Pan American Health Organization

World Health Organization
REGIONAL OFFICE FOR THE Americas

SAFE + GREEN = SMART

UKaid
from the British people

NOA Rated Materials

Technical Review and Recommendations

for Selection of Materials for

PAHO Smart Health Facilities Retrofit

Introduction

The principal idea of the PAHO Smart Hospital Retroffiting project is to upgrade existing health facilities with hardware and equipment, which can stand extreme forces of hurricanes that can be expected in areas where facilities are situated. Beside standard building requirements in hurricane areas, hardware chosen must have resistance to aggressive corrosion prevalent in coastal areas with high content of salt in the air. Furthermore, due care should be given to earthquake potential in some of geographical areas where materials will be installed. For better understanding of challenges posed by extreme wind forces, please see US FEMA's document here: https://www.fema.gov/media-library-data/20130726-1707-25045-9020/chapter10.pdf.

It is generally recognized that the overall best source and codification for mitigation related to building envelope in hurricane prone areas is the Miami Dade Building (MDB) code. However, those standards do not take into account the topographic acceleration of the wind, which is commonplace in the Caribbean islands. It is important to mention that NOA (Notice of Acceptance, document that certifies conformity of particular product to MDB code as either impact resistant product or not impact resistant product). MDB code is in addition to the Florida Building code. The 2010 edition is available here: http://ecodes.biz/ecodes_support/free_resources/2010Florida/Building/10FL_Building.html.

It is very important to note that in the eastern Caribbean states the "OECS Building code, 2016 Revision" is used and this document sets the minimum standards that shall be followed in every aspect of building and associated activities. 2015 version of OECS Building code can be accessed here: http://www.oecs.org/sdu-resources?task=document.viewdoc&id=263.

NOTE:

The mention of specific companies or certain manufacturers' products does not imply that they are endorsed or recommended by the Pan American Health Organization in preference to others of similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

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The materials listed are recommended as examples because they meet the minimum standards of the Smart Hospitals Retrofit; however, equivalent or better products may be specified.

The information in this document can be used to supplement the Technical Specifications that are to be prepared by the design teams for each retrofit design.

Prepared by Zeljko Vejnovic

Materials

As a result of the fore mentioned demands, use of aluminum is widespread in applications where architectural hardware is needed. Aluminum is a material that is good match for mentioned requirements due to its strength and ease of use, among other positive characteristics. Another thing to keep in mind when ordering or specifying aluminum systems is structural resistance of frames/members. Non-impact systems are not tested on positive pressure (forces causing bending of metal members, especially transom member) and therefore, whole metal structure may fail when exposed to strong winds. In addition to aluminum, recommended is use of tempered or heat hardened glass. There are few ways to improve glass characteristics by using heat. Annealed glass is softest of all forms of heat treated glass and this type of glass shall be avoided in PAHO projects which recommends usage of stronger types of glass. Consequently, for places and installations where there is a possibility that systems may be directly exposed to the strong winds, but impact glass cannot be supplied, ordering impact rated system glassed with non-impact glass can be good choice. This will limit eventual wind damage only to glass replacement instead of replacement of whole system. All details about Florida and MDB code can be found here: https://floridabuilding.org/pr/pr_app_srch.aspx

The previous link offers a detailed overview of Florida-approved building envelope products and can be used as source of details or reference for product needed in PAHO projects. Also, most of the product drawings contain assembly or installation requirements and bill of materials. There are many manufacturers and sellers of materials that are of interest for PAHO projects. However, buying or making references to large numbers of suppliers can end up in confusion and higher costs, so to alleviate that problem sources are consolidated in this document. In a process, mentioned are major suppliers for some of the costliest products, but elaborated only products or materials from one supplier. For doors that is Trulite, for windows Asura (former AWP windows etc.) Descriptions for products in this document are only for basic configurations and all optional accessories and /or hardware needs to be ordered according to intended use. In general, and especially in case of doors, windows and architectural hardware recommended is the use of hardware from renown hardware suppliers such as Assa Abloy group, details here:
https://www.assaabloydss.com/Local/DSS/Sustainability/Codes%20and%20Standards/ASSAABLOYCodeResourceHandbook_FINAL%20(2).PDF)

The best approach would be the use of heavy duty, commercial grade products, but sometimes that can be costly and unnecessary. In cases where there is suspicion that heavy duty commercial hardware may be too much for intended use, consultation with supplier's sales representative can be very useful. Furthermore, all of the vendors that are recommended in this document have practice of giving quotes based on customer drawings. More details about different products and sources can be found in table "Links and references for sourcing".

