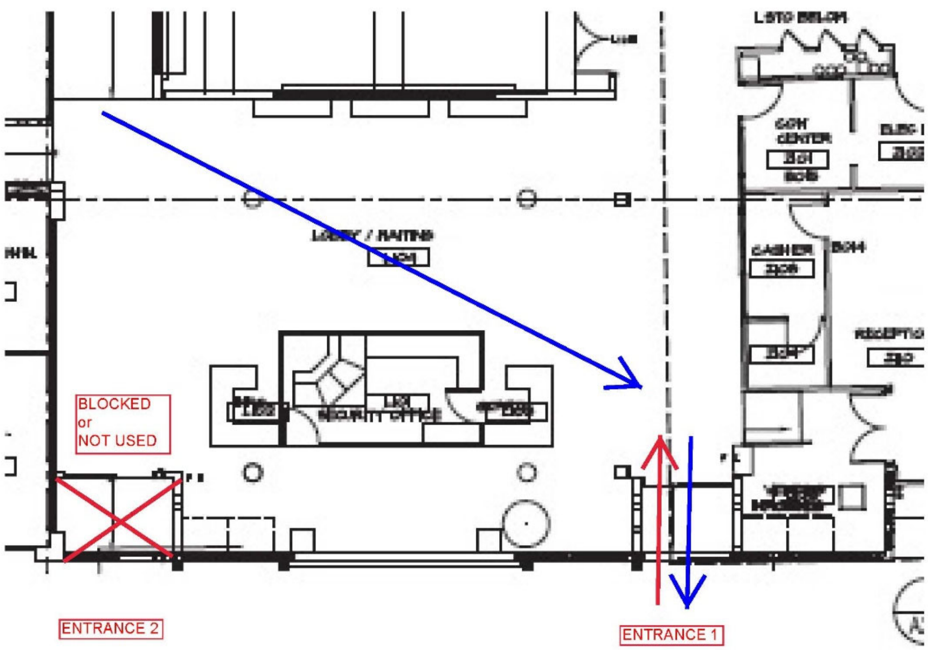
This mold may be caused from the moist humid conditions/environment, low quality paint, from an inferior, damaged or missing vapor barrier or simply the exterior materials used. Another influence, could be negative pressure rooms located at/near the exterior wall drawing the moisture into the building. Buildings in general should be positively pressured. The GMH facility is actually under negative pressure. **MAJOR SCHEDULED REPLACEMENT (MSR) Repair: Recommend that the entire exterior of the facility be sprayed with chemicals to kill the mold, power washed, then sealed, caulked and painted with a high quality mold resistant paint. Implement a mold prevention/ maintenance plan to clean the exterior regularly.**

Exterior Doors: Exterior doors have a mixture of either aluminum or hollow metal. Majority of the original building doors are in GOOD condition. Typical door frames are hollow metal. The only issue identified are failed seals probably due to exposure and corrosive environment. A couple of the overhead doors at the central utility plant also needs to be replaced due to condition and damage. **PRIORIT Repair: Recommend replace all man door seals, recondition hardware to either full replacement of overhead coiling CUP doors to reconditioned (oil/lubricate) to replace latches, wheels, bearing and coil springs.**



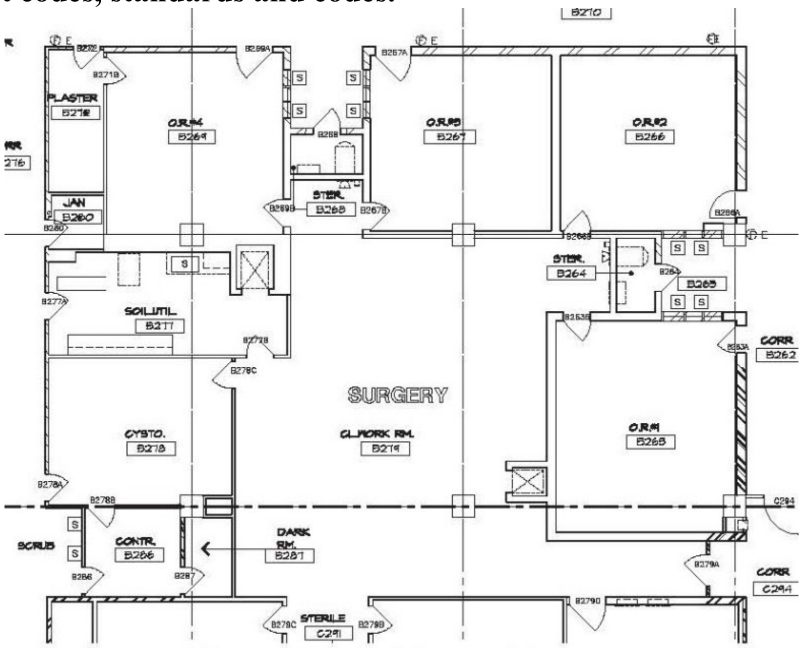
Front Entrance/Vestibules: The hospital front entrance vestibules has both an exterior and interior single sliding door configuration with possible break away feature. However, the door separation depth is only about 6 feet. Both sliding doors open simultaneously when someone approaches at either side (ingress or egress) allowing the hot, humid, moist outdoor air to gust/enter into the building. The arrangement, operation and separation does not function properly as both sets of doors are open simultaneously the majority of the time (duration of the day) due to the traffic conditions. The mechanical air curtain installed does not provide any assistance. The main contributor is that the second set of entrance doors, opposite side of the front entrance, are not in operation. This also significantly increases the egress capacity/occupant load at this single vestibule.

Vestibules are typically required for all medical facilities located at primary entrances. The depth of the vestibules shall comply with ABA requirements and should be sufficient depth to allow the outside doors to close before the inside doors are opened when someone passes through. ABA specifies the distance between two hinged or pivoted doors in series shall be 48 inches minimum plus the width of the door swinging into the space or about 10 feet. ASHRAE 90.1 also requires a minimum distance of 7'-0" between closed interior and exterior vestibule doors. These minimum separation distance requirements are typically NOT sufficient. The automatic closing speeds of these doors can have a significant impact on door function, timing/sequence and passage. The distance separating the doors combined with a large number of personnel passing through, especially at shift change, can results in both sets of doors staying open continually. Vestibules are provided to reduce infiltration losses (or gains) from wind and stack effects by creating an air lock entry. This has been a recurring problem with most facilities. **PRIORITY Repair: Recommend (1) a building traffic study be completed to include "rush hour" entry and exit volumes to properly configure and size vestibules such that the automated doors are not continuously open. (2) both vestibules will need to be modernized to a greater depth (10 feet +/-) and install new doors, sensors for more ideal operation or sequence and possibly offset of doors/ opening (diagonal) in lieu of aligning. Alternative option for consideration would be a large revolving door with an emergency man door located at both entrances. EMERGENCY Repair: Recommend that the current closed, second vestibule be fixed and placed back in operation so one is dedicated to ingress traffic and the other egress. This would split the usage between two entrances, in lieu of one, reducing the wear and tear and air infiltration until they can be redesigned, reconfigured and updated.**

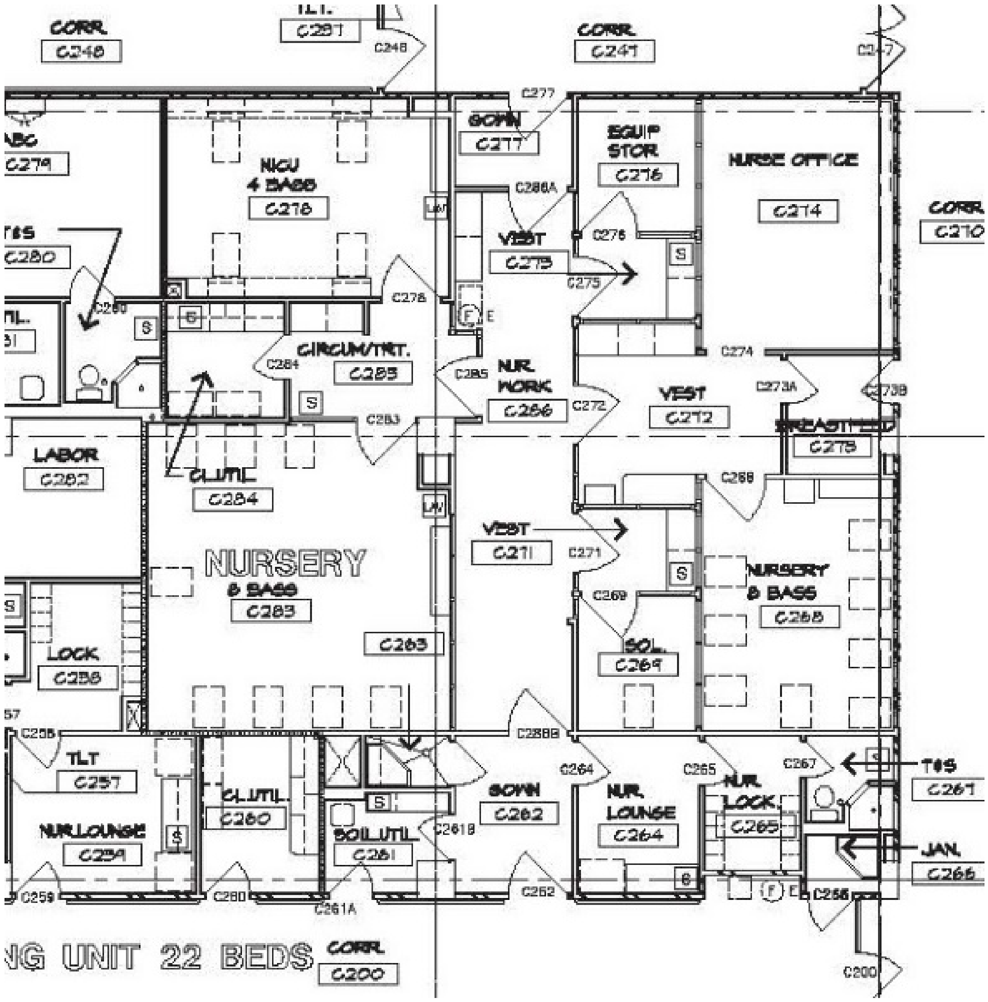


OR Layout: Although the current or existing OR room are functional, they are not compliant with today's newer standards for size, layout, clearance, equipment or flow as the design is outdated and does not comply with current codes or FGI guidelines. **MAJOR SCHEDULED REPLACEMENT (MSR) Repair: Recommend redesign of entire surgical**

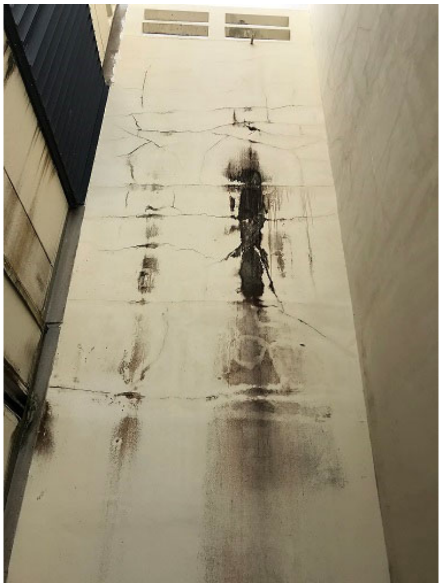
suite/department for better flow, adjacencies, space allocation and upgraded OR's to current codes, standards and codes.

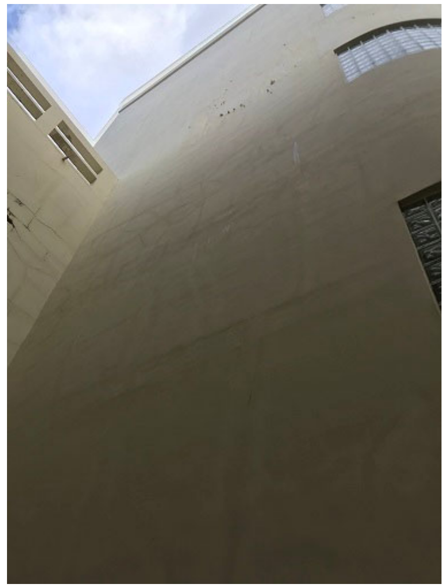


NICU Layout: Although the current or existing NICU rooms are functional, they are not compliant with today's newer standards for size, layout, clearances, equipment, light levels (controls) or flow as the design is outdated and does not comply with current codes or FGI guidelines. **MAJOR SCHEDULED REPLACEMENT (MSR) Repair: Recommend redesign of entire NICU suite/department for better flow, adjacencies, space allocation and upgraded nursery to current codes, standards and codes.**

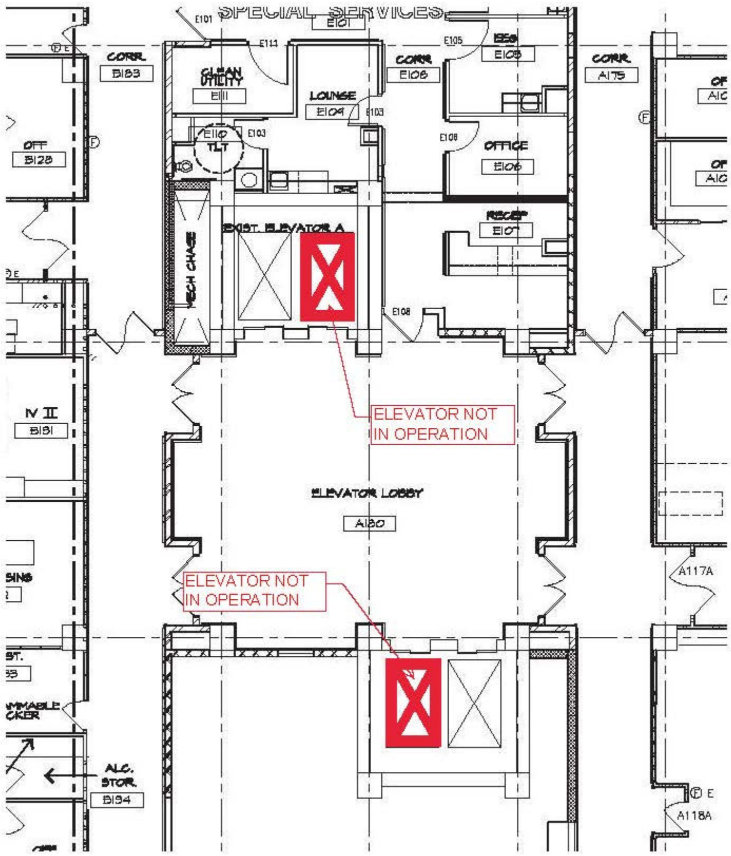


Exterior Stair Walls: Center stair enclosures (#2 & #3) at both north and south ends of building have infill poured in place concrete walls which have significant cracking issues and settlement. A project is currently underway replacing the glass block windows due to failure of rebar and leaks. **PRIORITY Repair: Recommend that a full in-depth structural analysis be conducted on the walls and foundation supporting these stairs. The wall cracks may be injected with epoxy to bond and seal the cracks within the exterior wall. The foundation may need to be expanded/enlarged, reinforced and or even replaced. The foundations could be jacked up/lifted then added concrete could be added for stability and support meeting current seismic requirements.**





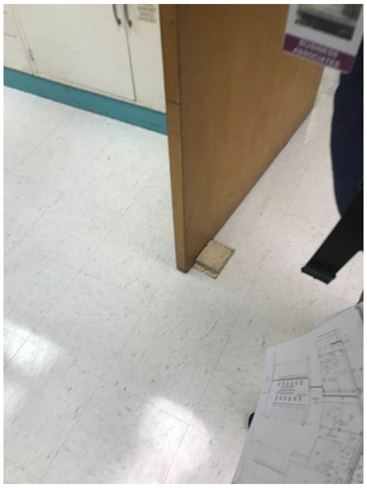
Elevators: Two of the four elevators for the facility were down, not working and under significant repair. Another was down for a short time for maintenance related repairs. The facility did have ISLM in place for the elevators. There is a current awarded project to modernize and replace the existing elevators (motors, gears, ropes, controls, etc.) and update the car/cabs to current standards. (LS03.01.50, NFPA, IBC, etc.) **PRIORITY Repair: Recommend getting this project started as soon as possible to get all elevators up in operation. Elevators are essential for moving patients to/from upper floors and critical departments. Keep all ILSM's in place throughout the construction phase.**

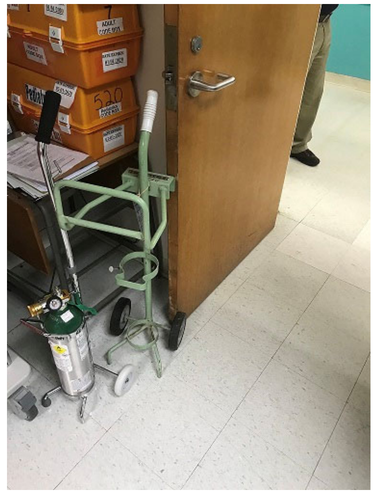


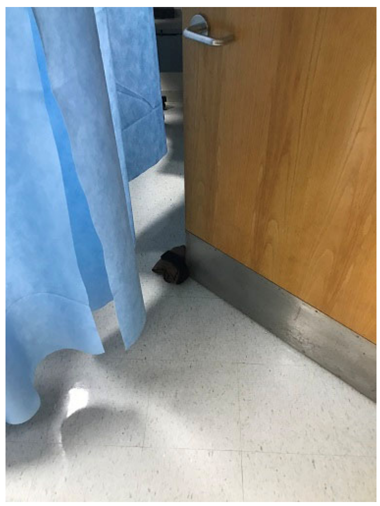
ENVIRONMENT OF CARE/LIFE SAFETY DEFICIENCIES:

PT Corridor doors propped Open: Three rooms located on the first floor (A-Wing) Physical Therapy (PT) had the corridor doors propped open with a floor door wedge or by equipment. Occupational Therapy A116, Clean Utility A115 and Treatment A113. Corridor doors are required to latch LS.02.01.30 EP 11, 12, 14 and LS.02.01.20 EP 11, EP 32, EP33 , EP34.

