PREINSTALLATION REQUIREMENTS FOR HIGHLY COMPLEX MEDICAL EQUIPMENT TO SUPPORT THE PROCESSES OF DESIGN, PLANNING & MONITORING IN HOSPITAL CONSTRUCTION

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About the author

• Biomedical Engineer, a specialist in Hospital Infrastructure since 2012 - Department of oversight of construction belonging to the Investment Division of the Ministry of Health in Chile.

• Biomedical engineer, focused on Quality Management, Engineering and Construction Hospital.

2012

January - Practitioner of the Medical Equipment Unit belonging to the Investment Division

September - Biomedical Engineer of the Medical Equipment Unit belonging to the Investment Division

December - Biomedical Engineering graduate, Valparaiso University 2006 - 2012

2014

April - Biomedical Engineer of the Medical Equipment Unit belonging to the Investment Division

May - Biomedical Engineer, Specialist in Hospital Infrastructure of the oversight of construction belonging to the Investment Division

2015 - 2016

Actually - Biomedical Engineer, Specialist in Hospital Infrastructure of the oversight of construction belonging to the Investment Division

• Biomedical engineer, focused on Quality Management, Engineering and Construction Hospital.

Department of oversight of construction belonging to the Investment Division of the Ministry of Health in Chile.
This paper aims to create a methodological tool where the technical requirements of installation and assembly of highly complex medical devices are explained through tables with technical parameters and installation recommendations.
Topics

- Analysis of what we have today
- Methodology of Work
- Requirements
- Design
- Implementation
- Validation
- Results
Analysis of what we have today ...

- Historical trend of management of infrastructure and technology in hospitals¹ in Latin America.
- Until 2009, 95% of health investments were in existing buildings².

Architectural design does not always have a file source containing the list of equipment with its installation requirements and parameters.

Usually planning about installation and assembly requirements is not coordinated with the construction’s Gantt chart.

**Project bids are awarded under incomplete history**

Source:
2. “Investments Public Health Network in Chile 1998-2008”, Andres Bello University. Dr. Ignacio Astorga
This research is a practical aid to understand...

**Weaknesses** that exist at the national level, in public and private spheres, on the issue of buildings and hospital facilities.

Lack of **standardized information** to make technical decisions about requirements of installation and assembly in the design stage, prior to bids.

Find tangible solutions to solve these problems by increasing **communication**, **understanding** and **knowledge** of the time needed to build or reform hospital setting requirements.
## Disadvantage v/s Advantages

<table>
<thead>
<tr>
<th>Disadvantage</th>
<th>Advantages</th>
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<tbody>
<tr>
<td>• Poor Specialty Design.</td>
<td>• Improve design considering the worst case scenario.</td>
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<tr>
<td>• Exchange value notes associated with the equipment.</td>
<td>• Decrease exchange value notes associated to equipment.</td>
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<tr>
<td>• Increased Deadlines.</td>
<td>• Decrease of deadlines associated with equipment modifications.</td>
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<tr>
<td>• Critical Path Modification.</td>
<td>• Slight modifications in the critical path.</td>
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<td>• Modification of deadlines in the implementation of the project.</td>
<td>• Optimization the times associated with acquisition and installation of equipment.</td>
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<tr>
<td>• Lack of coordination with the technical teams of the technical inspector of the construction site (ITO).</td>
<td>• Continuous monitoring of the level of progress at work, presenting alerts in case of errors in the execution.</td>
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<tr>
<td>• Delayed purchase of equipment.</td>
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<td>• The purchase programming, critical path modification based on the time of acquisition.</td>
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<tr>
<td>• Lack of human resources and equipment unit.</td>
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<td>• Market behavior affects shopping programming.</td>
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Methodology of work

Model to use

Classical model with feedback considering also expert criteria

Data Collection Process

Build a Big Data Base, including data sheets, installation and assembly design criteria in relation to different services.

- Selection of the services to analyze.
- Data collected in order to know and understand the parameters that require such medical equipment.

Preparation of documents

- Related to installation requirements.
- Definition of Installation criteria.
- Checklist for an in field review of hospitals.
What are highly complex medical equipment?

Equipment that requires supply, anchor and specific infrastructure to be used, considering among others:

- Large quantities and/or weight.
- Permanently connected to the facility.
- Attached to the physical infrastructure of the establishment.