1. **Doors**

   Doors that will be used in PAHO projects can be sorted in 4 categories: entrance doors, internal doors, back-emergency exit doors and special purpose doors. There are many manufacturers and many types of the entrance doors. The use of aluminum made doors with full glass leaf and ADA compliant 10" bottom (footer piece) is recommended. These doors must be MDB code compliant and single door opening must be at least 42'' wide. Taking into account doors

available from renowned companies such as Trulite, Kaweneer, YKK, Aldora and Old Castle, the recommendation would be to use Trulite MS 300 non impact and Trulite 351x impact series doors. More details about abovementioned doors can be found here: http://www.trulite.com/category/architectural-aluminum/entrance-doors/

All drawings and other details for Impact 351x series here: https://floridabuilding.org/upload/PR_Instl_Docs/FL21892_R1_II_SERIES%20351%20ALUMINUM%20OUT-SWING%20DOORS%20FA%201.17%20SS.pdf
https://floridabuilding.org/upload/PR_Instl_Docs/FL18413_R2_II_351%20Entrance%20Door%20-4-18-18%20SS.pdf

Drawings for non impact 300 series here: https://floridabuilding.org/upload/PR_Instl_Docs/FL17616_R1_II_4-03-15%20AD15-22%20%20MS-300%20MEDIUM%20STILE%20DOOR%20SS.pdf

Trulite 300 and 351x series doors are very solidly built, with steel reinforcements for hinges and with metal rod that reinforces cohesion of the door sides. The 300 series doors are non-impact doors and they shall be protected with hurricane shutters. It is recommended to glaze these doors with regular tempered glass at least ¼'' thick single glass sheet. In addition to glass, doors shall have bristle sweep or rubber lip on the bottom and water deflector lip where possible. Handles shall be of rim and pull style with 3 point lock.

Internal doors

Internal doors recommended are steel doors with foam filled core and primer coat for rust protection. Please see example with options here on page 148; https://us.allegion.com/content/dam/allegion-us-2/web-documents-2/Manual/Steelcraft_Tech_Data_Manual_105001.pdf
If doors need surface door closer, heavy duty door closer such as LCN 4010 series are recommended.

More details for closer here: https://us.allegion.com/content/dam/allegion-us-2/web-documents-2/Catalog/LCN_Door_Control_Full_Line_Catalog_109426.pdf.

In cases where doors are intended to be used in applications where dust intrusion is to be kept on minimum, such as pharmacies, these doors should be equipped with appropriate sweeps and stoppers to ensure tight closing and prevent penetration of dust.

Emergency exit doors

Panic-emergency exit doors or back doors in situations of infrequent use, can be made as full slab steel door. This way, use of shutter for this kind of doors will be avoided. These doors shall be equipped with panic door opener from inside and eventually with alarm to signal that door is open. From outside, door shall only have pull handle that opens the door but cannot lock it. Full catalogue here: https://us.allegion.com/content/dam/allegion-us-2/web-documents-2/Manual/Steelcraft_Tech_Data_Manual_105001.pdf.

Or here; Republic doors including specialty doors:
https://www.steeldoor.org/products.php
https://www.steeldoor.org/pdf/SDI%20Fact%20File.pdf
and here: https://www.cecodoor.com/Other/Ceco/Documents/Tech%20Manual/D10.pdf

Specialty doors

The most likely specialty doors that will be used in PAHO projects are doors usually used on X-ray room and they serve as protection from harmful X-Rays.
https://www.ambico.com/specs-cads/#ls-sc-tab-engineered-doors

2. Windows

Same as external doors, windows are supposed to withstand the same extreme force winds, as doors, therefore, recommended is the use of aluminum made windows, impact or no impact rated. Furthermore, due to the limits imposed by eventual use of shutters and security bars in windows openings, recommended is use of side sliding windows as first choice, followed by sash style (up-down sliding) windows or awning windows. Windows, as doors shall be also MDB code compliant. Something to keep in mind, when choosing windows type and shutters type, is security bar installation. In cases where security bars will be installed windows type shall be chosen accordingly.