EMERGENCY Repair: Recommend removing any door wedges or items that hold the door open that is not code compliant. Only use approved/ authorized methods for holding doors open like magnetic hold devices or other types of approved hardware door hold open devices.

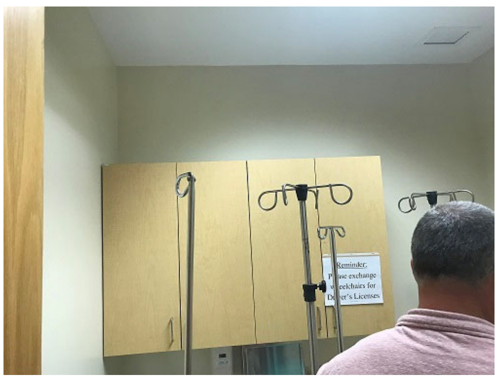






PT Storage Room/ Janitors Closet (A110) Wall Penetration: The wall mounted AC unit located on the north wall of Exercise A111 has a condensate drain line that routes through the wall and down to the floor sink. Walls are required to limit the transfer of smoke. **PRIORITY Repair: Recommend to seal penetration (both sides) with caulk to prevent the transfer of smoke.**

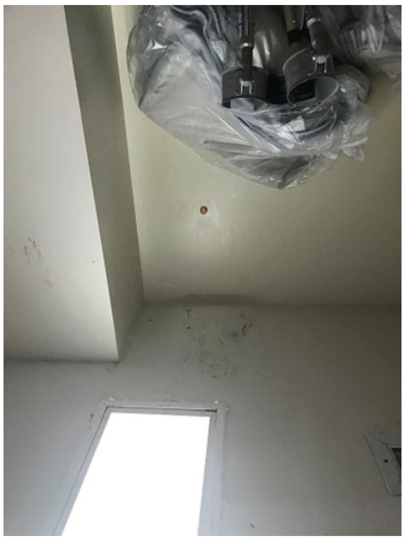
Wall Cabinet Tops/Closures: Numerous locations around the facility within healthcare occupancy had wall cabinets without any sloped tops or vertical enclosures to ceiling. Healthcare occupancies require for not only cleaning purposes due to access/reach and infection control with dust, debris accumulation but also to restrict or prevent stacking, that some sort of closure at wall cabinets be provided. (Example locations include: PT Treatment A113, Central Sterile Supply B151, Decontamination B158, ICU/CCU Treatment Rooms, ED Soiled Utility A281, CT, Mammo, Ultra Sound and others. **PRIORITY Repair: Recommend to install appropriate sloped tops at all wall cabinet locations or plastic laminate enclosures to/thru ceilings. This could not only lead to an OSHA violation, in stacking items on top of shelves above a certain height. Reaching to remove items from the tops of shelving can cause strains or other injuries that can lead to employee absence or worker's compensation claims. A safety hazard. It is common practice to provide enclosures at the top of wall cabinets, lockers and other shelving.**

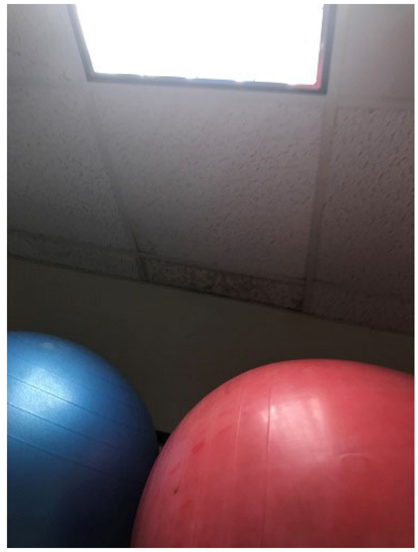


Fire Extinguisher Height (PT Corridor A112): Handle of fire extinguisher is higher than 60 inches. Portable fire extinguishers shall be selected, installed, inspected and maintained in accordance with NFPA 10, Standards for Portable Fire Extinguishers. TJC Environment of Care (EC.02.03.05 EP10, EP15 and EP16) fire extinguishers to be installed 4 to 40 inches AFF (top of cabinet or handle). NFPA 10, Section **6.1.3.8.1** Fire extinguishers having a gross weight not exceeding 40 lb (18.14 kg) shall be installed so that the top of the fire extinguisher is not more than 5 ft (1.53 m) above the floor. **PRIORITY Repair**: **Recommend removing bracket and reinstalling FE at appropriate height**

Rated Door Labels Painted: PT Clean Utility A115 along with multiple other rooms throughout the facility with rated doors had the labels painted over. Labels on fire door assemblies shall be maintained in legible condition, NFPA 101 Section 8.3.3.2.3 and LS02.01.10 EP5 & EP7. On the other hand, some doors that had labels may not necessarily need them based on room type and function of space. **PRIORITY Repair: Recommend to remove paint off frame labels. Have a third party Statement of Conditions (SOC) consultant inspect, assess, evaluate and provide appropriate documentation to include SOC/Life Safety drawings. In this survey, have the consultant inspect each floor, smoke compartment, rated walls in conjunction with rated doors (labels, gaps, hardware, etc.) incompliance with codes. Any door NOT needing the rating/label can be decommissioned (The label can either be removed on both the door and frame).**

Ceiling Damage: There is numerous areas around the facility that have significant ceiling damage not only to gypsum board ceiling but also lay-in acoustical ceiling tiles. The facility does have an extensive ceiling tile replacement program but there are a few areas with serious issues. (Location such as the following: PT Exercise A111, Women's Toilet A101, Pharmacy Lounge B138, Lab Area, corridors on ground floor adjacent to courtyards and others). **MAJOR SCHEDULED REPLACEMENT (MSR) Repair: Recommend the removal and replacement of all lay-in acoustical ceiling tiles and grid systems. Repair and/or replace gypsum board ceilings. Work to be performed after all of the exterior envelope issues, water intrusion, windows and HVAC deficiencies have been corrected.**





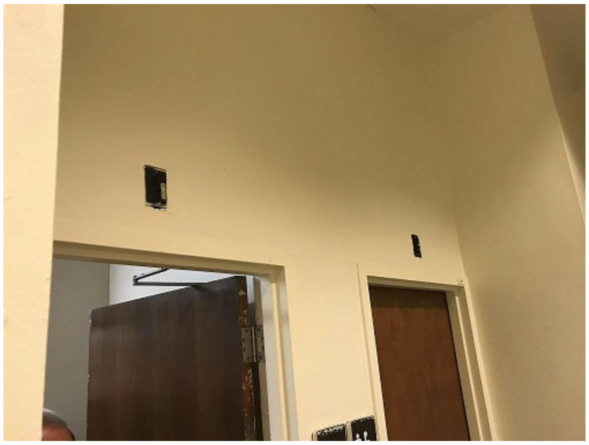
Door Access Control: There are numerous areas/rooms around the facility that utilizes "push to exit" buttons to release the magnetic locks for egress. Locations such as Doctor Corridor A117, Pharmacy Storage B125 & B127, CT 1, CT 2, Ultrasound A271, as well as others. Locking arrangement, delayed egress and access control shall comply with LS.02.01.20 EP1, NFPA 101 Sections 7.2, Chapter 18.2/19.2. Code Violation: **PRIORITY Repair: Recommend an in depth code study/assessment by a third party consultant in order to validate appropriate use and code compliance. Electronically controlled egress doors and security at OB Clinic needs to be coordinated per NFPA 101 Section 7.2.1.5.6 and 7.2.1.6.2. Manual release device shall be clearly identified by a sign that reads "PUSH TO EXIT" or per Section 7.2.1.9.1.3. A readily visible sign with letters not less than 1 in high on a contrasting background that reads "IN EMERGENCY PUSH TO OPEN".**

(1) Also, there is a clear cover on the device and someone would have to flip up to open in order to press the button, this is not considered readily available or accessible.

NPFA 101 Chapter 18 New Healthcare Section 10.2.2.4: Doors within a required means of egress shall not be equipped with a latch or lock that requires the use of a tool or key from the egress side, unless otherwise permitted by one of the following:

(1) Locks complying with 18.2.2.2.5 shall be permitted.
(2)*Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.
(3)*Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.
(4) Elevator lobby exit access door locking in accordance with 7.2.1.6.3 shall be permitted.

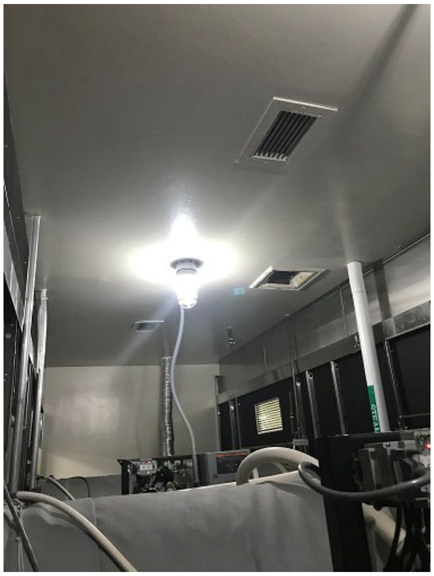
Corridor Wall Penetration: Open wall boxes located in corridor above toilet room doors (men and female). Corridor walls are to limit the passage of smoke per NFPA 101. When devices or other utilities are demolished they should be removed back to source and finished appropriately. **PRIORITY Repair: Recommend removal of wall boxes, wiring back to source and patch/paint walls.**



Fire Extinguisher Obstructed (Central Sterile Supply B151). Fire extinguisher obstructed with electrical cords to humidifier or other equipment. **EMERGENCY Repair: Recommend relocate equipment to prohibit blocking of FE.**

Light Fixture missing Lens (Central Sterile Supply B151). 2x4 light fixture in Central Supply does not have protective lens which has fluorescent bulbs exposed. Safety Risk. **PRIORITY Repair: Recommend installation of new light fixture lens for safety and Infection Control.**

Cart Wash Ventilation: Cart washer's produce excessive amounts of heat while in operation as well as discharges steam when doors are opened. The cart washers are typically enclosed with walls creating a mechanical space for maintenance and repair. This mechanical space is required to have supply/make-up air as well as exhaust. The existing grilles and system does not appear to be adequate. The facility has installed portable fans and even a alternative cooling system to alleviate the heat in this room. **MAJOR SCHEDULED REPLACEMENT (MSR) Repair: Recommend that the AHU supply and exhaust system serving this space needs to examined for compliance with code required air changes and ventilation (discharge) rates. New design and system requirement is probably necessary. See Mechanical for additional information.**



Pharmacy Storage Closet (B13) Wire at Sprinkler: There is an abandoned wire (COMM cable??) out of the plenum above and down through the gypsum board ceiling at this specific sprinkler head. Not sure what the wire is actually for and could obstruct sprinkler.
EMERGENCY Repair: Recommend removing wire back to source.

Pharmacy Storage Closet (B122) Sprinkler Obstruction: Supplies are stacked on top shelf of closes potentially blocking sprinkler. At least 18 inches of clearance is required to be maintained below sprinkler deflector to the top of storage. Perimeter wall shelving not located directly under a sprinkler head is permitted. Measurement is within the plane of the room – not a conical distribution from each head. (LS.03.01.35 EP 6 & NFPA 13 Section 8.5.5.3 & 8.6.5.2.1.1).
EMERGENCY Repair: Recommend the removal of staked boxes so the 18 inch clearances are met.

Pharmacy Storage (B125) Sprinkler Clearance (18" Rule): At least 18 inches of clearance is required to be maintained below sprinkler deflector to the top of storage. Perimeter wall shelving not located directly under a sprinkler head is permitted. Measurement is within the plane of the room – not a conical distribution from each head. (LS.03.01.35 EP 6 & NFPA 13 Section 8.5.5.3 & 8.6.5.2.1.1). EMERGENCY Repair: **Recommend Removing/reorganizing storage items on top shelf to comply with the 18 inch clearance requirement.**

Pharmacy Sprinkler Escutcheon Plate: Lay-in ceiling sprinkler escutcheon falling down which could potentially block or prevent sprinkler activation. NFPA 25 Section 5.2.1. **EMERGENCY Repair: Recommend fixing or installing sprinkler head escutcheon flush with ceiling.**

CUP Roof Guardrail (Safety/OSHA). The stairs, stair guard/handrail and roof guardrail system at the power plant has significant signs of corrosion, deterioration and failure. Not only has the exposed fasteners failed, the guardrail vertical supports and horizontal railings are corroded through, broken and weak. There is no way this guardrail system could protect personnel or even support the required horizontal pressure by code. This area should be barricaded for limited/controlled access. Alternative measures such as ILSM as well as potential tie off points may need to be incorporated. This stair and railing system needs immediate attention, removal and replacement. **OSHA violation. EMERGENCY Repair: Recommend removing entire stair/railings and roof guardrail systems and replace with NEW, stainless steel or marine grade aluminum materials due to the corrosive environment. Fasteners, bolts, washers, etc. should also be stainless steel (316 or 316L).**

ED Equipment Alcove Wall Damage (F201): Walls have excessive damage due to carts, equipment and/or beds. Drywall no longer has protective qualities or painted surface which now exposes the inner core. Blood or other fluids along with dust and mold can now be easily absorbed into these damaged areas creating a high risk and infection control risk. (EC.02.06.01 EP20) **MAJOR SCHEDULED REPLACEMENT (MSR) Repair: Recommend to Patch and paint damaged walls. Then install wall protection treatment such as acrovyn/FRP panels for durability, impact resistance and easy cleaning.**

ED Door Frame Damage (F202): Door frame has excessive wear due to carts, equipment and/or cleaning agents used. Frame no longer has protective qualities with painted surface which now exposes the bare metal. (EC.02.06.01 EP20) **MAJOR SCHEDULED REPLACEMENT (MSR) Repair: Recommend painting frames. Additional added protection would be to add door frame protection acrovyn/FRP/stainless steel products for durability, impact resistance and easy cleaning.**

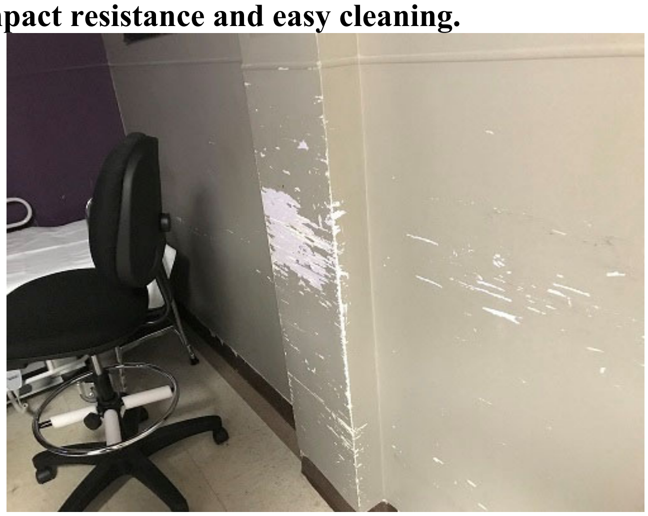
ED Door Label Painted (F202): Door frame has the labels painted over. Labels on fire door assemblies shall be maintained in legible condition, NFPA 101 Section 8.3.3.2.3 and LS02.01.10 EP5 & EP7. On the other hand, some doors that had labels may not necessarily need them based on room type and function of space. **PRIORITY Repair: Recommend removing paint off frame labels for code and TJC compliance.**

ED Patient Toilet Nurse Call (A213). Nurse call in patient toilet room does not have a dedicated nurse call light located outside the room at the corridor. Typically, NC lights are provided directly outside the room for quick visual identification. When the NC pull chord is activated it actually illuminates the corridor NC light at the end of the corridor at the decontamination room. **PRIORITY Repair: Recommend installing a NC light on the wall directly above this patient room door similar to all of the other rooms in this area.**

ED Electrical Room (A212). Electrical or COMM panel has a lot of wiring which some appears to be abandoned or not used. Some of the wires actually are routed thru this panel preventing the door to be securely closed. **MAJOR SCHEDULED REPLACEMENT (MSR) Repair: Recommend removing any unnecessary or abandoned wires back to source, clean and organize wiring so the panel can close and secure properly.**

ED Electrical Room (A212). Electrical panel door interference with adjacent panel. Adjacent panel appears to be installed on a locker. Door cannot properly close, be secured/locked or comply with NEC clearance requirements. Code Violation. **PRIORITY Repair: Recommend that the locker be removed with the relocation, rearrangement of electrical panel with more ideal location providing the proper NEC clearances.**

Ultra-Sound Wall Damage (A271). Walls have excessive damage due to carts, equipment and/or beds. Drywall no longer has protective qualities or painted surface which now exposes the inner core. Blood or other fluids along with dust and mold can now be easily absorbed into these damaged areas creating a high risk and infection control risk. (EC.02.06.01 EP20) **MAJOR SCHEDULED REPLACMENT (MSR) Repair: Recommend patch and paint of damaged walls. Then install wall protection treatment such as acrovyn/FRP panels for durability, impact resistance and easy cleaning.**

