PAHO Smart Hospital Project

MEP DESIGN ISSUES

Lessons Identified

Smart Hospitals Project

Pan American Health Organization

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Acknowledgement of contributors to this document

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- Mr Latchman Bholasing – MEP Check Consultant & Case Study Writer
- Dr Dana van Alphen – Project Lead
- Ms Sherish Mccaskie- Document Editor

SAFE + GREEN = SMART

CASE STUDY

MEP DESIGN ISSUES

Lessons identified

PAHO Smart Hospitals Projects started in 2013 and has been implemented across nine countries in the Caribbean Region. Lessons have been learnt from the retrofitting of facilities as the project progresses. The information being presented highlights our experiences.

This case study highlights the challenges and recommendations for the Mechanical and Electrical Engineering (MEP) aspect of the PAHO refurbishment of Healthcare facilities in the Smart Phase 2 projects. Key issues identified in the review and execution of the MEP works are:

1. Quality of design
2. Procurement Issues
3. Contract Execution and Installation
4. Testing and Commissioning

The second section of this study considers the factors involved in the proper sizing of generators.

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1.0 Quality of Design

The quality of the design work submitted by the consultants on the different projects varied considerably. In some cases, the quality was acceptable while lacking in others. In the latter case, the Check Consultant needed to assume some of the design responsibility to ensure that the mechanical and electrical designs were up to standard and the works could be feasibly executed. Design consultants should be aware that the retrofits are being done to a budget and should be done with the use of appropriate technology on all projects.

Recommendation

The review and engagement of consultants for projects in the region may need to be more detailed. Design consultants should submit a listing of references for previous clients for which they have worked, and a list of similar projects completed.

Coordination Issues

Design consultants often did not properly coordinate the designs between the Electrical and Mechanical systems. In some cases, the Check Consultant had to assume the responsibility to ensure that designs are coordinated so that variations issues on site are reduced.

Recommendation

The MEP design consultant should properly coordinate the retrofit works of each of the services: electrical, mechanical (air conditioning, ventilation, fire installations, etc.). This should include how each of the services are related to and operate together, including existing and new services.

Site Investigations

In some retrofits, issues arose in the installation of mechanical and electrical equipment on-site due to inadequate space. For example, Automatic Transfer Switches (ATS) were purchased that were too big for the physical room size.

Recommendation

It is recommended that design consultants always carry out detailed site investigations so that issues on site that affect the execution of the works can be identified and mitigated against. This specifically relates to equipment location including Generators, ATS and electrical panels. The intended locations for solar panels, roof angles and orientation need to also be carefully assessed and checked during the design stage.

Image 1 - ATS panel with un-used space. May have been better to select more compact module to meet the needs of the project.

Overdesign and Under design

Bigger is not always better! Consultants should pay attention to the sizing of equipment specifically generators, air conditioning equipment and pressure tanks.

Generators should not be subjected to loads less than 30 % of the generator rating. This rule of thumb should be used in determining the size of a generator for projects where future loads are expected to

be added. Oversizing generator sets to cater for future expansion will result in wet stacking and damage to the cylinder heads by prolonged use at low loads.
Air conditioning units should not be oversized since this results in frequent cycling of the unit and affects the life of the equipment. Similarly, pressure tanks should not be undersized since this also affects the number of starts and stops on the pump and hence the life of the equipment.

Note: *Overdesign results in increased capital cost, increased running cost, decreased system reliability and decreased equipment lift.*

Recommendation

Suitably size electrical and mechanical equipment to feasibly meet the needs of the facility. Only allow for future expansion within reasonable optimal functioning of the equipment.

2.0 Procurement

Bulk purchase of equipment by PAHO to reduce cost is not always in the interest of the project. The bulk purchase of generators for the Saint Lucia Health Centre's resulted in unique issues which affected the successful implementation of the project. These issues are as follows:

Image 2 - Outdoor genset with large capacity built-in fuel storage bolted onto RC plinth

1. The supplier for the generators was not stationed in Saint Lucia, where the generators were being installed. When suppliers are from the same country, they will be aware of the specific conditions and voltage configurations that exist on the island.

2. If equipment is sourced from an outside supplier, the supplier must visit the island to carry out minor modifications during installation and testing. These requirements may need several site visits which are costly and may not have been catered for during the tender stage. It may also lead to higher prices.