When using shutters, glass used in windows shall be tempered glass, no need for impact glass. I would like to recommend Asura brand windows. These windows are widely used throughout Florida and they represent medium quality windows. A good window to recommend is the Asura 6800 non-impact type. Details here:
https://floridabuilding.org/upload/PR_Instl_Docs/FL21850_R1_II_SS%20-%206800%20Horizontal%20Roller%20(NI)-2017%20DWG%20W17-12.pdf
For applications that requires impact windows recommended is Asura 805 series:
https://floridabuilding.org/upload/PR_Instl_Docs/FL21850_R1_II_SS%20-%20805%20Horizontal%20Roller%20(LMI)-2017%20DWG%20W15-29.pdf

3. Shutters

Accordion style shutters

Shutters, like most of the items elaborated in this report come in many types and are made from many types of materials. First choice will be shutters made in accordion style.
This shutter style is in many ways superior to other styles due to its ease of maintenance and especially due to ease of use. Furthermore, when shutters are not in use they are folded in a way that does not significantly impede with visual appearance of the building. Shutters are made of aluminum or steel with peephole or see through leaf to provide for some light while shutters are in use. Typically, it takes just a minute or two to open or close the shutters and maintenance consists of greasing joints with spray grease once a year. No specific shutter manufacturer is recommend due to the fact that accordion shutters are very similar and only thing that sets them apart is price.

Bahama style shutters

Another solution would be Bahama or awning shutters for places where solar protection is necessary. These shutters are of type that acts like a lid on the window opening; top of the shutter is permanently fixed on the top side of the window and shutter is secured on the bottom side when it is deployed as wind and debris protection. Unfortunately there is no Bahamas shutters that are approved in HVHZ and here is detail for non HVHZ approved shutter: https://floridabuilding.org/upload/PR_Instl_Docs/FL5480_R4_II_Dwg_.pdf

4. **Ceiling**

In many health facilities throughout warm weather zone countries ceiling is not traditionally used but bottom side of the roof structure serves as ceiling. This type of construction has couple of advantages; most notable one is provision on higher space to provide for better circulation of air. At the same time, non insulated metal roofs in this non ceiling configuration are also big source of radiated heat coming from non insulated roof cover. As remedy for excess heat recommend is use of insulation bats such as Pink wool (https://www.homedepot.com/p/Owens-Corning-R-30-Unfaced-Fiberglass-Insulation-Roll-23-in-x-25-ft-12-Rolls-RU71/202691435) to be placed between rafters and closed with appropriate membrane and ceiling material such as T1-11 grooved plywood boards or other appropriate material. Insulating wool "R" number shall be higher than 15, preferably R-30 and higher.

For places that require a suspended ceiling recommended product is made by well known Armstrong brand; Armstrong offers ceiling solutions that fit healthcare requirements. Please see link for more specifics: https://www.armstrongceilings.com/content/dam/armstrongceilings/commercial/north-america/brochures/places-to-heal-brochure.pdf

https://www.armstrongceilings.com/pdbupimages-clg/217391.pdf/download/data-sheet-suprafine-ml-xl.pdf

Walls

Walls in the buildings can be done in a couple of styles based on the way they are constructed. Most common ones are traditional, plastered walls built with clay bricks or concrete blocks. Second type are drywalls built with studs and drywall boards. Beside traditional finishes used on the walls, some paint manufacturers have developed lines of products that are suitable for use in healthcare facilities. One of them is Sherwin Williams and recommend is their line of products. Product details link: https://images.sherwin-williams.com/content_images/sw-pdf-healthcare-spec-guide.pdf

For walls that are of drywall or paneled type recommended solutions offered by Armstrong group of products and more details for their products can be seen here: https://www.armstrongceilings.com/commercial/en-ht/commercial-ceilings-walls/acoustic-wall-panels.html

5. **Flooring - seamless, tiles, decorative epoxy/ paint**

Flooring in health facilities is a big challenge due to very specific requirements such as high volume traffic, bio resistance, caster resistance etc. As per PAHO specs, Armstrong brand is the first choice for flooring products. They have wide range of products suitable for use in health facilities. Probably the best match for facilities retrofitted by PAHO would be various coatings,

then linoleum in rolls, PVC or mineral tiles. Either of these products shall provide for all requirements set for health facilities and can be customized to fit specific need for each facility. Moisture in the floors can be issue with this type of products, so due diligence is needed before choosing type of the flooring.