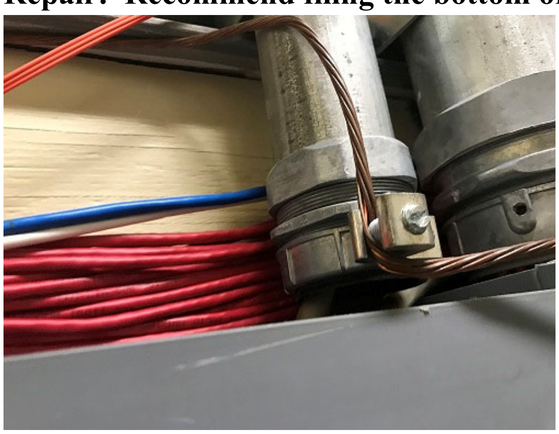


Radiology Storage Sprinkler Clearance (A246): At least 18 inches of clearance is required to be maintained below sprinkler deflector to the top of storage. Perimeter wall shelving not located directly under a sprinkler head is permitted. Measurement is within the plane of the room – not a conical distribution from each head. (LS.03.01.35 EP 6 & NFPA 13 Section 8.5.5.3 & 8.6.5.2.1.1). **EMERGENCY Repair: Recommend removing/reorganizing storage items on top shelf to comply with the 18 inch clearance requirement.**

ICU/CCU Staff Corridor Zone Valve Box Labeling: Med gas shutoff zone valve box labeling does not match between cover and interior per EC.02.05.09 EP5. **PRIORITY Repair: Recommend removing non matching labels and update labels to match on the cover and interior of the zone box per code requirements.**

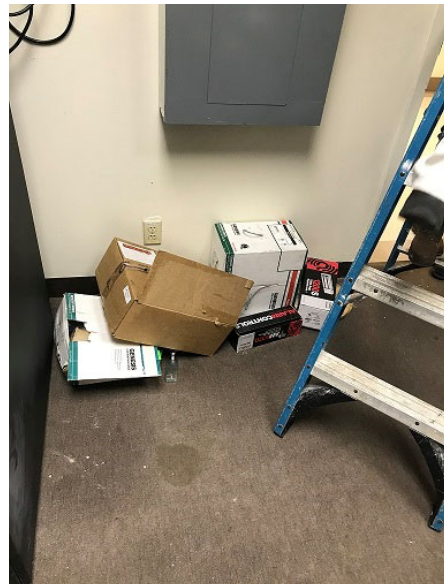
ICU/CCU Isolation Patient Ante Room 7 (B208) Sliding Door Latching: Sliding corridor door latching hardware broke and does not function. Corridor doors are to be fitted with positive latching hardware, are arranged to restrict the movement of smoke. NFPA 101 18/19.3.6.3.5, 18/19.3.6.3.1 and 7.2.1.4.1. **Priority Repair: Recommend installing new correct latch on door by contacting door manufacturer for replacement latch (parts).**

ICU/CCU COMM Room (B293) Conduit: Conduit on the far left actually routes up and then horizontally through the corridor wall, but not sure where it goes. The perimeter walls for this room are 1 hour rated, protection. This conduit needs to be sealed at the bottom. **PRIORITY Repair: Recommend filing the bottom of pipe with Hilti or equal rated caulk.**



Recovery Hazardous Storage B238: Bins located in storage room appears to exceed allowable capacities. Soiled Linen and trash receptacles larger than 32 gallons (including recycling containers) are located in a room protected as a hazardous area per LS.03.01.70 and NFPA 101 18/19.7.5.7. **PRIORITY Repair: Recommend validation each container capacity, total capacity for room and that the room has the required protection (rated walls) per code.**

Storage in Electrical Room (A309): Main electrical room third floor D-Wing has items such as filers, floor fan, boxes, spools of wire and other items being stored. **PRIORITY Repair: Recommend removing all items not associated with the Electrical room. Storage in Electrical rooms is prohibited per NFPA 101, CMS and The Joint Commission (TJC). Electrical and/or Communications/TR rooms should never be used for storage or have equipment and misc. items stored.**



Med Surg Soiled Utility (A367) Storage Bins: Bins located in storage room appears to exceed allowable capacities. Soiled Linen and trash receptacles larger than 32 gallons (including recycling containers) are located in a room protected as a hazardous area per LS.03.01.70 and

NFPA 101 18/19.7.5.7. **PRIORITY Repair: Recommend validation of each container capacity, total capacity for room and that the room has the required protection (rated walls) per code.**

<u>AMERICAN WITH DISABILITIES ACT (ADA) STANDARDS FOR ACCESSBLE DESIGN</u>

The ADA document contains scoping and technical requirements for *accessibility* to *sites*, *facilities*, *buildings*, and *elements* by individuals with disabilities. The requirements are to be applied during the design, construction, *addition* to, *and alteration of sites, facilities*, *buildings*, and *elements* to the extent required by regulations issues by Federal agencies under the American with Disabilities Act of 1990 (ADA).

Single Occupancy Toilet Rooms: There are a number of existing single occupancy toilet rooms throughout the facility that do not comply with ADA standards Section 213, that ALL toilet rooms provided, each shall comply with 603. The only exception applicable would be item 4. Where multiple single user toilet rooms are clustered at a single location, no more than 50 percent of the single user toilet rooms for each use at each cluster shall be required to comply with 603. **MAJOR SCHEDULED REPLACEMENT (MSR) Repair: Recommend modernization due to the age of the facility the existing conditions are more than likely grandfathered in. However, if any alterations or renovations are provided to the facility, they will be required to comply with current codes.**

ABA Clearances: The majority of the private/ public toilet rooms and rooms throughout the facility do not appear to comply with ADA clearances. **(1) Turning Space (Section 304):** 60 inch diameter turning space or "T" shaped space. **(2) Clear Floor or Ground Space (Section 305**): 30 inch by 48 inch minimum. **(3) Door Clearances (Section 404):** 18 inch latch side clearance front approach, pull side doors. As well as multiple other configurations established for hinge approach (push/pull sides), latch approach (push/pull sides), etc. **(4) Fixture**

Clearances (Chapter 6): Clearance around a water closet 60 inch minimum measured perpendicular from the side wall and 56 inches minimum measured perpendicular from the rear wall. Lavatory and urinal clearance of 30 inch by 48 inch. **MAJOR SCHEDULED REPLACEMENT (MSR) Repair: Recommend modernization due to the age of the facility the existing conditions are more than likely grandfathered in. The majority of the rooms throughout the facility are too small to accommodate ADA clearances as well as other space requirements (bariatric, etc.). However, if any alterations or renovations are provided to the facility, they will be required to comply with current codes.**

INTERIOR CONSTRUCTION & FINISHES

Floors: VCT, sheet vinyl and some tile are generally used throughout the facility. Condition is GOOD to FAIR condition but appear to be old, brittle and wearing excessively. Some areas have concrete slab divots projecting through the material. Rubber base in some areas delaminating off walls or missing. Harsh chemicals from disinfecting and housekeeping over time has severely impacted these finishes. **MAJOR SCHEDULED REPLACEMENT (MSR) Repair: Recommend complete removal of flooring and base throughout facility with the installation of new healthcare quality products due to age. Grind high spots in concrete slab and/or use self-leveling floor compound to patch existing concrete slab prior to installation of new finishes. Ensure that the correct materials are used with respect to flexibility, durability, cleanability and maintainability with correct finish for the room's purpose. Floors should be replaces every 10 to 15 years.**

Painted Surfaces: Interior surfaces are in GOOD to FAIR condition. Some areas of walls and other painted surfaces are warn limiting the protective properties. As they are damaged, scuffed, peeling or have mold growth. There are a number of other areas throughout the facility that have been patched which are not finished. Drywall mud has not been sanded, walls primed and not painted. Selection of interior construction and finishes must consider the need for aseptic environments. Use smooth, nonporous, seamless materials to minimize contamination and reduce housekeeping requirements. Smooth, seamless wall and floor coverings facilitate cleaning. Cabinetry should be designed and installed without gaps behind or underneath base units. At a minimum, these areas shall be designed for ease of housekeeping, with elimination of materials or surfaces that could harbor contamination and to minimize maintenance. Painted surfaces should be durable, cleanable and maintained on a continuous basis to include annual maintenance plans. **MAJOR SCHEDULED REPLACMENT (MSR) Repair: Recommend chemically cleaning and paint of all walls, doors and gypsum board ceilings throughout the facility. Areas where mold is found, perform in depth investigation as to extent, causes and treatment. Remove and replace drywall as necessary and finish. Facility should have a campus wide interior painting plan with a 2 to 5 year life expectancy as well as one for repairs.**

Interior Doors: Interior doors are typically laminated with hollow metal frames. The majority of the doors and frames are in GOOD condition. None appeared to need replacing. **MAJOR SCHEDULED REPLACMENT (MSR) Repair: Recommend replacing doors as needed**

that are damaged, chipped, delaminating, stained and/or failing. Currently the majority of the doors appear to be in good shape.

Appendix C

Electrical

Appendix C, Electrical

Guam Memorial Hospital – Facilities Condition Assessment 18-22 November 2019

I. Introduction

The USACE MX electrical engineer visited the site during the week of November 18 – 22, 2019 to assess the condition of the existing electrical systems. As is to be expected, the electrical system has been altered in many ways since the initial occupancy of the hospital in 1978. Several portions of the power system have been upgraded in recent years by renovation projects, but much of the main distribution system for the hospital remains much as it was on day 1. Several factors affect the adequacy, reliability, safety, and efficiency of the systems, including age of equipment and wiring, the aggressive climate of Guam, destructive events such as typhoons and earthquakes, code changes over the last 40+ years, and lack of space.

The overall focus of the USACE report will be to explore and compare a significant renovation to the hospital versus construction of a new hospital at a different site. Electrically, the renovation alternative will consist of proposed repairs and upgrades to provide the existing hospital with an electrical system that is code-compliant, reliable, and maintainable for a 25-year lifecycle. The new hospital alternative is largely a programming and cost exercise, accompanied by proposed repairs/upgrades to address the most critical electrical problems for a shorter lifecycle until the new hospital is open – 7 to 10 years.

For each of the headings below, Observations describe one or more conditions that need improvement or replacement, and Recommendations are provided for each of the two possible hospital replacement scenarios – New Construction and Significant Renovation in Place. Several recommendations refer to "2019 Electrical Design," which was a 2019 design project titled "GUAM MEMORIAL HOSPITAL – REMOVAL AND REPLACEMENT OF MAIN ELECTRICAL SWITCHBOARD." This design produced drawings and specifications that depicted the replacement of much of the hospital's electrical distribution system. It addressed much more than the main electrical switchboard 'MS,' as the title of the project would suggest. An abbreviated list of major items addressed by the 2019 design is shown below:

1) Replace pad-mounted switch with GPA-owned pad-mounted switchgear
2) Replace 2500 kVA pad-mounted transformer with two 2000 kVA pad-mounted transformers
3) Replace main switchboard 'MS' with a double-ended switchboard
4) Replace one of the three generators with a new, larger unit.
5) Replace all old motor control centers
6) Demolish manual transfer switches, kirk-key interlocks, and breakers that are the present means for transferring load from one generator to another
7) Provide paralleling switchgear to connect all generators to the Essential Electrical System (EES)
8) Provide new LS, CR, EQ, NE boards
9) Provide new automatic transfer switches for Life Safety, Critical,

Equipment, and Non-Essential loads, including two chillers

10) Provide new 600 kW load bank and connection for larger load bank

II. Primary Power Arrangement

A. Observations

1. There are two 13.8kV primary circuits (P401 and P403) entering a single pad-mounted switch. One is an overhead line, and the other is an underground line, and the two are fed from separate switching stations.

2. The pad-mounted switch feeds a single pad-mounted transformer that is the sole normal power source for the entire facility. The single switch and single transformer each represents a single point of failure that could render the hospital without utility power for an extended period.

B. Recommendations – Repairs/Upgrades to Existing Facility for New Construction Option

1. Provide a second pad-mounted switch or replace the existing switch, so that a second transformer may be served.

2. Provide a second pad-mounted transformer and a concrete-encased service ductbank to one end of the new switchboard described in the following section. The existing service feeder will need to be terminated at the other end of the new switchboard; conduit must be reused where possible, and new conductors must be provided.

C. Recommendations – Significant Renovation of Existing Facility

1. Provide the GPA-owned and operated pad-mounted switchgear, two new pad-mounted service transformers, and two concrete-encased service ductbanks – one from each transformer to one end of the new switchboard described in the following section, following the intent, approach, and level of detail of the 2019 Electrical Design.

III. Main Distribution Equipment in Poor Condition and Inadequate for Hospital

A. Observations

1. Split-Bussed Switchgear Arrangement Inadequate for Hospital – Because there is presently only one service transformer, the existing main switchboard ‘MS’ has only a single service feeder that terminates at the center of the board and splits into two buses that serve five main breakers between them. No redundancy exists in this type of switchboard.

2. Age - The fundamental components of the electrical distribution system are far beyond their reasonable lifespan. The Main Switchboard ‘MS’ and much of the other electrical equipment in the Power Plant area are over 40 years old.

3. Effect of Climate – The harsh tropical climate, combined with much leaking over the years, have taken a great toll on the components of all of the normal and emergency electrical equipment in many areas of the hospital.

4. Code Violations - In the Power Plant area in numerous locations, old electrical equipment no longer in use is still utilized for routing feeders to new equipment. Electrical equipment such as breakers, panelboards, and disconnect switches have been "bolted on" to existing equipment because of lack of space in the equipment or lack of free wall space. Many of these installations violate electrical code, and they could be overloading the equipment to which they are connected.

B. Recommendations – Repairs/Upgrades to Existing Facility for New Construction Option

1. Provide a new Main Electrical Room, following the intent, approach, and level of detail of the 2019 Electrical Design except as noted herein regarding separate rooms for generators and for the Emergency Power Supply System (EPSS).

2. Provide a double-ended service switchboard, with full drawout construction, following the intent, approach, and level of detail of the 2019 Electrical Design.

3. The new switchboard must supply normal power to all of the facility's equipment requiring electrical power, including the transfer equipment for the EES, the fire pump controller, the Non-Essential Electrical System, and all existing and new normal power distribution equipment. The design shall follow the intent, approach, and level of detail of the 2019 Electrical Design.

C. Recommendations – Significant Renovation of Existing Facility

1. Provide a new Main Electrical Room, following the intent, approach, and level of detail of the 2019 Electrical Design except as noted herein regarding separate rooms for generators and for the EPSS.

2. Provide a double-ended service switchboard, with full drawout construction, following the intent, approach, and level of detail of the 2019 Electrical Design.

3. The new switchboard must supply normal power to all of the facility's equipment requiring electrical power, including the transfer equipment for the EES, the fire pump controller, the Non-Essential Electrical System, and all existing and new normal power distribution equipment. The design shall follow the intent, approach, and level of detail of the 2019 Electrical Design.

IV. Emergency Power System in Poor Condition and Not a Code-Compliant Essential Electrical System (EES)

A. Observations

In most places, the system does not have an Essential Electrical System (EES) with Life Safety, Critical, and Equipment branches, as required by NFPA 72 and 99. The original electrical system was comprised of only a Normal system (with no generator backup) and an Emergency system (with generator backup). The present system is a combination of several generations of modifications, each of which attempted to make the hospital's emergency systems more compliant with code. These efforts have not resulted in a code-compliant system. Rather, the system is an overly complicated, non-code-compliant system with inconsistent segregation of loads.

1. Age - The fundamental components of the Emergency Power System are beyond their reasonable lifespan. The Generator Switchboard 'ES' is over 40 years old. The diesel generators 'EG-1,' 'EG-2,' and 'EG-3' are not as old as the main distribution equipment, but as generators go, they are very old (1992, 2005, and 1996, respectively) – especially for a tropical environment.

2. System Not Arranged in Automated Redundant Configuration - There are presently three generators and three automatic transfer switches (ATSs #1, #2, and #4R) that feed mixed combinations of Life Safety, Critical, Equipment, and Non-Essential loads. There was a fourth ATS (ATS #3) for Life Safety, but it was taken out of commission by a typhoon, and its life safety loads were moved to the ATS #1, which also serves most of the Critical Branch loads. Generally, one generator is associated with one of the three ATS's, but a process has been implemented by the electrical maintenance staff to provide some level of redundancy. The process involves kirk-key backup procedures for electrical maintenance staff to execute during an outage when one of the three generators fails, but it is non-automatic, cumbersome, and somewhat complicated to perform during a crisis.

3. No Bypass/Isolation for ATS's - None of the ATS's have bypass/isolation capability, which would allow their load to still be fed if the ATS failed or needed maintenance.

4. Code Violations - The Emergency equipment is not installed in a dedicated space. Rather, it is located in the Power Plant room with the normal power switchboard and the central mechanical equipment and is immediately adjacent to a 20,000-gallon water tank.

5. Identification and Naming Inconsistent / Incorrect – Some areas have only Normal and Emergency, while other areas have Life Safety, Critical, and Equipment branch panelboards. These panelboards, installed at different periods over 40-plus years, have very inconsistent naming conventions. Some even have color coding that is misleading as to their purpose, such as Normal system panels being painted red. This has resulted in many circuits fed by panels on the wrong system - Emergency panelboards serving Normal loads, Equipment Branch panelboards serving Critical loads, etc.

B. <u>Recommendations – Repairs/Upgrades to Existing Facility for New Construction Option</u>

1. Replace the older of the two 1.6 MW generators in kind. Provide repairs and/or upgrades to the two remaining generators as needed to give the hospital a satisfactory emergency power supply to support the EES for the 7-10 years or more before occupancy of the new hospital.