3. Response to minor technical issues takes time which could easily be completed when suppliers are from the same island.
4. After commissioning and Handover, the local suppliers should provide routine maintenance service to ensure that the equipment continues to function without major problems.

Recommendation

If bulk purchasing is e considered as an option, then the supplier should be from the country where the works are being done. Alternatively, procurement can be on a project by project basis from local suppliers in that country.

3.0 Installation

Retrofit and upgrade works are always more complex and require more design inputs than new build works on a greenfield site. It is therefore critical that the design Engineer carry out detailed site investigations prior to commencing the design phase so that issues that affect the design works can be identified and accounted for.

Some of the issues related to the abovementioned include the following:

- The equipment cannot fit in the spaces allocated.
- The ingress of rain into generator rooms due to the orientation and existing type or quality of construction.
- The equipment rooms do not have adequate space or access for maintenance.
- The interaction and coordination issues between Electrical, Plumbing and Structural need to be addressed during the Construction Phase.

Note: *During the design phase consultants should consider that installation is being done in a functional healthcare facility so as to ensure the continuity of service in the facility during the execution phase.*

Recommendation

During the site reconnaissance, proper checks should be done to ascertain the existing services, building structure and architecture. Measurements should be taken to ensure proposed services installations (cables, pipes, and equipment) can practically be run and fit in the intended locations.
The design consultant should consider the methodology for installation of these services at each specific facility and whether the facility is to remain operational during the retrofit.

Image 3 - Pump with pressure tanks installed in existing pump room.

Testing, Commissioning and Handover

Testing, Commissioning and Handover need to be detailed in the Tender Package and the contractor should be allowed to include a cost for this item in the bills of quantities. It was found that Testing, Commissioning and Handover procedures are lacking on some projects.

Recommendation

The Tender package should include the following requirements and procedures:

- Testing and Commissioning Procedures should be agreed to with the Engineer prior to the scheduling of the test
- Testing and Commissioning should be scheduled with the Engineer as a witness
- Test Sheets should be signed off by all parties after the testing is completed

- Full maintenance manuals, spare parts listing and troubleshooting guidelines should form a part of the Handover Package in addition to the final as-built drawings.

Factors to Consider When Sizing Generators

There are many factors to consider when sizing generators. Some of the more important factors are:

- The type of electrical loads that are being supplied
- Will the generator be used all the time or as a standby unit
- Ambient conditions
- The expected load on the generator

Types of Loads Being Supplied

Types of loads being supplied will impact on the size of the generator and the specification for the unit. Motor loads generally have high starting currents approximately six times the normal running currents. Therefore, the generators, will have to be able to cater for these starting surges. When there are multiple motor loads, one method is to sequence the starting of the motor loads so that the generator is not required to handle a large step load. The other and more important factor which will ensure that the generator is not oversized is the specification of systems which will allow the generator to handle the high starting currents.

Note: *Permanent Magnet Excitation and Digital Automatic Voltage Regulator will allow the smaller sized generator to handle the high starting currents and resultant voltage dips.*

Prime and Standby Ratings

Generators carry two ratings: a prime rating and a standby rating. When specifying generators that are expected to be in operation all the time, the generator should be specified as a prime-rated power. This ensures that the generator will be able to carry the rated load continuously. Standby rated generators are for systems where they are expected to perform for short durations in a standby capacity. The standby rating of a generator is approximately 10-20% above the prime rating.

Ambient Conditions

An engine requires a certain quantity of air for combustion to achieve its rated power. Altitude, temperature, and humidity will all affect air density. An engine's power rating assumes a nominal altitude of less than 1000 feet above sea level, an ambient temperature less than 85°F, and humidity less than 75%. Manufacturers detail the percentage reduction in available power for ambient conditions that exceed those assumed for the nominal rating.

Expected Load

In addition to considering the starting of motor loads, care should be taken in sizing a generator so that they are not oversized. Lightly loaded generators can lead to wet stacking which significantly reduces the engine life. Manufacturers recommend that generators should not operate under 30% loads for any extended period. It is necessary to ensure that in sizing generators, the baseload of the building is always greater than 30 % of the generator rating. In some instances, engineers may consider sizing

generators to cater for future expansion. This can only be done to a limit! Generators that are sized too small will result in excessive voltage drops and overheating of the unit.