Catalog for floor coating intended for use in health facilities can be seen here:
https://images.sherwin-williams.com/content_images/sw-pdf-healthcare-spec-guide.pdf
https://www.armstrongflooring.com/commercial/en-pr/products/hom/medintech.html

Shall meet or exceed the following:

Flexibility
Will not crack or break when bent around a 1.4" (3.5mm) diameter cylinder.

Static Load Limit
850 pounds per square inch when tested in accordance with ASTM F 970-00, Standard Test Method for Static Load Limit.

Slip Resistance
Meets or exceeds the industry recommendation of >0.5 for flat surfaces when tested in accordance with ASTM D 2047, Standard Test Method for Static Coefficient of Friction.

Castor Resistance
Suitable for office chairs with castors when tested in accordance with EN 425, Castor Chair Test.

Impact Sound Reduction
6db when tested in accordance with ISO 717-2, Impact Sound Insulation Test.

Resistance to Bacteria
Provides a self-sanitizing quality in the form of a bactericidal effect. Independent testing has shown that a sterile zone around the material inhibits the growth of organisms such as staphylococcus aureus, Clostridium difficile, and Klebsiella pneumonia (CRE).

Anti-Static Properties
Naturally anti-static. This property makes cleaning easier because dirt and dust does not cling to the surface as it may with other materials.

Fire Testing
Class 1 when tested in accordance with ASTM E 648/NFPA 253, Standard Test Method for Critical Radiant Flux. Meets 450 or less when tested in accordance with ASTM E 662/NFPA 258, Standard Test Method for Smoke Density. Class C when tested in accordance to ASTM E 84/NFPA 255, Standard Test Method for Surface Burning Characteristics. FSR – 150; SDC – 145 when tested in accordance to AN/ULC S102.2, Standard Test Method for Flame Spread Rating and Smoke Development. Meets or exceeds all technical requirements as set forth in ASTM F

2034 Standard Specification for linoleum Sheet Flooring, Type I Consider the need for conductive flooring in operating rooms to remove static charges.

6. Toilets

Toilet bowls are widely available in many configurations in reference to flush systems. Recommended is a bowl with water tank because of eventual problems related to low pressure that can be expected in some of health facilities, especially when water is supplied from on site water tanks by gravitation. Furthermore, water consumption in flush tanks can be adjusted easily to meet US EPA water efficiency standard of 1.28 gallons per flush.

List of ADA compliant products related to restroom use: https://www.americanstandard-us.com/parts-support/innovations/ada-compliant

https://www.us.kohler.com/us/browse/bathroom-commercial-bathroom-commercial-toilets/_/N-2d82
https://www.americanstandard-us.com/bathroom/commercial-toilets?page=1&plimit=21

Models should be dual flush and/or water-efficient, back mount toilets. The volume per (full) flush, should be low volume, but dependent on the needs of the gravity fed system. Toilets must be labeled as water efficient by European or American standards.
Must meet or exceed the following:

ASME A112.19.2-2008/CSA B45.1-08 for Vitreous China Fixtures.
US EPA Water Sense® Specification for High Efficiency Toilets (HET's)

A link to the Water Sense Program product search is available here:
https://www.epa.gov/watersense/product-search

7. Faucets

Most commonly used faucets in health facilities are these that are 90 degrees, lever valve operated and aerated. Furthermore, in public areas, e.g. waiting areas or patient toilets, different type of faucets shall be used. They all shall be aerated, and in public places metered (meaning to stop by itself).