2. The generators must connect to a common switchgear, following the intent, approach, and level of detail of the 2019 Electrical Design. The switchgear must be designed to connect to a permanent load bank and a load bank used for annual testing.

3. Provide an EES for the hospital, fed by the Generator Switchgear, following the intent, approach, and level of detail of the 2019 Electrical Design except as noted herein. The scope of the work shall follow the intent of that design from the Generator Switchgear downstream, including transferring loads to proper branches, but shall also extend to electrical equipment provided by projects that were executed after the 2019 design was completed. The Generator Switchgear and transfer switches must be located in a dedicated room, separated from the Main Electrical Room, per NFPA 110-7.2.

C. Recommendations – Significant Renovation of Existing Facility

1. Replace the existing generator plant with two or more new diesel generators that will operate in parallel upon loss of utility power. The generators must be in a dedicated room per NFPA 110-7.2.

2. The generators must be of equal capacity and rating, and each generator must be sized to serve the combined loads of the Life Safety and Critical Branches, medical air compressor(s), medical-surgical vacuum pumps, fire pump(s), generator fuel pumps, and other generator set accessories plus 20 percent.

3. Provide a separate day tank for each generator, sized for a minimum of 4 hours runtime at full load. The fuel system must be redesigned as necessary to automatically supply fuel to the day tanks from the fuel storage tanks.

4. Provide a set of duplex transfer pumps for each main storage tank. Each fuel transfer pump must be sized to accommodate all generator sets. Provide fuel filtration system per recommendations of the generator set manufacturer, to meet NFPA 110 and maintain the integrity of on-site fuel.

5. The generators must connect to a common switchgear, following the intent, approach, and level of detail of the 2019 Electrical Design. The switchgear must be designed to connect to the permanent load bank and the load bank used for annual testing.

6. Provide an EES for the hospital, fed by the Generator Switchgear, following the intent, approach, and level of detail of the 2019 Electrical Design except as noted herein. The scope of the work shall follow the intent of that design from the Generator

Switchgear downstream, including transferring loads to proper branches, but shall also extend to electrical equipment provided by projects that were executed after the 2019 design was completed. The Generator Switchgear and transfer switches must be located in a dedicated room, separated from the Main Electrical Room, per NFPA 110-7.2.

V. Power System Not Selectively Coordinated

A. Observations

Selective coordination has apparently not ever been considered. Selective coordination is a vital component of the design and operation of a code-compliant hospital electrical system. This requires the system to be modeled and a short circuit analysis to be performed by the designer. The circuit breakers of the system must be selected to coordinate with each other in all load conditions, so that the most downstream breaker will open on a fault. The requirement for selective coordination also requires that adjustable-trip breakers be specified for the new distribution equipment.

B. Recommendations – Repairs/Upgrades to Existing Facility for New Construction Option

1. The contract that will perform the electrical design for the repairs/upgrades should include a short circuit analysis, selective coordination study, and arc flash analysis for all new work, and must extend downstream as far as the knowledge of installed conditions allows, to include at least the projects completed after the 2012 As-Built documents were generated.

C. Recommendations – Significant Renovation of Existing Facility

1. The contract that will perform the electrical design for the renovation must include a short circuit analysis, selective coordination study, and arc flash analysis for all new work, and must extend downstream to all remaining electrical equipment.

Appendix D
Communications/IT

Appendix D, Communications/IT
Guam Memorial Hospital – Facilities Condition Assessment 18-22 November 2019

HIPAA Data Protection

Cyber security practices are lacking risking care disruption and/or liability concerns. Recommend increased Information Technology (IT) security measures for protection of patient data in accordance with the Health Insurance Privacy and Portability Act (HIPAA). More information can be found at: https://www.hhs.gov/hipaa/for-professionals/security/laws-regulations/index.html

Methodologies for HIPAA compliance vary depending on the confidentiality, integrity, and availability of electronic protected health information. Recommend utilization of two factor authentication such as Personal Identify Verification (PIV) card and user pin for access to HIPAA data. The PIV is required by the Federal Information Processing Standard (FIPS) - 201 and is industry best practice. The PIV is also required for access control for all federal facilities.

Department of Defense Inspector General report from 2018 included military findings on improper HIPAA protection. Recommend utilizing the lessons learned from their report. More information can be found at: https://www.healthcareitnews.com/news/dod-ig-finds-massive-security-flaws-army-navy-ehr-and-handling-patient-data.

Staff training is a major component of HIPAA protection. Logical controls and user training should limit possibilities for patient data to transit means other than approved devices. For example, USB thumb drives are convenient but present difficulty to maintain integrity and confidentiality of data.

Security of IT Equipment & Spaces

IT switches are located throughout the facility lacking physical security to include offices, conference rooms, electrical and mechanical spaces. Presence of IT equipment in electrical and mechanical spaces will cause disruption to each service during maintenance, renovations and shorten lifespans. Numerous switches are wall mounted which do not appear seismically compliant. Recommend utilization of excess storage rooms repurposed as proper telecommunication rooms. Excess storage poses risk for future joint commission findings. Lack of 3' clearance between front of electrical panels and IT equipment can also result in a joint commission finding. Modernization of IT equipment such as electronic health records, security cameras (TJC finding) will require additional space.

Estimate location and quantity of telecommunication rooms (TRs) is approximately 150 square foot per 15,000 square foot of the facility. Current spaces are also overpopulated. The new server room is an excellent upgrade. However, it was undersized for the number of equipment cabinets. Rear access to cabinets requires rolling it into the aisle. This poses significant seismic risk which can result in loss of service and/or electrical hazards.

Recommend access control systems be for IT spaces be added for monitoring, logging and authorization rather than physical keys. Access control can utilized the same PIV cards mentioned in the data protection section for access to TRs and clinical wards.

Network Segregation

Recommend physical (preferred) or logical separation of IT functions within the facility among. A possible solution include networks for: clinical (HIPAA data), administrative (web, email, research), building management (chillers, utility monitoring) and patient Wi-Fi/TV. DoD and the federal government are trending towards this approach to customize cybersecurity confidentiality, integrity and availability. This could enable future integration into federal partners such as the Cybersecurity and Infrastructure Security Agency (CISA) and/or Medical Community of Interest (MEDCOI) utilized by DoD and the Veterans Administration (VA). Cyber security practices are lacking inducing possibility of care disruption. Recent cyber-attacks resulted in disruption of care at hospitals in the UK and also Baltimore city government (twice).

Electronic Health Records

Staff noted the current electronic health record (EHR) system is end of life and in need of replacement. Recommend coordination with the Department of Interior if an enterprise solution is viable for U.S. Territories. Furthermore, recommend looking at how DoD and VA are collaborating at their enterprise solution for enterprise EHR. Consideration should be given for the business case towards selecting DoD and VA's EHR vendor. This could enable greater flexibility for the island's healthcare treatment portfolio.

Most EHR systems are migrating to cloud based housed in datacenters across the world rather than on-site. This lowers storage costs and enables greater functionality on diagnosis. Recommend utilizing lessons learns from DoD and VA by utilizing a hybrid cloud approach. This entails downloading records of expected patients prior to their arrival. This lessons the requirements of high availability and local storage costs.

Nurse Call, Infant Protection & RTLS

Overall clinical staff were pleased with the current Nurse Call system. Staff indicated some rooms were currently inoperable. Recommend checking the installation design with vendor for possible addition of corridor zone lights. These would point staff into the direction of the call without checking the master station at the nurse station. This can save valuable seconds in critical situations such as code blue.

Recommend a hospital expansion or major upgrades include a modern infant protection system. These systems sometimes referred to as "Code Pink" can provide value considering the high operation tempo of the current labor and delivery ward. Modern Code Pink systems track infants with a radio frequency identification (RFID) tags. Tags are paired with approved parent and staff tags to detect anomalous movement.

RFID tags can also for real time location systems (RTLS) for equipment, patients, and staff for communication and location. These types of systems require integration among different subsystems such as public address and access control. They've shown to increase business efficiency and quality of care however, they are not required by code. Recommend business case solution for or against inclusion of RFID utilization during a major renovation project.

Cable Support, Abatement & Design

Removal of unused/abandoned cable is always problematic for older facilities. Health care facilities have greater constraints than most due to ICRA requirements for open ceiling tiles. A major renovation effort should include removal of all unused cabling as per NFPA 70, 800.25. Furthermore, a major renovation should include installation of proper cable pathways (trays and/or conduit). Random inspections identified cabling laying on drop ceiling tiles in violation of NFPA 70, 800.24. Proper cable pathway design helps prevent IT cables from penetrating smoke/fire barriers which is a common TJC finding.

Recommend future substantial renovations or additions require stamped approval from a Registered Communication Distribution Designer (RCDD). The RCDD professional would verify cabling requirements along with industry best practices. For example, the dedicated TR within the ICU has backbone fiber with unneeded and excessive bends. Proper design could adjust placement to avoid risks associated with strains on the fiber. The new, exterior fiber pathway lacked adequate number of pull boxes. This would make future removal or additions difficult from the number of bends along the path.

Security Cameras

During the visit staff indicated most security cameras are at end of life. Industry has largely migrated to power over Ethernet (PoE) delivery of security cameras. Recommend consultation for major upgrades with a RCDD and/or electronic security systems expert. Balancing tradeoffs between number of cameras, storage, staffing, access control points and usability is a complex balancing act.

Dual Backbone Fiber Diversity

Proactive actions obtaining diverse fiber optic backbone connections was a great addition to enhance patient care. This is one of many examples demonstrating the dedication and expertise of hospital staff. Major upgrades for new, dedicated TRs should maintain this methodology.

IPTV

The recent addition of inpatient internet protocol television sets are and excellent addition for quality of care. Installation workmanship for this system was also well done other than lacking dedicated space (electrical room).

Appendix E
Structural

Appendix E, Structural
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General Structural
Facility Description
Guam Memorial Hospital is a collection of many buildings. The first building was the Z-building, constructed as a Medical Center of Marianas in the late 60s/early 70s by the Sister's of Our Lady of Mercy of Belmont, North Carolina, Diocese of Hagatna. In 1974 the Medical Center was purchased by the Government of Guam to serve as the new Guam Memorial Hospital. A-Wing and B-Wing were built in 1978. Between A & B-wing, exterior stair is located on the East and West side with two elevator shafts at the center. The exterior stairs and elevators are separated by a middle and rear courtyard. Power Plant or P-Wing was built sometime between 1978 and 1989. In 1989 there was a major expansion to the facility, the following buildings were added: B –Wing addition, C-Wing, D-Wing, M-Wing (Morgue), S-Wing (Shop), G-Wing (Materials Warehouse), Entry Wing and front courtyard. In the 1990s Generator, Autoclave and MDP building were added, along with exterior hallway addition for S-Wing and exterior porch addition for G-wing. In 2001 the rear courtyard and autoclave were enclosed. 2014 saw ED addition on the Northwest corner of A-wing. Also CCU and ICU expansion West of B-wing. In the 2000s a 2nd Floor and Backup Chiller room were added to the roof of G-Wing.

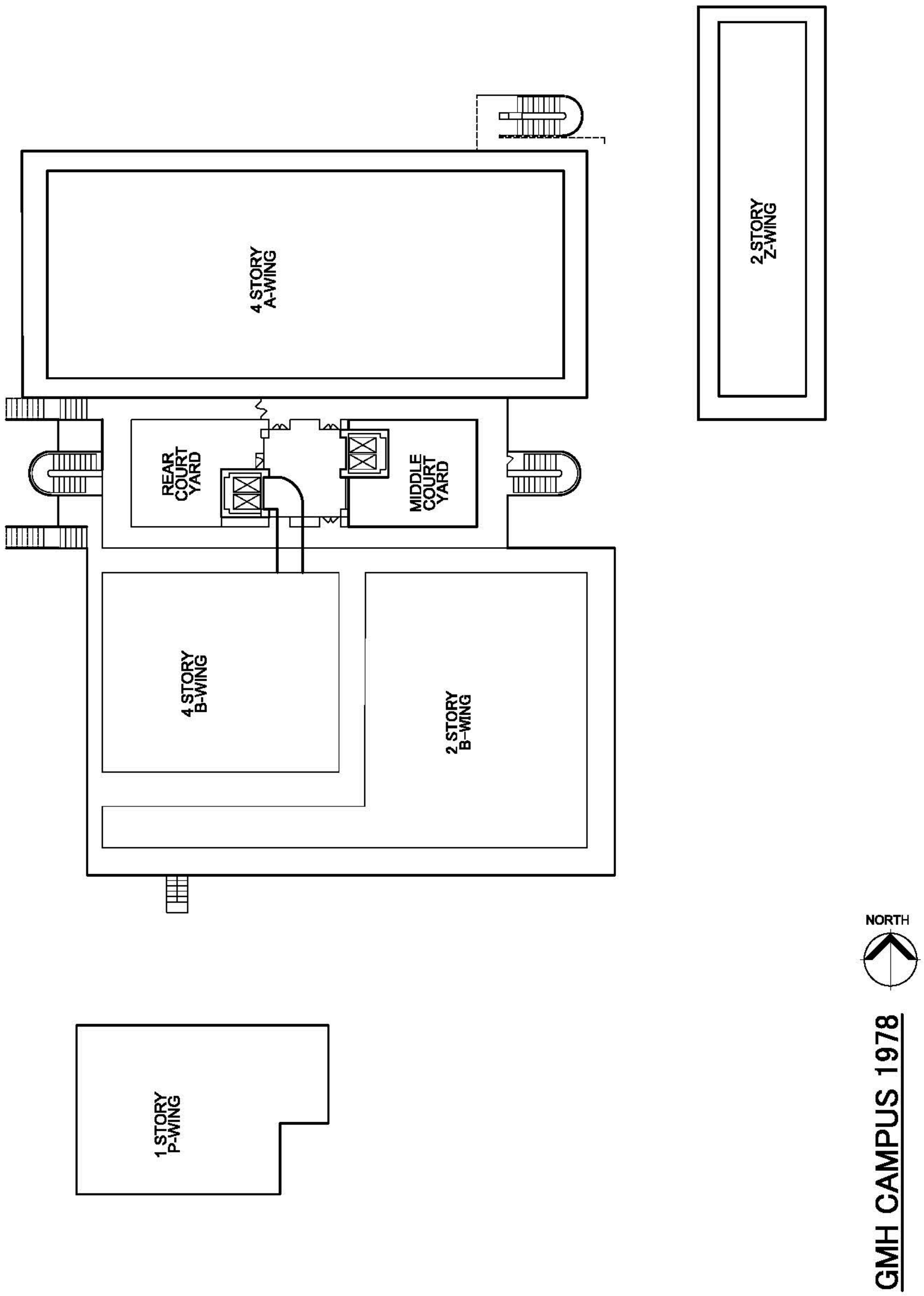
Drawings

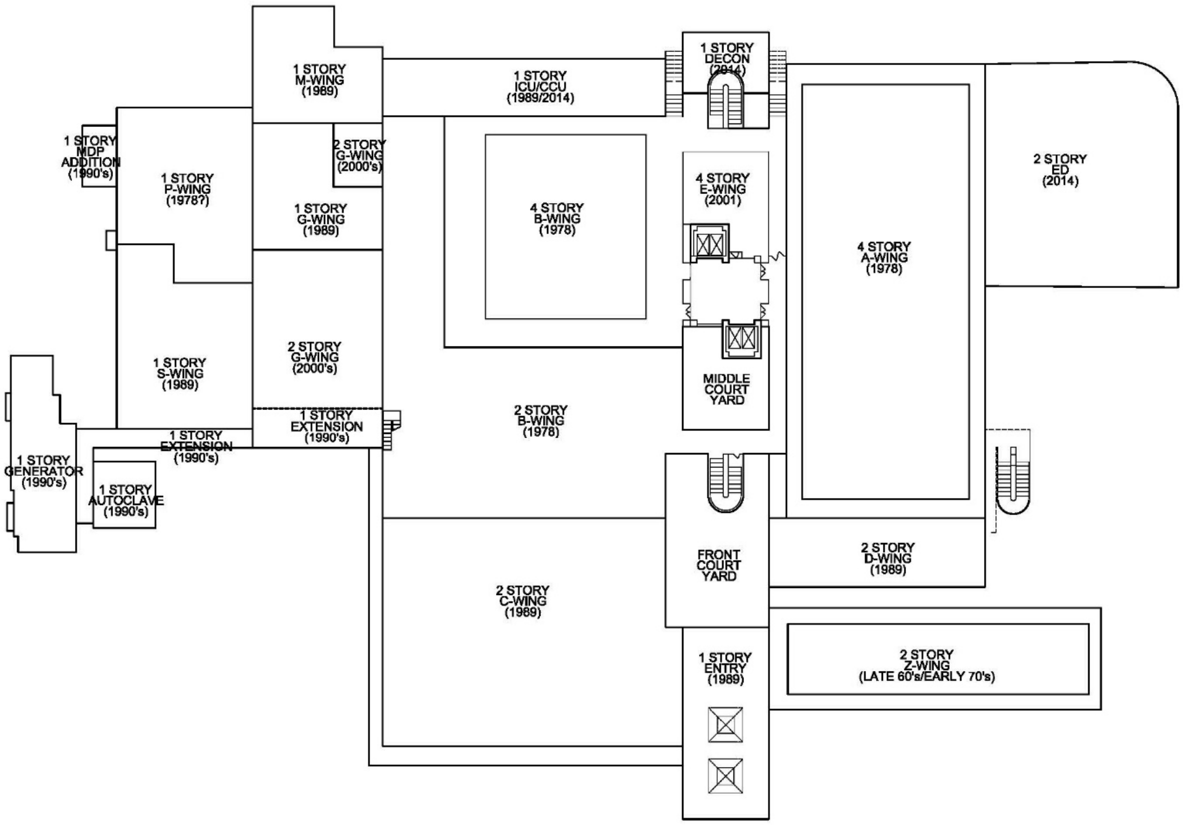
The following are available drawings:

- UP Grading and Expansion of the Guam Memorial Hospital: Package III, IV & V (1989)
- Enclosure of Rear Courtyard & Solariums (2001)
- GMHA Building Modifications for Medical Autoclave Waste System (2005)
- GMHA 2nd Floor Wall Mitigation Project (2006)
- Guam Memorial Hospital 3rd and 4th Floor A-Wing Wall Mitigation (2011)
- GMH ED & ICU Expansion (2014)
- MCH Renovation Project, GMHA 007-2014 (2016) proposed, not built

The following buildings had no available "As-Built" drawings:

- Z-wing (Late 1960's/Early 1970s)
- A-Wing, B-Wing, exterior stairs, elevator shafts (1978)
- P-wing (Between 1978 and 1989)
- Generator, Autoclave and MDP building (1990s)
- Exterior hallway addition for S-Wing (1990s)
- Porch addition for G-wing (1990s)
- 2nd Floor Addition on G-Wing (2000-2010)
- Backup Chiller Room on G-wing (2000-2010)


4 STORY
A-WING
2 STORY
Z-WING
REAR
COURT
YARD
MIDDLE
COURT
YARD
4 STORY
B-WING
2 STORY
B-WING
1 STORY
P-WING
NORTH
GMH CAMPUS 1978



GMH CAMPUS PRESENT

Structural assessment was based on available drawings, info from drawings available during our visit (November 18-22) and visual inspection. On 13 December 2019 additional As-Built drawings were provided.