Pathological anatomy - Dental Clinic - Ophthalmological Clinic - Otolaryngology Clinic - Food Nutrition Unit - Sterilization Unit - DAN (High Level Disinfection) – Dialysis – Pharmacy – Imaging - Clinical laboratory – Laundry - Physical Medicine and Rehabilitation - Hyperbaric Medicine - Surgical Pavilion – Radiotherapy - Milk Dietary Service - Critical Patient Unit - Flat washes and Macerators Services - ER (Resuscitation)
What characteristics have highly complex medical equipment?

- **Shuttle Logistics**
  - Installation and assembly

- **Network connections**
  - Allowing the proper functioning

- **Optimal space**
  - Both for the user and the patient

- **Adequate maintenance areas**
  - That permit easy access of the technical team

- **Air conditioning equipment**
  - That enables proper functioning of the equipment

- **Access doors**
  - To facilitate the entry of equipment to its installation area without making changes in workflow
Which are the stages of a Hospital Construction Project?

**Pre Investment**
- **Project Formulation**
  - Preinvestmental Study for Hospital Projects (EPH)
  - Medical Architectural Program (PMA)

**Investment**
- **Design**
  - General match
  - Stages of construction
  - Functional flows

**Construction**
- **Structural work**
- Facilities
- Terminations
- Monitoring

**Operation**
- **Start up**
  - Installation and assembly
  - Fitting out
Design

• Creating a technical tool considering:
  o Architectural plans.
  o Main workflows.
  o Guidelines about technical requirements for installation and assembly.
  o Recommendations and precautions.
  o Guidelines or protocol for support of the Hospital Construction Process.
Implementation

PRE INSTALLATION REQUIREMENTS FOR HIGHLY COMPLEX MEDICAL EQUIPMENT TO SUPPORT THE PROCESSES OF DESIGN, PLANNING & MONITORING IN HOSPITAL CONSTRUCTION

Installation requirements documents for medical equipment

Installation Criteria for emergency services high resoluteness (SAR) *Updating*

Installation Criteria for Health Care Community Center (CECOSF) *Updating*

Installation Criteria for Health Care Family Center (CESFAM) *In Development*

Installation Criteria for Hospital Facilities *In Development*

Check list for review of primary care centers and Hospital facilities

Checklist for High Resoluteness Emergency Services (SAR) *In Use*

Checklist for Health Care Community Center (CECOSF) *In Use*

Checklist for Health Care Family Center (CESFAM) *In Development*

Checklist for inspection of Hospitals Facilities *In Development*

Checklist for reception and installation of medical equipment in Hospital Facilities *In Use*

Review methodology - Ongoing Projects

Total of medical equipment with complex installation requirements: 94
Validation “Installation criteria for High Resoluteness Emergency Services (SAR) - Summary”

Sanitary
Avoid past or sanitary discharges (sewage, drinking water) in the skies of rooms
If any, incorporate measures for containment and preventing failures

Electricity
NCh 4/2003, connect emergency systems

HVAC
Minimum outside air flow: 5 renovation/hr
Temperature Range: 20-22°C

Structural
Rx BRS: 800-1000 Kg
Rx U Arc type: 324-600 Kg

Radiation
Always consider shielding the room, referring to this:
The study of ionizing radiation.
Comply with the basic technical standard (NTB).
Decree Nº 3/85 and 133/84 from CCHEN.
SEREMI and CCHEN certifications
Validation “Installation criteria for Health Care Community Center (CECOSF) - Summary”

**Sanitary**
Avoid past or sanitary discharges (sewage, drinking water) in the skies of rooms, near of Intraoral X-ray and Dental Unit. If any, incorporate measures for containment and preventing failures.
Dental unit: water connection (soft or household water); sanitary discharge. From floor, depending on the equipment, the connections may be head, center or foot.

**Electricity**
NCh 4/2003, connect emergency systems.

**Clinical gases**
Air compressor, dry air and free of oil (Enable form approved project)
Connections from floor

**Structural**
Equipment load requirements, patients and staff (kg / m2).
In the case of Dental X Ray equipment, define wiring will be done by sky, wall or floor.

**Radiation**
Always consider shielding the room, referring to this:
The study of ionizing radiation.
Comply with the basic technical standard (NTB).
Decree Nº 3/85 and 133/84 from CCHEN.
SEREMI and CCHEN certifications.
Validation “Installation criteria for Health Care Family Center (CESFAM) - Summary”

**Sterilization Unit**
- Distribution must be according to National normative.
- It requires soft water and osmosis water for washing disinfectors and steam sterilizer.
- Drying pistol requires: compressed air, dry air and free of oil.
- It requires in the storage area, controlled temperature to prevent condensation moisture in the sterile package.
- Sanitary downloads for Washer disinfectors and steam sterilizer equipment must be in copper material.