Where needed, almost every faucet can be equipped with alternative opening valve and most commonly used is pedal valve such as these shown here:
http://www.pedalvalve.com/commercial.html#page=page1

Showerheads

Shower system shall feature a wall supply with ½" NPT female inlets and ½" NPSM male outlet, 59" metal hose, vacuum breaker, 1.5gpm/5.7L/min. 3-function water-saving personal shower, 2-way diverter valve, showerhead and a 36" slide-grab bar. Pressure Balance valve shall feature a

cast brass body. Shall feature ceramic disc valve cartridge which controls water temperature and volume. Shall also feature hot limit safety stop.

Showerheads must be labeled as water efficient by European or American standards.

Must meet or exceed the following:
US EPA Water Sense® Specification for showerheads.

Faucets (bathrooms, kitchens, etc)

Provide water-efficient (aerated), commercial grade and lead-free faucets throughout that have 2.2 gpm/8.3 L/min. maximum flow rate or less. Faucets must be labeled as water efficient by European or American standards.

Centerset Bar Sink

Faucet shall be cast brass construction with all brass coupling nuts. Shall also feature 1/4 turn washerless ceramic disc valve cartridges.

Single handle pantry/bar sink

Faucet shall feature cast brass construction. Shall feature all brass shank nut and coupling nut. Shall also feature 1/4 turn washerless ceramic disc valve cartridge.

Pillar Tap Faucet (Metering)

Metered faucets require decent water pressure in order to deliver required amount of water, so in places where it is expected that water pressure can be very low, non-metered faucets can be better solution.
https://www.justmfg.com/institutional-faucets.html
https://www.americanstandard-us.com/bathroom/commercial-faucets?Activation%20Type=Manual&page=2&plimit=21

Faucet shall feature a single handle, vandal-resistant brass construction with a replaceable valve cartridge and an adjustable flow cycle. Shall also feature a water-conserving pressure compensating 1.5gpm/5.7L/min vandal-resistant aerator. Factory set to maintain flow below the maximum 0.25 gallons per cycle.

Urinal (Flush valve)

Manual urinal flush valve shall feature self-cleaning brass piston valve with integral wiper spring in bypass orifice to prevent clogging. Valve remains closed and does not need to be reset after loss of water pressure. Includes cast brass valve body and cover with chrome finish and vandal resistant stop cap. Includes sweat solder kit with wall flange and cover tube. Angle stop with back-flow protection and vacuum breaker included. 0.125 gpf / 0.5Lpf Flush valve.

Flush valves must be labeled as water efficient by European or American standards.

A link to the product search feature of the Water Sense program is provided here:
https://www.epa.gov/watersense/product-search

8. Internal partitions/ NS walls

Depending of type of need for internal partitions, there are many choices of partitioning walls available. The most common one would be drywall built with either metal or wooden studs, covered with drywall sheets. These are available in most local hardware stores.
Second type is partition wall made of glass in the aluminum frame (same as partition walls installed in PAHO Jamaica office).

Glass partitions

This type of wall is made of various styles of glass (clear, frosted, patterned etc http://www.khabars.net/door-glass-styles-2/brilliant-door-glass-styles-36-in-interior-home-inspiration-with-door-glass-styles/). All aluminum hardware manufacturers make this kind of partition wall and I would like to recommend Trulite partition walls. The advantage of this type of partition wall is that this can be moved and relatively easily adjusted to the need.

Modular partitions

The Next type of partition walls are modular walls. These walls are made of members that are usually interlocking and they are highly adaptable and easy to install. In cases where there is expectation of changing room patterns, this type of wall would work the best. More here: http://alliedmodular.com/partitions-walls/

9. Paint

Interior

Shall meet the following requirements: zero or low VOCs, natural pigments, virtually odorless, 100% Acrylic, self-priming.

Exterior

Shall provide UV resistance, superior adhesion, durable, soap and water cleanup, resistant to fading, cracking, peeling, chalking blistering, dirt pick-up, provides a mildew resistant film, self-priming in most situations, vapor permeable. Shall have low VOC content.
All exterior paints have fungicides, and low-biocide paints are not available for exteriors. The desired choice for exterior paint is one that has zinc oxide as the fungicide. Next best choices are zero to very low-VOC paints, acrylic or latex paints, and recycled water-based paint. Milk paint and natural paints are the first choice for commercially available interior paint. Avoid oil-based paints because of their high VOC content. Also, use light colored paints. The choice of color must be approved by the MoH/Project Manager. Consider paint colours that aid in health and wellness for health facilities.
https://www.healthdesign.org/sites/default/files/color_in_hc_environ.pdf

Roofs to be painted in light colors (white, if the surrounding residential/commercial development would not be affected by glare, or grey).