I tried to find unavailable drawings through the Guam Building Department, however I was told it may have been destroyed in a past typhoon. It is important for a facility like GMH to have structural "As-Builts" for all its buildings. In viewing the "Solarium drawing" there seem to be reproductions of A & B–wing drawing, I believe the structural engineer has "As- Built" drawings for A & B-wings. It seems that it is the same company that is involved with many GMH projects. It may be that this company has many of the unavailable "As-Built" drawings in their storage. It would be good for GMH to contact the AE to obtain the unavailable drawings.

Code Investigation

Currently Guam building design follows the International Building Code (IBC) 2009. Since the earliest building built (Z-Wing) was in the late 1960s/early 1970s, none would be called "Pre-Code" buildings. Buildings built prior to 1941 would be considered "Pre-Code", prior to adoption of seismic codes in building design.

A & B-wing, exterior stairs and elevator shafts were built in 1978. Government documents indicate that UBC 1976 was adopted on March 28, 1978. It may be these buildings were designed for UBC 1973.This may include the P-wing as well. In terms of seismic loads for UBC 1973, equations did not include importance factor and the Seismic Zone was No. 2 (0.5) was increased to Seismic Zone 3 (0.75- moderate damage) was used. Wind loading is not available, however the most conservative load in UBC 1973 ranges from 40psf for heights below 30 feet, 50psf for heights 30 to 49 feet and 60psf for heights below 99 feet. Importance factor for wind loads were not considered for buildings.

There was a major building expansion in 1989: A-wing addition (D-Wing), B-wing addition, C-wing, Entry Wing, S-Wing, G-Wing, and M-Wing. Seismic equations on the drawings indicate UBC 1988 was used in the structural design. The seismic zone indicated on the drawing is Zone No. 3. Compared to the UBC 1976 the Seismic Zone coefficient decreased from 0.5 to 0.3 and a new importance factor was added. Overall the seismic load as compared to the UBC 1976 code increased by 211%. Rw value of 12 was used, indicating a special moment-resisting space frame (SMRSF). S & G wing are actually Rw=6.0 as they are concrete shear wall buildings. Concrete shear wall buildings as compared to SMRF attract more than 240% of UBC 1988 and 512% of UBC 1976 shear load. Since there are no calculations and relying solely on structural information on the drawings, S & G wings maybe under designed by 60%. Drawings indicate the wind speed to be 155mph with basic wind pressure at 61.5psf. The importance factor should be 1.15, importance factor of 1.0 is incorrect. The design wind speed should be 15% higher, however this may not be an issue in that the seismic load will govern. Drawings indicate ASTM A36 steel, ASTM A325 bolts, Grade 60 reinforcing, 3000 psi concrete compressive strength for foundations/slab on grade, 5000psi for C-Wing and 4000 psi for remainder. The M-Wing part of the 1989 drawing set, seismic equation indicates the building being designed according to UBC 1985. Wind load on M-wing is similar to other 1989 buildings. Drawings indicate the M-wing to use Grade 40 reinforcing, 3000psi for foundations/slab on grade and 4000 psi for remainder of concrete. Allowable soil bearing pressure was 6000psf (Dl + LL) and 9000psf (DL + LL+W/EQ) for all buildings except for M-wing. M wing was 4000psf (DL + LL) and 6000psf (DL + LL+W/EQ).

On August 8, 1993, Guam experienced a magnitude 8.1 earthquake. The thrust of the earthquake generated a non-destructive tsunami, injured 71 people and inflicted $250 million dollars in damage. Power and water were knocked out for more than 12 hours. One bridge collapsed. Guam Memorial Hospital (GMH) operated on auxiliary power. As a result of the 1993 earthquake, Guam legislature voted on April 29, 1996 to change the Seismic Zone No. 3 to 4. The change increased the seismic load by 33%.

In 2001 the rear courtyard between A & B wing was enclosed. Drawings indicate the structural design was in accordance with UBC 1994 with seismic at Zone No. 4. Materials are the following: ASTM A36 steel, reinforcing Grade 40 for #3 bars and Grade 60 for larger bars, foundation/slab on grade is 3000 psi and 4000 psi for all other concrete. Allowable soil bearing pressure was 6000psf (Dl + LL) and 9000psf (DL + LL+W/EQ).

ED-wing addition and CCU/ICU expansion constructed in 2014 and designed in accordance IBC 2009. Examination of the structural equations on sheet S1.1 is incorrect. Since this is a hospital, seismic importance factor should be 1.5, not 1.25. Abbreviation "CS" should be "Cs", "CS =0.20" should be "Cs=0.30". Cs = Sds /(R/I) equals 1.0/(5/1.5) = 0.30. Actual seismic load is 50% higher than shown. Compared to the UBC 1994, seismic loads are 30% higher. Wind loads are also higher using IBC 2009, wind speed increased from 155mph to 170mph, also topographic effects were added. The hospital is close to the ocean and situated on a ridge which would increase the wind speeds. Materials are the following: grade 60 reinforcing, 6000psi for precast concrete, 3000 psi for foundation/slab on grade and 4000psi for remaining concrete. Allowable soil bearing pressure was 4000psf (Dl + LL) and 6000psf (DL + LL+W/EQ).

There are plans for a "GMHA Family Birth Center" addition located where the front court yard is, between A and B-wings. It is designed in accordance with the IBC 2009 for seismic and wind. Materials are the following: steel wide flange is ASTM A992 (Grade 50), other steel is ASTM A36, HSS sections to be ASTM A500, pipes are ASTM A53, bolts are ASTM A325 and concrete is 4000psi typical. Reinforcing steel strength is not mentioned in the drawing but I assume it to be Grade 60. On the drawings, the allowable soil bearing pressure was 4000psf (Dl + LL) and 6000psf (DL + LL+W/EQ). However, the soils report dated 27 August 2015 by "Pacific Soils Engineering & Testing" recommends a 3000psf (DL + LL) allowable soils bearing pressure with a one third increase for wind/seismic. With this discrepancy the foundation may be undersized.

IBC 2009, Section 1609.1.2 "Protection of Openings", requires glazing or covering in wind borne debris regions to be impact resistant. Wind borne debris regions are areas greater than 110 mph, Guam is 170 mph. To be impact resistant window glazing or covering must pass testing in accordance with ASTM E1886 and ASTM E1996. Testing involves missile impact by a 2 x 4. Besides meeting or exceeding the appropriate wind pressures the glazing or shutter manufacturer must provide certification that it has passed requirements of ASTM E1886 and ASTM E1996. Hurricane shutters do not offer the best protection against debris or high winds. Shutters rely on the strength of the window.

Building Descriptions

Z-wing is a two story concrete moment frame building, 35’ x 121’ in plan, narrow end facing North. 1st floor to 2nd floor is 11’ and 2nd floor to roof is 10’. Columns are located in the building perimeter, spaced 16’ along the long direction, and spaced 13’, 8’, 13’ at end walls. Columns are 16” x 26” in plan, long dimension perpendicular to the exterior wall. The 2nd floor and roof have 16” wide transverse beams connecting to columns at 16’ spacing. There is also 16” wide longitudinal beam at the 2nd floor and roof at exterior walls. The roof also has two longitudinal beams spaced at 4’ at the center of the building to support a pop up section. 2nd floor and roof slabs are 6” thick. The second story has a 6’ 6” balcony around the entire building, the roof is flat and eaves also extends out all around the building similar to the balcony. 2nd floor balcony had concrete railings, the West side was replace with a steel pipe railing which has since corroded and failed. The roof eave has a concrete parapet all around. Original design I believe had an open concept, with aluminum windows/ doors between columns. However in later years, space between columns were filled in with CMU. In the building center there are two longitudinal CMU walls spaced at 8’ providing a corridor on the 1st and 2nd floor.

A and B-wing have similar construction. Columns are typically 30”x 30”, spaced at 30’ on center. Girders are typically 30” wide x 36” deep. Suspended slabs appear to be 12” thick. 2001 drawings show the existing footings to be 12’ x 12’ in plan, thickness unknown. Floor to floor height for 1st and 2nd floor is 17’, while 3rd and 4th floors are 13’ in height. The 12” thick balcony extends out 8’ all around the building at 2nd, 3rd and 4th floors. At the edge of the balcony there is a precast concrete railing 8’ 6” high (3’6” above the floor) x 6” wide. The roof is flat and eaves also extends all around the building similar to the balcony with railing. 6” high column stubs appear on the roof which may indicate another floor could be added. The lateral resisting system appears to be special concrete moment resisting frames. Originally exterior wall consists of cement veneer plaster supported by heavy gauge metal studs. The A – wing is 4 stories, 92’ 6” wide x 242’ 6” long, excluding the balconies. The narrow end faces the ocean or Westward. Ground floor at the West end of the building is really the second floor, first 30’ of this floor is open to vehicles as a drop off area, then the next 30’ slopes down to the first floor. North side of the building at the ground floor (1st floor), 30’ Southward and 30’ Westward from the East end, approximately 120’ space is open to parking. There are two 27’ 6” square openings into the roof of the 4th floor, called solariums. The B-wing has a two story base which is 122’ 6” wide x 183’ 9” long, and a four story portion which continues up with a 92’ 6” square plan dimension. Like the A-wing, the narrow end faces the ocean, the four story portion is located in the Northwest corner. The West end of the B-wing is 30’ East of end of the A-wing. The first bay of the West end of the B-wing is into the slope. At the center of the fourth floor roof there is a 27’ 6” square opening. Both buildings have vertical and horizontal irregularities. Between A and B-wings there are open concrete stairs on the West and East ends with two elevator shafts at the center. Between the West concrete stair and elevator was a “Rear Courtyard” and between elevator and East concrete stairs is the “Middle Courtyard”. Over the years some of the original exterior walls failed due to typhoon winds and were replaced 8” thick cast-in-place (CIP) concrete walls. First and second floor exterior walls in both wings are a mixture of the original exterior walls and CIP concrete walls. The original exterior walls on the 2nd floor were replaced in 2006 and 3rd and 4th floors in 2011 were replaced with 8" thick CIP concrete walls. The new CIP exterior walls were doweled in at the bottom, however gaps were provided at the top between the wall and beam above and at the sides between wall and columns. If dowels were used at top and at sides, the lateral resisting system would act more as a shear wall. Gaps allow the lateral resisting system to remain as intended. Top the wall and the bottom of the girder were connected by two steel angle clips, allowed to move horizontally in-plane and to resist out of plane loads caused by wind or seismic. Since no calculations were available, it is not known whether a seismic evaluation was performed to include the additional load of the 8" CIP exterior wall infills. In 2001 due to typhoons, solariums in both wings were enclosed with 3"concrete topping over 1 ½"metal deck supported on open web joist.

P-wing (Power Plant) is one story, L-shaped in plan, 62' 6" wide x 66' 6" long, narrow end facing West. 32' 6" wide x 18' 6" long, wide portion facing the West and added to the Northeast side of the building. Floor to roof height is approximately 20 feet. There are 30" square concrete columns and 30" wide x 36" deep girders spaced similar to the A & B wings. Exterior walls on the West, South and East sides are 8" CIP concrete walls, no walls on the North side facing the G-wing. It is believed the original exterior walls were cement plaster over heavy gauge metal studs and later was changed to CIP concrete walls. The P-wing appears to be a special moment frame similar in construction to the A and B – wing.

A-Wing Addition (D-Wing) was added to the East end of the A-wing. Floor heights was to match A-wing. It is two stories and 22' wide in the E-W direction and 92' 6" in the N-S direction. It consist of two rows of 4- 24" square columns spaced at 30' in the N-S- direction and 22' in the E-W direction. 2nd floor girders in the E-W direction are 24" wide 24" deep, while beams in the N-S direction are 18" wide x 24" deep. All roof beams at the roof are 18" wide x 24" deep. Ground floor has a 4" slab on grade while the 2nd floor and roof slabs are 6" thick. North, East and South sides of the building have an 8" cast-in-place (CIP) concrete exterior wall. Columns are supported on 6' square x 1' thick spread footings. This building was designed as a special moment frame.

B-wing Addition (ICC/CCU) was added to the West end of the B-wing. It is one story with a sloped crawl space below, 31' 4" wide in the E-W direction and 122' in the N-S direction. Ground level on the West end is the 2nd floor of the B-wing. 2nd floor to roof height is approximately 17'. Columns are 24"square with similar spacing as the A-wing addition except in the N-S direction it has 5 columns spaced at 30'. Ground floor and roof beams are all 18" wide x 24" deep. Ground floor has a 6" thick structural slab. The roof has a 6" thick concrete slab covering 50' of the North end the remainder is open and has no slab. 8" CIP concrete exterior infill walls in the E-W direction on the North end and 50' South of the North end, also on the West side for 50'. Columns are supported on 7' square x 1' thick spread footings. In 2014 this wing was converted from open area to the ICU/CCU area. Since the building was built into a slope it has a vertical irregularity and originally designed as a special moment frame. In 2014 existing walls between the B-wing and B-wing addition were removed. The open areas were enclosed with an 8” thick CIP concrete walls, and the roof areas were filled in with a 3” metal deck with 2 ½” concrete topping.

Entry wing is located on the East side between the C-wing and Z-wing, separated by a 2” gap. It is one story (17’ floor to roof height), with 18” round concrete columns spaced on a 24’ grid, 4 rows in the N-S direction and two rows in the E-W direction. Columns are supported on 4’ square x 1’ thick spread footings. 14” wide x 36” deep girders are located on gridlines, while intermediate beams are 12” wide x 36” deep. Floor slab is a 4” thick concrete slab on grade with 6” thick roof slab. 6” eave roof slab extends out 8’ 6” on the North, East and South sides. Edge of the eave slab there is a 6” wide concrete parapet wall. Between the first and second grids and the second and third grids from the East side, roof pops up like a pyramid with openings like a skylight and the remainder of the roof being flat. The structure is open with no walls between columns designed as a special moment frame.

C-wing added to East end of the B-wing. Floor heights was to match the B-wing. It is two stories and 91’ wide in the E-W direction and 122’ 6” in the N-S direction. Columns are spaced on a 30’ grid, 3 rows in the E-W direction and 5 rows in the N-S direction. Interior columns are 24” square supported on 9’ square by 1.5’ thick spread footings and exterior perimeter columns are 15” wide x 30” long, the long side facing exterior and supported on 8’ x 10’ x 1’ 8” thick spread footings. There are 24” wide x 36” deep girders on the gridlines. Intermediate beams 18” wide x 24” deep are only in the E-W direction. Girders on the E-W gridlines are supported onto corbels of the 30x30” columns of the B-wing. There is a 2” gap between the B-wing and C-wing. Ground floor level has 24” wide x 30” deep grade beams at the gridlines, except no interior grade beams in the E-w direction connecting to existing 30”x30” columns of the B-wing. There is a 4” thick slab on grade and 6” thick slabs at 2nd floor and roof. Balcony and roof eave extend out 8’, on the North, East and South sides. Balcony/eave is 6” slab supported on girders. The edge of the balcony/eave support a 6” wide x 8’ 6” (3’ 6” above floor) precast concrete railing. The building was designed as a special moment frame.

S-wing is added to the East side of the P-wing. The building is L-shaped in plan, 62.5 wide x 58.42’ long, narrow end facing the West. 30’wide x 18’ 6” long portion, wide portion facing the West and added to the Southwest side of the building. Floor to roof height matches the P-wing. There is a 2” seismic joint between the P and S wings. Walls are typically 8” thick load bearing walls supported on 3’ wide x 1’ thick wall footings. Roof girder is 18” wide x 24” deep spanning in the E-W direction, approximately 35’ long. Roof beams 12” wide x 24” deep spanning in the N-S direction and spaced about 12’ 10” in the E-W direction. The floor slab is a 4” thick concrete slab on grade with a 6” thick concrete roof slab.