**Dental Box**
- Used same criteria that CECOSF Facilities

**X Ray**
- Used same criteria that SAR facilities
Validation “Installation criteria for the Design Stage in the Hospital Facilities - Summary”

- Review of documents, analyze the medical equipment with the installation requirements.
- Review of regulations associated with clinical services that have equipment with installation requirements.
- Review and compare to architecture blueprints and specialties, checking each clinical service that has equipment with installation requirement.
- Visit the construction in the execution stage.
Results

Medical equipment parameters with complex installation

State of the reception and installation of medical equipment in Hospital Facilities

Checklist for reception and installation of medical equipment in Hospital Facilities

Documents of installation requirements for Medical Equipment

Checklist for Health Care Community Center (CECOSF)
Results

• The first year (2012) we only analyzed 6 clinical services

High Complexity Hospital
- Total areas analyzed 46%
- Remaining areas 54%

Medium Complexity Hospital
- Total areas analyzed 13%
- Remaining areas 87%

Historical Hospital Construction Projects - Increasing term execution of the work
- > 1 Year: 9
- 7 – 11 Month: 5
- < 7 Month: 3

Structural work
Installations
Terminations
Results of Design Criteria in 2014-2015 period

Primary Care Facilities

- TOTAL EXCHANGE VALUE NOTES (M$)
- EXCHANGE VALUE NOTES ASSOCIATED WITH COMPLEX INSTALLATION EQUIPMENT (M$)

<table>
<thead>
<tr>
<th>EXCHANGE VALUE NOTES PERCENTAGE BY CONCEPT OF EQUIPMENT (M$)</th>
<th>APS 1</th>
<th>APS 2</th>
<th>APS 3</th>
<th>APS 4</th>
<th>APS 5</th>
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<td>6%</td>
<td>7%</td>
<td>19%</td>
<td>9%</td>
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High Complexity Hospital

- TOTAL EXCHANGE VALUE NOTES (M$)
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<tr>
<td>2%</td>
<td>19%</td>
<td>10%</td>
<td>13%</td>
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Results of Design Criteria

Among the commonly evidenced errors, we find the following:

• Errors in the installation of dental chairs, connections are not located on the defined area.

• Equipment material working at high temperatures, such as milk dietary services, sterilization, laundry and central feeding, made with PVC material.

• Vapor evacuation ducts for dryers, trouser or roller washers and washer desinfectors, are not considered in the project.

• The logistics of the implementation of anchoring rails and support slab imaging equipment doesn’t consider the details involved from the TDF connection to the control room.

• Hood enclosure gas for dialysis filters cleaning systems, among others.
Conclusions

• It is evident that there are issues that affect the design, therefore increasing the costs and time of execution.
• It can be seen that there is little knowledge of requirements when designing a hospital and, as a result of such a lack of knowledge, there is an increase of costs and work deadlines.
• This tool is meant to be a support program for architects, construction engineers, specialty designers and any professional who needs to modify infrastructure that includes highly complex equipment, or constructing a new area.
As can be seen, the creation of this tool is useful in the following aspects:

- Allows project managers to understand the importance of pre-installation planning and requirements of highly complex medical equipment.
- It helps to remind and consider the planning and execution of work space logistics for the transport and fixing of equipment.
- In the case of an architectural redesign, it allows us to know the limitations and possibilities for certain equipment installation.
My message ... Passion, Commitment and Vocation

• In my opinion, the infrastructure of a hospital should last at least 20 to 25 years, this of course, considers a periodical equipment replacement program which depends on the lifecycle of each unit and its location, as well as the provider’s recommendation.

• It is our responsibility to provide a work frame that contains all the necessary infrastructure and equipment for an optimal performance and to create a better environment for the patients and staff who live and work in a Hospital on a daily basis.

• We need to open our minds and put ourselves in the place of the other. Analyzing projects as if we were nurses, doctors, maintenance and administrative staff, among others. Think about the details and consider all possible domestic issues as elements that can cause problems in the project implementation.
References ...


• Secretaría de Salud, Programa de Acción Específica. 1A edición, México 2008.


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Thank you for your attention...

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