10. Stainless steel sinks

Where needed, stainless steel sinks can be used to fit the purpose and depending on intended use appropriate sink can be found here: https://www.webstaurantstore.com/14943/hand-sinks-and-accessories.html and https://www.justmfg.com/search#?keywords=Cu-j&ab=yes OR scrub sinks faucets are usually required to operate hand free and most common solution for such

requirement is use of paddle valves. Details here:
http://www.pedalvalve.com/commercial.html#page=page1
https://www.steris.com/healthcare/products/scrub-sinks/

11. **Signage for emergency exits**

In terms of signage for emergency exits, below is comprehensive information about US OSHA requirements with strong remark that countries may have official polices related to emergency signage and procedures. In these cases only local legislation applies; supplied info is for reference purpose only. Details here: https://www.grainger.com/content/qt-emergency-lighting-exit-sign-requirements-265.
Furthermore, here is a list of emergency equipment that may be needed for some of facilities: https://www.grainger.com/category/fire-protection/safety/ecatalog/N-b03, and here is source for illuminated signs: https://www.grainger.com/category/exit-signs-and-light-combinations/exit-signs-and-retrofit-kits/emergency-lighting-and-accessories/lighting/ecatalog/N-

12. **Disabled Grab bars**

Grab bars could be sourced together with rails from the same manufacturer of toilets and toilet accessories or additionally from here:https://www.c-sgroup.com/acrovyn-wall-protection/handrails/product-selector

CRL http://www.crlaurence.com/crlapps/showline/default.aspx?GroupID=28175

13. **Handrails**

Depending on need, there are rails that fit most of the requirements in health facilities, from simple tubular rails to combined rails and crash bars.
https://www.c-sgroup.com/acrovyn-wall-protection/handrails
https://www.gerflor.com/product-ranges/handrail.html

14. **Cleaning supplies**

There is wide variety of cleaning products for health facilities. Good overview of health care suitable products is given here: https://www.hfmmagazine.com/articles/3025-cleaning-and-disinfection-chemicals-for-health-care.

Clorox brand and its products are widely available on most of the markets and here is Clorox line of cleaning supplies recommended for use in health facilities.
https://www.cloroxprofessional.com/industry/health/overview-portfolio/
Due care should be given to interaction in between cleaning product and surface material where product will be applied. Some of cleaning products are corrosive and they can damage surfaces. In order to avoid it, follow the manufacturers recommendations for use. Also see recommendations in Smart Hospital Toolkit.

15. **Solar panels and battery UPS (Uninterrupted Power Supply) systems**

In general, there are 2 basic types of solar panels, one for production of the electricity, aka PV (Photo Voltaic) and thermal panels used to heat water. There are hundreds of different solar panels on the market which makes it difficult to select quality panels which will perform over

the expected 25 year life of a solar photovoltaic (PV), system. Good introduction to PV panels here: https://www.cleanenergyreviews.info/blog/2017/9/11/best-solar-panels-top-modules-review

The guiding idea is to present panels and systems, which are best value for money. However, it is important to know that installed panel systems are serious hurricane risk and complete systems are consisting of members that are coming from different suppliers and even though each element of the system can meet wind resistance requirement, whole system may not. It is very important that all components are chosen carefully and installed according to highest standards.

There is entity in Florida that certifies whole systems but that is option that may not be viable for PAHO. Here are detail for certified systems and providers of the systems:
http://www.fsec.ucf.edu/en/certification-testing/pv/PVsystems/certified_systems/index.php

List can be used as very good source of vendors and solutions for solar energy systems and parts. Please note that installation of systems and components may be regulated by local country building code and local specialist advice would be very beneficial.