G-wing is sandwiched in between P/S-wing and B-wing. It is 58’ wide x 122’ long, narrow end facing West. There are 24” square columns, 2 columns in the E-W direction on the South side from the East end and 5 columns in the E-W direction at center of building, spacing is 30’ on center. Columns are supported on 9’ square x 1.5’ thick spread footings. 8” concrete walls supported on 1’ 6” wide x 1’ 8” deep wall footing are at the building perimeter. There are 24” square girders in the N-S direction over the columns. Girders framing into an existing building is supported on a concrete corbel of an existing column with a 2” gap between the end of the girder and existing column. In the E-W direction there is a 24” square girder over the center columns. There are also intermediate 12”wide x 24” deep roof beams in the E-W direction spaced at approximately 10’ on center. Floor slab is 4” concrete slab on grade with roof slab being 6” thick concrete slab. Original lateral resisting design was a special moment frame. There is a steel framed mezzanine consisting of W8x18 girders and W8x10 beams. Mezzanine floor consist of 12 gauge steel plate over 18 gauge metal deck. In the 1990’s the East side of the building was extended 8’ Eastward. The extension consisted of 8” CIP concrete walls with a metal deck with concrete topping over open web steel joist. In the 2000’s a 2nd floor was added to the East end, 80’ in the E-W direction and 58’ in the N-S direction, 17’ height from 2nd floor to roof. Perimeter walls are 8”CIP concrete walls. Roof is concrete topping over metal deck supported by open web joist in the N-S direction. Also in the 2000’s a Backup Chiller room was constructed on the G-wing roof on the Northwest corner, 28’ E-W x 20’ N-S. Floor to roof height is 12’. 8” CIP concrete perimeter wall and 6” CIP concrete roof slab.

M-wing is added to the West side of the G-wing. The building is L-shaped in plan, 31’ 4” wide x 57’ 6” long, narrow end facing North. 20’ 9” wide x 36’ 2” long portion, narrow end facing North and added to the Southwest side of the G-wing. The building is embedded into a slope and transitions from the first floor of G-wing to the second floor which is the ground level on the West side. The height above the ground is 12’. On the first floor there is a 12” thick retaining wall in the N-S, approximately 19’ from the G-wing. All other walls are 8” thick bearing walls. First floor is 4” concrete slab on grade, second floor is partially 4” concrete slab on grade and partially 6” thick suspended concrete slab and roof is 6” concrete slab. The roof has a parapet, 1’ 6” high x 6” thick at roof perimeter.

Generator Building is 85’ 9” long and varies in width from 19’ 4” to 26’ 4”, long in the E-W direction. It is one story, 16’ floor to roof height. Columns are 14” x 24” in plan, spaced at 21’ on center. Beams are 14” wide by 30” deep, spaced at 21’. Exterior walls are 8” CIP concrete walls and roof slab is 6” thick.

Autoclave Building is approximately 25’ 4” by 31’ in plan, long side in the E-W direction. Floor to roof height is 20’. Columns are 12” square, with exterior walls are 8” CMU walls. The building is located adjacent to the Northwest end of the Generator building.

CMD Addition is approximately 20’ 9” by 36’ in plan, long side in the E-W direction. Floor to roof height is 12’. Exterior walls are 8” CIP concrete walls and roof slab is 6” thick. Building is located on the Southwest corner of the Power Plant.

E-Wing was created when in 2001 the rear courtyard was enclosed. The floors and roof consist of a 1 ½” metal deck with 3” concrete topping supported on open web steel joist (18” to 24” deep) resting on W16 x 26 steel beams supported on 12” square tube columns. 4” seismic joints separates it from the A & B wing.

ED- Wing is two stories approximately 80’ 6” x 96’ in plan at the second floor, narrow side facing West and next to the Northwest side of A-wing. First floor is approximately 30’ x 80’ 6” in plan the narrow side facing North and situated on the West side. Remainder of the first floor area below the 2nd floor is for parking. Floor to floor heights match the A-wing. 2nd floor of the West side is actually the ground floor. Columns vary from 18” square to 18” x 30” and footings vary from 5’ x 5’ to 10’ x 10’. First floor has one 12” retaining wall in the N-S direction and one in the E-W direction with a 5’ wide footing. Other first floor walls are typically 8” thick, supported on 2’ -3’ wide wall footings. First floor has a 4” thick concrete slab on grade. 2nd floor girders vary from 16” wide x 44” deep to 26”wide x 41” deep in the E-W direction. Roof girders vary from 14” wide x 40” deep to 14” wide x 56” deep in the E-W direction. 24” deep precast pre-stressed concrete double tees span between girders at 2nd floor and roof with 4” concrete topping at 2nd and 3” concrete topping at roof. 2nd floor walls are 8” thick at the perimeter.

DECON area is one story and encloses the West side of the rear stair between A and B wing. Floor to roof height is 11’. It is 40’ x 46’ in plan, narrower end is the West side. Exterior walls on the North, West and south sides are 8” CIP concrete walls. On the interior, there are 3 rows of 8” wide x 16” deep beams in the E-W direction, supported 4”square tube columns. The roof is 6” concrete slab.

Seismic Evaluations

Evaluations were performed using “Rapid Visual Screening of Buildings for potential Seismic Hazards: A Handbook” by FEMA, January 2015. The rapid visual screening (RVS) procedure has been developed to identify, inventory and screen buildings that are potentially seismic hazards. Once identified as potentially hazardous, such buildings should be further evaluated by a design professional experienced in seismic design to determine if, in fact, they are seismically hazardous. Basic scores for various building types are provided on the form. Basic score is modified by score modifiers based on various building attributes. Final scores typically range from 0 to 7, higher scores corresponding to better expected seismic performance. A final score of S min or less should be investigated by a design professional experienced in seismic design. If warranted a “Level 2” screening may be performed, this is only for structural engineers. For scores less than S min, a detailed structural evaluation would be required usually based on ASCE/SEI 41-06 “Seismic Evaluation and Retrofit of Existing Building”.

Rapid visual screening was done for all the GMH buildings. A-Wing and B-wing were concrete moment resisting frames. A-Wing had a severe vertical irregularity had a Level 1 score of 0.3 equal to S min=0.3. A-wing score appeared to be marginal so Level 2 evaluation was made. Level 2 score became -0.4 < 0.3, therefore a more detailed study required. Level 1 score for B-wing was -0.1<0.3 min. B-wing had both severe vertical irregularity and plan irregularity. Level 2 score = -2.0, well below the 0.3 min, therefore a more detailed study is required. Other buildings fell within acceptable limit

Existing Conditions

The GMH buildings have experienced typhoon, earthquake and aggressive corrosive environment. A survey was made of the condition of existing facilities in November 16 thru 20, 2019. Most of observations were made of the exterior and interior areas where accessible.

Z-wing is the oldest building over 50 years old. Several 1st floor concrete columns had extensive spalling with exposed corroded vertical bars and ties. Some columns had no ties or ties spaced more than 12" apart. There are numerous smaller spalling and cracks in columns and beams throughout the structure. There were also numerous spalling in eave and roof under slab. Concrete guardrail on the 2nd floor had a number of large cracks. The West side guardrail had been replace with a steel pipe railing, however it had corroded and failed, lying on its side. This building is scheduled for demolition, due extensive first floor column damage the building is unsafe and may fail in a strong earthquake. It is still being used for storage and has a communications room which needs to be moved. This building should have not be routinely occupied.

<u>Definitions</u>
Emergency Repair: A repair action required immediately due to a hazard impacting life, health, and/or safety. The repair action is assumed to be addressable within current budget, manpower, and local contracting capabilities.
Priority Repair: A repair action required within <1 year due to a high risk of failure associated with capital infrastructure that may eventually impact life, health, or safety.
Major Scheduled Replacement (MSR): A repair action required within 1-5 years normally anticipated with the end of lifecycle and programmed replacement of a capital infrastructure component.

A and B-wing have the majority of concrete corrosion damage, however compared to entire complex damage appears to be small. There are crack and spalls in columns or walls. There appears to be delamination at top of balcony slabs. There is cracking and spalling in the precast concrete balcony railings. Concrete stair railing adjacent to the A-wing has corroded exposed rebar. Northeast corner of the B-wing, third floor has a large vertical crack and fourth floor has much corrosion. The solarium parapet walls have cracking where water has been seeping through. Overall concrete corrosion damage in A & B wings is minor, however repairs should occur soon else it will grow into a major problem. The concrete corrosion damage may be considered **priority repair** if taken care of soon. There is evidence of seismic damage, 8" CIP concrete walls have been pushed out by as much as 1". Also floor at expansion joint at E-wing has settled by ¼" compared to B-wing and sloping toward A-wing. However, seismic damage is still within acceptable limits and will not require repair. Third and fourth floors of the A and B wings do not have sufficient floor to floor height for mechanical equipment and ducts. Floor to floor height is 13 feet, a minimum of 16 feet is required by code for hospitals.

P-wing on the Northwest corner has standing water. Standing water will infiltrate into the concrete and reach the rebar. The floor should be redesigned to eliminate standing water which would be a **priority repair.**

Exterior Stair areas between A and B-wings and courtyards are very dirty. Since courtyard is not being used this area appears to be neglected. The scum on the wall seems to collect moisture maybe detrimental to the concrete. Eventually moisture will infiltrate the concrete and reach the rebar which will then start to corrode. This seems to be the same problem with scupper areas, where the scum is allowed to grow. These areas should be power washed to not allow the scum to grow, this would be a **priority repair**.

Much of the steel railings and equipment supports are extremely corroded. The most extensive corrosion occurs at the base of the post, some post are not connected to the base. Much of the steel railings would be considered unsafe. Railings and supports should be replaced, possibly with stainless steel which would be an **emergency repair**.

Roofing in A, B & E-wings (2nd and 4th floor roofs) need to be replaced, the original roofing which is 40+ years old has never been replaced. Roofing appears to be filled with moisture and drains are corroded or missing. The present roof is flat and has poor drainage. Roofing over the power plant should also be replaced as it was constructed sometime between 1978 and 1989. Except for C-wing, all roofing of buildings built in 1989 (A-wing addition (D-wing), Entry Wing, S- wing, G-wing and M-wing) should be replaced. C-wing roofing was replaced in 2000. Once the existing roofing is removed, existing concrete cracks and spalls must be repaired. Also the new roofing and equipment on the roof must be designed to resist high wind uplift pressures. Roof replacement would be considered a **major scheduled repair.**

Corrosion through window condensation is currently a problem. Existing windows are of a single pane design. New window should be IGU, outer pane and inner pane, to relief the condensation problem. To meet IBC 2009 for wind borne debris region glazing needs to be impact resistant. Total window replacement will be a **priority repair.**

Future Expansion:

MCH Renovation Project, GMHA 007-2014, GMHA Family Birth Center (2016) proposed, not built. This project has a new addition located in the front courtyard between A & B-wings and behind the entry wing. It is two stories except for the four story portion which replace the existing East stairway. Another idea for this project would be, instead of two stories have four stories.

Since the courtyards are a neglected part, if more room is needed. Phase II could be to build another 4 story portion between A & B-wing replacing the middle courtyard and the E-wing.

Since there are already column stubs on the roof of the 4th floor of A & B-wing, another floor could be added.

Recommendations:

In review of the available plans and survey of GMH campus and existing conditions it is my belief that an additional 25 year life span is reasonable provided the following items are completed:

1. Structural Evaluation:

No available plans for existing Buildings A, B and connecting stairs, however records indicate they were constructed in 1978. Connecting stairs were open and later were enclosed between 1978 and 1989, also no available drawings. Immediate detailed structural evaluation is necessary to make wise future plans. Prior to evaluation, unless "As-Built" drawings can be located, non-destructive and destructive testing will be required to ascertain concrete strengths, reinforcing, foundation sizes, reinforcing steel sizes and spacing. Structural evaluation shall be made to resist gravity, seismic and wind loads in accordance with the International Existing Buildings Code (IEBC). Analysis shall be based on the current condition of the building, current live loading and added modifications. Deficiencies shall be identified with a retrofit plan. Evaluation shall also include the addition of a 5th story and additional two stories at the B-wing, East side. Evaluation shall be performed by a new structural engineer experienced in seismic retrofit design, with an independent technical reviewer. If plans are made to add a 5th story or add two stories at B-wing, structural engineer involved in the evaluation should also be part of the design team.

2. Deficient Structural Design:

Existing 2014 structural plans have an incorrect importance factor, which results in lower seismic design force 50% less than required. Hospital requires a higher standard than normal buildings, importance factor should be 1.5, not 1.25. Contact the original structural engineer to verify if his or her design is sufficient to resist the 1.5 importance factor.

Family Birthing Center structural drawings were based on a higher allowable soil bearing than the soils report. Please have the design engineer verify with soils engineer and provide changes if required.

Original structural engineer's work shall be reviewed by an independent technical reviewer.

3. Repair:

Lack of maintenance in an aggressive corrosive environment will reduce the life span of the building.

a. Priority Repair:

- Power wash all interior courtyards and scupper areas on quarterly basis.
- A survey of concrete cracks and spalls shall be made on all GMH buildings to include but not limited to columns, walls, slabs, parapets, railings and precast fascia. Plans shall be provided for typical repair details, and surveys to take place every 2-3 years.
- Replace windows with impact resistant glazing according to IBC 2009.
- Replace roofing at A, B & E-wings (2nd and 4th floor roofs) immediately.

b. Emergency Repair:

- Another survey shall be taken of all corroded metal items to include but not limited to decks, railings, ladders, post, bracing, and supports. Corroded metal shall be replaced or repaired if more cost effective. New metal items shall be surveyed every 2-3 years and repaired as necessary. Damaged or leaking expansion joints shall be repaired.

c. Major Scheduled Repair

- Also roofing at the P-wing, A-wing addition (D-wing), Entry Wing, S-wing, G-wing and M-wing need to be replaced within 5 years.

Appendix F
Fire Protection

Appendix F, Fire Protection
Guam Memorial Hospital – Facilities Condition Assessment 18-22 November 2019

General Description
The first floor is comprised of administration and fiscal departments, dietary services, central sterile supply, admissions, medical records, physical therapy and power plant. The second floor houses the maternity nursing unit, obstetrics, surgery, radiology, laboratory, urgent care, emergency department, the main area for critical and intensive care and additional business offices. The third floor houses the telemetry nursing unit, medical surgical nursing unit, respiratory care and the inpatient hemodialysis unit. The fourth floor houses the pediatric and surgical wards.

Referenced Documents Reviewed and Used for Assessment
NFPA 10, Standard for Portable Fire Extinguishers, 2010 Edition
NFPA 13, Standard for Installation of Sprinkler Systems, 2010 Edition
NFPA 14, Standard for Installation of Standpipe and Hose Systems, 2010 Edition
NFPA 17, Standard for Dry Chemical Extinguishing Systems, 2009 Edition
NFPA 17A, Standard for Wet Chemical Extinguishing Systems, 2009 Edition
NFPA 20, Standard for Installation of Stationary Pumps for Fire Protection, 2009 Edition
NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2011 Edition
NFPA 30, Flammable and Combustible Liquids Code, 2012 Edition
NFPA 72, National Fire Alarm and Signaling Code, 2010 Edition
NFPA 80, Standard for Fire Doors and Other Opening Protectives, 2010 Edition
NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems, 2012 Edition
NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations, 2011 Edition
NFPA 99, Health Care Facilities Code, 2012 Edition
NFPA 101, Life Safety Code, 2012 Edition
NFPA 2001, Standard for Clean Agent Fire Extinguishing Systems, 2012 Edition

FIRE SUPPRESSION

FP-01
Issue: There is no automatic sprinkler protection under the canopy over the entrance to Emergency Department and “A” Wing.
Recommendation: Extend automatic sprinkler protection to the exterior under the canopy.
Reference: Section 8.15.7.1 of NFPA 13 (2010 Edition).

FP-02
Issue: Several pairs of automatic sprinklers have been installed less than six feet from one another. For example, one location where this occurs is Rm B125 (Pharmacy Storage).

Recommendation: Move automatic sprinkler protection such that minimum distance between sprinklers is maintained.
Reference: Section 8.6.3.4 of NFPA 13 (2010 Edition).

FP-03
Issue: Upright automatic sprinklers are installed more than 22 inches below ceilings in several communications equipment rooms where room ceiling is considered to be obstructed construction. For example, see Rm B236 (Electrical Room).
Recommendation: Move upright automatic sprinklers such that maximum distance below ceiling is maintained.
Reference: Section 8.6.4 of NFPA 13 (2010 Edition).

FP-04
Issue: There are several lengths of piping for automatic sprinkler protection where the unsupported lengths exceed the maximum length permitted by NFPA 13. For example, Rm A108 (Corridor) and Rm A125 (Corridor).
Recommendation: Add support to piping for automatic sprinkler protection such that maximum distance between hangers or other acceptable means of support complies with NFPA 13.
Reference: Section 9.2.3.4 of NFPA 13 (2010 Edition).

FP-05
Issue: The existing flow meter on the piping at the fire pump is inadequate since the new fire pump is rated at 750 gallons per minute (gpm). For instance, a new flow meter must be able to account for the minimum requirement to test it to 150% of its volumetric waterflow rating.
Recommendation: Replace the existing flow meter with one that has a range of at least 1,500 gpm.
Reference: NFPA 20 (2009 Edition).

FP-06
Issue: There are extra control valves provided for the automatic sprinkler system that serve no purpose and should be removed. For instance, there is a backflow preventer installed downstream of the new fire pump when there already is one installed at the connection to the water tank.
Recommendation: In order to reduce long-term operations and maintenance costs associated with unnecessary equipment and appurtenances, removal schedule removal of such equipment and appurtenances.
Reference: None – this is a recommendation based upon visual inspection of the current installation.

FP-07
Issue: The supply of spare sprinklers does not match up with the number and variety of sprinkler types installed throughout the hospital. It is noted that that hinge to the lid on the spare sprinkler box is rusted and broken, which means the lid is not connected to the box.
Recommendation: Provide an adequate supply of spare sprinklers with respect to the types and number of sprinklers actually installed.
Reference: Section 6.2.9 of NFPA 13 (2010 Edition).

FP-08
Issue: Portions of piping for automatic sprinkler protection are being used to provide support for non-system components, like acoustical ceilings and runs of cables and wires above the suspended ceilings throughout the hospital.
Recommendation: Add independent means of support where non-system components (as mentioned above) have been erroneously attached to piping for automatic sprinkler protection.
Reference: Section 9.1.1.7 of NFPA 13 (2010 Edition).

FP-09
Issue: Automatic sprinkler protection has not been provided in Rm P101 (Power Plant).
Recommendation: Provide an adequate supply of spare sprinklers with respect to the types and number of sprinklers actually installed.
Reference: Section 6.2.9 of NFPA 13 (2010 Edition).

FP-10
Issue: The fire pump is not protected from the remainder of Rm P101 (Power Plant). This violates Section 4.12 (Equipment Protection) of NFPA 20. Also, Section 4.12.1.1.4 of NFPA 20 states, “rooms containing fire pumps shall be free from storage, equipment, and penetrations not essential to the operation of the fire pump and related components.”
Recommendation: Review Section 4.12 of NFPA 20 and provide adequate protection in accordance with Table 4.12.1.1.2 of NFPA 20. It is recommended that automatic sprinkler protection simply be extended to protect Rm P101 and that automatic fire detection (i.e., heat detectors) be decommissioned and removed.

Reference: Section 4.12 of NFPA 20 (2010 Edition).

FP-11
Issue: A minimum vertical clearance of 18 inches from automatic sprinklers is not being maintained in a few areas in the hospital, e.g., Rm B125 (Pharmacy Storage).
Recommendation: Take the necessary actions, like removing storage materials, to maintain this minimum vertical clearance from automatic sprinklers.
Reference: Section 8.6.5.3 (Obstructions that Prevent Sprinkler Discharge from Reaching the Hazard) of NFPA 13 (2010 Edition).

LIFE SAFETY AND MEANS OF EGRESS

FP-12
Issue: The self-closing device has been removed from the door to Rm B152 (Storage).
Recommendation: Take the necessary actions to make this a self-closing door. A door closer is a labeled device that, where applied to a door and frame, causes an open door to close by mechanical force.
Reference: Section 5.2.4 of NFPA 80 (2010 Edition).

FP-13
Issue: There are unsealed penetrations of smoke and fire separations. For example, see Rm B293 (Communications), Rm A110 (Storage Space), and the area above the ceiling in Rm A308 (Corridor) between hazardous rooms.
Recommendation: Review all penetrations [through-penetrations and membrane penetrations] of smoke separations and fire separations and seal them with the proper firestopping assemblies. Apply the requirements in Section 8.3.5 of NFPA 101 for penetrations of fire-rated separations and the requirements in Section 8.4.4 of NFPA 101 for penetrations of smoke partitions and Section 8.5.6 of NFPA 101 for penetrations of smoke barriers.
Reference: Section 19.3.2 of NFPA 101 (2012 Edition).

FP-14
Issue: The door at the exterior exit from the back of Rm C112 (Kitchen) could not be opened and thus was not readily available from the egress side during the site survey.
Recommendation: Make the necessary repairs to this exit from the kitchen.
Reference: Section 19.3.2 of NFPA 101 (2012 Edition).

FP-15
Issue: Stair No 4, which is an interior exit enclosure, discharges onto a corridor on the ground floor at the level of exit discharge. This violates Section 7.1.3.2 (Exits) and Section 7.7 (Discharge from Exits) of NFPA 101.
Recommendation: Review the means of egress, where Stair No 4 discharges onto the ground floor, and develop alternative methods to address and resolve this important egress issue that

bring the means of egress into compliance with NFPA 101. At least one option to consider would be to extend the bottom of Stair No 4 with an interior exit passageway to the exterior exit discharge, which would provide a protected pathway for occupants during an emergency.
Reference: Section 7.1.3.2 (Exits) and Section 7.7 (Discharge from Exits) of NFPA 101 (2012 Edition).

FP-16
Issue: Fire-rated door assemblies, which have been provided with self-closers, throughout the hospital have been propped open with wedges and other similar obstructions.
Recommendation: Maintain a constant surveillance program and remove such obstructions, plus reinforce this instruction into the existing safety program to educate staff.
Reference: Section 8.5.4 (Opening Protectives) of NFPA 101 (2012 Edition).

FP-17
Issue: Labels on several fire-rated door assemblies throughout the hospital have either been painted over or simply removed. Where labels have been removed (or no longer legible), the listing of such doors is invalidated. For example, see door in Rm B183 (Corridor), where label has been pried from door and removed.
Recommendation: Maintain a constant surveillance program and remove paint over labels on fire-rated door assemblies. Replace door assemblies where labels have been removed.
Reference: Section 4.2 (Listed and Labeled Products) of NFPA 80 (2010 Edition).

FP-18
Issue: While no life safety plans were made available to the survey team, it appears that the ground floor may be considered to have a single-occupancy classification of business in accordance with NFPA 101. In particular, since GMH staff indicated that provisions for smoke compartments were added during the last major rehabilitation project, where health-care occupancies from other floors were temporarily relocated to the ground floor (as swing spaces only), it may be possible to declassify existing smoke compartments and their accompanying components. This would be a cost savings in terms of long-term operations and maintenance.
Recommendation: Maintain a constant surveillance program and remove paint over labels on fire-rated door assemblies. Replace door assemblies where labels have been removed.
Reference: Section 4.2 (Listed and Labeled Products) of NFPA 80 (2010 Edition).

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NOTE: As of 13DEC2019, the survey team still has not been provided with either an electronic copy of Statement of Conditions (SoC) or Life Safety Plans for review.
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FP-19
Issue: There is an intervening room issue in Labor and Delivery Department, where exit access from one space passes through two intervening rooms.
Recommendation: Consider removing one or more doors such that no more than one intervening room is present.
Reference: Section 7.5.1.6 of NFPA 101 (2012 Edition).

FIRE ALARM-FIRE DETECTION

FP-20
Issue: The public address system interface with the facility's system for fire alarm and fire detection does not comply with Section 24.4.2.28 of NFPA 72. According to GMH staff, voice messages for emergency communications (e.g., fire alarm and mass notification) are delivered on the newer public address system, which is not interconnected with the existing system for fire alarm and fire detection. [See NOTE below this item concerning the previous public address system, which failed during the last hospital survey.] Section 23.1.5 of NFPA 72 requires compliance with Chapter 24 where in-building fire emergency voice/alarm communications systems are used.
Recommendation: Retain the services of an emergency communications system designer to review and evaluate the current installation, programming, and interface between the two systems (i.e., one for fire alarm and the other for public address). See Section 24.4.2.27 of NFPA 72.
Reference: Section 23.1.5 and Section 24.4.2.27, and 24.4.2.28 of NFPA 72 (2012 Edition).

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NOTE: According to a letter from TJC to GMH dated 19JAN2018, "The organization was not able to demonstrate they had an effective way to communicate emergencies to staff as the hospital's public announcement (PA) system became inoperable on 12/22/17, nor was there an alternate communication method for staff to communicate emergencies." Furthermore, the accompanying report stated, "The hospital put an alternate plan in place to notify staff of emergencies. When a dietary worker was asked how they were made aware of emergencies, it was stated they were made aware through the public address system and indicated the announcement was heard from the ceiling speaker. The change in announcing emergencies was not effectively communicated. This was confirmed by the Compliance Officer."
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FP-21
Issue: All visual notification appliances provided throughout the hospital have been set at 15 candelas (cd) regardless of the area or space being served or covered. This procedure (which must have occurred during installation) appears to have been arbitrarily set. Thus, the current level of coverage for visual notification does not consistently comply with the minimum requirements of NFPA 72, especially Section 18.5.4.3 (Spacing in Rooms) and Section 18.5.4.4 (Spacing in Corridors).
Recommendation: Retain the services of fire protection engineer to review and evaluate the current layout and distribution of visual notification throughout the hospital and then provide a report [to document that evaluation] along with recommendations to comply with NFPA 72.
Reference: Section 18.5.4.3 (Spacing in Rooms) and Section 18.5.4.4 (Spacing in Corridors) of NFPA 72 (2010 Edition).

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NOTE: According to the report entitled "Evaluation for 2018 Life Safety Management Plan" (with signatures made on various dates in 2019), "Testing are [is] done as scheduled. More system troubles are experienced due to the system's age. It has met its useful life expectancy of 10 years. At the end of 2017 a thorough assessment was conducted and that a system refurbishment is recommended by system provider. Repairs and upgrades after the annual ITM and certification is sought for 2019."
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FIRE EXTINGUISHMENT

FP-22
Issue: The tops of some portable fire extinguishers have been installed over the maximum permitted height of five feet (or 60 inches). For example, see Rm C112 (Kitchen) and Rm A112 (PT Corridor).
Recommendation: Make the necessary adjustments to ensure tops of PFEs do not exceed five feet.
Reference: Section 6.1.3.8.1 of NFPA 10 (2010 Edition).

FP-23
Issue: The room housing the defunct magnetic resonance imaging (MRI) apparatus ("Old Nuclear Medicine") is being used for storage. Also, there are damaged ceiling tiles and other unsealed penetrations such that an enclosed volume for the clean agent fire extinguishing system is no longer present. Enclosure inspections are required by NFPA 2001 to occur at least once per year.
Recommendation: Decommission this clean agent fire extinguishing system, which uses the clean agent, HFC-227ea, and is more commonly referred to as FM-200, and remove it from the three rooms currently being protected by this one system. It is also recommended to decommission and remove the other systems using FM-200 currently in use as well. Then, ensure automatic sprinkler protection is maintained in each space where these clean agent fire extinguishing systems are being removed.
Reference: Section 1.4.2.3 and Section 7.4 of NFPA 2001 (2012 Edition).


120/208 VOLTS
THREE PHASE

Appendix G
Mechanical

Appendix G, Mechanical
Guam Memorial Hospital – Facilities Condition Assessment 18-22 November 2019

General Mechanical

Climate – Guam lies within a chain of islands off the western Pacific basin dwelling in a tropical maritime climate, characterized by high temperatures, and extreme relative humidity. The 1% and 99% design dry bulb temperatures are 89 F and 75 F respectively. The 1% and 99% design dewpoints are 79 F and 65 F respectively with a mean dewpoint of 74 F. As a result, outside air for ventilation imposes an extremely high latent load. (293,000 btu/cfm/yr compared with 100,000 btu/cfm/yr for Honolulu, or 140,000 btu/cfm/yr for Tampa, Florida.) Any HVAC system handling outside air must be specifically designed to accommodate this extremely high latent load. Due to the very high prevailing dewpoint, building envelope, building pressurization, and equipment insulation are critical elements that require specific detailed consideration in any design. There is no heating or humidification season. In addition, Guam Memorial Hospital is located almost directly on the shore of the Pacific Ocean (within 500 ft. horizontally and roughly 100 ft. vertically.) This close proximity subjects any exterior equipment, and any equipment handling outside air, to salt spray and its resultant brutal corrosion.

View from roof of B-wing overlooking the central plant and showing the proximity to the Pacific Ocean

Infection Control and HVAC – No outbreaks were reported by the staff. Nosocomial infection rates were reported as stable and as would be expected. There have been local cases (on the island) of Dengue fever within the past year after 75 years of none. The single most significant HVAC observation that would relate to infection control was the lack of appropriate building pressure control. As a result of nearly all outside air systems being taken out of service (discussed later), the building is significantly negative. This negative pressure is demonstrated by the wind tunnel of incoming air through entry doors while they are open. Since the outside air is being forcibly drawn into the building through open doors, and cracks in the building envelope typically around windows or at building expansion joints, this air is not being conditioned or filtered. Effectively the HVAC system is bringing the great outdoors directly into the facility. The end result is high humidity, high temperatures, condensation, and in some areas mold within the building envelope (discussed in the architectural section). Finally, the negative building pressure makes maintaining pressure relationships between spaces within the building problematic. The facility has 14 certified Airborne Infection Isolation (AII) rooms and 45 negative pressure capable rooms. All the AII rooms assessed were functioning correctly as evidenced by the pressure monitor in spite of the negative building pressurization.

The filtration in all of the in-patient systems investigated was not in compliance with current industry guidelines (FGI/ASHRAE STD 170). Only one bank of MERV 8 filters was installed. This bank was located upstream of all coils. ASHRAE STD 170 require two sets of filters for all inpatient areas; a minimum MERV 7 upstream of all coils, and a minimum MERV 14 downstream of all wetted coils and supply fans. The installed filter meets the requirements of the first filter bank; however, no second filter bank is provided. It is important to note that even the most recently renovated areas (ICU/ED), based on the as-builts, do not have ASHRAE STD 170 compliant filtration.

MERV 8 filter, typical of all air handling units observed.

At the time of the survey, space temperature and humidity conditions within the patient care areas were mostly compliant with industry criteria (FGI/ASHRAE). In the areas that have not been recently renovated, the staff did mention that during extreme weather the humidity would often get high. This is most likely due to the extreme latent load, during extreme weather, being imposed on the ward space cooling HVAC systems from the unconditioned outside air being drawn in as mentioned above.

With the exception of the recently renovated areas (ICU/ED), all outside air supply systems were non-functional. In all cases observed, this was a result of extreme corrosion, and the systems were blanked off and taken out of service. Without outside air, odor and contaminant dilution cannot take place and CO_2 levels are not controlled. This violates Joint Commission requirements and the specific ventilation requirements of ASHRAE STD 170. In addition, the lack of sufficient outside air, to balance out the mandatory exhaust from the building, causes the building to be negatively pressurized as mentioned above. Of particular note is the inoperative kitchen makeup air unit. The kitchen area has significant exhaust for cooking operations. Without the makeup air system operating, the space is severely negative and must pull air from surrounding areas. This negative pressure causes excessive door forces at the entrance to the cafeteria, and is a life safety issue (discussed under the life safety section).

Corroded outside air ductwork drawing air from inside the building.

Blocked off outside air intake

Overall condition of HVAC equipment – The majority of HVAC equipment have exceeded their useful life. Condition is FAIR to POOR and in need of significant replacement. Accelerated corrosion due to the tropical marine environment has significantly reduced the useful life. The boilers have been re-tubed several times, one is currently out of service for re-tubing. The air cooled condenser coils for the critical back-up chiller are significantly corroded. All sections of fresh air ductwork observed exhibited significant corrosion to the point that the ductwork is no longer usable. At a minimum, all ductwork handling outside air needs to be evaluated and failed sections repaired. A capital investment plan/program for replacement should be developed for any continued long term operation of the facility.

Central Utility Plant

Available Utilities – Available public utilities are electricity, water and sanitary sewage. There is no natural gas available on the island. Diesel is the only available fuel for generators and boilers.

Water Supply – Domestic water is provided by the local water utility provider. GMHA has two 400,000 gallon below grade on-site storage tanks, a 20,000 gallon above grade tank, and a domestic water pumping unit. The domestic water pumping unit is manufactured by FlowTherm, includes triplex Goulds pumps, was replaced recently, and appears to be in good operating condition. All domestic water is conditioned by a duplex salt brine ion exchange softening system. Chlorination was said to be provided by the local water utility provider. There is no additional chlorination or secondary water treatment at the tanks or within the facility. No Legionella outbreaks were reported by the staff.

Domestic water pumping unit

Chilled Water – The CHW system consists of two 450 ton water-cooled centrifugal Carrier Evergreen chillers with two chilled water pumps, and two condenser water pumps. Bypasses are provided to operate either pump with either chiller or cooling tower. There is also a third emergency 265 ton air-cooled rotary screw Carrier chiller that is utilized to serve critical loads if both of the other chillers are not operational. Transfer to the third emergency chiller is manual. This includes the electrical feeds also. (discussed in the electrical section)

Water cooled chiller

Based on the as-builts the chilled water supply set-point is 42 deg F; however, the chillers are providing a 44 deg F supply temperature. While this difference did not seem to effect the ability of the system to maintain temperature and humidity in the patient care areas at the time of the survey, this difference could contribute to the high humidity reported when the ambient weather approaches design day conditions.

The emergency air-cooled chiller has three compressors and three remote air-cooled condensers with common refrigerant piping. While the emergency chiller is tested regularly, and appears to be operational, the condensers are severely corroded from exposure to the salt spray. The inlet side of the aluminum/copper fin-tube coil is completely corroded to just past the first row of copper tubes. It is only a matter of time before the coils are corroded to the point that high refrigerant head pressures prevent the chiller from operating at all. Based on the level of corrosion observed, the condensers are nearing the end of their usable life.