Photovoltaic Systems

PVs are available in 2 configurations; mono crystalline (black in appearance) and poly crystalline (blue). Mono crystalline panels are considered more advanced and energy efficient, however, polycrystalline panels are more resilient to the high temperatures of the Tropics, hence these are recommended for use in the Caribbean Region. Type A panels from well known manufacturers, with 20+ years warranty such as LG, Tesla, Sun Power, and Panasonic are available.

Photovoltaic Systems shall comply with the performance standards in this guide.

Modules

- UL 1703 listed
- International Electrotechnical Commission (IEC) 61215 standard for monocrystalline and polycrystalline photovoltaic modules
- Module efficiency should be ≥ 15.4%
- Power output should be ≥ 80% the rated power after 25 years

Inverter

- UL 1741 Listed
- Inverter should be pure sine wave
- Should comply with NEC 2014 690.12 rapid shut down
- Inverter should have internet based monitoring
- Inverter efficiency should be ≥ 98%

Roof Mount System

- UL 2703 listed
- Data sheet should include wind load capacity

Solar controllers

In addition to panels, equally important are controllers, either as combined charger and inverters or as separate charger and inverter. They may also be as off grid or as grid tie capacity, UPS capacity etc. There are many available and recommended ones are made by Schneider Electric, Magnum, ABB, and Morning Star.

Panel installation railings

Next important elements in solar systems are railings used to attach and hold panels. These are usually made of extruded aluminum and quite reliable. Sun Modo corp. or Unirac are good sources of fastening hardware and railings for panels.

Batteries

And last thing in PV systems are batteries. Not every system needs batteries, however, health facilities shall have one battery bank UPS in order to have backup energy source when main electricity supply fails. Also, stored electricity can be used in addition to grid electricity and on that way provide for savings in expenditures and as contribution to reduction of carbon emissions.
Trojan acid flooded or AGM 6V battery is US made, well-built and for many years on the market.

However, top of the league for batteries is lithium ion battery packs. Far superior to any other battery type, but prices are still quite high. However it is important to note that storage capacity of Li Ion batteries needed is half of capacity of acid batteries. (E.g. in battery bank where is needed power of 3Kw, acid battery storage must be 6Kw and power of Li Ion can be 3Kw). This is due to fact that acid batteries should not be discharged to more than 50% of full charge and Li Ion batteries can be discharged 100%. Li Ion batteries are recommended.
More info here: https://www.tesla.com/powerwall?redirect=no or overview of many similar products: https://www.cleanenergyreviews.info/energy-storage/
Excellent source of solar components can be found here: http://sunelec.com/home/

Thermal solar systems

In addition to PV systems there are thermal solar systems used for water heating. Even though we didn't discuss thermal systems, these can be of great use in smart facilities especially when taking in consideration that water heating energy makes around 30% of energy use in typical household. Thermals come in 2 types, as direct heating systems where water is directly exposed to solar radiation in heating tubes in panels and second type is indirect thermal panels where solar energy is captured by media circulated in panel and transferred to water in heat exchanger. Second system is bit more expensive but much more efficient. Good sample of indirect pressurized thermal system here: http://sunelec.com/pressurized-water-heater.pdf

16. Electrical

Receptacles

120V receptacles should be hospital grade and Underwriters Laboratories (UL) Listed

LED Lamps

LED Lamps shall comply with the performance standards in this guide, test reports should be available upon request for the following.

- LM-79 Electrical & Photometric Testing
- LM-80 Lumen Maintenance
- TM-21 Lumen Depreciation Projections

Lamps shall be UL Listed and ballast-independent with no external drivers.
Efficiency should be ≥100 lumens per watt.
Lamps should have a colour temperature of 4000K.

17. Fans

Appropriately sized ceiling or wall mounted fans to be installed as appropriate. Stainless steel hardware to resist rust. 13 degree blade pitch optimized to ensure ideal air movement and peak performance. ENERGY STAR® or similar certified motor to ensure superior energy efficiency with maximum performance. Shall include dust-free technology to reduce build-up on blades.
Models must be labelled as Energy efficient and dust-free and should match the décor/use of the facility.
Must meet or exceed the following:
US EPA Energy Star® Specification
A link to the Energy Star Program product search is available here:
https://www.energystar.gov/productfinder/