Emergency chiller

Corroded emergency chiller condenser coils

Condenser Water – The condenser water system serving the two primary chillers consists of two fiberglass cooling towers with fabricated stainless steel supports located on the roof of the Central Utility Plant. The condenser water system appears to be in good operating condition. This is likely due to the selection of materials with high resistance to corrosion and careful attention to condenser water treatment. It should be noted that there is some light rusting of the stainless steel in areas where the stainless steel was either cut or welded during the fabrication of the cooling tower support. This is likely due to a reduction of the self-passivizing chromium oxide layer caused by the welding or cutting operation. For any new stainless steel fabrications that will be exposed to the local environment, a post-fabrication passivation treatment is recommended.

Cooling towers

Steam - Steam is provided by two 125 HP (4300 lbs/hr) diesel fuel fired boilers operating at 75 PSI. Steam is utilized for sterilization, and to generate domestic hot water. One boiler is currently out of service for re-tubing. The tubes in the other boiler are planned for replacement once the one currently being worked on is operational. The boilers are in excess of 25 years old, exhibit significant exterior corrosion, and are beyond their useful life. In addition, when the boiler restarts at low load, significant smoke is produced. This continues for several minutes. Repair/renewal of the facility would require replacement of the boiler system. The boiler feedwater/condensate recovery tank is severely corroded, leaking, almost non-operational, and beyond repair. Complete replacement is the only viable remedy.

Replacement of the boilers should also consider inclusion of a pressurized deaerator for feedwater treatment to reduce corrosion in the steam system.

Steam boiler


Boiler feedwater/condensate receiver tank

HVAC

General – Space temperature and humidity conditions in the patient care areas were mostly compliant with criteria. Due to the large amount of outside air infiltrating through the entry doors as a result of the negative building pressure, the central common area temperature and humidity was not in compliance with criteria.

With the exception of the newly renovated areas, a typical patient ward is served by independent recirculating fan coil units (which include only a filter, fan, and cooling coil) for each room, and typically three or four outside air fan coil units which also include only a filter, fan, and cooling coil. The recirculating room fan coil units draw air from the above ceiling plenum space formed by a soffit above and just inside the room entry door, and discharge through the side of the soffit into the patient room. Return air is drawn into the plenum space through a combination access panel/grille in the bottom of the soffit. This is not in compliance with ASHRAE STD 170 which requires fully ducted return for all inpatient areas. The outside air fan coil units are located above the ceiling in the corridors. Outside air is ducted from a louver above the exit doors to the outside air fan coil units. From there it is ducted to each room and discharges through a volume damper into each soffit plenum space. However, since these systems are not operational, or their outside air louver has been blocked off as discussed above, there is no outside air being provided to the spaces at this time.


Access panel/grille into patient bedroom soffit space


View through access panel/grille inside patient bedroom soffit/plenum space

The newly renovated areas (ICU and ED) are served by a combination of fan coil units and small constant volume air handling units. Individual ducted fan coil units provide space cooling for each ICU inpatient room. The Emergency Department and the common areas of ICU are served by small air handling units. Outside air is provided by a dedicated outside air precooling air handling unit (PAHU) and is ducted to the return side of the fan coil units and the small air handlers. Patient rooms 12 and 13 are exceptions, with the outside air being provided from AHU 3 not PAHU. There does not appear to be sufficient outside air provided to any of the patient rooms. A typical patient room with 60 cfm of outside air, as indicated on the as-builts, would yield 1.67 ACH of outside air while ASHRAE STD 170 requires 2 ACH of outside air. For patient rooms 12 and 13, which are not tied to the 100% outside air unit PAHU, but rather are tied to the mixed air unit AHU3, which provides approximately 15% outside air, these rooms only receive 0.25 ACH of outside air.

There is no reheat provided for any fan coil or air handling units which limits the ability to meet the latent load without overcooling the space. Since there is no heating season, heat is not necessary to meet the sensible cooling loads of the space. However, reheat is necessary to avoid overcooling while still meeting the extreme latent (dehumidification) load imposed by ventilation. To prevent bringing in the extreme outside humidity, all outside air used for ventilation must be cooled to a dewpoint below the target dewpoint that corresponds to the temperature and humidity requirements of the space. This dewpoint is typically between 47 – 53 deg. F. During low sensible load conditions, without reheat, providing approximately 50 deg. F to the space will cause the space to go below the lower temperature limit. On the other hand, raising the discharge temperature of the outside air units will cause the humidity to exceed the upper limit. Reheat is often necessary to maintain both temperature and humidity.

The current HVAC approach with distributed air-conditioning, especially of outside air, makes maintenance difficult and costly. There are over 60 AHUs, and over 15 FCUs. This results in more than 75 different locations throughout the building that require filter changes, with most being above the ceiling in patient care spaces. Outside air is being drawn in and conditioned at around 30 different locations throughout the facility. Each of these locations poses a risk of corrosion and failure from the environment. Any long term solution should seek to centralize the conditioning of outside air and include materials suitable for long term service in the tropical marine environment.

Surgical Department – The surgical department, with the exception of operating room #2, is served by a single 100% outside air constant volume air handling unit. Operating room #2, which is currently not being used, is served by AHU3 that also serves the ICU common areas. While space temperatures within the ORs were reported as within requirements, portable dehumidifiers were being used to keep the space humidity within limits. This is likely due to the lack of reheat in the AHU's serving the ORs. Without reheat it is difficult, if not impossible, to lower the humidity without overcooling the space as described above. In addition, the air supply to the ORs does not comply with current industry requirements (ASHRAE STD 170) since the unidirectional low aspirating diffusers do not cover at least 70% of the ceiling space above the surgical table and extend 12 in. on either side.

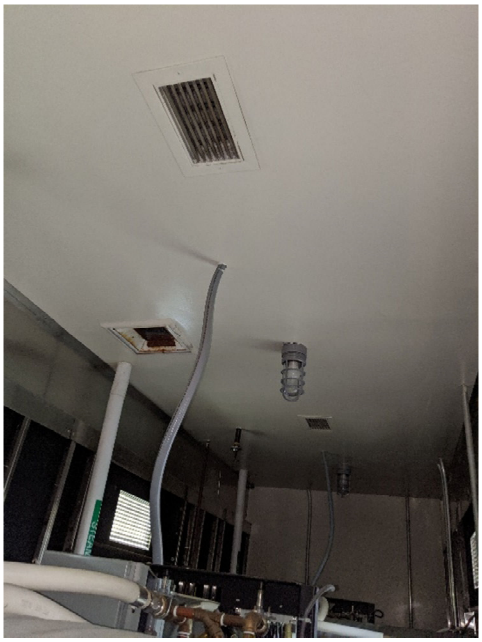

OR ceiling showing inadequate coverage


Portable dehumidifiers being used in ORs

CMS (Central Sterilization) – The central sterilization department is not compliant with current industry guidelines (FGI/ASHRAE STD 170). FGI now requires at least a two room suite with the decontamination area separated from the clean workroom (assembly/prepack) and sterile storage by a building partition. There is currently a wall between the decontamination area and the clean workroom. However, since the pass through window is not large enough to accommodate most of the items/containers processed, the door between the spaces is being propped open and the items carried through the doors. While not specifically required by criteria, typical industry practice is to provide double sided pass through washers between decontamination and the clean work room, similar to the pass through sterilizers between the clean workroom and sterile storage. In addition, a pass through window is typically provided to accommodate those items that would not be processed through the washers. With the door between the decontamination area and the clean workroom being propped open it is impossible to maintain the ASHRAE STD 170 required negative pressure in the decontamination area and the positive pressure in the clean work room.

Sterilization clean workroom with decontamination beyond

New double sided pass through sterilizers have recently been added between the clean work room (assembly/prepack) and sterile storage similar to a three room sterilization suite. This is an industry accepted best practice. However, it does not appear that the HVAC system was upgraded to comply with current requirements for the sterilizer equipment space created with this change. ASHRAE STD 170 requires this space to have 10 ACH, be at a negative pressure, and all space air exhausted directly to the outdoors. Currently to keep temperatures within the space under control, the access doors are propped open and fans are positioned to circulate air in the space, and based on the size of the exhaust diffusers in the space, it does not appear that sufficient exhaust is being provided to meet the required ACH rate.



Inadequate exhaust in sterilizer equipment room

Pharmacy – Space temperature in the pharmacy, as a whole, was comfortable. ASHARE STD 170 does not establish requirements for humidity and temperature for the pharmacy, but does require the space to be positive. Due to the proximity to the kitchen, the pharmacy is at a negative pressure to the central areas, and the influx of air from the central area is elevating the humidity within the department.

The compounding area consists of a three room suite comprised of one hazardous compounding buffer space, one non-hazardous compounding buffer space, and an anteroom between. All three spaces are constructed and certified to meet the requirements of an ISO class 7 cleanroom. The primary engineering controls include one Class II B2 biological safety cabinet in the hazardous compounding space and three laminar flow workbenches in the non-hazardous compounding space. Based on the recent (Nov 2019) inspection and certification reports, and observations during the assessment, the compounding area is compliant with the requirements of previous versions of USP 797. USP published an update to chapter 797 and a new chapter 800 (Hazardous Drugs) in July of 2019. The current facility is not compliant with these new requirements. Based on the as-builts, return air from the hazardous compounding buffer zone (room B130) is ducted to the return side of AHU B118 to be recirculated throughout the department. To comply with USP 800, air drawn from the hazardous buffer zone must be ducted directly to the outdoors. A final item to note is that the negative pressure mentioned previously draws warm humid air from the hallway into the pharmacy near the compounding suite any time the door to the hallway is opened.

Kitchen – In addition to the inoperative make-up air unit mentioned previously, at least two sections of the kitchen exhaust hood grease duct have been replaced with light gauge galvanized metal as opposed to the NFPA 96 required 16 ga. black steel or 18 ga. stainless steel. While this is not an immediate threat to life or health, in the event of a cooking fire, the exhaust duct may not effectively contain the fire within the exhaust system. At a minimum, the non-compliant kitchen exhaust hood duct sections should be replaced with materials that comply with NFPA 96.

Inappropriate kitchen exhaust duct material

MEDICAL GAS SYSTEMS

General – Med gas producers appear to be in working order, and no significant issues were reported by the staff. All med gas systems (vacuum pumps, medical air compressors, oxygen manifold, and nitrous oxide manifold) are located either in the open medical gas building or in the unconditioned CUP. This subjects the medical gas equipment to the corrosive ambient environment. In addition, the medical vacuum pumps, and medical air compressors are located within the CUP in the same room with both fuel burning and refrigeration equipment, and adjacent to the above ground water storage tank. While this location is not in direct conflict with NFPA 99, it places the medical gas producers where catastrophic failure of the other equipment could result in loss of these lifesaving systems.

Medical air compressors with 20,000 gal water tank beyond

Zone Valves and Alarming – Zone valves appear to be present where required by NFPA 99 and most are appropriately labeled. Area alarms were observed at all critical care and anesthetizing locations, and are also labeled as required by NFPA 99. A single master alarm panel is provided in the MIS room which is constantly supervised. NFPA 99 requires two master alarm panels in two separate locations for Category 1 Medical Gas Systems one of which is in the office of the personnel responsible for maintaining the system, the other in a continuously supervised location.

Medical Vacuum (MV), Waste Anesthetic Gas Disposal (WAGD) – Both of these services are being provided by a common vacuum system. WAGD is provided by active scavenging accessories included with the anesthesia machines connected to the facility medical vacuum system. The medical vacuum system features CLAW type non-contact pumps typical of systems suitable for higher oxygen concentrations. This system was recently installed and is in good working condition.

Medical Air (MA) – Medical air is provided by a BeaconMedeas quadraplex oil-free dry scroll compressor system. This system was installed in 2008 and is in good working condition. The medical inlet is located closer than 25 ft. from the central plant exhaust fan discharge. NFPA 99 requires that medical air inlets be located at least 25 ft. from ventilating system exhausts, fuel storage vents, combustion vents, plumbing vents, vacuum and WAGD discharges, or areas that can collect vehicular exhausts or other noxious fumes.


Medical air inlet closer than 25 ft. from exhaust fan discharge

Oxygen – There are two bulk oxygen systems located in the detached medical gas compound. System #1 was installed in 1996, and is not currently in service. System #2 was installed in 2004 and is in working condition. Reserves are provided by a cylinder manifold system also located in the medical gas compound. There is no emergency oxygen connection provided on the exterior of the building. NFPA 99 requires an emergency oxygen supply connection anytime the oxygen supply is not located within the building and within building reserves are not provided. Since both the primary and reserve supply are located remote from the building, an emergency oxygen supply connection is required.

Oxygen system #1

Oxygen system #2

Nitrous Oxide – Nitrous oxide is provided by a primary/reserve cylinder manifold system located in the medical gas compound. This manifold system is in good working condition.

Nitrous oxide system

PLUMBING

Disinfection is provided by the water utility. There is no monitoring of disinfectant residual or secondary water treatment (e.g. chlorination, copper/silver ionization etc.) provided after the storage tanks. Given the fact that the incoming water passes through two 400,000 gallon underground tanks, and a 20,000 gallon above grade tank, it is likely that little or no chlorine residual is present within the hospital. Based on the condition of the plumbing fixtures and mechanical equipment, the water softening system appears to be functioning properly.

Domestic hot water is generated by steam to water heat exchangers at the CUP and distributed to the hospital. It was indicated that the generation temp and supply temp is 140 deg F. While the actual water temperature delivered to the faucets was not checked, a few hand washing locations were operated, and hot water was available within a reasonable time (around 30 seconds).

Domestic hot water heat exchangers

MECHANICAL RECOMMENDATIONS

The local climate, as stated previously, with its high temperatures, extreme humidity, and salt spray presents a high risk of condensation with the resultant microbial growth. It also subjects any exterior equipment and any equipment handling outside air to salt spray and its resultant brutal corrosion. As a result there are recommendations common to all courses of action. Any new construction (or renovation) must fully address critical design elements and features to mitigate the harsh climate and meet infection control requirements. The following is an abbreviated list of critical design features that should be incorporated into either a replacement facility or renovation of the existing facility:

1. HVAC system must be designed to comply with prudent tropical design criteria. UFC 3-440-05N is an example of such criteria and could be utilized.
2. The most conservative 99.6% and 0.4% ambient conditions must be used, especially for outside air. Both the 0.4% dehumidification dewpoint/MCDB and 0.4% enthalpy conditions must be considered for conditioning of outside air.
3. Dedicated outside air systems should be considered to control outside air humidity before it enters the recirculating units. Outside air ductwork and air handling units starting at the air intakes and continuing through the cooling coil sections must be constructed of stainless steel.
4. Designs must analyze any airstreams (outside and mixed) passing through pre-filters and measures incorporated to avoid filter wetting (and mold).
5. Cooling coils should be provided with ultraviolet treatment to limit mold growth on the coils and drain pans.
6. Direct expansion (DX), also known as split systems, should be avoided.
7. All equipment (HVAC, Med gas, plumbing, etc.), to include both equipment within the facility and within the central plant, must be installed in a conditioned (dew-point controlled) environment.
8. Building pressurization must be incorporated.
9. Building envelope design must control moisture and outside air infiltration.
10. All mechanical insulation must be carefully installed to ensure that all pipes, components, or equipment, operating below or within 5F degrees of the prevailing dewpoint, are protected from condensation by a continuous vapor barrier.
11. Condensate drainage must be addressed to ensure drain pans readily drain water (i.e. appropriate trap design). Condensate drain pans must be stainless steel.

Due to the age and condition of the mechanical systems in the facility, significant repair/renovation is required. Since nearly all the existing HVAC systems are outdated designs and not compliant with current healthcare facility standards, a total HVAC renovation of most areas within the facility is recommended. Following is a list of recommendations for the existing facility:

1. The non-compliant light gauge galvanized ductwork needs to be removed from the kitchen exhaust and replaced with 16 ga. welded black steel to comply with NFPA 96.
2. The kitchen make-up air system needs to be repaired and placed back in service.
3. All HVAC systems need to be evaluated and renovations/repairs made to provide ASHRAE STD 170 minimum outside ACH rates.

4. All HVAC systems need to be evaluated and renovations/repairs made to provide the minimum filtration levels required by ASHRAE STD 170.
5. The HVAC systems serving the patient wards, with the exception of the newly renovated areas, need to be completely replaced with a ducted return system. This, along with items 4 and 5 above, necessitate a complete HVAC remodel for these areas.
6. The back-up chiller condensing units require replacement. Any long term solution should consider providing robust automated redundancy of the chilled water system.
7. The steam boilers require replacement. Due to the age of the steam system, a complete steam system replacement should be considered.
8. The surgical department needs a complete HVAC renovation to provide the air change rates, filtration levels, and sterile field delivery concept required by ASHRAE STD 170. An analysis of system psychrometrics is required to keep OR humidity within limits without the use of portable dehumidifiers. A supply air dewpoint of 47F is recommended.
9. The central sterile department is in need of a complete HVAC renovation to provide sufficient cooling for the sterilization equipment, appropriate pressure differentials across the spaces, and adequate exhaust of the sterilizer equipment space to comply with ASHRAE STD 170. The renovation should be in conjunction with an architectural renovation to comply with current FGI requirements.
10. The facility management should monitor the status of the new USP 800 and revised USP 797, and affect the necessary modifications as these significantly revised standards become applicable.
11. An additional medical gas master alarm panel needs to be installed. This would typically be installed in the office of the personnel responsible for the maintenance of the medical gas system.
12. An Emergency Oxygen Supply Connection needs to be installed on the exterior of the building.
13. Domestic water systems should be evaluated for potential of legionella. This would include monitoring of disinfectant residual. Based on the configuration of the domestic water supply, secondary disinfectant treatment is likely required. ASHRAE STD 188 is the standard for addressing the risk of legionella in water systems. In addition the CDC has a toolkit on their website.